PERCUSSION BOREHOLE LOG

ERM Southern Africa (Pty) Ltd
Building 23, The Woodlands
Woodmead
Sandton
2052
Republic of South Africa
Tel: +27 (0) 11 802 8263
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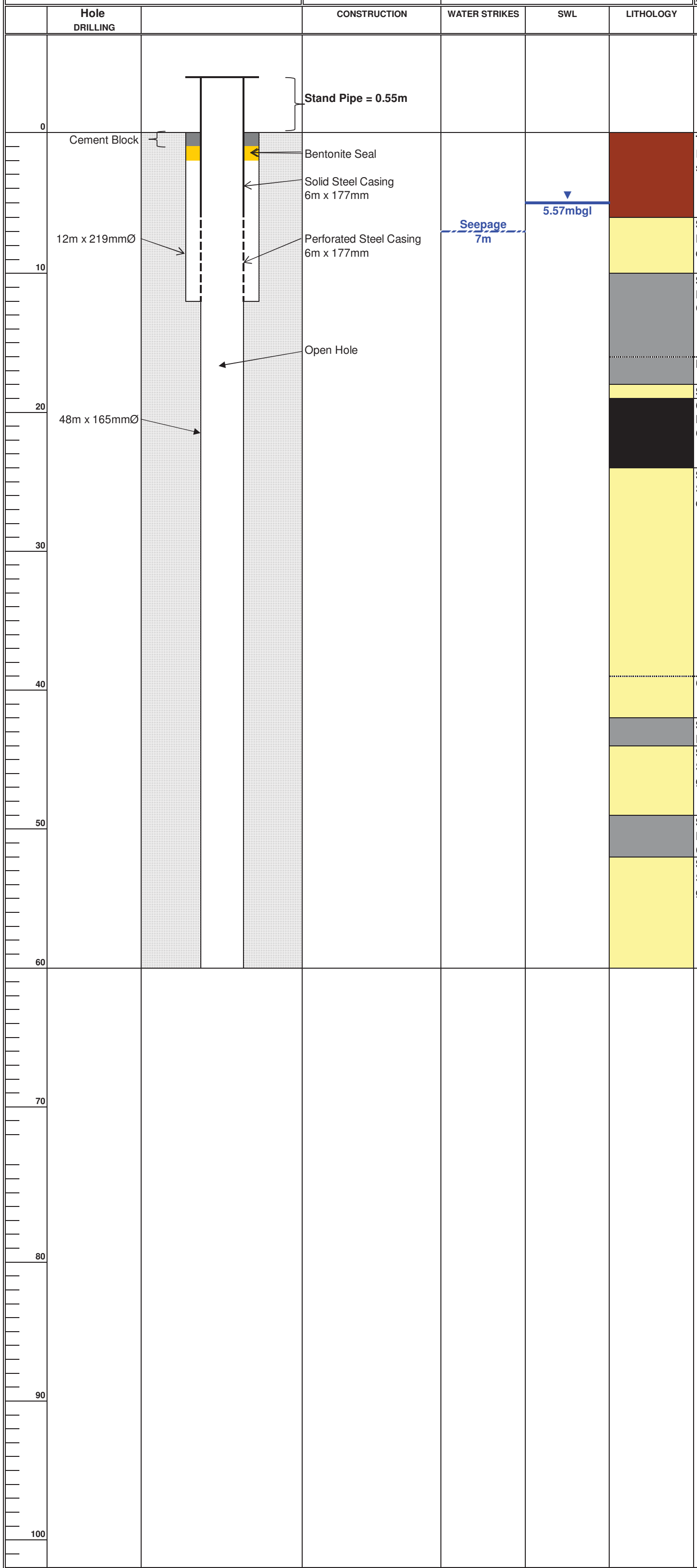
PROJECT:	**0129245 - Kusipongo EIA GW**	**BH No.:**	**ERMBH 9**
CLIENT:	**Kangra Coal**	**ALTERNATIVE No.:**	
LOCATION:	**Kusipongo (Piet Retief- Amersfoort)**	**X-COORDINATE:**	**-71539**
CONTRACTOR:	**J&M Drilling**	**Y-COORDINATE:**	**-2990605**
LOGGED BY:	**JB**	**Z-COORDINATE:**	**1550 mamsl**
NEARBY OTHER BH:		**FINAL DEPTH:**	**60m**
NEARBY RIVER:	**30m**	**FINAL BLOW OUT YIELD:**	**Seepage**
OBSERVATION BH:	**ERMBH 1 & ERMBH 2**	**DATE COMPLETED:**	**26-Mar-11**
		DATE WATER LEVEL MEASURED:	**14-Apr-11**



DESCRIPTION	LITHOSTRATIGRAPHIC CODE
TOPSOIL Decomposed, Yellowish brown colour, Mixed origins of Clay, silt & sand, Unconsolidated.	
SANDSTONE Highly weathered, Light grey colour, Very fine grained quartz and alkali feldspar grains. Unconsolidated	
SHALE Highly weathered, Medium grey colour, Very fined grained silt Consolidated.	
Moderately weathered, dark grey colour,	
SANDSTONE, Light grey colour, Very fine grained	
CARBONATIONS SHALE / COAL Moderately weathered, Black colour, Very fine grained, Consolidated	
SANDSTONE Slightly weathered, Light grey colour, Very fine grained quartz and alkali feldspar grains. Consolidated	
Course to very coarse grained sand	
SHALE Highly weathered, Medium grey colour, Very fined grained silt	
SANDSTONE Slightly weathered, Light grey colour, medium to course grained. Consolidated	
SHALE Highly weathered, Medium grey colour, Very fined grained silt Consolidated	
SANDSTONE Slightly weathered, Light grey colour, medium to course grained. Consolidated	

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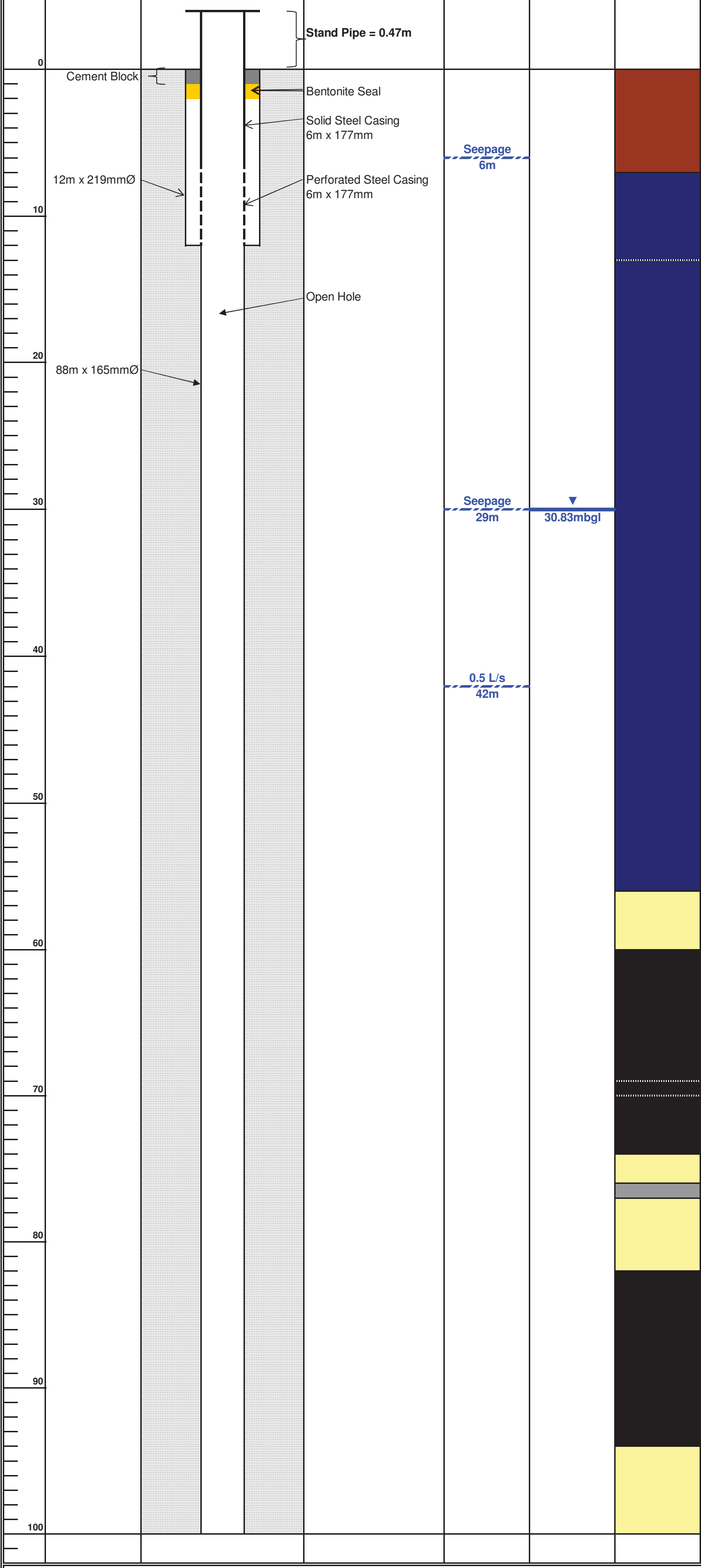
PROJECT:	0129245 - Kusipongo EIA GW	BH No.:	ERMBH 10
CLIENT:	Kangra Coal	ALTERNATIVE No.:	
LOCATION:	Kusipongo (Piet Retief- Amersfoort)	X-COORDINATE:	-70599
CONTRACTOR:	J&M Drilling	Y-COORDINATE:	-2992281
LOGGED BY:	JB	Z-COORDINATE:	1762 mamsl
NEARBY OTHER BH:		FINAL DEPTH:	100m
NEARBY RIVER:	30m	FINAL BLOW OUT YIELD:	0.5 L/s
OBSERVATION BH:	ERMBH 1 & ERMBH 2	DATE COMPLETED:	10-Apr-11
COORDINATE SYSTEM:	Lo31, WGS84	DATE WATER LEVEL MEASURED:	14-Apr-11

Hole DRILLING	CONSTRUCTION	WATER STRIKES	SWL	LITHOLOGY	DESCRIPTION	LITHOSTRATIGRAPHIC CODE



DESCRIPTION
TOPSOIL Decomposed, Pale orange colour, Mixed origins of Clay, silt & sand, Unconsolidated.
DOLERITE Highly weathered, Dark grey colour, Consolidated Very fine grained crystals (Chill zone)
Moderately weathered to slightly weathered, Fine grained crystals, Consolidated
SANDSTONE Fresh, Light grey colour, Very fine to coarse grained sand, Poorly sorted, surrounded & Consolidated
CARBONATIONS SHALE / COAL Fresh, Black colour, Very fine grained, Consolidated
Weathered zone, Dark brown colour
SANDSTONE Fresh, Light grey colour, Very fine to coarse grained sand,
SHALE Fresh, Medium grey colour.
SANDSTONE Fresh, Light grey colour, Medium to coarse grained sand, Poorly sorted, surrounded & Consolidated
CARBONATIONS SHALE / COAL Fresh, Black colour, Very fine grained,
SANDSTONE Fresh, Light grey colour, Medium to coarse grained sand, Poorly sorted, surrounded & Consolidated

PERCUSSION BOREHOLE LOG

Annex E

Aquifer Test and Packer Test Data and Interpretation

Telephone: 043-732 1211
Fax no: 043-732 1422
Fax to e-mail: 0866 717 732
E mail: office@abpumps.co.za

BOREHOLE TEST RECORD

Ground water solutions t/a AB Pumps CC

PR0JECT #	P943
BBR	JP
PRODUCTION BONUS:	MARTIN
	PETER
EC meter number	20

CONSULTANT: ERM CONSULTING

DISTRICT: PIXLEGKA SEME ROAD

PROVINCE: MPUMALANGA

FARM / VILLAGE NAME : DONKER HOEK 14 HT

DATE TESTED: 2011/03/28

MAP REFERENCE:

CO-ORDINATES:

FORMAT ON GPS: hddd ° mm ' ss.s " hddd ' mm.mmm ' hddd.ddddd °

LATITUDE: ° ' " OR ° ' OR 27.01916 °

LONGITUDE: ° ' " ° ' 30.28519 °

BOREHOLE NO: ERM BH01

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: NEW BOREHOLE

BOREHOLE DEPTH: (mbgl) 60.30

COMMENTS: NONE

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	No	Test for:	macro	bacterio-logical
Date sample taken	2011/03/30		If consultant took sample, give name:		
Time sample taken	08H28				

DATA CAPTURED BY:	AILENE VAN NIEKERK
DATA CHECKED BY:	AILENE VAN NIEKERK

CONSULTANT GUIDELINES

BOREHOLE DEPTH:		m	STEP 1:		l/s	WATER STRIKE 1:			m
BLOW YIELD:		m	STEP 2:		l/s	WATER STRIKE 2:			m
STATIC WATER LEVEL:		m	STEP 3:		l/s	WATER STRIKE 3:			m
PUMP INSTALLATION DEPTH:		m	STEP 4:		l/s	**COMMENTS:**			
RECOVERY:			STEP 5:		l/s				
AFTER STEPS:		h	STEP 6:		l/s	TELEPHONE NUMBERS PHONE : (NAME & TEL)			
AFTER CONSTANT:		h	STEP DURATION:		min				

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	60.30
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M	23.27
CASING DETECTION:	NO	1	SAND/GRAVEL/SILT PUMPED?	YES/NO	0
SUPPLIED NEW STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	1
BOREHOLE MARKING	NO	0	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	1	LAYFLAT (M):	M	50
LOGGERS FOR WATERLEVEL MONITORING	NO	1	LOGGERS FOR pH AND EC:	NO	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ____________ **SIGNATURE:** ____________

DESIGNATION: ____________ **DATE:** ____________

BOREHOLE TEST CONTROL SHEET
Groundwater Solutions t/a AB PUMPS

Borehole number:	ERM BH01	Old / Alternative number:	
Contractor:	AB PUMPS	Supervisor:	JOHAN
Operator:	MARTIN	Rig number & Type rig:	38 TOYOTA

EXISTING EQUIPMENT

Type pump	Depth	Condition	**Drive unit**	Condition	**Pump house**	Condition	**Remarks**

TESTING EQUIPMENT

Pump type	**Depth installed (m)**	**Date & time (started)**	**Date & time (completed)**
P100	54.80	28/03/2011 15H20	28/03/2011 22H40

MULTI-RATE OR STEPTEST DETAILS

STEP	**DURATION (MIN)**	**RECOVERY (MIN)**	**YIELD (L/S)**		**DRAWDOWN (m)**
1	60		0.13	l/s	1.34
2	60		0.24	l/s	5.03
3	60		0.43	l/s	21.25
4	57	220	0.54	l/s	41.69
5				l/s	
6				l/s	
7				l/s	
8				l/s	
Calibration:				l/s	
TOTAL:	237	220	1.34	l/s	69.31
COMMENT:					

CONSTANT RATE DISCHARGE TEST

Pump type	**Depth installed (m)**	**Date & time (started)**		**Date & time (completed)**	
P100	54.80	2011/03/29	08H30	2011/03/31	08H30
Yield l/s	**Drawdown (m)**	**Duration (min)**		**Recovery (min)**	
0.15	14.35	1440		1440	
Total: (Multi-rate and Constant Discharge rate)		1677		1660	
COMMENT:					

MAINTENANCE

Work time: hour	Transport existing equipm. Km	Travelling (To fix); Km
List of parts replaced or repaired:		

	Borehole number	**Duration (min) CONSTANT**	**Drawdown (m)**	**Hand/logger**	**Distance (m)**
Observation Hole 1					120
Observation Hole 2					260
Observation Hole 3					40
Observation Hole 4					
Observation Hole 5					

GENERAL

ESTABLISHMENT	From:		To:			
Site Move	From project#		To #:	P943	Travelling km:	ESTABLISHMENT
	Village	Borehole no	Village	Borehole no		
	WS		DONKER HOEK 14 HT	ERM BH01		
Maintenance:	Work time hr		Parts repaired/		Travelling km	
After test measurements	Water level	23.27	Borehole depth	60.30	Casing depth m	12.38
Water level before installing test pump:			12.89			
Depth before installing test pump:			60.30			
Testpump Installed	**Once** /Twice /More		Reason:			
Installed Testpump	**<10 l/s** / >10ls/s		Reason:			
Was existing equipment re-installed:			**No:**	If not where was it left:		
GPS Unit number:						
EC Unit number:			20.00			
Remarks:						

Signed Contractor:	Signed Consultant:

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	0	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH01			DISTRICT:	PIXLEGKA SEME ROAD
ALT BH NO:	0			SITE NAME:	DONKER HOEK 14 HT
ALT BH NO:	0				
BOREHOLE DEPTH (m)	60.30	DATUM LEVEL ABOVE CASING (m):	0.34	EXISTING PUMP:	0
WATER LEVEL (mbgl):	13.11	CASING HEIGHT: (magl):	0.30	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	54.80	DIAM PUMP INLET (mm):	165.00	PUMP TYPE:	P100

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 — RPM

DATE: 28/03/2011 TIME: 15H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.10		1	
2	0.17		2	
3	0.18		3	
5	0.18		5	
7	0.18		7	
10	0.25	0.14	10	
15	0.46		15	
20	0.65	0.14	20	
30	0.89		30	
40	1.03	0.13	40	
50	1.19		50	
60	1.34	0.13	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	6.50		150	
TEMP	23.90	℃	180	
EC	175.00	µS/cm	210	

DISCHARGE RATE 2 — RPM

DATE: 28/03/2011 TIME: 16H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.41		1	
2	1.47	0.24	2	
3	1.53		3	
5	1.60	0.24	5	
7	1.70		7	
10	1.77	0.23	10	
15	1.84		15	
20	1.93	0.24	20	
30	2.40		30	
40	3.48	0.24	40	
50	4.53		50	
60	5.03	0.24	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	7.29		150	
TEMP	23.40	℃	180	
EC	152.00	µS/cm	210	

DISCHARGE RATE 3 — RPM

DATE: 28/03/2011 TIME: 17H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	5.18		1	
2	5.25	0.43	2	
3	5.53		3	
5	6.37	0.42	5	
7	9.00		7	
10	12.04	0.43	10	
15	15.64		15	
20	17.26	0.43	20	
30	18.64		30	
40	19.51	0.42	40	
50	20.90		50	
60	21.25	0.43	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	7.22		150	
TEMP	19.20	℃	180	
EC	158.00	µS/cm	210	

DISCHARGE RATE 4 — RPM

DATE: 28/03/2011 TIME: 18H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	22.13		1	38.07
2	23.48	0.54	2	34.88
3	24.51		3	33.09
5	26.27	0.54	5	31.50
7	28.06		7	30.09
10	30.79	0.53	10	28.46
15	33.44		15	26.34
20	36.26	0.54	20	24.24
30	37.78		30	19.06
40	41.69	0.54	40	16.43
41	41.69	0.27	50	15.56
60			60	14.43
70			70	13.88
80			80	13.53
90			90	12.74
100			100	12.17
110			110	11.61
120			120	11.03
pH	7.25		150	10.46
TEMP	19.60	℃	180	9.92
EC	147.00	µS/cm	210	9.35
			220	9.30
			300	
			360	

DISCHARGE RATE 5 — RPM

DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		℃	180	
EC		µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 6 — RPM

DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		℃	180	
EC		µS/cm	210	
			240	
			300	
			360	

S/W/L: 12.89

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	27.01916	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH01		30.28519	DISTRICT:	PIXLEGKA SEME ROAD
ALT BH NO:	0			SITE NAME:	DONKER HOEK 14 HT
ALT BH NO:	0				
BOREHOLE DEPTH:	60.30	DATUM LEVEL ABOVE CASING (m):	0.34	EXISTING PUMP:	0
WATER LEVEL (mbgl):	18.91	CASING HEIGHT: (magl):	0.30	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	54.80	DIAM PUMP INLET(mm):	165	PUMP TYPE:	P100

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**					
DATE:	29/03/2011	TIME:	08H30	DATE:	29/03/11	TIME:		TYPE OF PUMP:	P100

					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:	**BH03**		NR:	**ERM BH02**		NR:	BH01
	DISCHARGE BOREHOLE				Distance(m);		120	Distance(m);		260	Distance	40
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	1.16		**1**	10.82	**1**	0.00		**1**	0.00		**1**	0.00
2	1.60		**2**	10.01	**2**			**2**			**2**	
3	1.68		**3**	9.98	**3**			**3**			**3**	
5	1.70		**5**	9.96	**5**			**5**			**5**	
7	1.72		**7**	9.94	**7**			**7**			**7**	
10	1.74	0.10	**10**	9.92	**10**			**10**			**10**	
15	3.18		**15**	9.92	**15**			**15**			**15**	
20	5.86	0.16	**20**	9.91	**20**			**20**			**20**	
30	7.27		**30**	9.80	**30**	0.03		**30**	0.10		**30**	0.00
40	7.96		**40**	9.32	**40**			**40**			**40**	
60	8.71	0.16	**60**	8.48	**60**			**60**			**60**	
90	9.12		**90**	7.67	**90**			**90**			**90**	
120	9.86	0.15	**120**	7.12	**120**	0.00		**120**	0.08		**120**	0.00
150	9.93		**150**	6.68	**150**			**150**			**150**	
180	10.02	0.15	**180**	6.41	**180**			**180**			**180**	
210	10.57		**210**	6.14	**210**			**210**			**210**	
240	10.96	0.15	**240**	5.91	**240**	0.00		**240**	0.12		**240**	0.00
300	11.00		**300**	5.64	**300**			**300**			**300**	
360	11.38	0.16	**360**	5.36	**360**			**360**			**360**	
420	11.67		**420**	5.16	**420**	0.03		**420**	0.12		**420**	0.00
480	11.98	0.16	**480**	4.94	**480**			**480**			**480**	
540	12.32		**540**	4.80	**540**			**540**			**540**	
600	12.58	0.15	**600**	4.70	**600**			**600**			**600**	
720	12.81		**720**	4.58	**720**			**720**			**720**	
840	12.96	0.16	**840**	4.42	**840**			**840**			**840**	
960	13.12		**960**	4.34	**960**			**960**			**960**	
1080	13.29	0.15	**1080**	4.21	**1080**			**1080**			**1080**	
1200	13.46		**1200**	4.08	**1200**	0.06		**1200**	0.11		**1200**	0.00
1320	13.62	0.15	**1320**	4.00	**1320**	0.06		**1320**	0.10		**1320**	0.00
1440	14.35		**1440**	3.90	**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1440		**W/L**	**5.28**		**W/L**	**3.19**		**W/L 12.0**
Average yield (l/s):				0.15								

FORM 5 F

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:		PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH01			DISTRICT:	PIXLEGKA SEME ROAD
ALT BH NO:				SITE NAME:	DONKER HOEK 14 HT
ALT BH NO:					
BOREHOLE DEPTH:	60.30	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	0
WATER LEVEL (mbgl)::	18.91	CASING HEIGHT (magl):	0.00	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	54.80	DIAM PUMP INLET(mm):	0.00		

CONSTANT DISCHARGE TEST

DISCHARGE BOREHOLE

TIME (MIN)	REAL TIME	MEASUREMENTS				TIME (MIN)	REAL TIME	MEASUREMENTS		
		pH	TEMP ℃	EC µS/cm				pH	TEMP ℃	EC µS/cm
1		7.89	20	141						
120		7.69	26.9	141						
240		7.75	27.3	139						
360		7.43	27.1	161						
480		7.3	23.9	165						
600		7.32	25.6	164						
720		7.41	23.7	163						
840		7.29	26.4	159						
960		8.18	15.8	156						
1080		8.17	16.9	151						
1200		8.18	16.7	154						
1320		8.24	16.6	147						
1440		8.28	21.6	122						
1800										
2160										
2520										
2880										
3240										
3600										
3960										
4320										
4680										
5040										
5400										
5760										
6120										
6480										
7200										
7560										
7920										
8280										
8640										
9000										
9360										
9720										
10080										
10440										
10800										
11160										
11520										
11880										
12240										

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	0	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH01			DISTRICT:	PIXLEGKA SEME ROAD
ALT BH NO:	0			SITE NAME:	DONKER HOEK 14 HT
ALT BH NO:	0				
BOREHOLE DEPTH (m)	60.30	DATUM LEVEL ABOVE CASING (m):	0.34	EXISTING PUMP:	0
WATER LEVEL (mbgl):	13.11	CASING HEIGHT: (magl):	0.30	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	54.80	DIAM PUMP INLET (mm):	165.00	PUMP TYPE:	P100

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 — RPM — DATE: 28/03/2011 TIME: 15H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.10		1	
2	0.17		2	
3	0.18		3	
5	0.18		5	
7	0.18		7	
10	0.25	0.14	10	
15	0.46		15	
20	0.65	0.14	20	
30	0.89		30	
40	1.03	0.13	40	
50	1.19		50	
60	1.34	0.13	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	6.50		150	
TEMP	23.90	℃	180	
EC	175.00	µS/cm	210	

DISCHARGE RATE 2 — RPM — DATE: 28/03/2011 TIME: 16H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.41		1	
2	1.47	0.24	2	
3	1.53		3	
5	1.60	0.24	5	
7	1.70		7	
10	1.77	0.23	10	
15	1.84		15	
20	1.93	0.24	20	
30	2.40		30	
40	3.48	0.24	40	
50	4.53		50	
60	5.03	0.24	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	7.29		150	
TEMP	23.40	℃	180	
EC	152.00	µS/cm	210	

DISCHARGE RATE 3 — RPM — DATE: 28/03/2011 TIME: 17H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	5.18		1	
2	5.25	0.43	2	
3	5.53		3	
5	6.37	0.42	5	
7	9.00		7	
10	12.04	0.43	10	
15	15.64		15	
20	17.26	0.43	20	
30	18.64		30	
40	19.51	0.42	40	
50	20.90		50	
60	21.25	0.43	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	7.22		150	
TEMP	19.20	℃	180	
EC	158.00	µS/cm	210	

DISCHARGE RATE 4 — RPM — DATE: 28/03/2011 TIME: 18H20

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	22.13		1	38.07
2	23.48	0.54	2	34.88
3	24.51		3	33.09
5	26.27	0.54	5	31.50
7	28.06		7	30.09
10	30.79	0.53	10	28.46
15	33.44		15	26.34
20	36.26	0.54	20	24.24
30	37.78		30	19.06
40	41.69	0.54	40	16.43
41	41.69	0.27	50	15.56
60			60	14.43
70			70	13.88
80			80	13.53
90			90	12.74
100			100	12.17
110			110	11.61
120			120	11.03
pH	7.25		150	10.46
TEMP	19.60	℃	180	9.92
EC	147.00	µS/cm	210	9.35
			220	9.30
			300	
			360	

DISCHARGE RATE 5 — RPM — DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		℃	180	
EC		µS/cm	210	
			240	
			300	
			360	

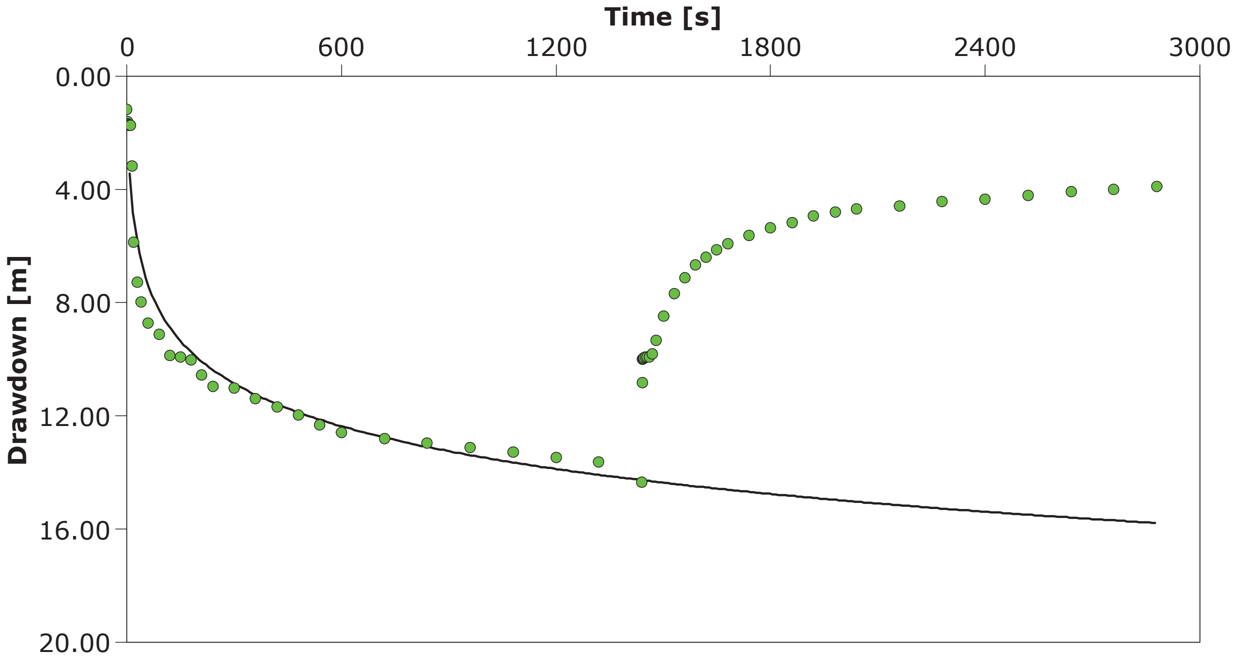
DISCHARGE RATE 6 — RPM — DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		℃	180	
EC		µS/cm	210	
			240	
			300	
			360	

S/W/L: 12.89

City, State/Province Address Contact Info Company Name	Pumping Test Analysis Report A
	Project: 0129245
	Number: Kangra Coal
	Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH1
Test conducted by: AB PUMPS		Test date: 2011/06/11
Analysis performed by: ERM	Theis	Date: 2011/06/11
Aquifer Thickness: 47.22 m	Discharge: variable, average rate 0.075 [l/s]	

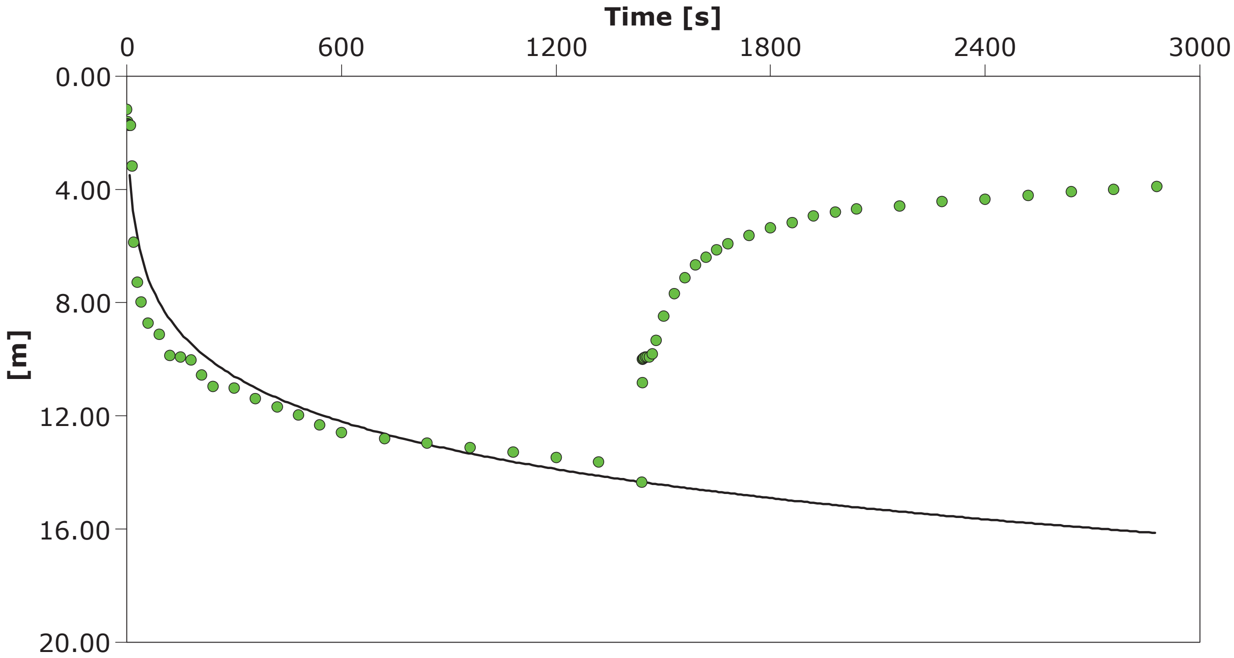


Calculation after Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH1	2.36×10^{-1}	5.01×10^{-3}	1.87×10^{-3}	0.08	

City, State/Province Address Contact Info Company Name	Pumping Test Analysis Report	a
	Project: 0129245	
	Number: Kangra Coal	
	Client: Kangra Coal	

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH1
Test conducted by: AB PUMPS		Test date: 2011/06/11
Analysis performed by: ERM	Jacob Cooper	Date: 2011/06/11
Aquifer Thickness: 47.22 m	Discharge: variable, average rate 0.075 [l/s]	

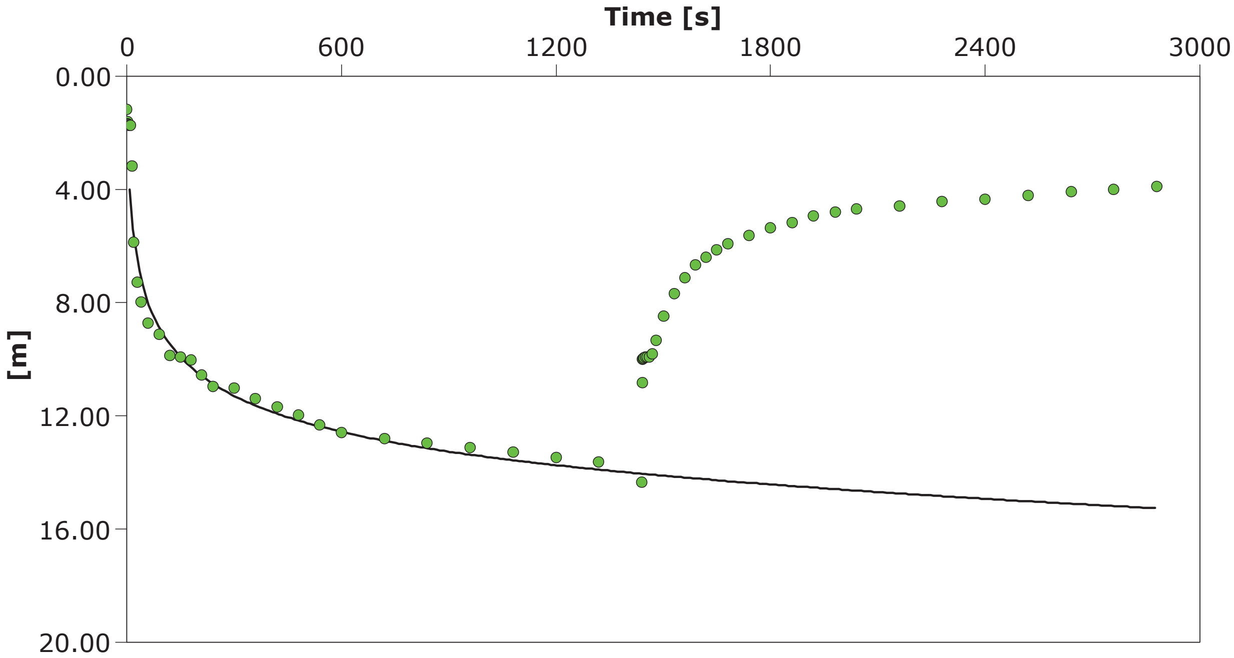


Calculation after Theis with Jacob Correction

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH1	2.93×10^{-1}	6.21×10^{-3}	1.60×10^{-3}	0.08	

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report** a Project: 0129245 Number: Kangra Coal Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH1
Test conducted by: AB PUMPS		Test date: 2011/06/11
Analysis performed by: ERM	Double Porosity	Date: 2011/06/11
Aquifer Thickness: 47.22 m	Discharge: variable, average rate 0.075 [l/s]	

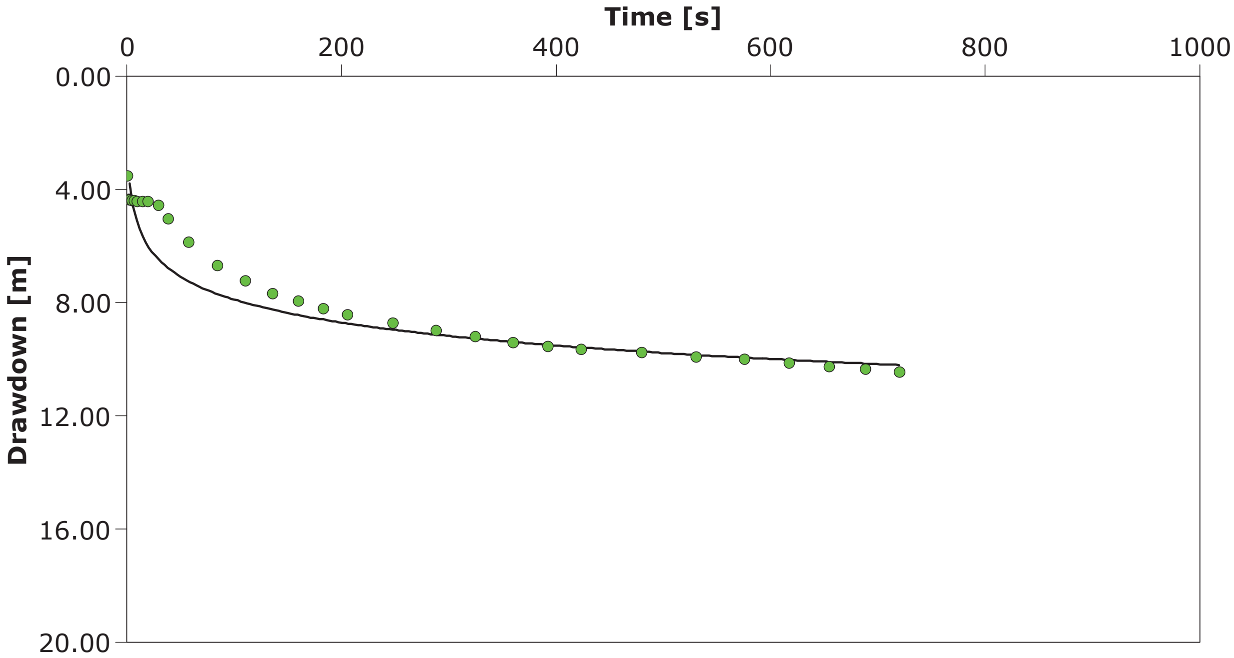


Calculation after Double Porosity

Observation well	Transmissivity [m²/d]	K [m/d]	Specific storage	Sigma	Lambda	Radial distance to PW [m]
ERMBH1	2.32×10^{-1}	4.91×10^{-3}	1.43×10^{-3}	1.00×10^{0}	2.09×10^{-3}	0.08

City, State/Province Address Contact Info Company Name	Pumping Test Analysis Report A
	Project: 0129245
	Number: Kangra Coal
	Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH1
Test conducted by: AB PUMPS		Test date: 2011/06/11
Analysis performed by: ERM	Theis Recovery	Date: 2011/06/11
Aquifer Thickness: 47.22 m	Discharge: variable, average rate 0.075 [l/s]	



Calculation after AGARWAL + Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH1	8.80×10^{-1}	1.86×10^{-2}	4.00×10^{-4}	0.08	

City, State/Province **Address** **Contact Info** **Company Name**	**Pumping Test Analysis Report** A Project: 0129245 Number: Kangra Coal Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH1
Test conducted by: AB PUMPS		Test date: 2011/06/11
Aquifer Thickness: 47.22 m	Discharge: variable, average rate 0.075 [l/s]	

	Analysis Name	Analysis performed by	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Theis	ERM	2011/06/11	Theis	ERMBH1	2.36×10^{-1}	5.01×10^{-3}	1.87×10^{-3}
2	Jacob Cooper	ERM	2011/06/11	Theis with Jacob Co	ERMBH1	2.93×10^{-1}	6.21×10^{-3}	1.60×10^{-3}
3	Double Porosity	ERM	2011/06/11	Double Porosity	ERMBH1	2.32×10^{-1}	4.91×10^{-3}	1.43×10^{-3}
4	Theis Recovery	ERM	2011/06/11	AGARWAL + Theis	ERMBH1	8.80×10^{-1}	1.86×10^{-2}	4.00×10^{-4}
					Average	4.10×10^{-1}	8.69×10^{-3}	1.33×10^{-3}

Report Date:	2011/04/12 17:23
Report User Name:	User
Report Computer Name:	USER-PC

Log File Properties

File Name	Slug Test ERM BH 02_2011-04-12_17-23-36-774.
Create Date	2011/04/12 17:23

Device Properties

Device	Level TROLL 300
Site	Piet Retief
Device Name	Obuasi
Serial Number	127154
Firmware Version	2.04
Hardware Version	2

Log Configuration

Log Name	Slug Test ERM BH 02
Created By	User
Computer Name	USER-PC
Application	WinSitu.exe
Application Version	5.6.16.0
Create Date	2011/04/12 17:09
Current Time Zone	South Africa Standard Time(Use Local Time)
Notes Size(bytes)	4096
Overwrite when full	Disabled
Scheduled Start Time	Manual Start
Scheduled Stop Time	No Stop Time
Type	Fast Linear
Interval	Days: 0 hrs: 00 mins: 00 secs: 01

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999
Level Reference Mode:	Set first logged value to offset
Level Reference Offset:	0 (m)

Other Log Settings

Zero Pressure Offset:	103.142 (kPa)
Depth of Probe:	2.28348 (m)
Head Pressure:	22.3709 (kPa)
Temperature:	20.3255 (C)

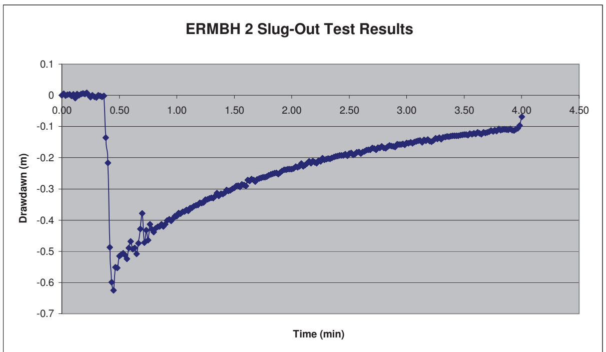
Log Notes:

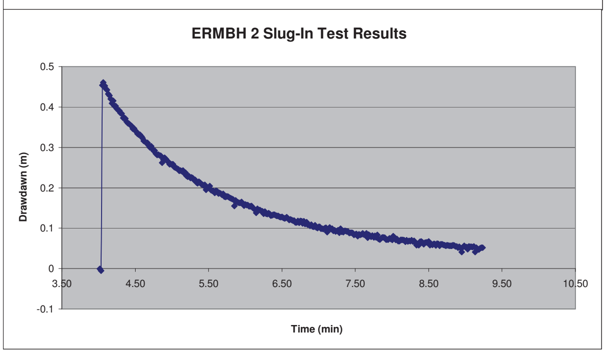
Date and Time	Note
2011/04/12 17:09	Sensor: 127154 Factory calibration has expired.: 2009/02/09 06:59:44 PM
2011/04/12 17:09	Used Battery: 18% Used Memory: 12% User Name: User
2011/04/12 17:14	Manual Start Command
2011/04/12 17:23	Used Battery: 18% Used Memory: 12% User Name: User
2011/04/12 17:23	Manual Stop Command

Log Data:

Record Count	555	
Sensors	1	
	1	127154 Pressure/Temp 100 PSIA (60.1m/197.3ft)

Time Zone: South Africa Standard Time





Date and Time	Elapsed Time Seconds	Minutes	Sensor: Pres(A) 197.3ft SN#: 127154 Level Depth To Water (m)	Sensor: Pres(A) 197.3ft SN#: 127154 Temperature (C)
SLUG out				
2011/04/12 17:14	0	0.00	0	19.145
2011/04/12 17:14	1.001	0.02	0.005	19.145
2011/04/12 17:14	2.001	0.03	-0.001	19.146
2011/04/12 17:14	3.001	0.05	0.002	19.148
2011/04/12 17:14	4.001	0.07	0.003	19.148
2011/04/12 17:14	5.001	0.08	-0.002	19.156
2011/04/12 17:14	6.001	0.10	0.003	19.151
2011/04/12 17:14	7.001	0.12	-0.009	19.149
2011/04/12 17:14	8.001	0.13	0.004	19.145
2011/04/12 17:14	9.001	0.15	0	19.146
2011/04/12 17:14	10.001	0.17	0.004	19.155
2011/04/12 17:14	11.001	0.18	0.006	19.145
2011/04/12 17:14	12.001	0.20	0.004	19.144
2011/04/12 17:14	13.001	0.22	0.008	19.142
2011/04/12 17:14	14.001	0.23	0.001	19.141
2011/04/12 17:14	15.001	0.25	-0.006	19.151
2011/04/12 17:14	16.001	0.27	0	19.146
2011/04/12 17:14	17.001	0.28	-0.005	19.142
2011/04/12 17:14	18.001	0.30	-0.007	19.141
2011/04/12 17:14	19.001	0.32	0	19.139
2011/04/12 17:14	20.001	0.33	-0.002	19.149
2011/04/12 17:14	21.001	0.35	-0.005	19.14
2011/04/12 17:14	22.001	0.37	-0.002	19.139
2011/04/12 17:14	23.001	0.38	-0.136	19.138
2011/04/12 17:14	24.001	0.40	-0.217	19.132
2011/04/12 17:14	25.001	0.42	-0.487	19.144
2011/04/12 17:14	26.001	0.43	-0.599	19.138
2011/04/12 17:14	27.001	0.45	-0.625	19.135
2011/04/12 17:14	28.001	0.47	-0.551	19.133
2011/04/12 17:14	29.001	0.48	-0.553	19.13
2011/04/12 17:14	30.001	0.50	-0.515	19.141
2011/04/12 17:14	31.001	0.52	-0.51	19.133
2011/04/12 17:14	32.001	0.53	-0.506	19.132
2011/04/12 17:14	33.001	0.55	-0.512	19.13
2011/04/12 17:14	34.001	0.57	-0.524	19.129
2011/04/12 17:14	35.001	0.58	-0.489	19.138
2011/04/12 17:14	36.001	0.60	-0.468	19.13
2011/04/12 17:14	37.001	0.62	-0.493	19.124
2011/04/12 17:14	38.001	0.63	-0.489	19.122
2011/04/12 17:14	39.001	0.65	-0.508	19.125
2011/04/12 17:14	40.001	0.67	-0.474	19.135
2011/04/12 17:14	41.001	0.68	-0.428	19.124
2011/04/12 17:14	42.001	0.70	-0.378	19.124
2011/04/12 17:14	43.001	0.72	-0.472	19.122
2011/04/12 17:14	44.001	0.73	-0.432	19.117
2011/04/12 17:14	45.001	0.75	-0.464	19.118
2011/04/12 17:14	46.001	0.77	-0.413	19.128
2011/04/12 17:14	47.001	0.78	-0.429	19.122
2011/04/12 17:14	48.001	0.80	-0.438	19.117
2011/04/12 17:14	49.001	0.82	-0.426	19.115
2011/04/12 17:14	50.001	0.83	-0.421	19.128
2011/04/12 17:14	51.001	0.85	-0.42	19.117
2011/04/12 17:14	52.001	0.87	-0.413	19.117
2011/04/12 17:14	53.001	0.88	-0.42	19.113
2011/04/12 17:14	54.001	0.90	-0.413	19.111
2011/04/12 17:14	55.001	0.92	-0.401	19.125
2011/04/12 17:15	56.001	0.93	-0.397	19.114
2011/04/12 17:15	57.001	0.95	-0.402	19.114
2011/04/12 17:15	58.001	0.97	-0.395	19.112
2011/04/12 17:15	59.001	0.98	-0.387	19.111
2011/04/12 17:15	60.001	1.00	-0.387	19.12
2011/04/12 17:15	61.001	1.02	-0.377	19.114
2011/04/12 17:15	62.001	1.03	-0.379	19.107
2011/04/12 17:15	63.001	1.05	-0.373	19.108
2011/04/12 17:15	64.001	1.07	-0.372	19.105
2011/04/12 17:15	65.001	1.08	-0.367	19.119
2011/04/12 17:15	66.001	1.10	-0.37	19.11
2011/04/12 17:15	67.001	1.12	-0.361	19.107
2011/04/12 17:15	68.001	1.13	-0.36	19.108
2011/04/12 17:15	69.001	1.15	-0.355	19.102
2011/04/12 17:15	70.001	1.17	-0.352	19.114
2011/04/12 17:15	71.001	1.18	-0.351	19.108
2011/04/12 17:15	72.001	1.20	-0.344	19.104
2011/04/12 17:15	73.001	1.22	-0.345	19.101
2011/04/12 17:15	74.001	1.23	-0.343	19.102
2011/04/12 17:15	75.001	1.25	-0.334	19.111
2011/04/12 17:15	76.001	1.27	-0.333	19.104
2011/04/12 17:15	77.001	1.28	-0.33	19.105
2011/04/12 17:15	78.001	1.30	-0.328	19.101
2011/04/12 17:15	79.001	1.32	-0.329	19.099
2011/04/12 17:15	80.001	1.33	-0.323	19.111
2011/04/12 17:15	81.001	1.35	-0.313	19.104
2011/04/12 17:15	82.001	1.37	-0.322	19.098
2011/04/12 17:15	83.001	1.38	-0.315	19.1
2011/04/12 17:15	84.001	1.40	-0.316	19.096
2011/04/12 17:15	85.001	1.42	-0.312	19.106
2011/04/12 17:15	86.001	1.43	-0.303	19.099
2011/04/12 17:15	87.001	1.45	-0.306	19.097
2011/04/12 17:15	88.001	1.47	-0.304	19.095
2011/04/12 17:15	89.001	1.48	-0.3	19.096
2011/04/12 17:15	90.001	1.50	-0.297	19.106
2011/04/12 17:15	91.001	1.52	-0.291	19.102
2011/04/12 17:15	92.001	1.53	-0.29	19.096
2011/04/12 17:15	93.001	1.55	-0.294	19.094
2011/04/12 17:15	94.001	1.57	-0.286	19.091
2011/04/12 17:15	95.023	1.58	-0.288	19.105
2011/04/12 17:15	96.001	1.60	-0.291	19.095
2011/04/12 17:15	97.001	1.62	-0.272	19.096
2011/04/12 17:15	98.001	1.63	-0.275	19.093
2011/04/12 17:15	99.001	1.65	-0.269	19.094
2011/04/12 17:15	100.094	1.67	-0.272	19.103
2011/04/12 17:15	101.001	1.68	-0.277	19.099
2011/04/12 17:15	102.001	1.70	-0.27	19.092
2011/04/12 17:15	103.001	1.72	-0.267	19.093
2011/04/12 17:15	104.001	1.73	-0.265	19.092
2011/04/12 17:15	105.023	1.75	-0.263	19.103
2011/04/12 17:15	106.001	1.77	-0.263	19.097
2011/04/12 17:15	107.001	1.78	-0.261	19.096
2011/04/12 17:15	108.001	1.80	-0.257	19.091
2011/04/12 17:15	109.001	1.82	-0.254	19.088
2011/04/12 17:15	110.001	1.83	-0.252	19.104
2011/04/12 17:15	111.001	1.85	-0.25	19.096
2011/04/12 17:15	112.001	1.87	-0.249	19.094
2011/04/12 17:15	113.001	1.88	-0.253	19.092
2011/04/12 17:15	114.001	1.90	-0.248	19.093
2011/04/12 17:15	115.001	1.92	-0.243	19.101
2011/04/12 17:16	116.001	1.93	-0.239	19.095
2011/04/12 17:16	117.001	1.95	-0.239	19.092
2011/04/12 17:16	118.001	1.97	-0.237	19.092
2011/04/12 17:16	119.001	1.98	-0.237	19.09
2011/04/12 17:16	120.001	2.00	-0.237	19.103
2011/04/12 17:16	121.001	2.02	-0.235	19.094
2011/04/12 17:16	122.001	2.03	-0.229	19.094

2011/04/12 17:16	123.001	2.05	-0.231	19.092
2011/04/12 17:16	124.001	2.07	-0.228	19.093
2011/04/12 17:16	125.001	2.08	-0.219	19.104
2011/04/12 17:16	126.001	2.10	-0.228	19.096
2011/04/12 17:16	127.001	2.12	-0.224	19.095
2011/04/12 17:16	128.001	2.13	-0.219	19.09
2011/04/12 17:16	129.001	2.15	-0.212	19.089
2011/04/12 17:16	130.001	2.17	-0.218	19.107
2011/04/12 17:16	131.001	2.18	-0.211	19.096
2011/04/12 17:16	132.001	2.20	-0.215	19.091
2011/04/12 17:16	133.001	2.22	-0.218	19.093
2011/04/12 17:16	134.001	2.23	-0.21	19.094
2011/04/12 17:16	135.001	2.25	-0.212	19.106
2011/04/12 17:16	136.001	2.27	-0.202	19.099
2011/04/12 17:16	137.001	2.28	-0.207	19.093
2011/04/12 17:16	138.001	2.30	-0.205	19.094
2011/04/12 17:16	139.001	2.32	-0.203	19.096
2011/04/12 17:16	140.001	2.33	-0.204	19.105
2011/04/12 17:16	141.001	2.35	-0.201	19.1
2011/04/12 17:16	142.003	2.37	-0.198	19.097
2011/04/12 17:16	143.001	2.38	-0.196	19.095
2011/04/12 17:16	144.001	2.40	-0.195	19.096
2011/04/12 17:16	145.001	2.42	-0.193	19.109
2011/04/12 17:16	146.001	2.43	-0.193	19.099
2011/04/12 17:16	147.001	2.45	-0.193	19.097
2011/04/12 17:16	148.001	2.47	-0.189	19.097
2011/04/12 17:16	149.001	2.48	-0.194	19.096
2011/04/12 17:16	150.001	2.50	-0.187	19.109
2011/04/12 17:16	151.001	2.52	-0.185	19.102
2011/04/12 17:16	152.001	2.53	-0.191	19.102
2011/04/12 17:16	153.001	2.55	-0.189	19.097
2011/04/12 17:16	154.001	2.57	-0.183	19.098
2011/04/12 17:16	155.001	2.58	-0.182	19.111
2011/04/12 17:16	156.001	2.60	-0.187	19.105
2011/04/12 17:16	157.001	2.62	-0.182	19.103
2011/04/12 17:16	158.001	2.63	-0.18	19.102
2011/04/12 17:16	159.001	2.65	-0.176	19.101
2011/04/12 17:16	160.001	2.67	-0.175	19.114
2011/04/12 17:16	161.001	2.68	-0.175	19.105
2011/04/12 17:16	162.001	2.70	-0.169	19.104
2011/04/12 17:16	163.001	2.72	-0.171	19.104
2011/04/12 17:16	164.001	2.73	-0.175	19.101
2011/04/12 17:16	165.001	2.75	-0.168	19.117
2011/04/12 17:16	166.001	2.77	-0.169	19.112
2011/04/12 17:16	167.001	2.78	-0.164	19.108
2011/04/12 17:16	168.001	2.80	-0.169	19.106
2011/04/12 17:16	169.001	2.82	-0.17	19.106
2011/04/12 17:16	170.001	2.83	-0.165	19.119
2011/04/12 17:16	171.001	2.85	-0.161	19.109
2011/04/12 17:16	172.001	2.87	-0.163	19.108
2011/04/12 17:16	173.001	2.88	-0.164	19.11
2011/04/12 17:16	174.001	2.90	-0.166	19.111
2011/04/12 17:16	175.003	2.92	-0.157	19.12
2011/04/12 17:17	176.001	2.93	-0.158	19.117
2011/04/12 17:17	177.001	2.95	-0.158	19.111
2011/04/12 17:17	178.001	2.97	-0.156	19.113
2011/04/12 17:17	179.001	2.98	-0.159	19.113
2011/04/12 17:17	180.001	3.00	-0.153	19.126
2011/04/12 17:17	181.001	3.02	-0.154	19.12
2011/04/12 17:17	182.001	3.03	-0.151	19.114
2011/04/12 17:17	183.001	3.05	-0.154	19.117
2011/04/12 17:17	184.001	3.07	-0.15	19.115
2011/04/12 17:17	185.003	3.08	-0.148	19.13
2011/04/12 17:17	186.001	3.10	-0.146	19.121
2011/04/12 17:17	187.001	3.12	-0.145	19.12
2011/04/12 17:17	188.001	3.13	-0.151	19.115
2011/04/12 17:17	189.001	3.15	-0.143	19.12
2011/04/12 17:17	190.011	3.17	-0.146	19.135
2011/04/12 17:17	191.001	3.18	-0.142	19.123
2011/04/12 17:17	192.001	3.20	-0.147	19.123
2011/04/12 17:17	193.001	3.22	-0.149	19.121
2011/04/12 17:17	194.001	3.23	-0.145	19.124
2011/04/12 17:17	195.018	3.25	-0.138	19.136
2011/04/12 17:17	196.001	3.27	-0.14	19.131
2011/04/12 17:17	197.001	3.28	-0.136	19.126
2011/04/12 17:17	198.001	3.30	-0.141	19.124
2011/04/12 17:17	199.001	3.32	-0.135	19.123
2011/04/12 17:17	200.026	3.33	-0.134	19.14
2011/04/12 17:17	201.001	3.35	-0.132	19.129
2011/04/12 17:17	202.001	3.37	-0.133	19.128
2011/04/12 17:17	203.001	3.38	-0.131	19.129
2011/04/12 17:17	204.001	3.40	-0.13	19.127
2011/04/12 17:17	205.035	3.42	-0.13	19.142
2011/04/12 17:17	206.001	3.43	-0.13	19.134
2011/04/12 17:17	207.001	3.45	-0.13	19.135
2011/04/12 17:17	208.001	3.47	-0.128	19.131
2011/04/12 17:17	209.001	3.48	-0.127	19.133
2011/04/12 17:17	210.043	3.50	-0.126	19.147
2011/04/12 17:17	211.001	3.52	-0.126	19.141
2011/04/12 17:17	212.001	3.53	-0.128	19.138
2011/04/12 17:17	213.001	3.55	-0.123	19.133
2011/04/12 17:17	214.001	3.57	-0.125	19.136
2011/04/12 17:17	215.05	3.58	-0.122	19.148
2011/04/12 17:17	216.001	3.60	-0.124	19.141
2011/04/12 17:17	217.001	3.62	-0.119	19.138
2011/04/12 17:17	218.001	3.63	-0.122	19.138
2011/04/12 17:17	219.001	3.65	-0.125	19.139
2011/04/12 17:17	220.059	3.67	-0.119	19.154
2011/04/12 17:17	221.001	3.68	-0.121	19.147
2011/04/12 17:17	222.001	3.70	-0.119	19.146
2011/04/12 17:17	223.001	3.72	-0.117	19.142
2011/04/12 17:17	224.001	3.73	-0.113	19.142
2011/04/12 17:17	225.106	3.75	-0.116	19.161
2011/04/12 17:17	226.001	3.77	-0.112	19.149
2011/04/12 17:17	227.001	3.78	-0.115	19.15
2011/04/12 17:17	228.001	3.80	-0.108	19.147
2011/04/12 17:17	229.001	3.82	-0.112	19.147
2011/04/12 17:17	230.001	3.83	-0.11	19.16
2011/04/12 17:17	231.001	3.85	-0.109	19.155
2011/04/12 17:17	232.001	3.87	-0.11	19.15
2011/04/12 17:17	233.001	3.88	-0.111	19.149
2011/04/12 17:17	234.001	3.90	-0.108	19.151
2011/04/12 17:17	235.077	3.92	-0.112	19.162
2011/04/12 17:18	236.001	3.93	-0.113	19.159
2011/04/12 17:18	237.001	3.95	-0.109	19.157
2011/04/12 17:18	238.001	3.97	-0.106	19.157
2011/04/12 17:18	239.001	3.98	-0.097	19.152
2011/04/12 17:18	240.084	4.00	-0.069	19.165

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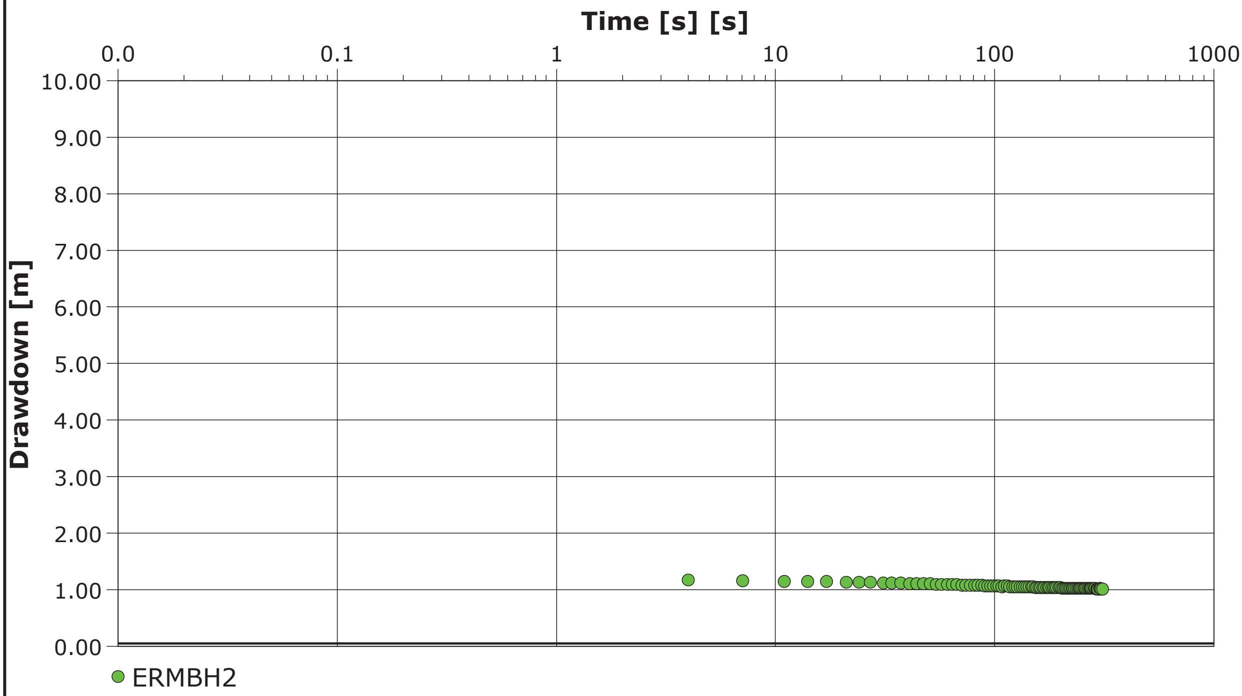
2011/04/12 17:18	241.012	4.02	-0.001	19.162
2011/04/12 17:18	242.001	4.03	-0.005	19.161
2011/04/12 17:18	243.001	4.05	0.454	19.159
2011/04/12 17:18	244.001	4.07	0.461	19.162
2011/04/12 17:18	245.085	4.08	0.452	19.172
2011/04/12 17:18	246.001	4.10	0.445	19.162
2011/04/12 17:18	247.001	4.12	0.442	19.167
2011/04/12 17:18	248.001	4.13	0.432	19.162
2011/04/12 17:18	249.001	4.15	0.428	19.165
2011/04/12 17:18	250.093	4.17	0.42	19.177
2011/04/12 17:18	251.001	4.18	0.409	19.171
2011/04/12 17:18	252.001	4.20	0.415	19.17
2011/04/12 17:18	253.001	4.22	0.402	19.17
2011/04/12 17:18	254.001	4.23	0.402	19.167
2011/04/12 17:18	255.1	4.25	0.395	19.181
2011/04/12 17:18	256.001	4.27	0.392	19.171
2011/04/12 17:18	257.001	4.28	0.391	19.174
2011/04/12 17:18	258.001	4.30	0.385	19.169
2011/04/12 17:18	259.001	4.32	0.384	19.169
2011/04/12 17:18	260.109	4.34	0.373	19.181
2011/04/12 17:18	261.001	4.35	0.374	19.175
2011/04/12 17:18	262.001	4.37	0.371	19.175
2011/04/12 17:18	263.001	4.38	0.364	19.174
2011/04/12 17:18	264.001	4.40	0.36	19.172
2011/04/12 17:18	265.117	4.42	0.358	19.184
2011/04/12 17:18	266.001	4.43	0.355	19.178
2011/04/12 17:18	267.001	4.45	0.353	19.176
2011/04/12 17:18	268.001	4.47	0.346	19.175
2011/04/12 17:18	269.001	4.48	0.347	19.174
2011/04/12 17:18	270.125	4.50	0.341	19.189
2011/04/12 17:18	271.001	4.52	0.338	19.181
2011/04/12 17:18	272.001	4.53	0.334	19.175
2011/04/12 17:18	273.001	4.55	0.331	19.174
2011/04/12 17:18	274.001	4.57	0.331	19.173
2011/04/12 17:18	275.132	4.59	0.327	19.187
2011/04/12 17:18	276.001	4.60	0.323	19.184
2011/04/12 17:18	277.001	4.62	0.316	19.18
2011/04/12 17:18	278.001	4.63	0.314	19.179
2011/04/12 17:18	279.001	4.65	0.311	19.179
2011/04/12 17:18	280.141	4.67	0.311	19.189
2011/04/12 17:18	281.001	4.68	0.304	19.182
2011/04/12 17:18	282.001	4.70	0.3	19.178
2011/04/12 17:18	283.001	4.72	0.303	19.179
2011/04/12 17:18	284.001	4.73	0.296	19.179
2011/04/12 17:18	285.156	4.75	0.291	19.189
2011/04/12 17:18	286.001	4.77	0.292	19.184
2011/04/12 17:18	287.001	4.78	0.284	19.179
2011/04/12 17:18	288.001	4.80	0.281	19.179
2011/04/12 17:18	289.001	4.82	0.282	19.178
2011/04/12 17:18	290.163	4.84	0.28	19.19
2011/04/12 17:18	291.001	4.85	0.279	19.186
2011/04/12 17:18	292.001	4.87	0.262	19.18
2011/04/12 17:18	293.001	4.88	0.27	19.18
2011/04/12 17:18	294.001	4.90	0.274	19.177
2011/04/12 17:18	295.172	4.92	0.271	19.189
2011/04/12 17:19	296.001	4.93	0.267	19.186
2011/04/12 17:19	297.001	4.95	0.264	19.182
2011/04/12 17:19	298.001	4.97	0.258	19.18
2011/04/12 17:19	299.001	4.98	0.259	19.18
2011/04/12 17:19	300.179	5.00	0.258	19.191
2011/04/12 17:19	301.001	5.02	0.258	19.184
2011/04/12 17:19	302.001	5.03	0.251	19.18
2011/04/12 17:19	303.001	5.05	0.25	19.18
2011/04/12 17:19	304.001	5.07	0.248	19.184
2011/04/12 17:19	305.181	5.09	0.246	19.191
2011/04/12 17:19	306.001	5.10	0.242	19.186
2011/04/12 17:19	307.001	5.12	0.243	19.18
2011/04/12 17:19	308.001	5.13	0.241	19.18
2011/04/12 17:19	309.001	5.15	0.243	19.182
2011/04/12 17:19	310.189	5.17	0.236	19.189
2011/04/12 17:19	311.001	5.18	0.237	19.184
2011/04/12 17:19	312.001	5.20	0.23	19.184
2011/04/12 17:19	313.001	5.22	0.227	19.18
2011/04/12 17:19	314.001	5.23	0.229	19.175
2011/04/12 17:19	315.197	5.25	0.224	19.189
2011/04/12 17:19	316.001	5.27	0.226	19.182
2011/04/12 17:19	317.001	5.28	0.224	19.181
2011/04/12 17:19	318.001	5.30	0.22	19.178
2011/04/12 17:19	319.001	5.32	0.22	19.178
2011/04/12 17:19	320.205	5.34	0.213	19.188
2011/04/12 17:19	321.001	5.35	0.211	19.185
2011/04/12 17:19	322.001	5.37	0.215	19.18
2011/04/12 17:19	323.001	5.38	0.213	19.173
2011/04/12 17:19	324.001	5.40	0.209	19.174
2011/04/12 17:19	325.001	5.42	0.207	19.193
2011/04/12 17:19	326.001	5.43	0.206	19.181
2011/04/12 17:19	327.001	5.45	0.207	19.178
2011/04/12 17:19	328.001	5.47	0.195	19.175
2011/04/12 17:19	329.001	5.48	0.201	19.174
2011/04/12 17:19	330.001	5.50	0.2	19.19
2011/04/12 17:19	331.001	5.52	0.204	19.178
2011/04/12 17:19	332.001	5.53	0.194	19.176
2011/04/12 17:19	333.001	5.55	0.193	19.172
2011/04/12 17:19	334.001	5.57	0.192	19.169
2011/04/12 17:19	335.001	5.58	0.187	19.187
2011/04/12 17:19	336.001	5.60	0.193	19.175
2011/04/12 17:19	337.001	5.62	0.191	19.174
2011/04/12 17:19	338.001	5.63	0.186	19.17
2011/04/12 17:19	339.001	5.65	0.187	19.173
2011/04/12 17:19	340.001	5.67	0.186	19.186
2011/04/12 17:19	341.001	5.68	0.183	19.175
2011/04/12 17:19	342.001	5.70	0.185	19.171
2011/04/12 17:19	343.001	5.72	0.178	19.171
2011/04/12 17:19	344.001	5.73	0.177	19.169
2011/04/12 17:19	345.001	5.75	0.179	19.187
2011/04/12 17:19	346.001	5.77	0.178	19.174
2011/04/12 17:19	347.001	5.78	0.176	19.168
2011/04/12 17:19	348.001	5.80	0.174	19.166
2011/04/12 17:19	349.001	5.82	0.173	19.168
2011/04/12 17:19	350.003	5.83	0.171	19.184
2011/04/12 17:19	351.001	5.85	0.155	19.17
2011/04/12 17:19	352.001	5.87	0.169	19.168
2011/04/12 17:19	353.001	5.88	0.166	19.166
2011/04/12 17:19	354.001	5.90	0.164	19.164
2011/04/12 17:19	355.01	5.92	0.163	19.181
2011/04/12 17:20	356.001	5.93	0.163	19.169
2011/04/12 17:20	357.001	5.95	0.165	19.166
2011/04/12 17:20	358.001	5.97	0.16	19.163
2011/04/12 17:20	359.001	5.98	0.156	19.162
2011/04/12 17:20	360.018	6.00	0.159	19.178
2011/04/12 17:20	361.001	6.02	0.157	19.167
2011/04/12 17:20	362.001	6.03	0.157	19.161
2011/04/12 17:20	363.001	6.05	0.154	19.16
2011/04/12 17:20	364.001	6.07	0.154	19.157
2011/04/12 17:20	365.001	6.08	0.155	19.158
2011/04/12 17:20	366.001	6.10	0.151	19.17

2011/04/12 17:20	367.001	6.12	0.149	19.162
2011/04/12 17:20	368.001	6.13	0.146	19.157
2011/04/12 17:20	369.001	6.15	0.138	19.156
2011/04/12 17:20	370.033	6.17	0.148	19.173
2011/04/12 17:20	371.001	6.18	0.145	19.161
2011/04/12 17:20	372.001	6.20	0.145	19.158
2011/04/12 17:20	373.001	6.22	0.143	19.155
2011/04/12 17:20	374.001	6.23	0.142	19.154
2011/04/12 17:20	375.041	6.25	0.136	19.172
2011/04/12 17:20	376.001	6.27	0.141	19.157
2011/04/12 17:20	377.001	6.28	0.136	19.154
2011/04/12 17:20	378.001	6.30	0.135	19.151
2011/04/12 17:20	379.001	6.32	0.137	19.149
2011/04/12 17:20	380.049	6.33	0.135	19.165
2011/04/12 17:20	381.001	6.35	0.131	19.155
2011/04/12 17:20	382.001	6.37	0.132	19.149
2011/04/12 17:20	383.001	6.38	0.133	19.149
2011/04/12 17:20	384.001	6.40	0.133	19.148
2011/04/12 17:20	385.134	6.42	0.131	19.163
2011/04/12 17:20	386.001	6.43	0.13	19.154
2011/04/12 17:20	387.001	6.45	0.13	19.149
2011/04/12 17:20	388.001	6.47	0.128	19.146
2011/04/12 17:20	389.001	6.48	0.127	19.142
2011/04/12 17:20	390.001	6.50	0.128	19.166
2011/04/12 17:20	391.001	6.52	0.126	19.149
2011/04/12 17:20	392.001	6.53	0.124	19.143
2011/04/12 17:20	393.001	6.55	0.125	19.141
2011/04/12 17:20	394.001	6.57	0.127	19.142
2011/04/12 17:20	395.001	6.58	0.124	19.158
2011/04/12 17:20	396.001	6.60	0.12	19.146
2011/04/12 17:20	397.001	6.62	0.122	19.142
2011/04/12 17:20	398.001	6.63	0.12	19.14
2011/04/12 17:20	399.001	6.65	0.119	19.138
2011/04/12 17:20	400.08	6.67	0.119	19.151
2011/04/12 17:20	401.013	6.68	0.114	19.143
2011/04/12 17:20	402.001	6.70	0.114	19.14
2011/04/12 17:20	403.001	6.72	0.118	19.137
2011/04/12 17:20	404.001	6.73	0.113	19.136
2011/04/12 17:20	405.081	6.75	0.118	19.15
2011/04/12 17:20	406.001	6.77	0.117	19.139
2011/04/12 17:20	407.001	6.78	0.112	19.136
2011/04/12 17:20	408.001	6.80	0.117	19.134
2011/04/12 17:20	409.001	6.82	0.11	19.131
2011/04/12 17:20	410.089	6.83	0.115	19.149
2011/04/12 17:20	411.001	6.85	0.109	19.137
2011/04/12 17:20	412.001	6.87	0.109	19.133
2011/04/12 17:20	413.001	6.88	0.106	19.131
2011/04/12 17:20	414.001	6.90	0.109	19.13
2011/04/12 17:20	415.097	6.92	0.104	19.144
2011/04/12 17:21	416.001	6.93	0.103	19.133
2011/04/12 17:21	417.001	6.95	0.107	19.131
2011/04/12 17:21	418.001	6.97	0.102	19.127
2011/04/12 17:21	419.001	6.98	0.1	19.126
2011/04/12 17:21	420.105	7.00	0.103	19.14
2011/04/12 17:21	421.001	7.02	0.103	19.129
2011/04/12 17:21	422.001	7.03	0.099	19.127
2011/04/12 17:21	423.001	7.05	0.099	19.122
2011/04/12 17:21	424.001	7.07	0.098	19.122
2011/04/12 17:21	425.105	7.09	0.1	19.139
2011/04/12 17:21	426.001	7.10	0.101	19.13
2011/04/12 17:21	427.001	7.12	0.09	19.122
2011/04/12 17:21	428.001	7.13	0.099	19.121
2011/04/12 17:21	429.001	7.15	0.102	19.118
2011/04/12 17:21	430.112	7.17	0.098	19.134
2011/04/12 17:21	431.001	7.18	0.099	19.126
2011/04/12 17:21	432.001	7.20	0.093	19.121
2011/04/12 17:21	433.001	7.22	0.095	19.117
2011/04/12 17:21	434.001	7.23	0.092	19.116
2011/04/12 17:21	435.12	7.25	0.093	19.129
2011/04/12 17:21	436.001	7.27	0.095	19.121
2011/04/12 17:21	437.001	7.28	0.089	19.117
2011/04/12 17:21	438.001	7.30	0.099	19.111
2011/04/12 17:21	439.001	7.32	0.091	19.114
2011/04/12 17:21	440.128	7.34	0.09	19.126
2011/04/12 17:21	441.001	7.35	0.093	19.118
2011/04/12 17:21	442.001	7.37	0.093	19.113
2011/04/12 17:21	443.001	7.38	0.092	19.113
2011/04/12 17:21	444.001	7.40	0.092	19.108
2011/04/12 17:21	445.146	7.42	0.088	19.125
2011/04/12 17:21	446.001	7.43	0.089	19.114
2011/04/12 17:21	447.001	7.45	0.089	19.111
2011/04/12 17:21	448.001	7.47	0.088	19.109
2011/04/12 17:21	449.001	7.48	0.083	19.108
2011/04/12 17:21	450.155	7.50	0.085	19.123
2011/04/12 17:21	451.001	7.52	0.086	19.114
2011/04/12 17:21	452.001	7.53	0.08	19.108
2011/04/12 17:21	453.001	7.55	0.085	19.104
2011/04/12 17:21	454.001	7.57	0.083	19.106
2011/04/12 17:21	455.162	7.59	0.085	19.118
2011/04/12 17:21	456.001	7.60	0.087	19.109
2011/04/12 17:21	457.001	7.62	0.084	19.106
2011/04/12 17:21	458.001	7.63	0.083	19.104
2011/04/12 17:21	459.001	7.65	0.087	19.1
2011/04/12 17:21	460.171	7.67	0.076	19.113
2011/04/12 17:21	461.001	7.68	0.084	19.106
2011/04/12 17:21	462.001	7.70	0.082	19.102
2011/04/12 17:21	463.001	7.72	0.079	19.096
2011/04/12 17:21	464.001	7.73	0.082	19.1
2011/04/12 17:21	465.159	7.75	0.077	19.111
2011/04/12 17:21	466.001	7.77	0.081	19.105
2011/04/12 17:21	467.001	7.78	0.077	19.097
2011/04/12 17:21	468.001	7.80	0.083	19.096
2011/04/12 17:21	469.001	7.82	0.073	19.094
2011/04/12 17:21	470.167	7.84	0.072	19.11
2011/04/12 17:21	471.001	7.85	0.075	19.098
2011/04/12 17:21	472.001	7.87	0.077	19.094
2011/04/12 17:21	473.001	7.88	0.077	19.096
2011/04/12 17:21	474.001	7.90	0.076	19.09
2011/04/12 17:21	475.175	7.92	0.072	19.103
2011/04/12 17:22	476.001	7.93	0.072	19.096
2011/04/12 17:22	477.001	7.95	0.072	19.095
2011/04/12 17:22	478.001	7.97	0.075	19.089
2011/04/12 17:22	479.001	7.98	0.073	19.088
2011/04/12 17:22	480.182	8.00	0.071	19.103
2011/04/12 17:22	481.001	8.02	0.08	19.095
2011/04/12 17:22	482.001	8.03	0.077	19.088
2011/04/12 17:22	483.001	8.05	0.071	19.089
2011/04/12 17:22	484.001	8.07	0.073	19.086
2011/04/12 17:22	485.187	8.09	0.068	19.097
2011/04/12 17:22	486.001	8.10	0.068	19.09
2011/04/12 17:22	487.001	8.12	0.071	19.088
2011/04/12 17:22	488.001	8.13	0.071	19.083
2011/04/12 17:22	489.001	8.15	0.071	19.082
2011/04/12 17:22	490.03	8.17	0.07	19.113
2011/04/12 17:22	491.001	8.18	0.066	19.09
2011/04/12 17:22	492.001	8.20	0.07	19.083
2011/04/12 17:22	493.001	8.22	0.067	19.083

2011/04/12 17:22	494.001	8.23	0.069	19.076
2011/04/12 17:22	495.069	8.25	0.068	19.11
2011/04/12 17:22	496.001	8.27	0.07	19.088
2011/04/12 17:22	497.001	8.28	0.067	19.083
2011/04/12 17:22	498.001	8.30	0.069	19.081
2011/04/12 17:22	499.001	8.32	0.064	19.077
2011/04/12 17:22	500.001	8.33	0.058	19.101
2011/04/12 17:22	501.001	8.35	0.061	19.081
2011/04/12 17:22	502.001	8.37	0.058	19.077
2011/04/12 17:22	503.001	8.38	0.066	19.077
2011/04/12 17:22	504.001	8.40	0.067	19.078
2011/04/12 17:22	505.001	8.42	0.065	19.102
2011/04/12 17:22	506.001	8.43	0.06	19.08
2011/04/12 17:22	507.001	8.45	0.064	19.079
2011/04/12 17:22	508.001	8.47	0.065	19.074
2011/04/12 17:22	509.001	8.48	0.065	19.073
2011/04/12 17:22	510.001	8.50	0.067	19.096
2011/04/12 17:22	511.001	8.52	0.058	19.077
2011/04/12 17:22	512.001	8.53	0.061	19.074
2011/04/12 17:22	513.001	8.55	0.059	19.071
2011/04/12 17:22	514.001	8.57	0.061	19.07
2011/04/12 17:22	515.001	8.58	0.061	19.094
2011/04/12 17:22	516.001	8.60	0.057	19.075
2011/04/12 17:22	517.001	8.62	0.062	19.071
2011/04/12 17:22	518.001	8.63	0.061	19.068
2011/04/12 17:22	519.001	8.65	0.056	19.066
2011/04/12 17:22	520.012	8.67	0.06	19.093
2011/04/12 17:22	521.001	8.68	0.06	19.074
2011/04/12 17:22	522.001	8.70	0.059	19.067
2011/04/12 17:22	523.001	8.72	0.058	19.067
2011/04/12 17:22	524.001	8.73	0.056	19.062
2011/04/12 17:22	525.003	8.75	0.058	19.093
2011/04/12 17:22	526.001	8.77	0.057	19.069
2011/04/12 17:22	527.001	8.78	0.056	19.065
2011/04/12 17:22	528.001	8.80	0.056	19.065
2011/04/12 17:22	529.001	8.82	0.056	19.062
2011/04/12 17:22	530.011	8.83	0.058	19.091
2011/04/12 17:22	531.001	8.85	0.057	19.066
2011/04/12 17:22	532.001	8.87	0.055	19.063
2011/04/12 17:22	533.001	8.88	0.055	19.063
2011/04/12 17:22	534.001	8.90	0.052	19.059
2011/04/12 17:22	535.018	8.92	0.054	19.088
2011/04/12 17:23	536.001	8.93	0.051	19.066
2011/04/12 17:23	537.001	8.95	0.041	19.061
2011/04/12 17:23	538.001	8.97	0.053	19.059
2011/04/12 17:23	539.001	8.98	0.056	19.057
2011/04/12 17:23	540.027	9.00	0.053	19.087
2011/04/12 17:23	541.001	9.02	0.053	19.061
2011/04/12 17:23	542.001	9.03	0.048	19.057
2011/04/12 17:23	543.001	9.05	0.055	19.054
2011/04/12 17:23	544.001	9.07	0.054	19.053
2011/04/12 17:23	545.037	9.08	0.054	19.083
2011/04/12 17:23	546.001	9.10	0.053	19.061
2011/04/12 17:23	547.001	9.12	0.055	19.057
2011/04/12 17:23	548.001	9.13	0.041	19.058
2011/04/12 17:23	549.001	9.15	0.052	19.05
2011/04/12 17:23	550.046	9.17	0.049	19.08
2011/04/12 17:23	551.001	9.18	0.047	19.059
2011/04/12 17:23	552.001	9.20	0.05	19.053
2011/04/12 17:23	553.001	9.22	0.052	19.05
2011/04/12 17:23	554.001	9.23	0.052	19.05

City, State/Province **Address** **Contact Info** **Company Name**	**Slug Test Analysis Report** A Project: 0129245 Number: Kankra Coal Client: Kangra Coal

Location:	Slug Test: Slug Test In	Test Well: ERMBH2
Test conducted by: ab pumps		Test date: 2011/06/09
Analysis performed by: ERM	Bouwer & Rice	Date: 2011/06/09
Aquifer Thickness: 37.36 m		

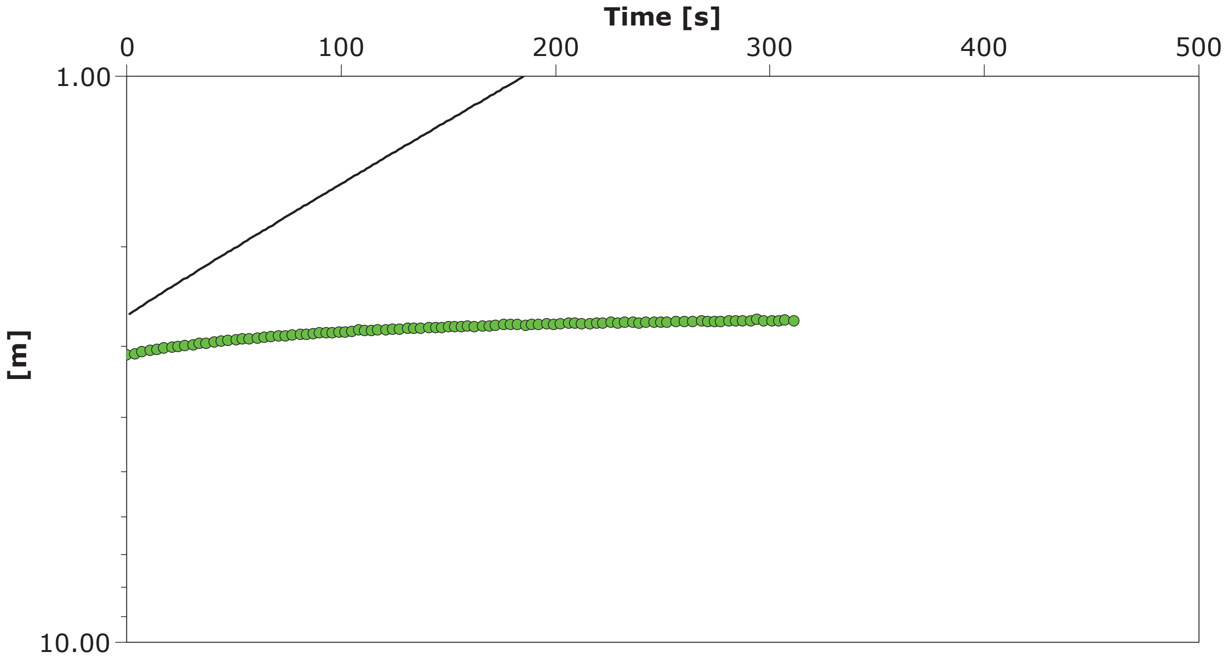


Calculation after Bouwer && Rice

Observation well	K [m/d]	
ERMBH2	1.60×10^{-2}	

City, State/Province Address Contact Info Company Name	Slug Test Analysis Report	A
	Project: 0129245	
	Number: Kankra Coal	
	Client: Kangra Coal	

Location:	Slug Test: Slug Test In	Test Well: ERMBH2
Test conducted by: ab pumps		Test date: 2011/06/09
Analysis performed by: ERM	cbp	Date: 2011/06/09
Aquifer Thickness: 37.36 m		

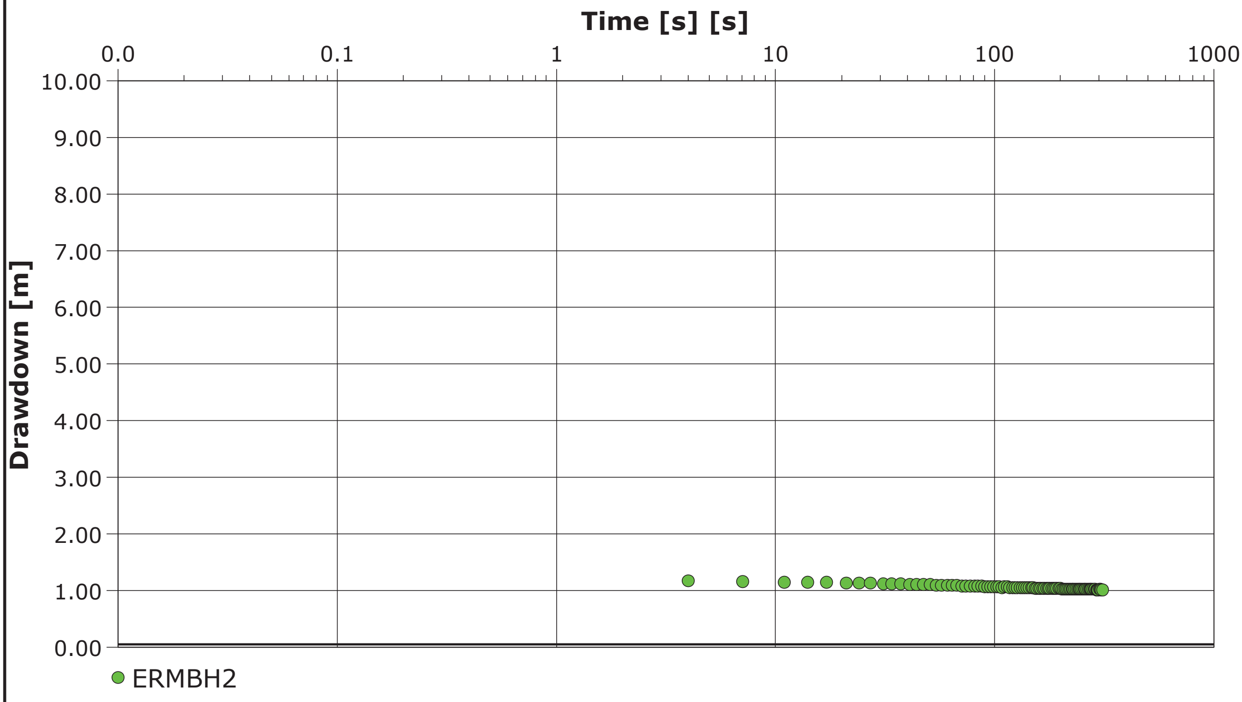


Calculation after Cooper-Bredehoeft-Papadopulos

Observation well	Transmissivity [m²/d]	K [m/d]	Well-bore storage coefficient	
ERMBH2	3.28×10^{1}	8.79×10^{-1}	4.97×10^{-18}	

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report** A Project: 0129245 Number: Kankra Coal Client: Kangra Coal

Location:	Slug Test: Slug Test In	Test Well: ERMBH2
Test conducted by: ab pumps		Test date: 2011/06/09
Analysis performed by: ERM	Hvorslev	Date: 2011/06/09
Aquifer Thickness: 37.36 m		



Calculation after Hvorslev

Observation well	K [m/d]	
ERMBH2	1.99×10^{-2}	

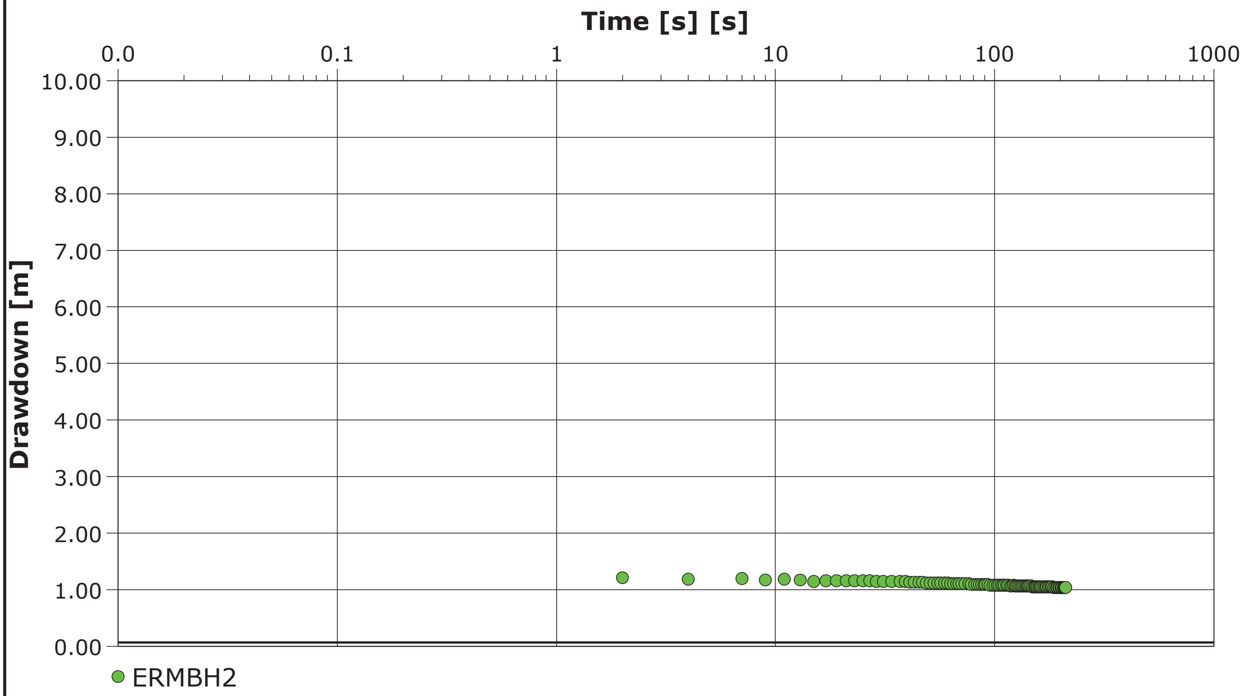
City, State/Province **Address** **Contact Info** **Company Name**	**Slug Test - Analyses Report** A Project: 0129245 Number: Kankra Coal Client: Kangra Coal

Location:	Slug Test: Slug Test In	Test Well: ERMBH2
Test conducted by: ab pumps		Test date: 2011/06/09
Aquifer Thickness: 37.36 m		

	Analysis Name	Analysis performed by	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Bouwer & Rice	ERM	2011/06/09	Bouwer && Rice	ERMBH2		1.60×10^{-2}	
2	Hvorslev	ERM	2011/06/09	Hvorslev	ERMBH2		1.99×10^{-2}	
3	cbp	ERM	2011/06/09	Cooper-Bredehoeft-Papadopulos	ERMBH2	3.28×10^{1}	8.79×10^{-1}	4.97×10^{-18}
					Average	3.28×10^{1}	3.05×10^{-1}	4.97×10^{-18}

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report**	A
	Project: 0129245	
	Number: Kankra Coal	
	Client: Kangra Coal	

Location:	Slug Test: Slug Test Out	Test Well: ERMBH2
Test conducted by: AB PUMPS		Test date: 2011/04/09
Analysis performed by: ERM	Bouwer & Rice	Date: 2011/06/09
Aquifer Thickness: 37.36 m		

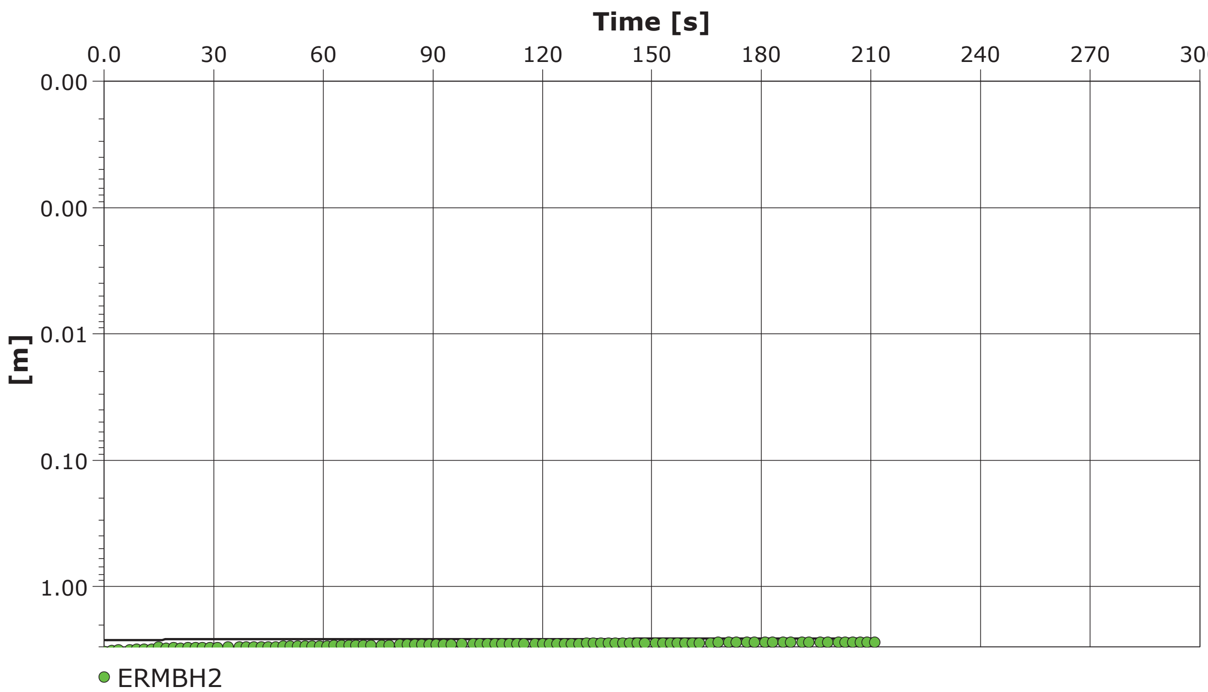


Calculation after Bouwer && Rice

Observation well	K [m/d]	
ERMBH2	2.67×10^{-2}	

City, State/Province Address Contact Info Company Name	Slug Test Analysis Report	A
	Project: 0129245	
	Number: Kankra Coal	
	Client: Kangra Coal	

Location:	Slug Test: Slug Test Out	Test Well: ERMBH2
Test conducted by: AB PUMPS		Test date: 2011/04/09
Analysis performed by: ERM	Cooper-Bredehoeft-Papadopolus	Date: 2011/06/09
Aquifer Thickness: 37.36 m		

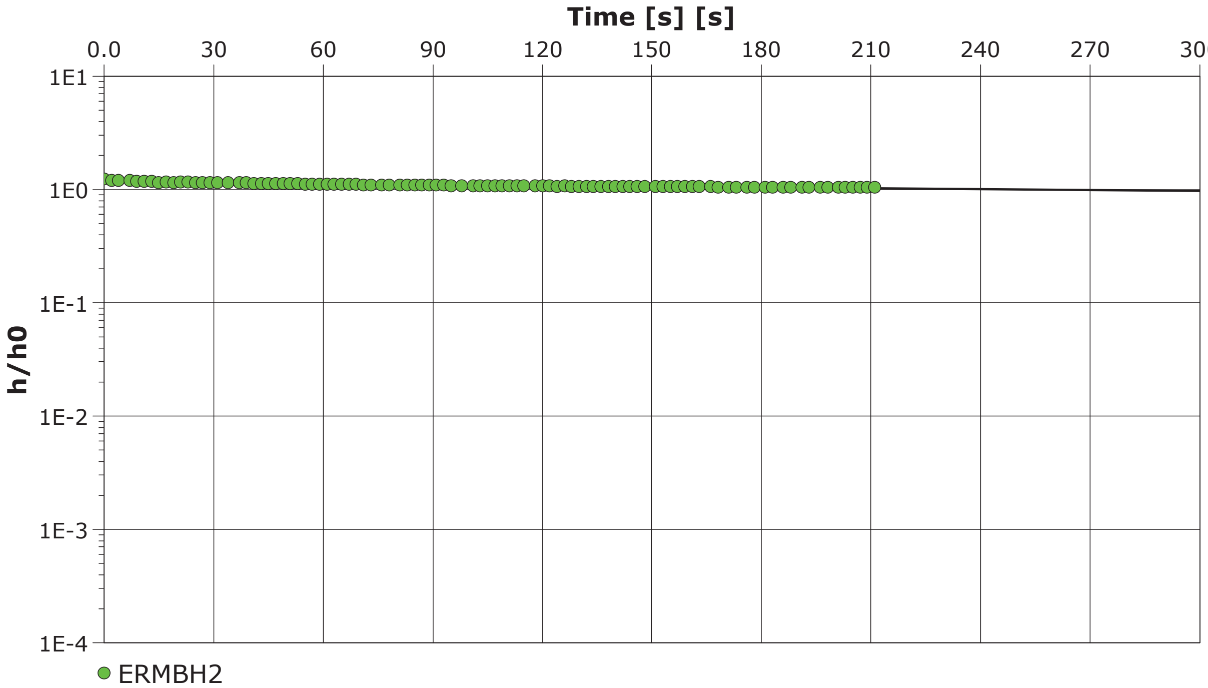


Calculation after Cooper-Bredehoeft-Papadopulos

Observation well	Transmissivity [m²/d]	K [m/d]	Well-bore storage coefficient	
ERMBH2	1.11×10^{-1}	2.98×10^{-3}	3.43×10^{-5}	

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report** A Project: 0129245 Number: Kankra Coal Client: Kangra Coal

Location:	Slug Test: Slug Test Out	Test Well: ERMBH2
Test conducted by: AB PUMPS		Test date: 2011/04/09
Analysis performed by: ERM	Hvorslev	Date: 2011/06/09
Aquifer Thickness: 37.36 m		



Calculation after Hvorslev

Observation well	K [m/d]	
ERMBH2	3.32×10^{-2}	

City, State/Province
Address
Contact Info
Company Name

Slug Test - Analyses Report	
Project: 0129245	
Number: Kankra Coal	
Client: Kangra Coal	

Location:	Slug Test: Slug Test Out	Test Well: ERMBH2
Test conducted by: AB PUMPS		Test date: 2011/04/09
Aquifer Thickness: 37.36 m		

	Analysis Name	Analysis performed	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Bouwer & Rice	ERM	2011/06/09	Bouwer && Rice	ERMBH2		2.67×10^{-2}	
2	Hvorslev	ERM	2011/06/09	Hvorslev	ERMBH2		3.32×10^{-2}	
3	Cooper-Bredehoeft-I	ERMdopolus	2011/06/09	Cooper-Bredehoeft-I	ERMBH2ılos	1.11×10^{-1}	2.98×10^{-3}	3.43×10^{-5}
					Average	1.11×10^{-1}	2.10×10^{-2}	3.43×10^{-5}

Telephone: 043-732 1211
Fax no: 043-732 1422
Fax to e-mail: 0866 717 732
E mail: office@abpumps.co.za

BOREHOLE TEST RECORD

Ground water solutions t/a AB Pumps CC

PR0JECT #	P943
BBR	MARTIN
PRODUCTION BONUS:	PETER
EC meter number	20

CONSULTANT: ERM

DISTRICT: PIET RETIEF

PROVINCE: MPUMALANGA

FARM / VILLAGE NAME : DONKER HOEK

DATE TESTED: 2011/04/02

MAP REFERENCE:

CO-ORDINATES:

FORMAT ON GPS: hddd ° mm ' ss.s " hddd ' mm.mmm ' hddd.ddddd °

LATITUDE: ° ' " OR ° ' OR 27.10680 °

LONGITUDE: ° ' " ° ' 30.28725 °

BOREHOLE NO: ERM BH03

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: NEW BOREHOLE

BOREHOLE DEPTH: (mbgl) 45.60

COMMENTS: NONE

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	No	Test for:	macro	bacterio-logical
Date sample taken	2011/04/04		If consultant took sample, give name:		
Time sample taken	07H57				

DATA CAPTURED BY:	AILENE VAN NIEKERK
DATA CHECKED BY:	AILENE VAN NIEKERK

CONSULTANT GUIDELINES

BOREHOLE DEPTH:		m	STEP 1:		l/s	WATER STRIKE 1:			m
BLOW YIELD:		m	STEP 2:		l/s	WATER STRIKE 2:			m
STATIC WATER LEVEL:		m	STEP 3:		l/s	WATER STRIKE 3:			m
PUMP INSTALLATION DEPTH:		m	STEP 4:		l/s	COMMENTS:			
RECOVERY:			STEP 5:		l/s				
AFTER STEPS:		h	STEP 6:		l/s	TELEPHONE NUMBERS PHONE : (NAME & TEL)			
AFTER CONSTANT:		h	STEP DURATION:		min				

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	45.60
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M	17.6
CASING DETECTION:	NO	1	SAND/GRAVEL/SILT PUMPED?	YES/NO	0
SUPPLIED NEW STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	1
BOREHOLE MARKING	NO	0	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	1	LAYFLAT (M):	M	50
LOGGERS FOR WATERLEVEL MONITORING	NO	0	LOGGERS FOR pH AND EC:	NO	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ____________________ **SIGNATURE:** ________________

DESIGNATION: ____________________ **DATE:** ________________

BOREHOLE TEST CONTROL SHEET
Groundwater Solutions t/a AB PUMPS

Borehole number:	ERM BH03	Old / Alternative number:	
Contractor:	AB PUMPS	Supervisor:	JOHAN
Operator:	MARTIN	Rig number & Type rig:	36 TOYOTA

EXISTING EQUIPMENT

Type pump	Depth	Condition	Drive unit	Condition	Pump house	Condition	Remarks

TESTING EQUIPMENT

Pump type	Depth installed (m)	Date & time (started)	Date & time (completed)
P150	44.87	02/04/2011 12H50	03/04/2011 0H50

MULTI-RATE OR STEPTEST DETAILS

STEP	DURATION (MIN)	RECOVERY (MIN)	YIELD (L/S)		DRAWDOWN (m)
1	60		1.75	l/s	1.88
2	60		3.01	l/s	2.78
3	60		4.50	l/s	3.93
4	60		6.51	l/s	4.40
5	60		8.45	l/s	6.84
6	60		10.02	l/s	8.04
7	60	360		l/s	
8				l/s	
Calibration:				l/s	
TOTAL:	420	360	34.24	l/s	27.87
COMMENT:					

CONSTANT RATE DISCHARGE TEST

Pump type	Depth installed (m)	Date & time (started)		Date & time (completed)	
P150	44.87	2011/04/03	08H00	2011/04/05	08H00
Yield l/s	**Drawdown (m)**	**Duration (min)**		**Recovery (min)**	
8.62	18.61	1440		1440	
Total: (Multi-rate and Constant Discharge rate)		1860		1800	
COMMENT:					

MAINTENANCE

Work time: hour	Transport existing equipm. Km	Travelling (To fix); Km
List of parts replaced or repaired:		

	Borehole number	Duration (min) CONSTANT	Drawdown (m)	Hand/logger	Distance (m)
Observation Hole 1					0
Observation Hole 2					0
Observation Hole 3					0
Observation Hole 4					
Observation Hole 5					

GENERAL

ESTABLISHMENT	From:		To:			
Site Move	From project#		To #:	P943	Travelling km:	2
	Village	Borehole no	Village	Borehole no		
	DONKER HOEK	ERM BH08	DONKER HOEK	ERM BH03		
Maintenance:	Work time hr		Parts repaired/		Travelling km	
After test measurements	Water level	17.60	Borehole depth	45.60	Casing depth m	11.31
Water level before installing test pump:			10.72			
Depth before installing test pump:			45.87			
Testpump Installed	**Once** /Twice /More		Reason:			
Installed Testpump	**<10 l/s** / >10ls/s		Reason:			
Was existing equipment re-installed:			**No:**	If not where was it left:		
GPS Unit number:						
EC Unit number:			20.00			
Remarks:						
Signed Contractor:				Signed Consultant:		

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	0	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH03			DISTRICT:	PIET RETIEF
ALT BH NO:	0			SITE NAME:	DONKER HOEK
ALT BH NO:	0				
BOREHOLE DEPTH (m)	45.60	DATUM LEVEL ABOVE CASING (m):	0.27	EXISTING PUMP:	0
WATER LEVEL (mbgl):	10.78	CASING HEIGHT: (magl):	0.50	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	44.87	DIAM PUMP INLET (mm):	165.00	PUMP TYPE:	P150

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 — RPM — DATE: 02/04/2011 TIME: 12H50

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.06		1	
2	0.08		2	
3	0.15	1.75	3	
5	0.24		5	
7	0.40	1.75	7	
10	0.45		10	
15	0.59	1.75	15	
20	0.70		20	
30	0.92	1.74	30	
40	1.07		40	
50	1.22	1.75	50	
60	1.38		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	8.26		150	
TEMP	26.60	℃	180	
EC	178.00	µS/cm	210	

DISCHARGE RATE 2 — RPM — DATE: 02/04/2011 TIME: 13H50

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.41		1	
2	1.46	2.75	2	
3	1.49	3.00	3	
5	1.55		5	
7	1.60	3.00	7	
10	1.71		10	
15	1.87	3.00	15	
20	2.00		20	
30	2.23	3.01	30	
40	2.54		40	
50	2.64	3.01	50	
60	2.78		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	6.95		150	
TEMP	24.30	℃	180	
EC	174.00	µS/cm	210	

DISCHARGE RATE 3 — RPM — DATE: 02/04/2011 TIME: 14H50

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	2.92		1	
2	2.96	4.36	2	
3	3.00	4.54	3	
5	3.14		5	
7	3.22	4.54	7	
10	3.38		10	
15	3.57	4.53	15	
20	3.70		20	
30	3.77	4.53	30	
40	3.84		40	
50	3.89	4.54	50	
60	3.93		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	6.98		150	
TEMP	24.30	℃	180	
EC	163.00	µS/cm	210	

DISCHARGE RATE 4 — RPM — DATE: 02/04/2011 TIME: 15H50

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	3.96		1	
2	3.98	6.50	2	
3	3.97		3	
5	3.99	6.50	5	
7	3.99		7	
10	3.99	6.51	10	
15	4.00		15	
20	4.00	6.51	20	
30	4.03		30	
40	4.10	6.51	40	
50	4.22		50	
60	4.40	6.51	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	8.21		150	
TEMP	19.60	℃	180	
EC	168.00	µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 5 — RPM — DATE: 02/04/2011 TIME: 16H50

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	4.62		1	
2	4.64	8.45	2	
3	4.68		3	
5	4.78	8.45	5	
7	4.98		7	
10	5.14	8.45	10	
15	5.30		15	
20	5.49	8.44	20	
30	5.92		30	
40	6.45	8.44	40	
50	6.66		50	
60	6.84	8.45	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	8.07		150	
TEMP	19.50	℃	180	
EC	185.00	µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 6 — RPM — DATE: 02/04/2011 TIME: 17H50

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	7.09		1	6.88
2	7.14	10.03	2	6.42
3	7.20		3	6.26
5	7.29	10.03	5	6.04
7	7.44		7	5.80
10	7.56	10.02	10	5.62
15	7.63		15	5.17
20	7.72	10.03	20	4.86
30	7.81		30	4.54
40	7.93	10.02	40	4.49
50	7.99		50	4.43
60	8.04	10.02	60	4.37
70			70	4.37
80			80	4.29
90			90	4.26
100			100	4.23
110			110	4.20
120			120	4.16
pH	8.09		150	4.05
TEMP	19.70	℃	180	3.94
EC	173.00	µS/cm	210	3.81
			240	3.69
			300	3.54
			360	3.45

S/W/L: 10.72

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	27.1068	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH03		30.28725	DISTRICT:	PIET RETIEF
ALT BH NO:	0			SITE NAME:	DONKER HOEK
ALT BH NO:	0				
BOREHOLE DEPTH:	45.60	DATUM LEVEL ABOVE CASING (m):	0.27	EXISTING PUMP:	0
WATER LEVEL (mbgl):	13.23	CASING HEIGHT: (magl):	0.50	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	44.87	DIAM PUMP INLET(mm):	165	PUMP TYPE:	P150

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**					
DATE:	03/04/2011	TIME:	08H00	DATE:		TIME:		TYPE OF PUMP:	P150

DISCHARGE BOREHOLE					OBSERVATION HOLE 1 NR: Distance(m);			OBSERVATION HOLE 2 NR: Distance(m);			OBSERVATION HOLE 3 NR: Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	0.34		**1**	16.38	**1**			**1**			**1**	
2	0.49		**2**	15.19	**2**			**2**			**2**	
3	0.75	6.70	**3**	14.21	**3**			**3**			**3**	
5	1.08	8.63	**5**	12.53	**5**			**5**			**5**	
7	1.20		**7**	11.38	**7**			**7**			**7**	
10	1.46	8.63	**10**	9.96	**10**			**10**			**10**	
15	1.65		**15**	9.59	**15**			**15**			**15**	
20	1.79	8.63	**20**	9.42	**20**			**20**			**20**	
30	1.93		**30**	8.98	**30**			**30**			**30**	
40	2.34	8.63	**40**	8.80	**40**			**40**			**40**	
60	3.28		**60**	8.16	**60**			**60**			**60**	
90	4.33	8.63	**90**	7.67	**90**			**90**			**90**	
120	5.07		**120**	7.35	**120**			**120**			**120**	
150	5.62	8.63	**150**	7.12	**150**			**150**			**150**	
180	5.80		**180**	6.93	**180**			**180**			**180**	
210	5.95	8.63	**210**	6.78	**210**			**210**			**210**	
240	6.14		**240**	6.62	**240**			**240**			**240**	
300	6.85	8.63	**300**	6.47	**300**			**300**			**300**	
360	7.90		**360**	6.16	**360**			**360**			**360**	
420	8.25	8.63	**420**	5.97	**420**			**420**			**420**	
480	9.80		**480**	5.76	**480**			**480**			**480**	
540	10.83	8.63	**540**	5.59	**540**			**540**			**540**	
600	11.32		**600**	5.42	**600**			**600**			**600**	
720	12.91	8.62	**720**	5.21	**720**			**720**			**720**	
840	13.75		**840**	5.07	**840**			**840**			**840**	
960	14.59	8.62	**960**	4.88	**960**			**960**			**960**	
1080	15.03		**1080**	4.73	**1080**			**1080**			**1080**	
1200	15.99	8.62	**1200**	4.58	**1200**			**1200**			**1200**	
1320	16.83		**1320**	4.39	**1320**			**1320**			**1320**	
1440	18.61	8.62	**1440**	3.21	**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1440		**W/L**			**W/L**			**W/L**
Average yield (l/s):				8.62								

FORM 5 F

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:		PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH03			DISTRICT:	PIET RETIEF
ALT BH NO:				SITE NAME:	DONKER HOEK
ALT BH NO:					
BOREHOLE DEPTH:	45.60	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	0
WATER LEVEL (mbgl)::	13.23	CASING HEIGHT (magl):	0.00	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	44.87	DIAM PUMP INLET(mm):	0.00		

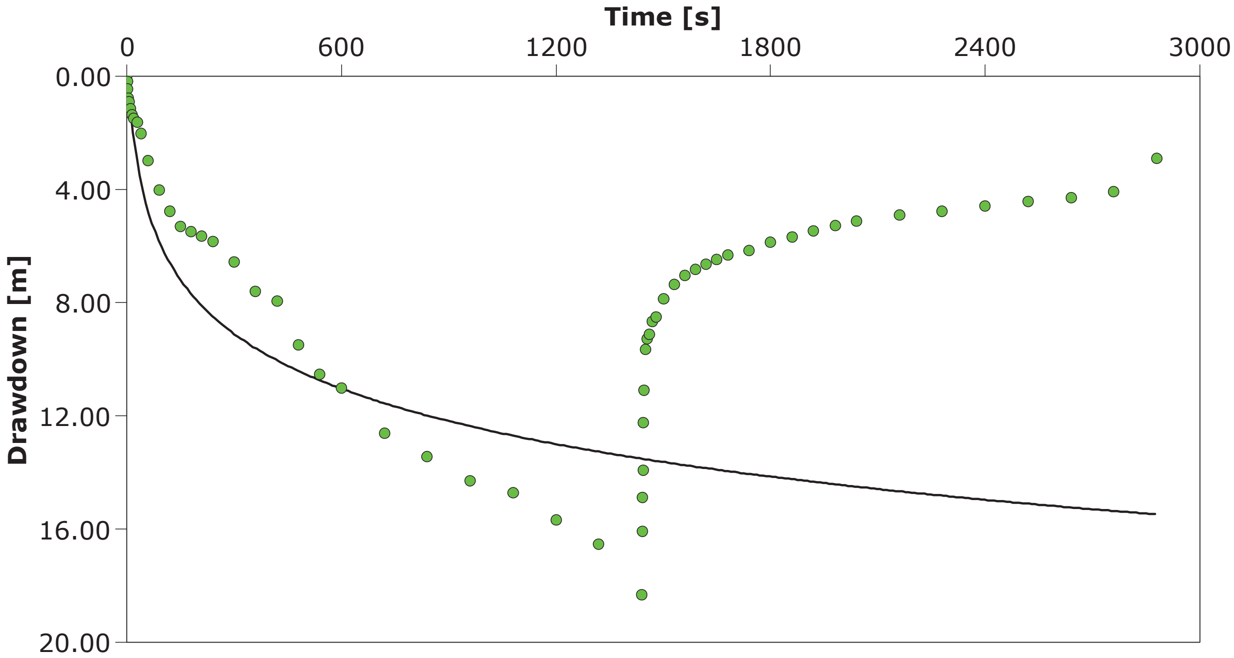
CONSTANT DISCHARGE TEST

DISCHARGE BOREHOLE

TIME (MIN)	REAL TIME	MEASUREMENTS pH	TEMP ℃	EC µS/cm		TIME (MIN)	REAL TIME	MEASUREMENTS pH	TEMP ℃	EC µS/cm
1		9.58	19.2	162						
120		6.29	24	183						
240		8.19	21.2	185						
360		8.53	20.6	189						
480		8.77	21.9	189						
600		8.62	20.7	187						
720		8.46	22.5	189						
840		8.38	30.7	188						
960		8.46	21.5	190						
1080		8.51	19.3	191						
1200		9	18.7	195						
1320		9.23	18.6	189						
1440		9.2	18.1	188						
1800										
2160										
2520										
2880										
3240										
3600										
3960										
4320										
4680										
5040										
5400										
5760										
6120										
6480										
7200										
7560										
7920										
8280										
8640										
9000										
9360										
9720										
10080										
10440										
10800										
11160										
11520										
11880										
12240										

City, State/Province Address Contact Info Company Name	Pumping Test Analysis Report a Project: 0129245 Number: Kangra Coal Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH3
Test conducted by:		Test date: 2011/06/11
Analysis performed by: erm	Theis	Date: 2011/06/11
Aquifer Thickness: 33.35 m	Discharge: variable, average rate 4.31 [l/s]	

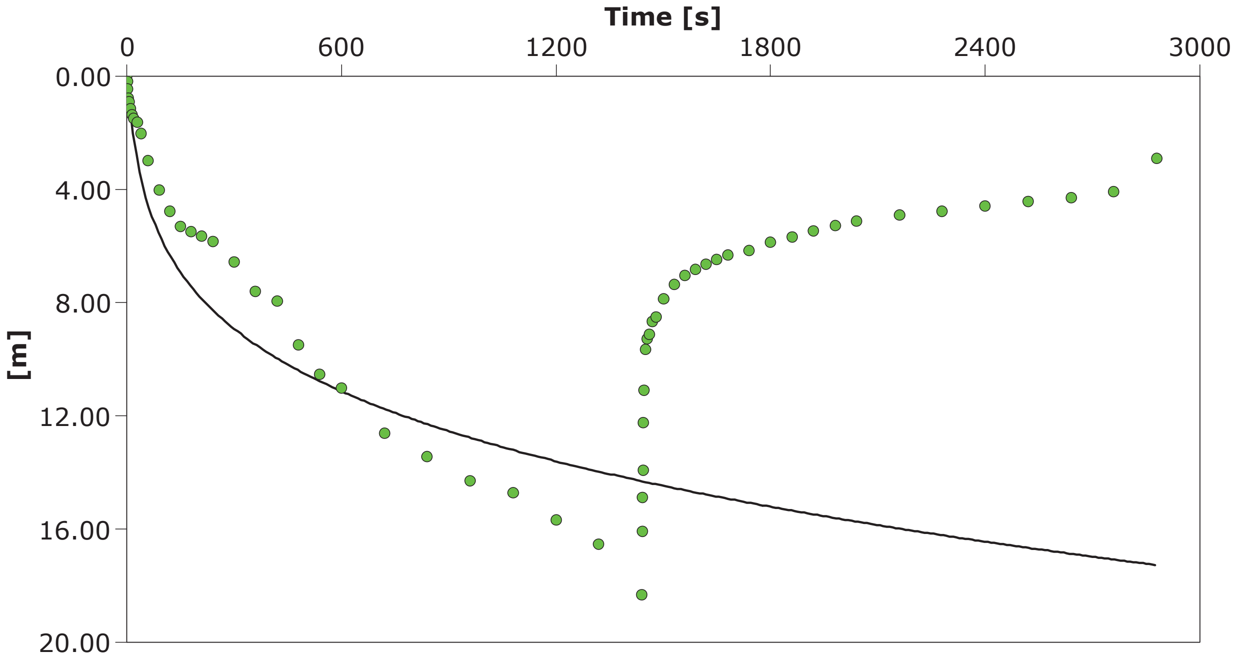


Calculation after Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH3	1.04×10^{1}	3.12×10^{-1}	5.00×10^{-1}	0.08	

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report** Project: 0129245 Number: Kangra Coal Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH3
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Jacob cooper	Date: 2011/06/11
Aquifer Thickness: 33.35 m	Discharge: variable, average rate 4.31 [l/s]	

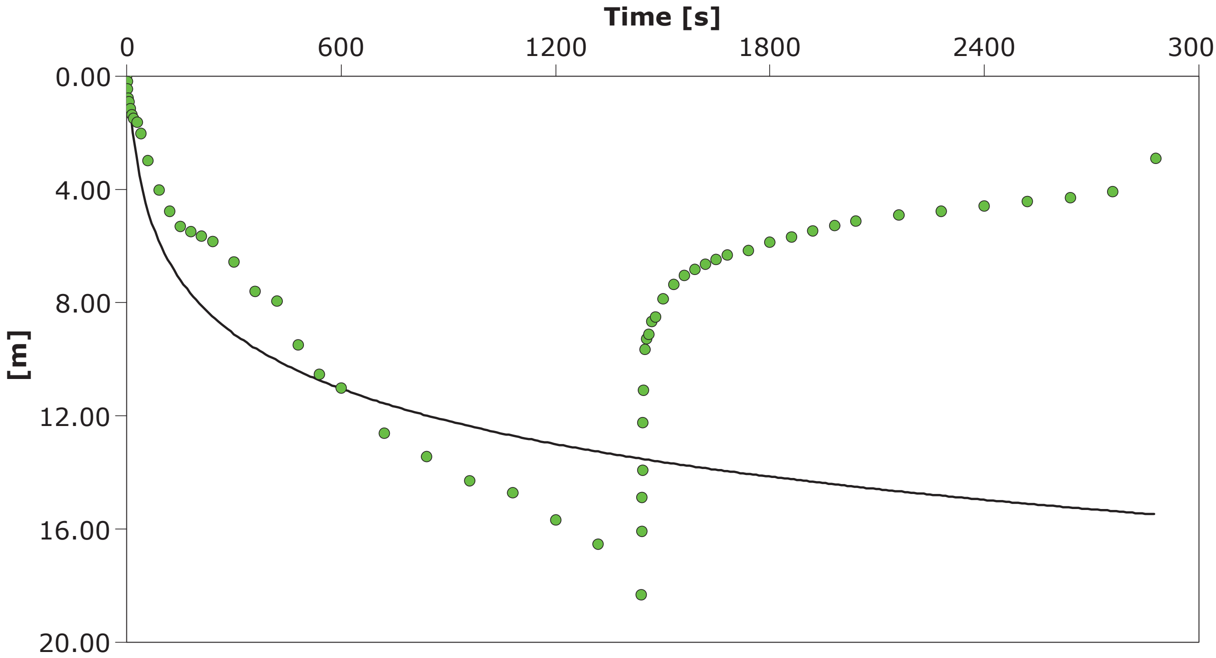


Calculation after Theis with Jacob Correction

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH3	1.31×10^{1}	3.93×10^{-1}	5.00×10^{-1}	0.08	

City, State/Province Address Contact Info Company Name	Pumping Test Analysis Report
	Project: 0129245
	Number: Kangra Coal
	Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH3
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Double porosity	Date: 2011/06/11
Aquifer Thickness: 33.35 m	Discharge: variable, average rate 4.31 [l/s]	

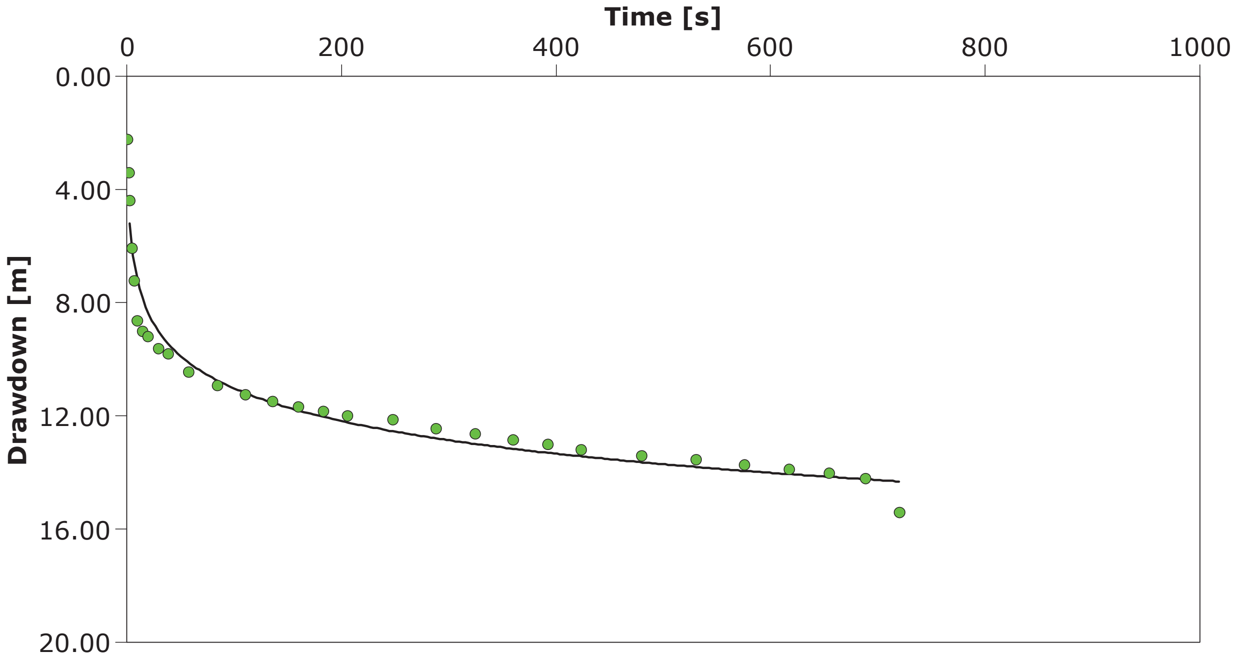


Calculation after Double Porosity

Observation well	Transmissivity [m²/d]	K [m/d]	Specific storage	Sigma	Lambda	Radial distance to PW [m]
ERMBH3	1.04×10^{1}	3.12×10^{-1}	5.00×10^{-1}	1.00×10^{0}	3.33×10^{-14}	0.08

City, State/Province Address Contact Info Company Name	Pumping Test Analysis Report Project: 0129245 Number: Kangra Coal Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH3
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Theis recovery	Date: 2011/06/11
Aquifer Thickness: 33.35 m	Discharge: variable, average rate 4.31 [l/s]	



Calculation after AGARWAL + Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH3	3.56×10^{1}	1.07×10^{0}	1.80×10^{-2}	0.08	

City, State/Province
Address
Contact Info
Company Name

Pumping Test Analysis Report

Project: 0129245

Number: Kangra Coal

Client: Kangra Coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH3
Test conducted by:		Test date: 2011/06/11
Aquifer Thickness: 33.35 m	Discharge: variable, average rate 4.31 [l/s]	

	Analysis Name	Analysis performed by	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Theis	erm	2011/06/11	Theis	ERMBH3	1.04×10^{1}	3.12×10^{-1}	5.00×10^{-1}
2	Jacob cooper		2011/06/11	Theis with Jacob Co	ERMBH3	1.31×10^{1}	3.93×10^{-1}	5.00×10^{-1}
3	Double porosity		2011/06/11	Double Porosity	ERMBH3	1.04×10^{1}	3.12×10^{-1}	5.00×10^{-1}
4	Theis recovery		2011/06/11	AGARWAL + Theis	ERMBH3	3.56×10^{1}	1.07×10^{0}	1.80×10^{-2}
					Average	1.74×10^{1}	5.21×10^{-1}	3.80×10^{-1}

Telephone: 043-732 1211
Fax no: 043-732 1422
Fax to e-mail: 0866 717 732
E mail: office@abpumps.co.za

BOREHOLE TEST RECORD

Ground water solutions t/a AB Pumps CC

PR0JECT #	P943
BBR	MARTIN
PRODUCTION BONUS:	
	PETER
EC meter number	20

CONSULTANT: ERM CONSULTING

DISTRICT: PIET RETIEF

PROVINCE: MPUMALANGA

FARM / VILLAGE NAME : DONKER POORT

DATE TESTED: 2011/04/12

MAP REFERENCE:

CO-ORDINATES:

FORMAT ON GPS: hddd ° mm ' ss.s " OR hddd ' mm.mmm ' OR hddd.ddddd °

LATITUDE: ° ' " OR ° ' OR 27.05965 °

LONGITUDE: ° ' " OR ° ' OR 30.30567 °

BOREHOLE NO: ERM BH04

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: NEW BOREHOLE

BOREHOLE DEPTH: (mbgl) 70.00

COMMENTS:

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	No	Test for:	macro	bacterio-logical
Date sample taken	2011/04/13		If consultant took sample, give name:		
Time sample taken	16H25				

DATA CAPTURED BY:	AILENE VAN NIEKERK
DATA CHECKED BY:	AILENE VAN NIEKERK

CONSULTANT GUIDELINES

BOREHOLE DEPTH:		m	STEP 1:		l/s	WATER STRIKE 1:		m
BLOW YIELD:		m	STEP 2:		l/s	WATER STRIKE 2:		m
STATIC WATER LEVEL:		m	STEP 3:		l/s	WATER STRIKE 3:		m
PUMP INSTALLATION DEPTH:		m	STEP 4:		l/s	**COMMENTS:**		
RECOVERY:			STEP 5:		l/s			
AFTER STEPS:		h	STEP 6:		l/s	TELEPHONE NUMBERS PHONE : (NAME & TEL)		
AFTER CONSTANT:		h	STEP DURATION:		min			

DESCRIPTION:	**UNIT**	**QTY**		**UNIT**	**QTY**
STRAIGHTNESS TEST:	**NO**	0	BOREHOLE DEPTH AFTER TEST:	**M**	70.00
VERTICALLY TEST:	**NO**	0	BOREHOLE WATER LEVEL AFTER TEST:	**M**	1.4
CASING DETECTION:	**NO**	1	SAND/GRAVEL/SILT PUMPED?	**YES/NO**	**0**
SUPPLIED NEW STEEL BOREHOLE COVER:	**NO**	0	DATA REPORTING AND RECORDING	**NO**	1
BOREHOLE MARKING	**NO**	0	SLUG TEST:	**NO**	0
SITE CLEANING & FINISHING	**NO**	1	LAYFLAT (M):	**M**	50
LOGGERS FOR WATERLEVEL MONITORING	**NO**	0	LOGGERS FOR pH AND EC:	**NO**	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ____________________ **SIGNATURE:** ________________

DESIGNATION: ____________________ **DATE:** ________________

BOREHOLE TEST CONTROL SHEET

Groundwater Solutions t/a AB PUMPS

Borehole number:	ERM BH04	Old / Alternative number:	
Contractor:	AB PUMPS	Supervisor:	JOHAN
Operator:	MARTIN	Rig number & Type rig:	36 TOYOTA

EXISTING EQUIPMENT

Type pump	Depth	Condition	Drive unit	Condition	Pump house	Condition	Remarks

TESTING EQUIPMENT

Pump type	Depth installed (m)	Date & time (started)	Date & time (completed)
P100	62.80	12/04/2011 11H00	12-04-2011 21H20

MULTI-RATE OR STEPTEST DETAILS

STEP	DURATION (MIN)	RECOVERY (MIN)	YIELD (L/S)		DRAWDOWN (m)
1	60		0.40	l/s	4.27
2	60		0.50	l/s	6.10
3	60		0.65	l/s	10.00
4	60		0.75	l/s	15.47
5	70	310	1.48	l/s	62.33
6				l/s	
7				l/s	
8				l/s	
Calibration:				l/s	
TOTAL:	310	310	3.78	l/s	98.17
COMMENT:					

CONSTANT RATE DISCHARGE TEST

Pump type	Depth installed (m)	Date & time (started)		Date & time (completed)	
P100	62.80	12/04/11	07H00	2011-04-15	07H00
Yield l/s	**Drawdown (m)**	**Duration (min)**		**Recovery (min)**	
0.50	9.77	1440		1440	
Total: (Multi-rate and Constant Discharge rate)		1750		1750	
COMMENT:					

MAINTENANCE

Work time: hour	Transport existing equipm. Km	Travelling (To fix); Km
List of parts replaced or repaired:		

	Borehole number	Duration (min) CONSTANT	Drawdown (m)	Hand/logger	Distance (m)
Observation Hole 1					0
Observation Hole 2					0
Observation Hole 3					0
Observation Hole 4					
Observation Hole 5					

GENERAL

ESTABLISHMENT	From:		To:			
Site Move	From project# P943		To #:	P943	Travelling km:	40
	Village	Borehole no	Village	Borehole no		
	DONKER POORT	ERM BH10	DONKER POORT	ERM BH04		
Maintenance:	Work time hr		Parts repaired/		Travelling km	
After test measurements	Water level	1.40	Borehole depth	70.00	Casing depth m	12.00
Water level before installing test pump:			0.38			
Depth before installing test pump:			70.00			
Testpump Installed	**Once** /Twice /More		Reason:			
Installed Testpump	**<10 l/s** / >10ls/s		Reason:			
Was existing equipment re-installed:			**No:**	If not where was it left:		
GPS Unit number:						
EC Unit number:			20.00			
Remarks:						
Signed Contractor:				Signed Consultant:		

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE: 0	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH04		DISTRICT:	PIET RETIEF
ALT BH NO:	0		SITE NAME:	DONKER POORT
ALT BH NO:	0			

BOREHOLE DEPTH (m)	70.00	DATUM LEVEL ABOVE CASING (m):	0.16	EXISTING PUMP:	0
WATER LEVEL (mbgl):	0.47	CASING HEIGHT: (magl):	0.40	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	62.80	DIAM PUMP INLET (mm):	165.00	PUMP TYPE:	P100

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE:	12/06/2011	TIME:	11H00		DATE:	21/04/2011	TIME:	12H00		DATE:	12/04/2011	TIME:	13H00	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.37		**1**		**1**	4.36		**1**		**1**	6.32		**1**	
2	2.82		**2**		**2**	4.64	0.51	**2**		**2**	6.49	0.60	**2**	
3	2.80		**3**		**3**	4.76		**3**		**3**	6.73	0.66	**3**	
5	3.50		**5**		**5**	5.17	0.51	**5**		**5**	7.10		**5**	
7	3.65	0.40	**7**		**7**	5.35		**7**		**7**	7.26	0.65	**7**	
10	3.66		**10**		**10**	5.47	0.51	**10**		**10**	7.92		**10**	
15	3.68	0.40	**15**		**15**	5.65		**15**		**15**	8.40	0.65	**15**	
20	3.73		**20**		**20**	5.74	0.51	**20**		**20**	8.93		**20**	
30	3.97	0.41	**30**		**30**	5.83		**30**		**30**	9.31	0.66	**30**	
40	4.10		**40**		**40**	5.86	0.50	**40**		**40**	9.47		**40**	
50	4.20	0.40	**50**		**50**	5.97		**50**		**50**	9.75	0.65	**50**	
60	4.27		**60**		**60**	6.10	0.50	**60**		**60**	10.00		**60**	
70			**70**		**70**			**70**		**70**			**70**	
80			**80**		**80**			**80**		**80**			**80**	
90			**90**		**90**			**90**		**90**			**90**	
100			**100**		**100**			**100**		**100**			**100**	
110			**110**		**110**			**110**		**110**			**110**	
120			**120**		**120**			**120**		**120**			**120**	
pH	10.43		**150**		**pH**	10.07		**150**		**pH**	9.34		**150**	
TEMP	26.10	℃	**180**		**TEMP**	21.00	℃	**180**		**TEMP**	21.20	℃	**180**	
EC	440.00	µS/cm	**210**		**EC**	340.00	µS/cm	**210**		**EC**	335.00	µS/cm	**210**	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE:	12/04/2011	TIME:	14H00		DATE:	12/04/2011	TIME:	15H00		DATE:		TIME:		
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	10.62		**1**		**1**	16.11		**1**	54.34	**1**			**1**	
2	11.66	0.78	**2**		**2**	16.64	1.16	**2**	47.94	**2**			**2**	
3	12.43		**3**		**3**	17.30	1.49	**3**	45.72	**3**			**3**	
5	12.85	0.75	**5**		**5**	19.76		**5**	39.56	**5**			**5**	
7	13.06		**7**		**7**	23.22	1.49	**7**	34.41	**7**			**7**	
10	13.42	0.76	**10**		**10**	27.22		**10**	28.97	**10**			**10**	
15	13.85		**15**		**15**	31.74	1.48	**15**	11.95	**15**			**15**	
20	14.11	0.75	**20**		**20**	34.83		**20**	7.92	**20**			**20**	
30	14.58		**30**		**30**	42.32	1.48	**30**	7.11	**30**			**30**	
40	14.96	0.75	**40**		**40**	50.01		**40**	6.59	**40**			**40**	
50	15.24		**50**		**50**	56.13	1.48	**50**	6.07	**50**			**50**	
60	15.47	0.75	**60**		**60**	60.84		**60**	5.53	**60**			**60**	
70			**70**		**63**	62.33	1.48	**70**	5.10	**70**			**70**	
80			**80**		**65**	62.33	0.85	**80**	4.75	**80**			**80**	
90			**90**		**67**	62.33	0.82	**90**	4.55	**90**			**90**	
100			**100**		**68**	62.33	0.78	**100**	4.36	**100**			**100**	
110			**110**		**110**			**110**	4.20	**110**			**110**	
120			**120**		**120**			**120**	4.00	**120**			**120**	
pH	9.34		**150**		**pH**	8.95		**150**	3.65	**pH**			**150**	
TEMP	19.80	℃	**180**		**TEMP**	15.40	℃	**180**	3.27	**TEMP**		℃	**180**	
EC	310.00	µS/cm	**210**		**EC**	329.00	µS/cm	**210**	3.03	**EC**		µS/cm	**210**	
			240					**240**	2.85				**240**	
			300					**300**	2.50				**300**	
			360					**310**	2.44				**360**	

S/W/L: 0.38

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	27.05965	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH04		30.30567	DISTRICT:	PIET RETIEF
ALT BH NO:	0			SITE NAME:	DONKER POORT
ALT BH NO:	0				
BOREHOLE DEPTH:	70.00	DATUM LEVEL ABOVE CASING (m):	0.16	EXISTING PUMP:	0
WATER LEVEL (mbgl):	1.87	CASING HEIGHT: (magl):	0.40	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	62.80	DIAM PUMP INLET(mm):	165	PUMP TYPE:	P100

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				TEST COMPLETED					
DATE:	13/04/2011	TIME:	07H00	DATE:		TIME:		TYPE OF PUMP:	P100

DISCHARGE BOREHOLE					OBSERVATION HOLE 1 NR: Distance(m);			OBSERVATION HOLE 2 NR: Distance(m);			OBSERVATION HOLE 3 NR: Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	1.11		1	7.95	1			1			1	
2	1.64		2	7.74	2			2			2	
3	1.98		3	7.18	3			3			3	
5	2.60	0.49	5	6.77	5			5			5	
7	2.96	0.50	7	6.49	7			7			7	
10	3.61		10	6.25	10			10			10	
15	4.42	0.50	15	5.96	15			15			15	
20	4.55		20	5.83	20			20			20	
30	4.68	0.50	30	5.46	30			30			30	
40	5.08		40	5.11	40			40			40	
60	5.51	0.50	60	4.66	60			60			60	
90	5.95		90	4.23	90			90			90	
120	6.30	0.51	120	3.88	120			120			120	
150	6.55		150	3.67	150			150			150	
180	6.77	0.50	180	3.40	180			180			180	
210	6.89		210	3.21	210			210			210	
240	7.08	0.50	240	3.02	240			240			240	
300	7.42		300	2.75	300			300			300	
360	7.76	0.52	360	2.51	360			360			360	
420	7.92		420	2.33	420			420			420	
480	8.01	0.52	480	2.23	480			480			480	
540	8.16		540	2.11	540			540			540	
600	8.28	0.51	600	1.98	600			600			600	
720	8.50		720	1.80	720			720			720	
840	8.66	0.50	840	1.74	840			840			840	
960	8.85		960	1.61	960			960			960	
1080	9.00	0.50	1080	1.51	1080			1080			1080	
1200	9.20		1200	1.38	1200			1200			1200	
1320	9.36	0.50	1320	1.25	1320			1320			1320	
1440	9.77		1440	1.02	1440			1440			1440	
1560			1560		1560			1560			1560	
1680			1680		1680			1680			1680	
1800			1800		1800			1800			1800	
1920			1920		1920			1920			1920	
2040			2040		2040			2040			2040	
2160			2160		2160			2160			2160	
2280			2280		2280			2280			2280	
2400			2400		2400			2400			2400	
2520			2520		2520			2520			2520	
2640			2640		2640			2640			2640	
2760			2760		2760			2760			2760	
2880			2880		2880			2880			2880	
3000			3000		3000			3000			3000	
3120			3120		3120			3120			3120	
3240			3240		3240			3240			3240	
3360			3360		3360			3360			3360	
3480			3480		3480			3480			3480	
3600			3600		3600			3600			3600	
3720			3720		3720			3720			3720	
3840			3840		3840			3840			3840	
3960			3960		3960			3960			3960	
4080			4080		4080			4080			4080	
4200			4200		4200			4200			4200	
4320			4320		4320			4320			4320	
Total time pumped(min):				1440		W/L			W/L			W/L
Average yield (l/s):				0.50								

FORM 5 F

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:		PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH04			DISTRICT:	PIET RETIEF
ALT BH NO:				SITE NAME:	DONKER POORT
ALT BH NO:					
BOREHOLE DEPTH:	70.00	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	0
WATER LEVEL (mbgl)::	1.87	CASING HEIGHT (magl):	0.00	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	62.80	DIAM PUMP INLET(mm):	0.00		

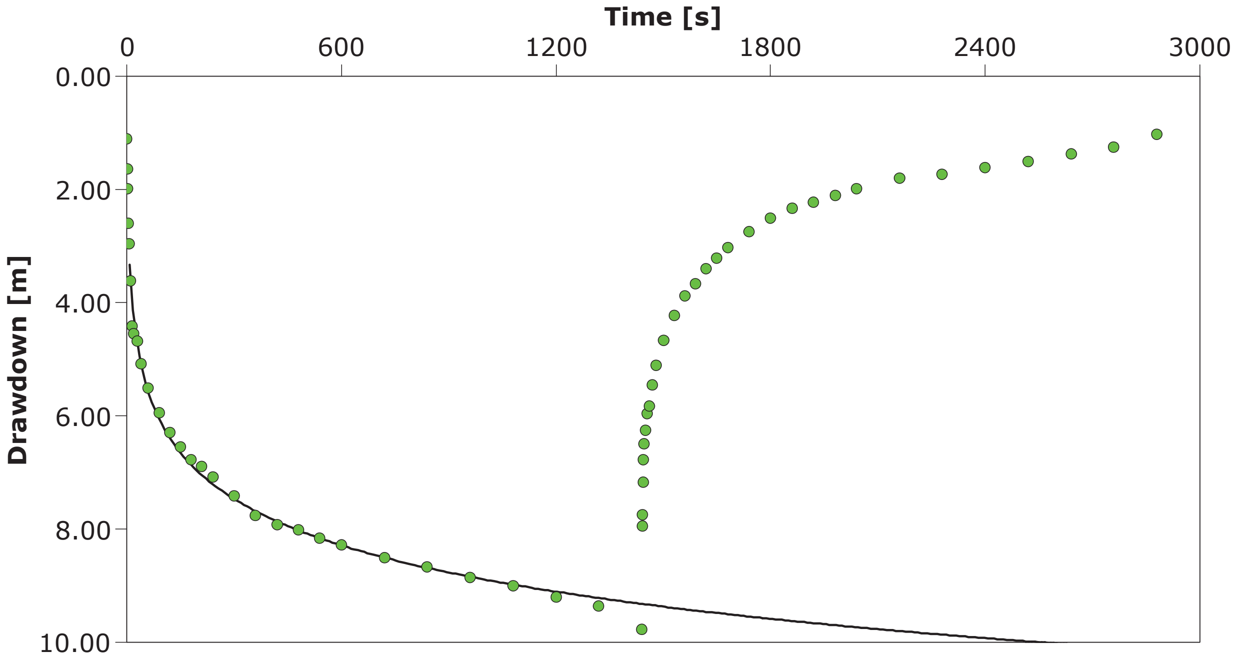
CONSTANT DISCHARGE TEST

DISCHARGE BOREHOLE

TIME (MIN)	REAL TIME	MEASUREMENTS				TIME (MIN)	REAL TIME	MEASUREMENTS		
		pH	TEMP ℃	EC µS/cm				pH	TEMP ℃	EC µS/cm
1		8.99	16.8	357						
120		8.67	20.2	288						
240		9.3	19.8	279						
360		9.01	23.7	267						
480		9.45	21.4	267						
600		9.32	21.6	259						
720		9.38	22.2	258						
840		9.11	19.8	257						
960		8.5	16.3	259						
1080		8.7	17.3	258						
1200		8.72	17.1	256						
1320		8.67	16.8	251						
1440		8.93	17.3	257						
1800										
2160										
2520										
2880										
3240										
3600										
3960										
4320										
4680										
5040										
5400										
5760										
6120										
6480										
7200										
7560										
7920										
8280										
8640										
9000										
9360										
9720										
10080										
10440										
10800										
11160										
11520										
11880										
12240										

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report**	
	Project: 0129245	
	Number: Kangra coal	
	Client: Kangra coal	

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH4
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Theis	Date: 2011/06/11
Aquifer Thickness: 69.53 m	Discharge: variable, average rate 0.25 [l/s]	



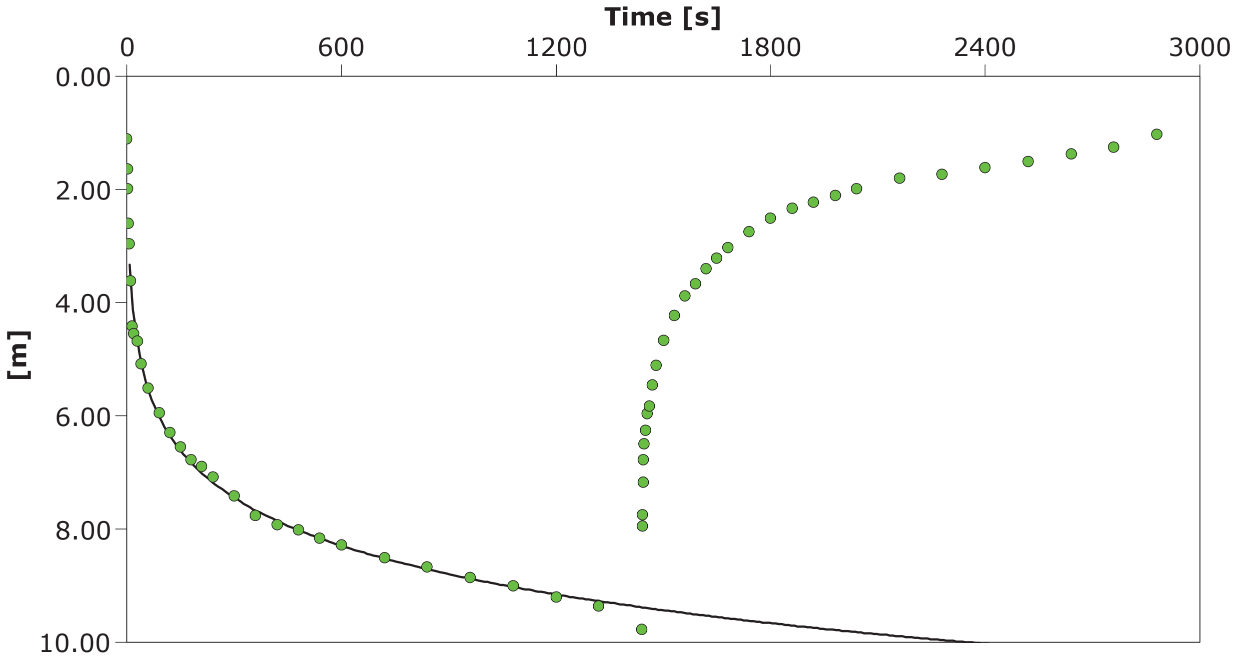
Calculation after Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH4	1.45×10^{0}	2.09×10^{-2}	3.02×10^{-3}	0.08	

City, State/Province
Address
Contact Info
Company Name

Pumping Test Analysis Report
Project: 0129245
Number: Kangra coal
Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH4
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Jacob cooper	Date: 2011/06/11
Aquifer Thickness: 69.53 m	Discharge: variable, average rate 0.25 [l/s]	

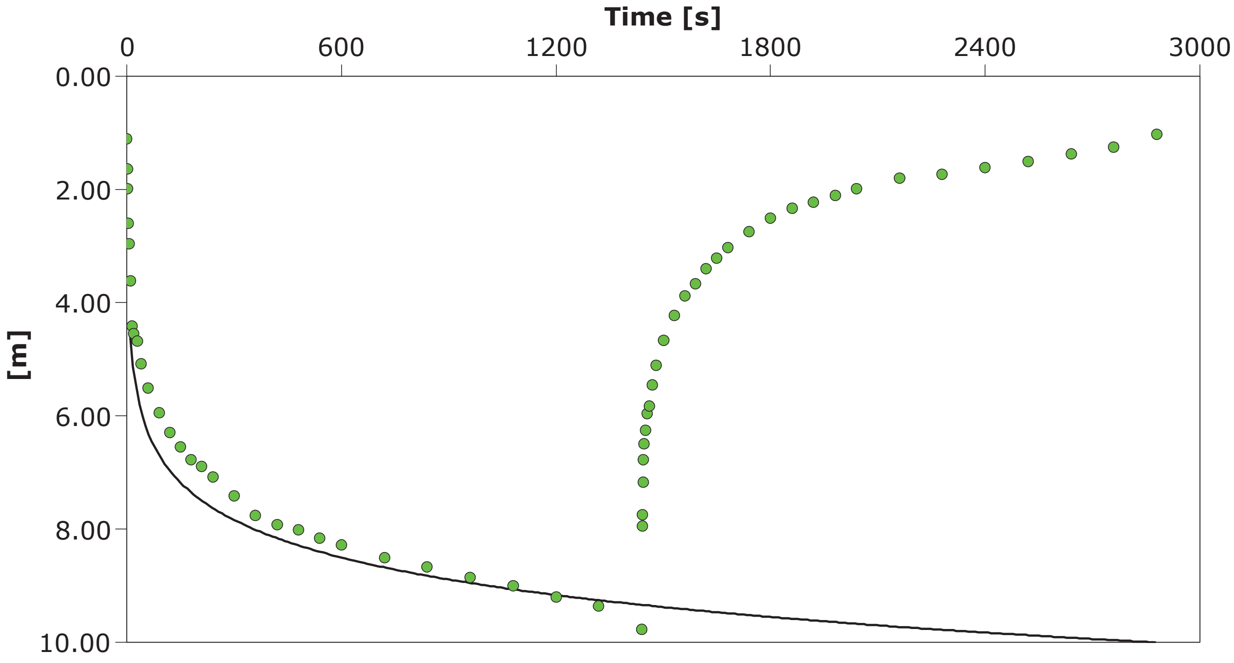


Calculation after Theis with Jacob Correction

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH4	1.59×10^{0}	2.28×10^{-2}	2.73×10^{-3}	0.08	

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report** Project: 0129245 Number: Kangra coal Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH4
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Double porosity	Date: 2011/06/11
Aquifer Thickness: 69.53 m	Discharge: variable, average rate 0.25 [l/s]	

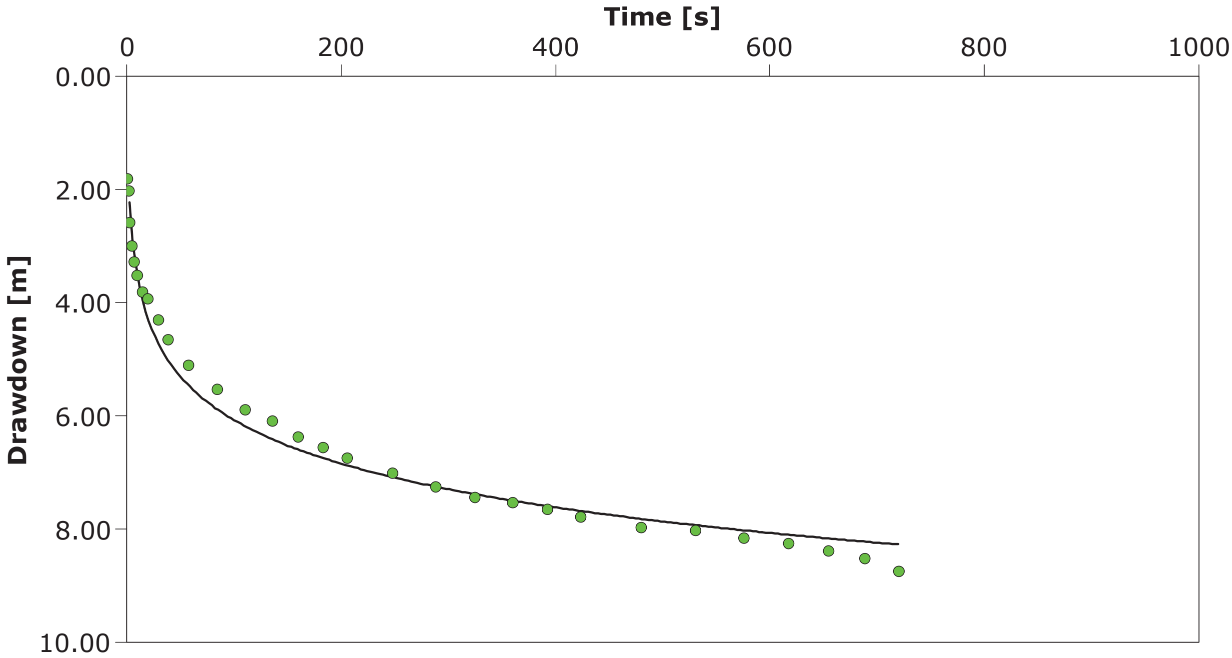


Calculation after Double Porosity

Observation well	Transmissivity [m²/d]	K [m/d]	Specific storage	Sigma	Lambda	Radial distance to PW [m]
ERMBH4	1.80×10^{0}	2.59×10^{-2}	5.66×10^{-4}	1.00×10^{0}	1.00×10^{-15}	0.08

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report**
	Project: 0129245
	Number: Kangra coal
	Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH4
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Theis Recovery	Date: 2011/06/11
Aquifer Thickness: 69.53 m	Discharge: variable, average rate 0.25 [l/s]	



Calculation after AGARWAL + Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH4	3.08×10^{0}	4.44×10^{-2}	5.08×10^{-3}	0.08	

City, State/Province Address Contact Info Company Name	Pumping Test Analysis Report Project: 0129245 Number: Kangra coal Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH4
Test conducted by:		Test date: 2011/06/11
Aquifer Thickness: 69.53 m	Discharge: variable, average rate 0.25 [l/s]	

	Analysis Name	Analysis performed	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Theis		2011/06/11	Theis	ERMBH4	1.45×10^{0}	2.09×10^{-2}	3.02×10^{-3}
2	Jacob cooper		2011/06/11	Theis with Jacob Co	ERMBH4	1.59×10^{0}	2.28×10^{-2}	2.73×10^{-3}
3	Double porosity		2011/06/11	Double Porosity	ERMBH4	1.80×10^{0}	2.59×10^{-2}	5.66×10^{-4}
4	Theis Recovery		2011/06/11	AGARWAL + Theis	ERMBH4	3.08×10^{0}	4.44×10^{-2}	5.08×10^{-3}
					Average	1.98×10^{0}	2.85×10^{-2}	2.85×10^{-3}

Report Date:	2011/04/11 13:35	
Report User Name:	User	
Report Computer Name:	USER-PC	
Log File Properties		
File Name	Slugtest ERMBH05_2011-04-11_13-34-25-896.wsl	
Create Date	2011/04/11 13:34	
Device Properties		
Device	Level TROLL 300	
Site	Piet Retief	
Device Name	Obuasi	
Serial Number	127154	
Firmware Version	2.04	
Hardware Version	2	
Log Configuration		
	Log Name	Slugtest ERMBH05
	Created By	User
	Computer Name	USER-PC
	Application	WinSitu.exe
	Application Version	5.6.16.0
	Create Date	2011/04/11 13:26
	Current Time Zone	South Africa Standard Time(Use Local Time)
	Notes Size(bytes)	4096
	Overwrite when full	Disabled
	Scheduled Start Time	Manual Start
	Scheduled Stop Time	No Stop Time
	Type	Fast Linear
	Interval	Days: 0 hrs: 00 mins: 00 secs: 01
Level Reference Settings At Log Creation		
	Level Measurement Mode	Level Depth To Water
	Specific Gravity	0.999
	Level Reference Mode:	Set first logged value to offset
	Level Reference Offset:	0 (m)
Other Log Settings		
	Zero Pressure Offset:	103.142 (kPa)
	Depth of Probe:	6.51919 (m)
	Head Pressure:	63.8674 (kPa)
	Temperature:	17.3335 (C)

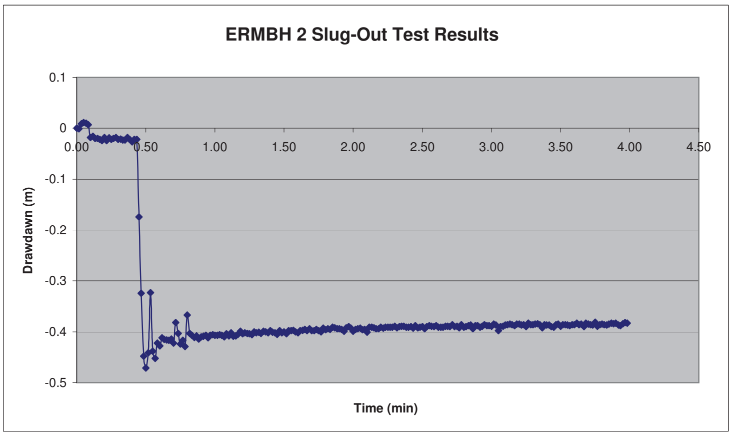
Log Notes:

Date and Time	Note
2011/04/11 13:26	Sensor: 127154 Factory calibration has expired.: 2009/02/09 06:59:44 PM
2011/04/11 13:26	Used Battery: 18% Used Memory: 12% User Name: User
2011/04/11 13:27	Manual Start Command
2011/04/11 13:34	Used Battery: 18% Used Memory: 12% User Name: User
2011/04/11 13:34	Manual Stop Command

Log Data:

Record Count	423	
Sensors	1	
	1	127154 Pressure/Temp 100 PSIA (60.1m/197.3ft)

Time Zone: South Africa Standard Time



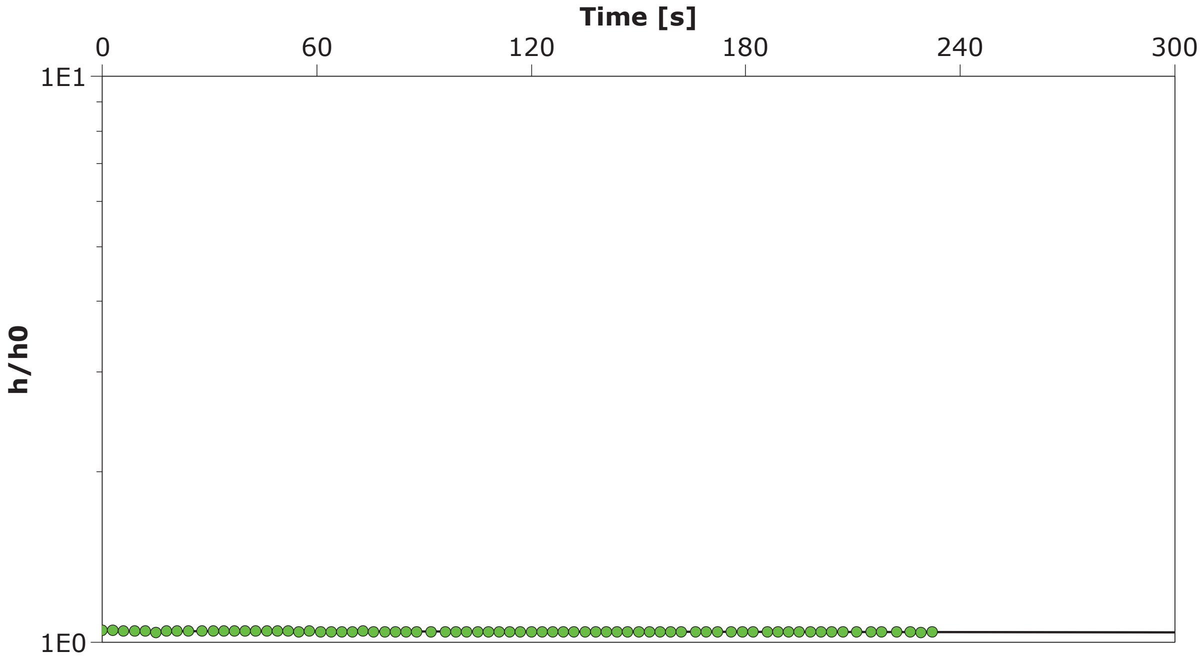
Date and Time	Elapsed Time Seconds		Sensor: Pres(A) 197.3ft SN#: 127154 Level Depth To Water (m)	Sensor: Pres(A) 197.3ft SN#: 127154 Temperature (C)
2011/04/11 13:27	0	0.00	0	17.072
2011/04/11 13:27	1.001	0.02	-0.001	17.072
2011/04/11 13:27	2.001	0.03	0.009	17.069
2011/04/11 13:27	3.001	0.05	0.011	17.065
2011/04/11 13:27	4.001	0.07	0.01	17.058
2011/04/11 13:27	5.001	0.08	0.007	17.067
2011/04/11 13:27	6.001	0.10	-0.018	17.056
2011/04/11 13:27	7.001	0.12	-0.016	17.052
2011/04/11 13:27	8.001	0.13	-0.02	17.048
2011/04/11 13:27	9.001	0.15	-0.02	17.045
2011/04/11 13:27	10.001	0.17	-0.022	17.051
2011/04/11 13:27	11.001	0.18	-0.024	17.039
2011/04/11 13:27	12.001	0.20	-0.018	17.032
2011/04/11 13:27	13.001	0.22	-0.024	17.029
2011/04/11 13:27	14.001	0.23	-0.019	17.023
2011/04/11 13:27	15.001	0.25	-0.022	17.029
2011/04/11 13:27	16.001	0.27	-0.02	17.019
2011/04/11 13:27	17.001	0.28	-0.018	17.015
2011/04/11 13:27	18.001	0.30	-0.022	17.009
2011/04/11 13:27	19.001	0.32	-0.021	17.006
2011/04/11 13:27	20.001	0.33	-0.023	17.011
2011/04/11 13:27	21.001	0.35	-0.023	17.002
2011/04/11 13:27	22.001	0.37	-0.018	16.997
2011/04/11 13:27	23.001	0.38	-0.022	16.993
2011/04/11 13:27	24.001	0.40	-0.027	16.986
2011/04/11 13:27	25.001	0.42	-0.022	16.99
2011/04/11 13:27	26.001	0.43	-0.022	16.981
2011/04/11 13:27	27.001	0.45	-0.174	16.977
2011/04/11 13:27	28.001	0.47	-0.324	16.971
2011/04/11 13:27	29.001	0.48	-0.448	16.971
2011/04/11 13:27	30.001	0.50	-0.471	16.976
2011/04/11 13:27	31.001	0.52	-0.441	16.965
2011/04/11 13:27	32.001	0.53	-0.323	16.961
2011/04/11 13:27	33.001	0.55	-0.438	16.957
2011/04/11 13:27	34.001	0.57	-0.452	16.95
2011/04/11 13:27	35.001	0.58	-0.422	16.959
2011/04/11 13:27	36.001	0.60	-0.428	16.946
2011/04/11 13:27	37.001	0.62	-0.412	16.941
2011/04/11 13:27	38.001	0.63	-0.415	16.937
2011/04/11 13:27	39.001	0.65	-0.416	16.935
2011/04/11 13:27	40.001	0.67	-0.417	16.941
2011/04/11 13:27	41.001	0.68	-0.414	16.932
2011/04/11 13:27	42.001	0.70	-0.422	16.923
2011/04/11 13:27	43.001	0.72	-0.382	16.92
2011/04/11 13:27	44.001	0.73	-0.403	16.913
2011/04/11 13:27	45.001	0.75	-0.424	16.925
2011/04/11 13:27	46.001	0.77	-0.417	16.912
2011/04/11 13:27	47.001	0.78	-0.429	16.906
2011/04/11 13:27	48.001	0.80	-0.367	16.905
2011/04/11 13:27	49.001	0.82	-0.403	16.901
2011/04/11 13:27	50.001	0.83	-0.407	16.907
2011/04/11 13:27	51.001	0.85	-0.411	16.898
2011/04/11 13:27	52.001	0.87	-0.408	16.892
2011/04/11 13:27	53.001	0.88	-0.414	16.889
2011/04/11 13:28	54.001	0.90	-0.41	16.886
2011/04/11 13:28	55.001	0.92	-0.409	16.895
2011/04/11 13:28	56.001	0.93	-0.407	16.882
2011/04/11 13:28	57.001	0.95	-0.412	16.879
2011/04/11 13:28	58.001	0.97	-0.407	16.873
2011/04/11 13:28	59.001	0.98	-0.406	16.869
2011/04/11 13:28	60.001	1.00	-0.407	16.878
2011/04/11 13:28	61.001	1.02	-0.407	16.871
2011/04/11 13:28	62.001	1.03	-0.406	16.86
2011/04/11 13:28	63.001	1.05	-0.407	16.858
2011/04/11 13:28	64.001	1.07	-0.41	16.853
2011/04/11 13:28	65.001	1.08	-0.404	16.861
2011/04/11 13:28	66.001	1.10	-0.408	16.852
2011/04/11 13:28	67.001	1.12	-0.402	16.848
2011/04/11 13:28	68.001	1.13	-0.409	16.843
2011/04/11 13:28	69.001	1.15	-0.408	16.841
2011/04/11 13:28	70.001	1.17	-0.405	16.847
2011/04/11 13:28	71.001	1.18	-0.399	16.836
2011/04/11 13:28	72.001	1.20	-0.404	16.83
2011/04/11 13:28	73.001	1.22	-0.402	16.829
2011/04/11 13:28	74.001	1.23	-0.403	16.824
2011/04/11 13:28	75.001	1.25	-0.404	16.834
2011/04/11 13:28	76.001	1.27	-0.406	16.824
2011/04/11 13:28	77.001	1.28	-0.4	16.82
2011/04/11 13:28	78.001	1.30	-0.402	16.816
2011/04/11 13:28	79.001	1.32	-0.401	16.814
2011/04/11 13:28	80.001	1.33	-0.403	16.819
2011/04/11 13:28	81.001	1.35	-0.399	16.811
2011/04/11 13:28	82.001	1.37	-0.4	16.806
2011/04/11 13:28	83.001	1.38	-0.402	16.8
2011/04/11 13:28	84.001	1.40	-0.398	16.798
2011/04/11 13:28	85.001	1.42	-0.401	16.806
2011/04/11 13:28	86.001	1.43	-0.402	16.796
2011/04/11 13:28	87.001	1.45	-0.405	16.792
2011/04/11 13:28	88.001	1.47	-0.398	16.792
2011/04/11 13:28	89.001	1.48	-0.402	16.782
2011/04/11 13:28	90.001	1.50	-0.4	16.792
2011/04/11 13:28	91.001	1.52	-0.404	16.784
2011/04/11 13:28	92.001	1.53	-0.398	16.78
2011/04/11 13:28	93.001	1.55	-0.398	16.776
2011/04/11 13:28	94.001	1.57	-0.397	16.775
2011/04/11 13:28	95.001	1.58	-0.4	16.792

2011/04/11 13:28	96.001	1.60	-0.402	16.773
2011/04/11 13:28	97.001	1.62	-0.398	16.77
2011/04/11 13:28	98.001	1.63	-0.397	16.764
2011/04/11 13:28	99.001	1.65	-0.395	16.761
2011/04/11 13:28	100.001	1.67	-0.398	16.769
2011/04/11 13:28	101.001	1.68	-0.394	16.76
2011/04/11 13:28	102.001	1.70	-0.398	16.756
2011/04/11 13:28	103.001	1.72	-0.398	16.753
2011/04/11 13:28	104.001	1.73	-0.395	16.748
2011/04/11 13:28	105.001	1.75	-0.398	16.757
2011/04/11 13:28	106.001	1.77	-0.4	16.746
2011/04/11 13:28	107.001	1.78	-0.393	16.743
2011/04/11 13:28	108.001	1.80	-0.396	16.739
2011/04/11 13:28	109.001	1.82	-0.394	16.736
2011/04/11 13:28	110.001	1.83	-0.395	16.747
2011/04/11 13:28	111.001	1.85	-0.391	16.736
2011/04/11 13:28	112.001	1.87	-0.392	16.735
2011/04/11 13:28	113.001	1.88	-0.394	16.728
2011/04/11 13:29	114.001	1.90	-0.394	16.73
2011/04/11 13:29	115.001	1.92	-0.395	16.736
2011/04/11 13:29	116.001	1.93	-0.399	16.725
2011/04/11 13:29	117.001	1.95	-0.392	16.724
2011/04/11 13:29	118.001	1.97	-0.39	16.717
2011/04/11 13:29	119.001	1.98	-0.393	16.715
2011/04/11 13:29	120.001	2.00	-0.399	16.724
2011/04/11 13:29	121.001	2.02	-0.395	16.716
2011/04/11 13:29	122.001	2.03	-0.394	16.712
2011/04/11 13:29	123.001	2.05	-0.393	16.705
2011/04/11 13:29	124.001	2.07	-0.396	16.704
2011/04/11 13:29	125.001	2.08	-0.395	16.715
2011/04/11 13:29	126.001	2.10	-0.401	16.705
2011/04/11 13:29	127.001	2.12	-0.391	16.703
2011/04/11 13:29	128.001	2.13	-0.391	16.697
2011/04/11 13:29	129.001	2.15	-0.392	16.695
2011/04/11 13:29	130.001	2.17	-0.394	16.706
2011/04/11 13:29	131.001	2.18	-0.394	16.695
2011/04/11 13:29	132.001	2.20	-0.391	16.692
2011/04/11 13:29	133.001	2.22	-0.393	16.691
2011/04/11 13:29	134.001	2.23	-0.391	16.683
2011/04/11 13:29	135.001	2.25	-0.391	16.692
2011/04/11 13:29	136.001	2.27	-0.391	16.687
2011/04/11 13:29	137.001	2.28	-0.391	16.679
2011/04/11 13:29	138.001	2.30	-0.389	16.679
2011/04/11 13:29	139.001	2.32	-0.392	16.676
2011/04/11 13:29	140.001	2.33	-0.39	16.687
2011/04/11 13:29	141.001	2.35	-0.389	16.677
2011/04/11 13:29	142.001	2.37	-0.389	16.672
2011/04/11 13:29	143.001	2.38	-0.391	16.67
2011/04/11 13:29	144.001	2.40	-0.391	16.668
2011/04/11 13:29	145.001	2.42	-0.39	16.676
2011/04/11 13:29	146.001	2.43	-0.393	16.666
2011/04/11 13:29	147.001	2.45	-0.388	16.663
2011/04/11 13:29	148.001	2.47	-0.392	16.662
2011/04/11 13:29	149.001	2.48	-0.391	16.658
2011/04/11 13:29	150.001	2.50	-0.39	16.667
2011/04/11 13:29	151.001	2.52	-0.394	16.658
2011/04/11 13:29	152.001	2.53	-0.39	16.657
2011/04/11 13:29	153.001	2.55	-0.388	16.653
2011/04/11 13:29	154.001	2.57	-0.389	16.648
2011/04/11 13:29	155.001	2.58	-0.39	16.658
2011/04/11 13:29	156.001	2.60	-0.388	16.649
2011/04/11 13:29	157.001	2.62	-0.391	16.649
2011/04/11 13:29	158.001	2.63	-0.391	16.643
2011/04/11 13:29	159.001	2.65	-0.391	16.641
2011/04/11 13:29	160.001	2.67	-0.389	16.653
2011/04/11 13:29	161.001	2.68	-0.389	16.643
2011/04/11 13:29	162.001	2.70	-0.39	16.638
2011/04/11 13:29	163.001	2.72	-0.386	16.635
2011/04/11 13:29	164.001	2.73	-0.39	16.635
2011/04/11 13:29	165.001	2.75	-0.389	16.645
2011/04/11 13:29	166.001	2.77	-0.392	16.634
2011/04/11 13:29	167.001	2.78	-0.386	16.63
2011/04/11 13:29	168.001	2.80	-0.391	16.629
2011/04/11 13:29	169.001	2.82	-0.39	16.626
2011/04/11 13:29	170.001	2.83	-0.388	16.632
2011/04/11 13:29	171.001	2.85	-0.387	16.627
2011/04/11 13:29	172.001	2.87	-0.394	16.625
2011/04/11 13:29	173.001	2.88	-0.388	16.62
2011/04/11 13:30	174.001	2.90	-0.388	16.617
2011/04/11 13:30	175.003	2.92	-0.391	16.629
2011/04/11 13:30	176.001	2.93	-0.389	16.619
2011/04/11 13:30	177.001	2.95	-0.386	16.615
2011/04/11 13:30	178.001	2.97	-0.388	16.614
2011/04/11 13:30	179.001	2.98	-0.388	16.611
2011/04/11 13:30	180.001	3.00	-0.389	16.622
2011/04/11 13:30	181.001	3.02	-0.385	16.61
2011/04/11 13:30	182.001	3.03	-0.387	16.608
2011/04/11 13:30	183.001	3.05	-0.398	16.605
2011/04/11 13:30	184.001	3.07	-0.39	16.602
2011/04/11 13:30	185.002	3.08	-0.389	16.612
2011/04/11 13:30	186.001	3.10	-0.387	16.605
2011/04/11 13:30	187.001	3.12	-0.386	16.6
2011/04/11 13:30	188.001	3.13	-0.385	16.597
2011/04/11 13:30	189.001	3.15	-0.386	16.595
2011/04/11 13:30	190.011	3.17	-0.388	16.607
2011/04/11 13:30	191.001	3.18	-0.385	16.6
2011/04/11 13:30	192.001	3.20	-0.385	16.591
2011/04/11 13:30	193.001	3.22	-0.387	16.589
2011/04/11 13:30	194.001	3.23	-0.386	16.587
2011/04/11 13:30	195.019	3.25	-0.39	16.599
2011/04/11 13:30	196.001	3.27	-0.383	16.591
2011/04/11 13:30	197.001	3.28	-0.386	16.587
2011/04/11 13:30	198.001	3.30	-0.386	16.585
2011/04/11 13:30	199.001	3.32	-0.385	16.583

2011/04/11 13:30	200.028	3.33	-0.384	16.594
2011/04/11 13:30	201.001	3.35	-0.386	16.583
2011/04/11 13:30	202.001	3.37	-0.392	16.58
2011/04/11 13:30	203.001	3.38	-0.386	16.576
2011/04/11 13:30	204.001	3.40	-0.387	16.576
2011/04/11 13:30	205.035	3.42	-0.387	16.585
2011/04/11 13:30	206.001	3.43	-0.39	16.579
2011/04/11 13:30	207.001	3.45	-0.391	16.574
2011/04/11 13:30	208.001	3.47	-0.386	16.572
2011/04/11 13:30	209.001	3.48	-0.385	16.566
2011/04/11 13:30	210.043	3.50	-0.389	16.581
2011/04/11 13:30	211.001	3.52	-0.386	16.573
2011/04/11 13:30	212.001	3.53	-0.386	16.57
2011/04/11 13:30	213.001	3.55	-0.387	16.566
2011/04/11 13:30	214.001	3.57	-0.388	16.562
2011/04/11 13:30	215.058	3.58	-0.386	16.575
2011/04/11 13:30	216.001	3.60	-0.386	16.566
2011/04/11 13:30	217.001	3.62	-0.383	16.56
2011/04/11 13:30	218.001	3.63	-0.386	16.559
2011/04/11 13:30	219.001	3.65	-0.385	16.556
2011/04/11 13:30	220.188	3.67	-0.39	16.568
2011/04/11 13:30	221.001	3.68	-0.383	16.561
2011/04/11 13:30	222.001	3.70	-0.385	16.556
2011/04/11 13:30	223.001	3.72	-0.386	16.553
2011/04/11 13:30	224.001	3.73	-0.387	16.552
2011/04/11 13:30	225.001	3.75	-0.381	16.562
2011/04/11 13:30	226.001	3.77	-0.389	16.553
2011/04/11 13:30	227.001	3.78	-0.386	16.55
2011/04/11 13:30	228.001	3.80	-0.385	16.545
2011/04/11 13:30	229.001	3.82	-0.386	16.547
2011/04/11 13:30	230.082	3.83	-0.387	16.558
2011/04/11 13:30	231.001	3.85	-0.385	16.549
2011/04/11 13:30	232.001	3.87	-0.383	16.546
2011/04/11 13:30	233.001	3.88	-0.384	16.543
2011/04/11 13:31	234.001	3.90	-0.383	16.541
2011/04/11 13:31	235.089	3.92	-0.387	16.55
2011/04/11 13:31	236.001	3.93	-0.388	16.543
2011/04/11 13:31	237.001	3.95	-0.384	16.541
2011/04/11 13:31	238.001	3.97	-0.382	16.537
2011/04/11 13:31	239.001	3.98	-0.383	16.534
2011/04/11 13:31	240.098	4.00	-0.381	16.546
2011/04/11 13:31	241.001	4.02	-0.391	16.535
2011/04/11 13:31	242.001	4.03	-0.384	16.534
2011/04/11 13:31	243.001	4.05	-0.383	16.532
2011/04/11 13:31	244.001	4.07	-0.386	16.53
2011/04/11 13:31	245.105	4.09	-0.387	16.54
2011/04/11 13:31	246.001	4.10	-0.381	16.534
2011/04/11 13:31	247.001	4.12	-0.384	16.533
2011/04/11 13:31	248.001	4.13	-0.384	16.526
2011/04/11 13:31	249.001	4.15	-0.384	16.522
2011/04/11 13:31	250.113	4.17	-0.387	16.535
2011/04/11 13:31	251.001	4.18	-0.384	16.527
2011/04/11 13:31	252.001	4.20	-0.381	16.522
2011/04/11 13:31	253.001	4.22	-0.38	16.525
2011/04/11 13:31	254.001	4.23	-0.384	16.521
2011/04/11 13:31	255.115	4.25	-0.384	16.532
2011/04/11 13:31	256.001	4.27	-0.387	16.524
2011/04/11 13:31	257.001	4.28	-0.388	16.518
2011/04/11 13:31	258.001	4.30	-0.38	16.517
2011/04/11 13:31	259.001	4.32	-0.382	16.516
2011/04/11 13:31	260.123	4.34	-0.339	16.527
2011/04/11 13:31	261.001	4.35	-0.41	16.518
2011/04/11 13:31	262.001	4.37	-0.353	16.513
2011/04/11 13:31	263.001	4.38	-0.411	16.511
2011/04/11 13:31	264.001	4.40	-0.385	16.511
2011/04/11 13:31	265.131	4.42	-0.372	16.52
2011/04/11 13:31	266.001	4.43	-0.4	16.517
2011/04/11 13:31	267.001	4.45	-0.38	16.514
2011/04/11 13:31	268.001	4.47	-0.196	16.508
2011/04/11 13:31	269.001	4.48	-0.254	16.505
2011/04/11 13:31	270.139	4.50	0.015	16.514
2011/04/11 13:31	271.001	4.52	0.034	16.511
2011/04/11 13:31	272.001	4.53	0.027	16.504
2011/04/11 13:31	273.001	4.55	0.025	16.502
2011/04/11 13:31	274.001	4.57	0.028	16.506
2011/04/11 13:31	275.154	4.59	0.021	16.511
2011/04/11 13:31	276.001	4.60	0.027	16.507
2011/04/11 13:31	277.001	4.62	0.023	16.503
2011/04/11 13:31	278.001	4.63	0.019	16.5
2011/04/11 13:31	279.001	4.65	0.021	16.497
2011/04/11 13:31	280.163	4.67	0.017	16.507
2011/04/11 13:31	281.001	4.68	0.023	16.503
2011/04/11 13:31	282.001	4.70	0.024	16.498
2011/04/11 13:31	283.001	4.72	0.027	16.497
2011/04/11 13:31	284.001	4.73	0.022	16.492
2011/04/11 13:31	285.17	4.75	0.022	16.507
2011/04/11 13:31	286.001	4.77	0.02	16.495

City, State/Province **Address** **Contact Info** **Company Name**	**Slug Test Analysis Report** a Project: 0129245 Number: Kangra Coal Client: Kangra Coal

Location:	Slug Test: Slug Test Out	Test Well: ERMBH5
Test conducted by: ab pumps		Test date: 2011/06/09
Analysis performed by: ERM	Bouwer & Rice	Date: 2011/06/09
Aquifer Thickness: 81.22 m		



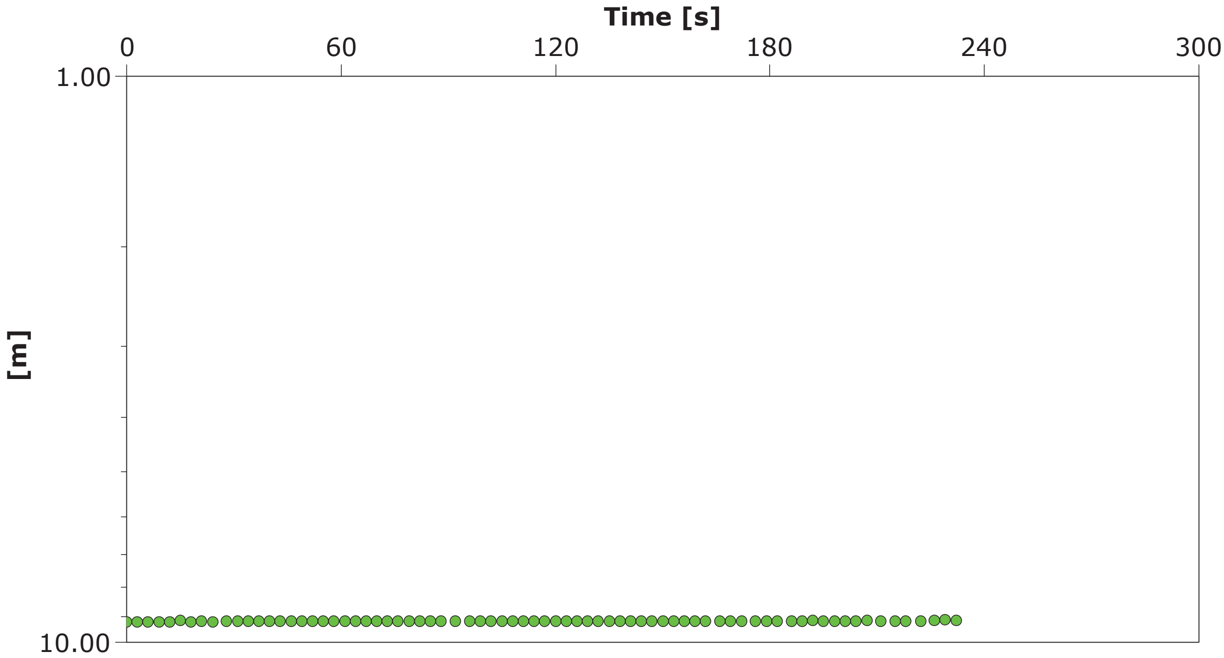
Calculation after Bouwer && Rice

Observation well	K [m/d]	
ERMBH5	3.50×10^{-4}	

City, State/Province
Address
Contact Info
Company Name

Slug Test Analysis Report		A
Project: 0129245		
Number: Kangra Coal		
Client: Kangra Coal		

Location:	Slug Test: Slug Test Out	Test Well: ERMBH5
Test conducted by: ab pumps		Test date: 2011/06/09
Analysis performed by: ERM	CBP	Date: 2011/06/09
Aquifer Thickness: 81.22 m		

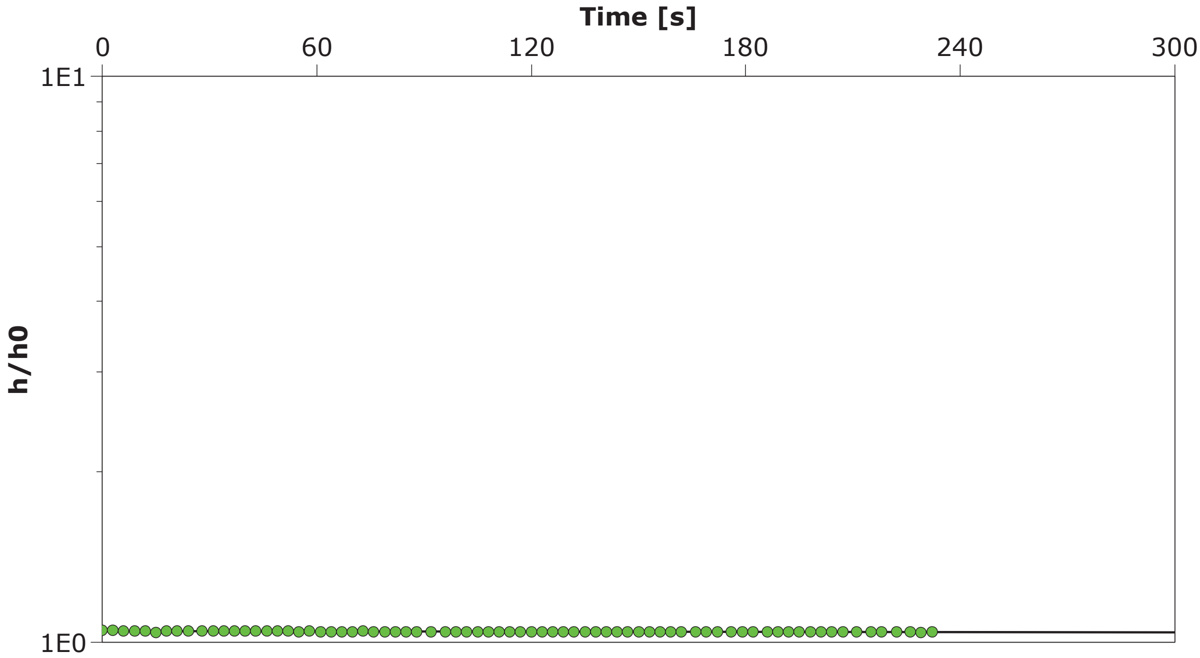


Calculation after Cooper-Bredehoeft-Papadopulos

Observation well	Transmissivity [m²/d]	K [m/d]	Well-bore storage coefficient	
ERMBH5	8.64×10^{5}	1.06×10^{4}	1.46×10^{-31}	

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report** A Project: 0129245 Number: Kangra Coal Client: Kangra Coal

Location:	Slug Test: Slug Test Out	Test Well: ERMBH5
Test conducted by: ab pumps		Test date: 2011/06/09
Analysis performed by: ERM	hVORSLEV	Date: 2011/06/09
Aquifer Thickness: 81.22 m		



Calculation after Hvorslev

Observation well	K [m/d]	
ERMBH5	4.15×10^{-4}	

City, State/Province
Address
Contact Info
Company Name

Slug Test - Analyses Report	A
Project: 0129245	
Number: Kangra Coal	
Client: Kangra Coal	

Location:	Slug Test: Slug Test Out	Test Well: ERMBH5
Test conducted by: ab pumps		Test date: 2011/06/09
Aquifer Thickness: 56.66 m		

	Analysis Name	Analysis performed by	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Bouwer & Rice	ERM	2011/06/09	Bouwer && Rice	ERMBH5		3.61×10^{-4}	
2	hVORSLEV	ERM	2011/06/09	Hvorslev	ERMBH5		4.29×10^{-4}	
3	CBP	ERM	2011/06/09	Cooper-Bredehoeft-Papadopulos	ERMBH5	8.64×10^{5}	1.52×10^{4}	1.46×10^{-31}
					Average	8.64×10^{5}	5.08×10^{3}	1.46×10^{-31}

Telephone: 043-732 1211
Fax no: 043-732 1422
Fax to e-mail: 0866 717 732
E mail: office@abpumps.co.za

BOREHOLE TEST RECORD

Ground water solutions t/a AB Pumps CC

PR0JECT #	P943
BBR	MARTIN
PRODUCTION BONUS:	PETER
EC meter number	20

CONSULTANT: ERM
DISTRICT: PIET RETIEF
PROVINCE: MPUMALANGA
FARM / VILLAGE NAME : DONKER HOEK

DATE TESTED: 2011/04/05

MAP REFERENCE:

CO-ORDINATES:

FORMAT ON GPS: hddd ° mm ' ss.s " hddd ° mm.mmm ' hddd.ddddd °

LATITUDE: ° ' " OR ° ' OR 27.04789 °
LONGITUDE: ° ' " ° ' 30.24784 °

BOREHOLE NO: ERM BH07
TRANSMISSIVITY VALUE:
TYPE INSTALLATION: NEW BOREHOLE
BOREHOLE DEPTH: (mbgl) 100.00

COMMENTS: NONE

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	**No**	Test for:	**macro**	**bacterio-logical**	
Date sample taken			If consultant took sample, give name:			
Time sample taken						

DATA CAPTURED BY:	AILENE VAN NIEKERK
DATA CHECKED BY:	AILENE VAN NIEKERK

CONSULTANT GUIDELINES

BOREHOLE DEPTH:		m	STEP 1:		l/s	WATER STRIKE 1:			m
BLOW YIELD:		m	STEP 2:		l/s	WATER STRIKE 2:			m
STATIC WATER LEVEL:		m	STEP 3:		l/s	WATER STRIKE 3:			m
PUMP INSTALLATION DEPTH:		m	STEP 4:		l/s	**COMMENTS:**			
RECOVERY:			STEP 5:		l/s				
AFTER STEPS:		h	STEP 6:		l/s	TELEPHONE NUMBERS PHONE : (NAME & TEL)			
AFTER CONSTANT:		h	STEP DURATION:		min				

DESCRIPTION:	**UNIT**	**QTY**		**UNIT**	**QTY**
STRAIGHTNESS TEST:	**NO**	0	BOREHOLE DEPTH AFTER TEST:	**M**	100.00
VERTICALLY TEST:	**NO**	0	BOREHOLE WATER LEVEL AFTER TEST:	**M**	5.35
CASING DETECTION:	**NO**	1	SAND/GRAVEL/SILT PUMPED?	**YES/NO**	**NO**
SUPPLIED NEW STEEL BOREHOLE COVER:	**NO**	0	DATA REPORTING AND RECORDING	**NO**	1
BOREHOLE MARKING	**NO**	0	SLUG TEST:	**NO**	1
SITE CLEANING & FINISHING	**NO**	1	LAYFLAT (M):	**M**	50
LOGGERS FOR WATERLEVEL MONITORING	**NO**	0	LOGGERS FOR pH AND EC:	**NO**	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ____________ **SIGNATURE:** ____________
DESIGNATION: ____________ **DATE:** ____________

BOREHOLE TEST CONTROL SHEET
Groundwater Solutions t/a AB PUMPS

Borehole number:	ERM BH07	Old / Alternative number:	
Contractor:	AB PUMPS	Supervisor:	JOHAN
Operator:	MARTIN	Rig number & Type rig:	6 TOYOTA

EXISTING EQUIPMENT

Type pump	Depth	Condition	Drive unit	Condition	Pump house	Condition	Remarks

TESTING EQUIPMENT

Pump type	Depth installed (m)	Date & time (started)	Date & time (completed)
P100	92.80	05/04/2011 13H00	06/04/2011 0H30

MULTI-RATE OR STEPTEST DETAILS

STEP	DURATION (MIN)	RECOVERY (MIN)	YIELD (L/S)		DRAWDOWN (m)
1	60		0.30	l/s	3.79
2	60		0.61	l/s	6.44
3	60		0.92	l/s	16.53
4	60		1.30	l/s	32.12
5	60		1.80	l/s	50.08
6	40	340	2.59	l/s	87.93
7				l/s	
8				l/s	
Calibration:				l/s	
TOTAL:	340	340	7.52	l/s	196.89

COMMENT:

CONSTANT RATE DISCHARGE TEST

Pump type	Depth installed (m)	Date & time (started)	Date & time (completed)
P100	92.80		
Yield l/s	**Drawdown (m)**	**Duration (min)**	**Recovery (min)**
0.00		1440	
Total: (Multi-rate and Constant Discharge rate)		1780	340

COMMENT:

MAINTENANCE

Work time: hour	Transport existing equipm. Km	Travelling (To fix); Km

List of parts replaced or repaired:

	Borehole number	Duration (min) CONSTANT	Drawdown (m)	Hand/logger	Distance (m)
Observation Hole 1					0
Observation Hole 2					0
Observation Hole 3					0
Observation Hole 4					
Observation Hole 5					

GENERAL

ESTABLISHMENT	From:		To:			
Site Move	From project#		To #:	P943	Travelling km:	
	Village	Borehole no	Village	Borehole no		
			DONKER HOEK	ERM BH07		
Maintenance:	Work time hr		Parts repaired/		Travelling km	
After test measurements	Water level	5.35	Borehole depth	100.00	Casing depth m	

Water level before installing test pump:		5.35		
Depth before installing test pump:		100.00		
Testpump Installed	**Once** /Twice /More	Reason:		
Installed Testpump	**<10 l/s** / >10ls/s	Reason:		
Was existing equipment re-installed:	**Yes:**	**No:**	If not where was it left:	
GPS Unit number:				
EC Unit number:		20.00		

Remarks:

Signed Contractor:	Signed Consultant:

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	0	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH07			DISTRICT:	PIET RETIEF
ALT BH NO:	0			SITE NAME:	DONKER HOEK
ALT BH NO:	0				
BOREHOLE DEPTH (m)	100.00	DATUM LEVEL ABOVE CASING (m):	0.33	EXISTING PUMP:	0
WATER LEVEL (mbgl):	4.87	CASING HEIGHT: (magl):	0.52	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	92.80	DIAM PUMP INLET (mm):	165.00	PUMP TYPE:	P100

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 — RPM — DATE: 05/04/2011 TIME: 13H00

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.92		1	
2	1.61		2	
3	1.92		3	
5	2.64	0.31	5	
7	2.89		7	
10	3.09	0.31	10	
15	3.22		15	
20	3.28	0.30	20	
30	3.36		30	
40	3.48	0.30	40	
50	3.60		50	
60	3.79	0.30	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	9.26		150	
TEMP	16.50	℃	180	
EC	107.00	µS/cm	210	

DISCHARGE RATE 2 — RPM — DATE: 05/04/2011 TIME: 14H00

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	4.05		1	
2	4.37	0.61	2	
3	4.45		3	
5	4.70	0.60	5	
7	4.97		7	
10	5.20	0.60	10	
15	5.54		15	
20	5.71	0.61	20	
30	5.98		30	
40	6.27	0.61	40	
50	6.36		50	
60	6.44	0.61	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	9.21		150	
TEMP	16.30	℃	180	
EC	106.00	µS/cm	210	

DISCHARGE RATE 3 — RPM — DATE: 05/08/2011 TIME: 15H00

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	6.60		1	
2	6.78	0.93	2	
3	6.95		3	
5	7.67	0.93	5	
7	8.00		7	
10	8.74	0.93	10	
15	9.92		15	
20	11.07	0.92	20	
30	12.33		30	
40	13.90	0.92	40	
50	14.72		50	
60	16.53	0.92	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	9.37		150	
TEMP	15.30	℃	180	
EC	107.00	µS/cm	210	

DISCHARGE RATE 4 — RPM — DATE: 05/04/2011 TIME: 16H00

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	16.82		1	
2	17.45	1.30	2	
3	18.42		3	
5	19.02	1.30	5	
7	20.34		7	
10	21.56	1.31	10	
15	23.56		15	
20	26.35	1.30	20	
30	27.78		30	
40	29.61	1.30	40	
50	30.90		50	
60	32.12	1.30	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	9.60		150	
TEMP	15.20	℃	180	
EC	129.00	µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 5 — RPM — DATE: 05-04-2011 TIME: 17H00

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	32.85		1	
2	33.62	1.80	2	
3	34.21		3	
5	35.62	1.80	5	
7	36.47		7	
10	38.00	1.81	10	
15	40.28		15	
20	41.85	1.81	20	
30	44.84		30	
40	47.10	1.81	40	
50	48.43		50	
60	50.08	1.80	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	9.53		150	
TEMP	15.40	℃	180	
EC	126.00	µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 6 — RPM — DATE: 05-04-2011 TIME: 18H00

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	51.14		1	62.20
2	51.58	2.31	2	60.33
3	54.92	3.00	3	60.25
5	56.56		5	60.21
7	58.19	3.00	7	59.97
10	59.82		10	59.72
15	61.43	3.00	15	59.40
20	64.05		20	58.70
30	72.26	3.00	30	57.96
40	87.93		40	57.25
50	87.93	2.26	50	56.58
60	87.93	2.12	60	55.79
70	87.93	2.04	70	55.19
80		2.59	80	54.34
90			90	53.47
100			100	52.59
110			110	51.70
120			120	50.86
pH	9.61		150	43.98
TEMP	15.10	℃	180	30.07
EC	128.00	µS/cm	210	23.14
			240	16.18
			300	8.21
			340	3.27

S/W/L: 4.66

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	27.04789	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH07		30.24784	DISTRICT:	PIET RETIEF
ALT BH NO:	0			SITE NAME:	DONKER HOEK
ALT BH NO:	0				
BOREHOLE DEPTH:	100.00	DATUM LEVEL ABOVE CASING (m):	0.33	EXISTING PUMP:	0
WATER LEVEL (mbgl):	5.47	CASING HEIGHT: (magl):	0.52	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	92.80	DIAM PUMP INLET(mm):	165	PUMP TYPE:	P100

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**					
DATE:	06/04/2011	TIME:	07H20	DATE:		TIME:		TYPE OF PUMP:	P100

					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
	DISCHARGE BOREHOLE				Distance(m);			Distance(m);			Distance(m);	
TIME	DRAW	YIELD	TIME	RECOVERY	TIME:	Drawdown	Recovery	TIME:	Drawdown	Recovery	TIME:	Drawdown
(MIN)	DOWN (M)	(L/S)	MIN	(M)	(min)	m	(m)	(min)	(m)		(min)	(m)
1	2.38		**1**	53.61	**1**			**1**			**1**	
2	3.74	1.22	**2**	52.81	**2**			**2**			**2**	
3	5.00		**3**	52.50	**3**			**3**			**3**	
5	6.16	1.22	**5**	52.29	**5**			**5**			**5**	
7	7.30		**7**	52.00	**7**			**7**			**7**	
10	8.47	1.22	**10**	51.73	**10**			**10**			**10**	
15	11.70		**15**	51.43	**15**			**15**			**15**	
20	14.01	1.21	**20**	50.91	**20**			**20**			**20**	
30	18.33		**30**	50.16	**30**			**30**			**30**	
40	20.90	1.21	**40**	49.09	**40**			**40**			**40**	
60	23.72		**60**	46.75	**60**			**60**			**60**	
90	26.77	1.22	**90**	42.69	**90**			**90**			**90**	
120	28.07		**120**	37.37	**120**			**120**			**120**	
150	29.16	1.22	**150**	29.77	**150**			**150**			**150**	
180	31.66		**180**	19.39	**180**			**180**			**180**	
210	33.75	1.22	**210**	7.30	**210**			**210**			**210**	
240	35.09		**240**	3.28	**240**			**240**			**240**	
300	36.34	1.20	**300**	2.15	**300**			**300**			**300**	
360	37.17		**360**	1.80	**360**			**360**			**360**	
420	37.96	1.20	**420**	1.58	**420**			**420**			**420**	
480	39.68		**480**	1.43	**480**			**480**			**480**	
540	41.46	1.21	**540**	1.32	**540**			**540**			**540**	
600	43.77		**600**	1.22	**600**			**600**			**600**	
720	50.55	1.22	**720**	1.11	**720**			**720**			**720**	
840	52.22		**840**	1.08	**840**			**840**			**840**	
960	53.85	1.21	**960**	0.99	**960**			**960**			**960**	
1080	55.46		**1080**	0.89	**1080**			**1080**			**1080**	
1200	57.13	1.22	**1200**	0.81	**1200**			**1200**			**1200**	
1320	58.79		**1320**	0.69	**1320**			**1320**			**1320**	
1440	59.98	1.22	**1440**	0.63	**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1440		**W/L**			**W/L**			**W/L**
Average yield (l/s):				1.20								

FORM 5 F

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:		PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH07			DISTRICT:	PIET RETIEF
ALT BH NO:				SITE NAME:	DONKER HOEK
ALT BH NO:					
BOREHOLE DEPTH:	100.00	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	0
WATER LEVEL (mbgl)::	5.47	CASING HEIGHT (magl):	0.00	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	92.80	DIAM PUMP INLET(mm):	0.00		

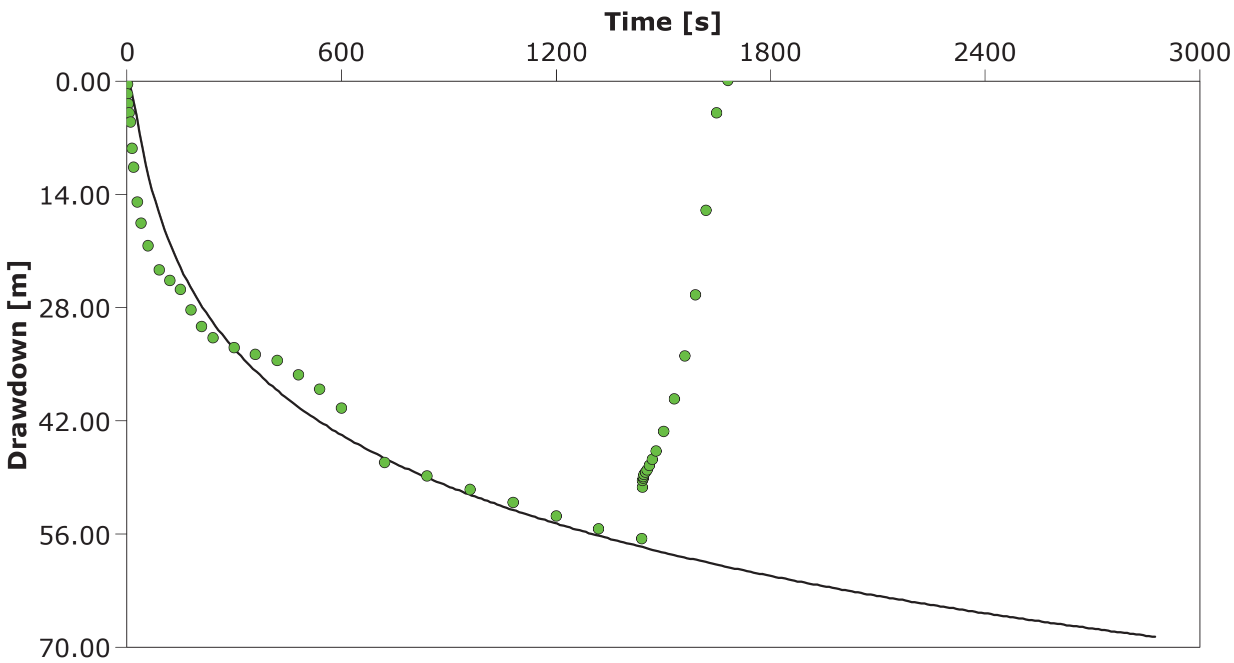
CONSTANT DISCHARGE TEST

DISCHARGE BOREHOLE

TIME (MIN)	REAL TIME	MEASUREMENTS				TIME (MIN)	REAL TIME	MEASUREMENTS		
		pH	TEMP ℃	EC µS/cm				pH	TEMP ℃	EC µS/cm
1		9.57	15	225						
120		9.45	16.5	97						
240		9.17	17.2	101						
360		9.82	18.1	96						
480		9.1	16.9	114						
600		9.17	16	112						
720		9.16	16.4	113						
840		9.17	16.6	116						
960		9.53	15.3	105						
1080		9.54	15	107						
1200		9.52	14.3	106						
1320		9.52	15.9	102						
1440		9.65	16.3	141						
1800										
2160										
2520										
2880										
3240										
3600										
3960										
4320										
4680										
5040										
5400										
5760										
6120										
6480										
7200										
7560										
7920										
8280										
8640										
9000										
9360										
9720										
10080										
10440										
10800										
11160										
11520										
11880										
12240										

City, State/Province **Address** **Contact Info** **Company Name**	**Pumping Test Analysis Report** Project: 0129245 Number: Kangra coal Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH7
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Theis	Date: 2011/06/11
Aquifer Thickness: 95.60 m	Discharge: variable, average rate 0.6 [l/s]	

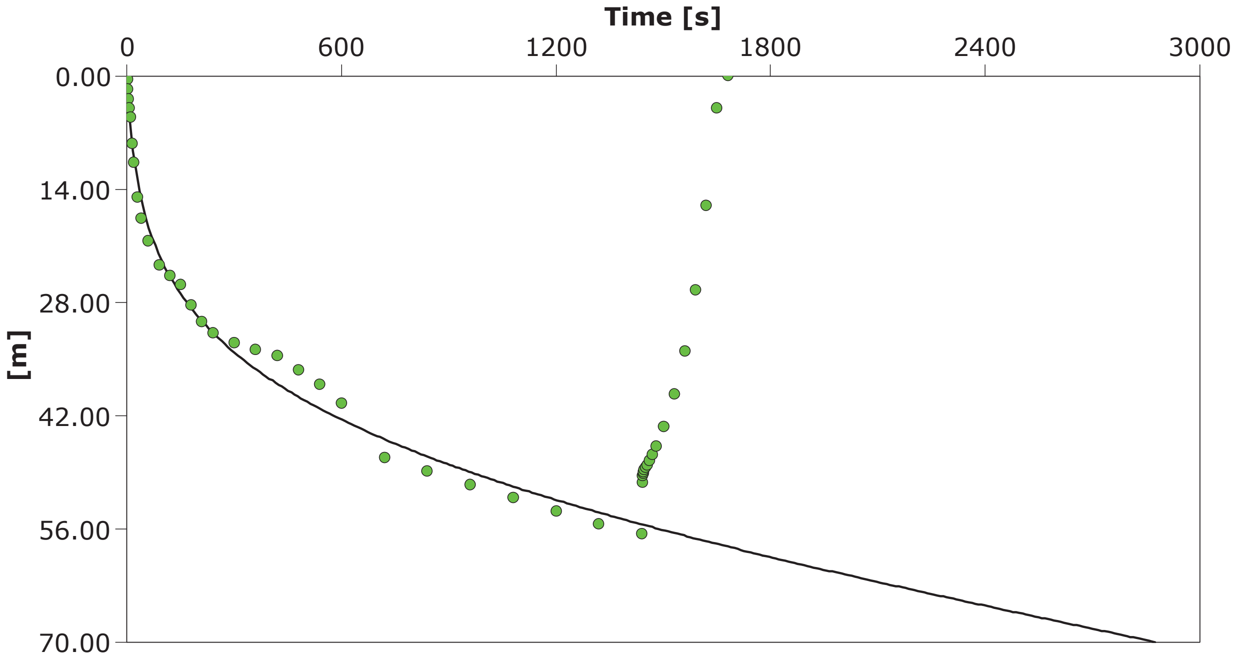


Calculation after Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH7	2.54×10^{-1}	2.66×10^{-3}	4.10×10^{-2}	0.08	

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report** Project: 0129245 Number: Kangra coal Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH7
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Jacob cooper	Date: 2011/06/11
Aquifer Thickness: 95.60 m	Discharge: variable, average rate 0.6 [l/s]	

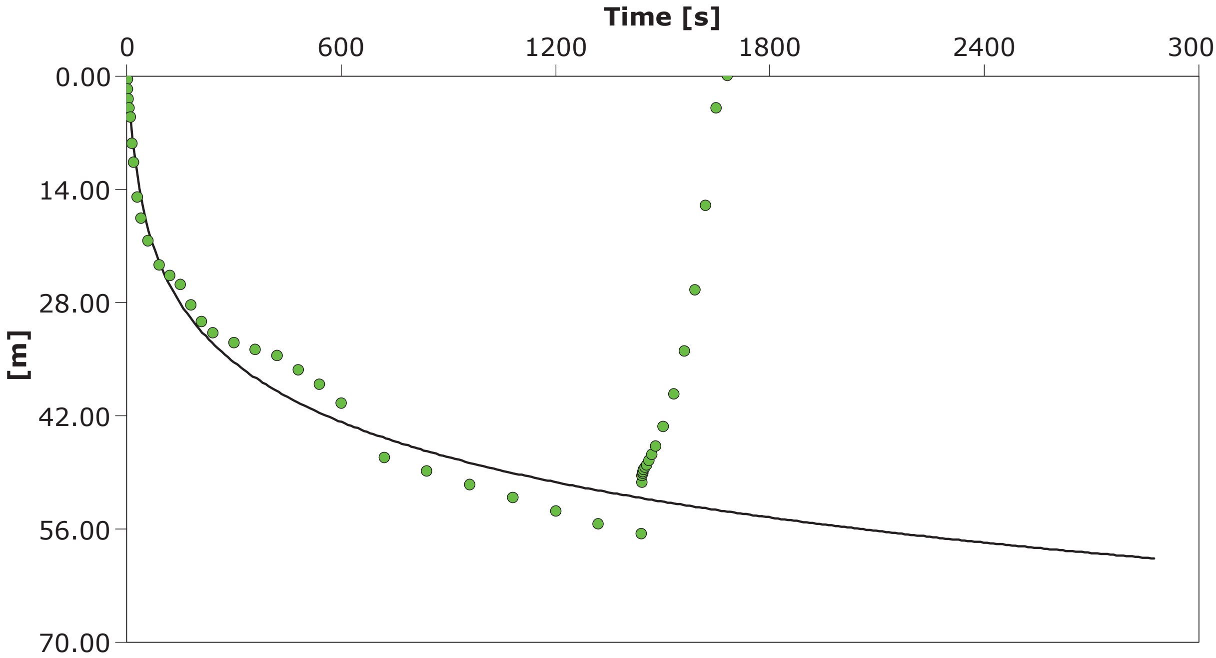


Calculation after Theis with Jacob Correction

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH7	5.69×10^{-1}	5.95×10^{-3}	1.38×10^{-2}	0.08	

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report** Project: 0129245 Number: Kangra coal Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH7
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Double porosity	Date: 2011/06/11
Aquifer Thickness: 95.60 m	Discharge: variable, average rate 0.6 [l/s]	

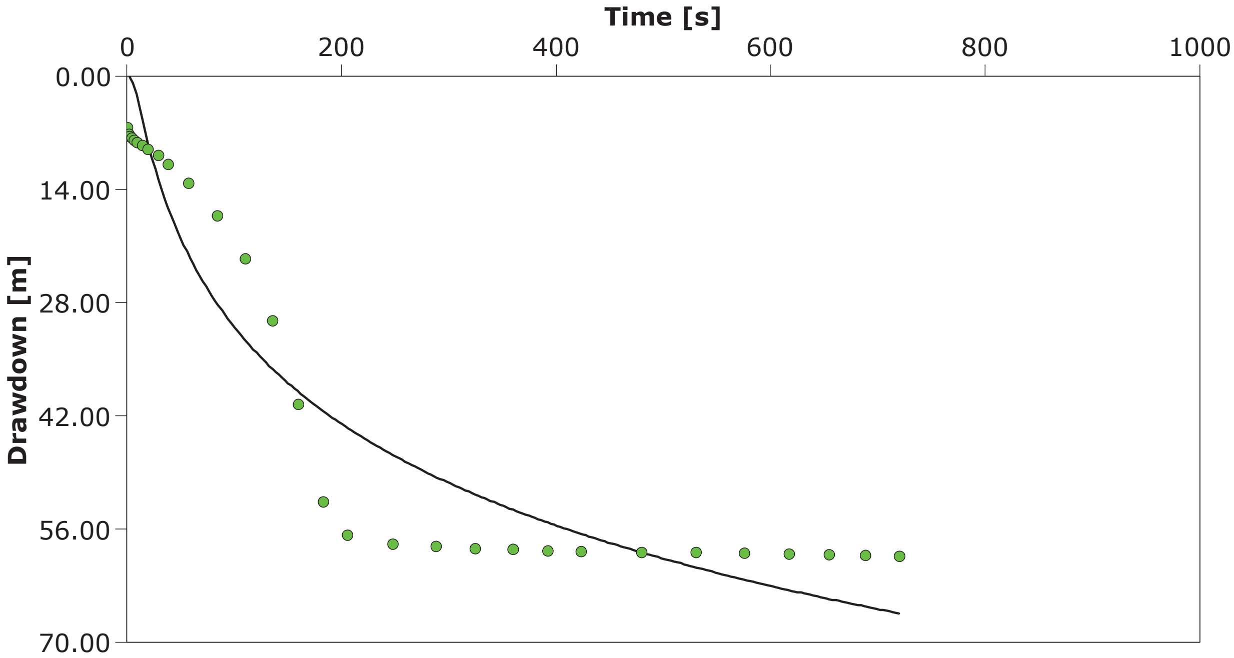


Calculation after Double Porosity

Observation well	Transmissivity [m²/d]	K [m/d]	Specific storage	Sigma	Lambda	Radial distance to PW [m]
ERMBH7	3.81×10^{-1}	3.98×10^{-3}	1.71×10^{-2}	1.00×10^{0}	1.00×10^{-15}	0.08

City, State/Province Address Contact Info Company Name	**Pumping Test Analysis Report** Project: 0129245 Number: Kangra coal Client: Kangra coal	

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH7
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	Theis recovery	Date: 2011/06/11
Aquifer Thickness: 95.60 m	Discharge: variable, average rate 0.6 [l/s]	



Calculation after AGARWAL + Theis

Observation well	Transmissivity [m²/d]	K [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH7	4.36×10^{-1}	4.56×10^{-3}	3.65×10^{-2}	0.08	

City, State/Province **Address** **Contact Info** **Company Name**	**Pumping Test Analysis Report** Project: 0129245 Number: Kangra coal Client: Kangra coal

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH7
Test conducted by:		Test date: 2011/06/11
Aquifer Thickness: 95.60 m	Discharge: variable, average rate 0.6 [l/s]	

	Analysis Name	Analysis performed	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Theis		2011/06/11	Theis	ERMBH7	2.54×10^{-1}	2.66×10^{-3}	4.10×10^{-2}
2	Jacob cooper		2011/06/11	Theis with Jacob Co	ERMBH7	5.69×10^{-1}	5.95×10^{-3}	1.38×10^{-2}
3	Double porosity		2011/06/11	Double Porosity	ERMBH7	3.81×10^{-1}	3.98×10^{-3}	1.71×10^{-2}
4	Theis recovery		2011/06/11	AGARWAL + Theis	ERMBH7	4.36×10^{-1}	4.56×10^{-3}	3.65×10^{-2}
					Average	4.10×10^{-1}	4.29×10^{-3}	2.71×10^{-2}

Telephone: 043-732 1211
Fax no: 043-732 1422
Fax to e-mail: 0866 717 732
E mail: office@abpumps.co.za

BOREHOLE TEST RECORD

Ground water solutions t/a AB Pumps CC

PR0JECT #	P943
BBR	MARTIN
PRODUCTION BONUS:	PETER
EC meter number	20

CONSULTANT: ERM CONSULTING
DISTRICT: PIXLEGKA SEME ROAD
PROVINCE: MPUMALANGA
FARM / VILLAGE NAME : DONKER HOEK 14HT

DATE TESTED: 2011/03/31

MAP REFERENCE:

CO-ORDINATES:

FORMAT ON GPS: hddd ° mm ' ss.s " hddd ' mm.mmm ' hddd.ddddd °

LATITUDE: ° ' " OR ° ' OR 27.01596 °
LONGITUDE: ° ' " ° ' 30.28630 °

BOREHOLE NO: ERM BH08
TRANSMISSIVITY VALUE:
TYPE INSTALLATION: NEW BOREHOLE
BOREHOLE DEPTH: (mbgl) 59.95

COMMENTS: NONE

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	No	Test for:	macro	bacterio-logical
Date sample taken	2011/04/01		If consultant took sample, give name:		
Time sample taken	22H13				

DATA CAPTURED BY:	AILENE VAN NIEKERK
DATA CHECKED BY:	AILENE VAN NIEKERK

CONSULTANT GUIDELINES

BOREHOLE DEPTH:		m	STEP 1:		l/s	WATER STRIKE 1:			m
BLOW YIELD:		m	STEP 2:		l/s	WATER STRIKE 2:			m
STATIC WATER LEVEL:		m	STEP 3:		l/s	WATER STRIKE 3:			m
PUMP INSTALLATION DEPTH:		m	STEP 4:		l/s	**COMMENTS:**			
RECOVERY:			STEP 5:		l/s				
AFTER STEPS:		h	STEP 6:		l/s	TELEPHONE NUMBERS PHONE : (NAME & TEL)			
AFTER CONSTANT:		h	STEP DURATION:		min				

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	59.95
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M	17.81
CASING DETECTION:	NO	1	SAND/GRAVEL/SILT PUMPED?	YES/NO	0
SUPPLIED NEW STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	1
BOREHOLE MARKING	NO	0	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	1	LAYFLAT (M):	M	50
LOGGERS FOR WATERLEVEL MONITORING	NO	0	LOGGERS FOR pH AND EC:	NO	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ________________ **SIGNATURE:** ______________
DESIGNATION: ________________ **DATE:** ______________

BOREHOLE TEST CONTROL SHEET
Groundwater Solutions t/a AB PUMPS

Borehole number:	ERM BH08	Old / Alternative number:	
Contractor:	AB PUMPS	Supervisor:	JOHAN
Operator:	MARTIN	Rig number & Type rig:	36 TOYOTA

EXISTING EQUIPMENT

Type pump	Depth	Condition	**Drive unit**	Condition	**Pump house**	Condition	**Remarks**
NA							

TESTING EQUIPMENT

Pump type	**Depth installed (m)**	**Date & time (started)**	**Date & time (completed)**
P100	54.80	31-03-2011 18H00	31-03-2011 20H30

MULTI-RATE OR STEPTEST DETAILS

STEP	DURATION (MIN)	RECOVERY (MIN)	YIELD (L/S)		DRAWDOWN (m)
1	60		0.21	l/s	3.24
2	60		0.51	l/s	7.58
3	60		0.63	l/s	12.37
4	60		1.42	l/s	28.43
5	10	250	1.62	l/s	44.05
6				l/s	
7				l/s	
8				l/s	
Calibration:				l/s	
TOTAL:	250	250	4.39	l/s	95.67
COMMENT:					

CONSTANT RATE DISCHARGE TEST

Pump type	**Depth installed (m)**	**Date & time (started)**		**Date & time (completed)**	
P100	54.80	01/04/11	10H15	2011-04-02	10H20
Yield l/s	**Drawdown (m)**	**Duration (min)**		**Recovery (min)**	
0.85	41.63	720		720	
Total: (Multi-rate and Constant Discharge rate)		970		970	
COMMENT:					

MAINTENANCE

Work time: hour	Transport existing equipm. Km	Travelling (To fix); Km
List of parts replaced or repaired:		

	Borehole number	**Duration (min) CONSTANT**	**Drawdown (m)**	**Hand/logger**	**Distance (m)**
Observation Hole 1					0
Observation Hole 2					0
Observation Hole 3					0
Observation Hole 4					
Observation Hole 5					

GENERAL

ESTABLISHMENT	From:		To:			
Site Move	From project#		To #:	P943	Travelling km:	1
	Village	Borehole no	Village	Borehole no		
	DONKER HOEK 14HT	ERM BH01	DONKER HOEK 14HT	ERM BH08		
Maintenance:	Work time hr		Parts repaired/		Travelling km	
After test measurements	Water level	17.81	Borehole depth	59.95	Casing depth m	10.72
Water level before installing test pump:			11.02			
Depth before installing test pump:			59.95			
Testpump Installed	**Once** /Twice /More		Reason:			
Installed Testpump	**<10 l/s** / >10ls/s		Reason:			
Was existing equipment re-installed:			**No:**	If not where was it left:		
GPS Unit number:			9.00			
EC Unit number:			20.00			
Remarks:						
Signed Contractor:				Signed Consultant:		

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	0	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH08			DISTRICT:	PIXLEGKA SEME ROAD
ALT BH NO:	0			SITE NAME:	DONKER HOEK 14HT
ALT BH NO:	0				
BOREHOLE DEPTH (m)	59.95	DATUM LEVEL ABOVE CASING (m):	0.26	EXISTING PUMP:	NA
WATER LEVEL (mbgl):	10.78	CASING HEIGHT: (magl):	0.40	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	54.80	DIAM PUMP INLET (mm):	165.00	PUMP TYPE:	P100

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM	
DATE:	31/03/2011	TIME:	12H00	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.60		1	
2	0.82		2	
3	0.89		3	
5	1.13		5	
7	1.24		7	
10	1.42		10	
15	1.68		15	
20	1.92	0.21	20	
30	2.60		30	
40	2.90	0.21	40	
50	3.07		50	
60	3.24	0.21	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	8.34		150	
TEMP	23.10	℃	180	
EC	201.00	µS/cm	210	

DISCHARGE RATE 2			RPM	
DATE:	31/03/2011	TIME:	13H00	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	3.49		1	
2	3.60	0.51	2	
3	3.77		3	
5	4.19	0.51	5	
7	4.23		7	
10	4.68	0.50	10	
15	5.29		15	
20	5.83	0.51	20	
30	6.47		30	
40	6.97	0.51	40	
50	7.32		50	
60	7.58	0.51	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	7.98		150	
TEMP	22.60	℃	180	
EC	192.00	µS/cm	210	

DISCHARGE RATE 3			RPM	
DATE:	31-03-2011	TIME:	14H00	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	7.97		1	
2	8.17	0.65	2	
3	8.39		3	
5	8.72	0.65	5	
7	8.98		7	
10	9.36	0.65	10	
15	9.86		15	
20	10.30	0.66	20	
30	10.95		30	
40	11.53	0.66	40	
50	12.03		50	
60	12.37	0.65	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	7.80		150	
TEMP	21.80	℃	180	
EC	192.00	µS/cm	210	

DISCHARGE RATE 4			RPM	
DATE:	31-03-2011	TIME:	15H00	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	12.80		1	
2	13.16	1.43	2	
3	13.48		3	
5	14.11	1.43	5	
7	15.22		7	
10	17.60	1.43	10	
15	19.83		15	
20	21.34	1.42	20	
30	23.55		30	
40	24.44	1.42	40	
50	25.16		50	
60	28.43	1.42	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	7.69		150	
TEMP	21.20	℃	180	
EC	193.00	µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 5			RPM	
DATE:	31-03-2011	TIME:	16H00	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	29.87		1	39.87
2	31.51	1.62	2	34.97
3	33.52		3	32.57
5	39.67	1.62	5	27.97
7	43.42		7	24.02
10	44.05	1.62	10	22.40
15	44.05	1.00	15	20.73
17	44.05	0.86	20	18.75
18	44.05	0.68	30	16.75
40			40	15.32
50			50	13.92
60			60	13.18
70			70	12.30
80			80	11.67
90			90	11.09
100			100	10.55
110			110	10.10
120			120	9.61
pH			150	8.65
TEMP		℃	180	8.00
EC		µS/cm	210	7.33
			240	6.89
			250	6.74
			360	

DISCHARGE RATE 6			RPM	
DATE:		TIME:		
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		℃	180	
EC		µS/cm	210	
			240	
			300	
			360	

S/W/L: 11.02

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	27.01596	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH08		30.2863	DISTRICT:	PIXLEGKA SEME ROAD
ALT BH NO:	0			SITE NAME:	DONKER HOEK 14HT
ALT BH NO:	0				
BOREHOLE DEPTH:	59.95	DATUM LEVEL ABOVE CASING (m):	0.26	EXISTING PUMP:	NA
WATER LEVEL (mbgl):	13.17 41.63	CASING HEIGHT: (magl):	0.40	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	54.80	DIAM PUMP INLET(mm):	165	PUMP TYPE:	P100

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**					
DATE:	04/04/2011	TIME:	10H15	DATE:		TIME:		TYPE OF PUMP:	P100

DISCHARGE BOREHOLE					OBSERVATION HOLE 1 NR: Distance(m);			OBSERVATION HOLE 2 NR: Distance(m);			OBSERVATION HOLE 3 NR: Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	0.64		**1**	39.09	**1**			**1**			**1**	
2	0.66		**2**	34.08	**2**			**2**			**2**	
3	0.68		**3**	31.11	**3**			**3**			**3**	
5	0.95		**5**	27.75	**5**			**5**			**5**	
7	1.24	0.86	**7**	26.17	**7**			**7**			**7**	
10	3.97		**10**	22.10	**10**			**10**			**10**	
15	6.54	0.86	**15**	20.92	**15**			**15**			**15**	
20	8.41		**20**	20.17	**20**			**20**			**20**	
30	10.15	0.85	**30**	19.09	**30**			**30**			**30**	
40	11.57		**40**	18.23	**40**			**40**			**40**	
60	13.47	0.86	**60**	16.87	**60**			**60**			**60**	
90	15.37		**90**	15.85	**90**			**90**			**90**	
120	16.72	0.85	**120**	14.79	**120**			**120**			**120**	
150	18.04		**150**	13.77	**150**			**150**			**150**	
180	18.72	0.85	**180**	12.73	**180**			**180**			**180**	
210	19.40		**210**	11.68	**210**			**210**			**210**	
240	20.10	0.86	**240**	10.65	**240**			**240**			**240**	
300	21.05		**300**	9.62	**300**			**300**			**300**	
360	21.60	0.85	**360**	8.59	**360**			**360**			**360**	
420	22.99		**420**	7.55	**420**			**420**			**420**	
480	24.56	0.85	**480**	6.90	**480**			**480**			**480**	
540	26.83		**540**	6.26	**540**			**540**			**540**	
600	30.40	0.85	**600**	5.86	**600**			**600**			**600**	
720	41.67		**720**	5.07	**720**			**720**			**720**	
722	41.67	0.69	**840**		**840**			**840**			**840**	
723	41.67	0.63	**960**		**960**			**960**			**960**	
724	41.67	0.58	**1080**		**1080**			**1080**			**1080**	
			1200		**1200**			**1200**			**1200**	
			1320		**1320**			**1320**			**1320**	
			1440		**1440**			**1440**			**1440**	
			1560		**1560**			**1560**			**1560**	
			1680		**1680**			**1680**			**1680**	
			1800		**1800**			**1800**			**1800**	
			1920		**1920**			**1920**			**1920**	
			2040		**2040**			**2040**			**2040**	
			2160		**2160**			**2160**			**2160**	
			2280		**2280**			**2280**			**2280**	
			2400		**2400**			**2400**			**2400**	
			2520		**2520**			**2520**			**2520**	
			2640		**2640**			**2640**			**2640**	
			2760		**2760**			**2760**			**2760**	
			2880		**2880**			**2880**			**2880**	
			3000		**3000**			**3000**			**3000**	
			3120		**3120**			**3120**			**3120**	
			3240		**3240**			**3240**			**3240**	
			3360		**3360**			**3360**			**3360**	
			3480		**3480**			**3480**			**3480**	
			3600		**3600**			**3600**			**3600**	
			3720		**3720**			**3720**			**3720**	
			3840		**3840**			**3840**			**3840**	
			3960		**3960**			**3960**			**3960**	
			4080		**4080**			**4080**			**4080**	
			4200		**4200**			**4200**			**4200**	
			4320		**4320**			**4320**			**4320**	
Total time pumped(min):				724		**W/L**			**W/L**			**W/L**
Average yield (l/s):				0.85								

FORM 5 F

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:		PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH08			DISTRICT:	PIXLEGKA SEME ROAD
ALT BH NO:				SITE NAME:	DONKER HOEK 14HT
ALT BH NO:					
BOREHOLE DEPTH:	59.95	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	NA
WATER LEVEL (mbgl)::	13.17	CASING HEIGHT (magl):	0.00	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	54.80	DIAM PUMP INLET(mm):	0.00		

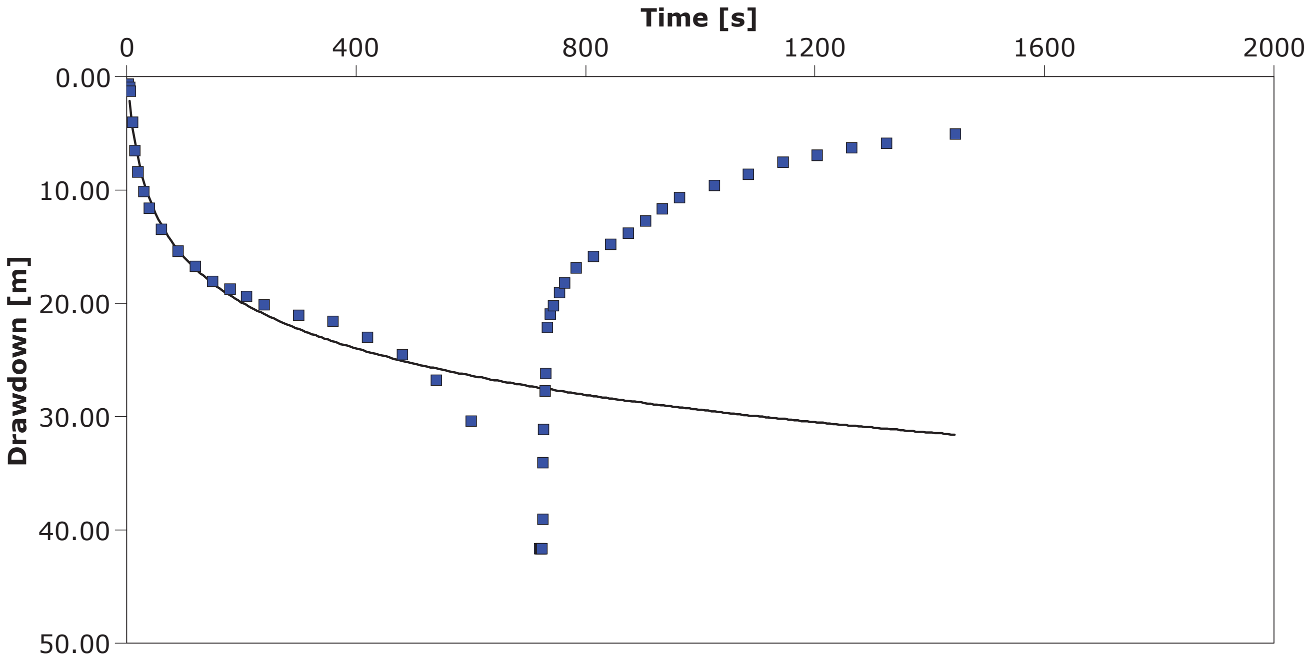
CONSTANT DISCHARGE TEST

DISCHARGE BOREHOLE

TIME (MIN)	REAL TIME	MEASUREMENTS			TIME (MIN)	REAL TIME	MEASUREMENTS		
		pH	TEMP ℃	EC µS/cm			pH	TEMP ℃	EC µS/cm
1		8.55	21.2	181					
120		8.26	20.5	185					
240		7.94	20.8	194					
360		7.96	20.9	191					
480		8.11	19.7	189					
600		8.16	19.4	195					
720		8.83	18.3	182					
840									
960									
1080									
1200									
1320									
1440									
1800									
2160									
2520									
2880									
3240									
3600									
3960									
4320									
4680									
5040									
5400									
5760									
6120									
6480									
7200									
7560									
7920									
8280									
8640									
9000									
9360									
9720									
10080									
10440									
10800									
11160									
11520									
11880									
12240									

	Pumping Test Analysis Report
	Project: 0129245
	Number: kANGRA COAL
	Client: KANGRA COAL

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH8
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	tHEIS	Analysis date: 2011/06/11
Aquifer Thickness: 49.37 m	Discharge: variable, average rate 0.42618 [l/s]	

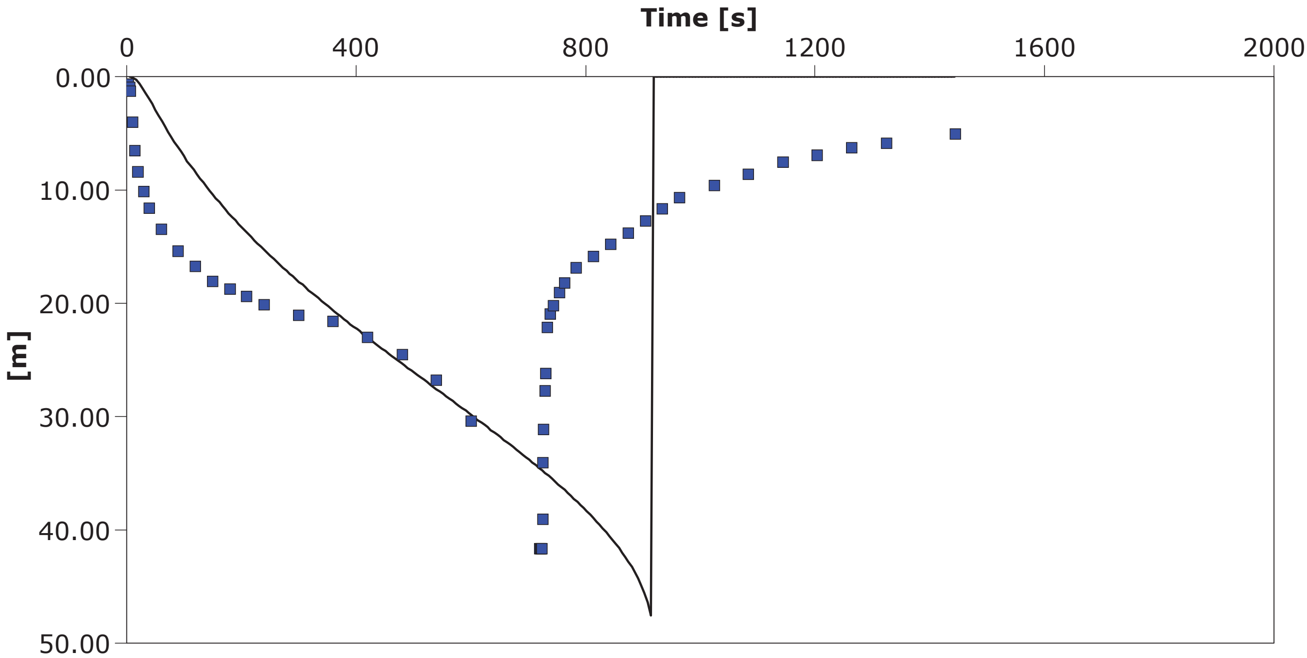


Calculation after Theis

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH8	4.91×10^{-1}	9.95×10^{-3}	1.36×10^{-2}	0.08	

	Pumping Test Analysis Report
	Project: 0129245
	Number: kANGRA COAL
	Client: KANGRA COAL

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH8
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	jACOB COOPER	Analysis date: 2011/06/11
Aquifer Thickness: 49.37 m	Discharge: variable, average rate 0.42618 [l/s]	

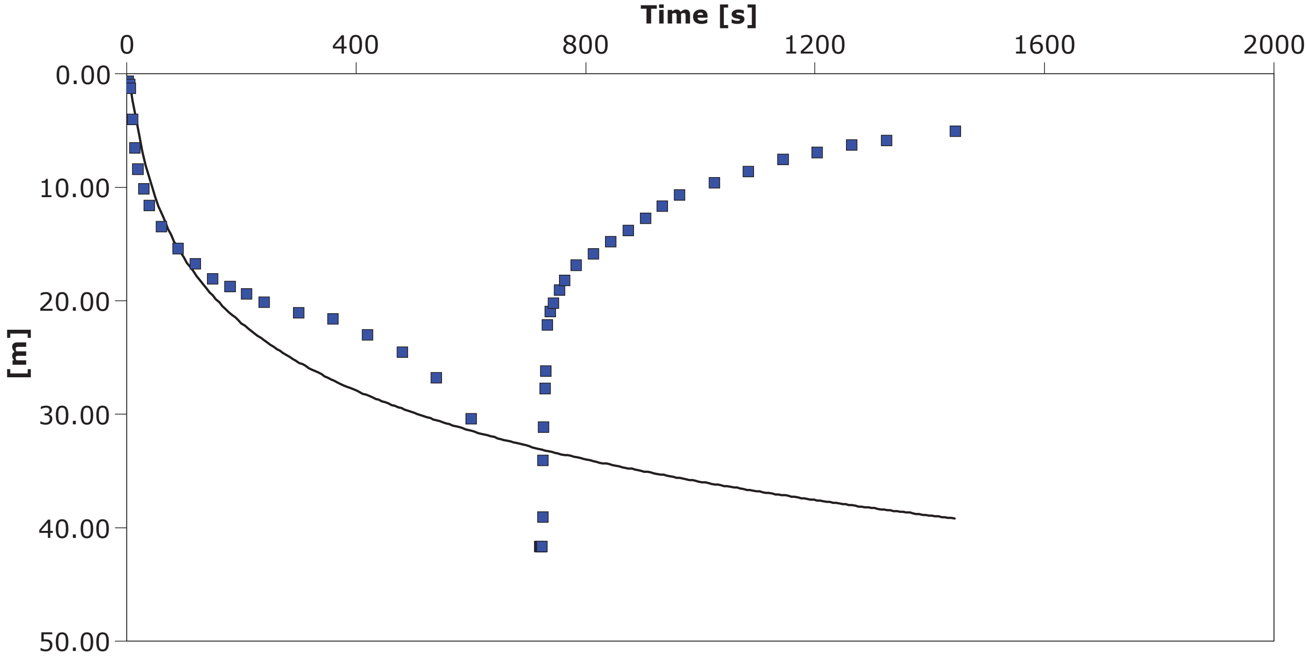


Calculation after Theis with Jacob Correction

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH8	3.04×10^{-1}	6.15×10^{-3}	8.61×10^{-2}	0.08	

	Pumping Test Analysis Report
	Project: 0129245
	Number: kANGRA COAL
	Client: KANGRA COAL

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH8
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	DOUBLE POROSITY	Analysis date: 2011/06/11
Aquifer Thickness: 49.37 m	Discharge: variable, average rate 0.42618 [l/s]	

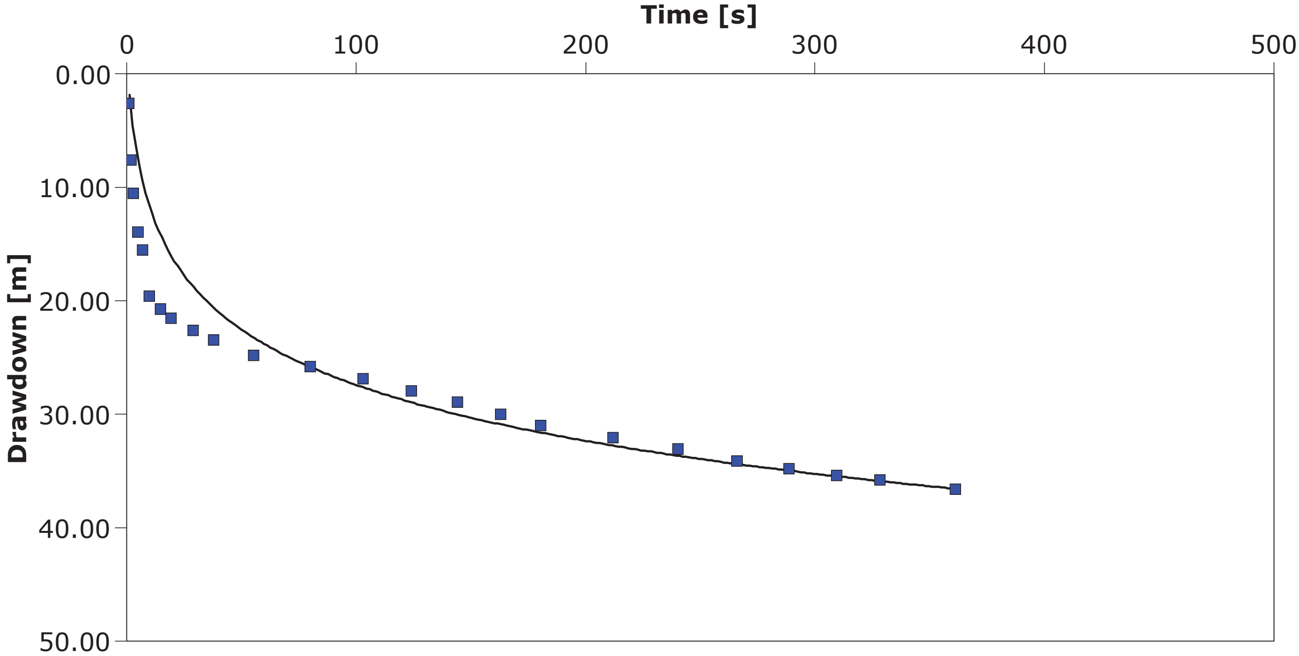


Calculation after Double Porosity

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Specific storage	Sigma	Lambda	Radial distance to PW [m]
ERMBH8	3.29×10^{-1}	6.66×10^{-3}	2.25×10^{-2}	1.00×10^{0}	1.00×10^{-15}	0.08

Pumping Test Analysis Report
Project: 0129245
Number: kANGRA COAL
Client: KANGRA COAL

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH8
Test conducted by:		Test date: 2011/06/11
Analysis performed by:	THEIS RECOVERY	Analysis date: 2011/06/11
Aquifer Thickness: 49.37 m	Discharge: variable, average rate 0.42618 [l/s]	



Calculation after AGARWAL + Theis

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH8	8.14×10^{-1}	1.65×10^{-2}	6.92×10^{-3}	0.08	

	Pumping Test Analysis Report
	Project: 0129245
	Number: kANGRA COAL
	Client: KANGRA COAL

Location:	Pumping Test: Pumping Test 1	Pumping well: ERMBH8
Test conducted by:		Test date: 2011/06/11
Aquifer Thickness: 49.37 m	Discharge: variable, average rate 0.42618 [l/s]	

	Analysis Name	Analysis performed by	Analysis date	Method name	Well	T [m²/d]	K [m/d]	S
1	tHEIS		2011/06/11	Theis	ERMBH8	4.91×10^{-1}	9.95×10^{-3}	1.36×10^{-2}
2	jACOB COOPER		2011/06/11	Theis with Jacob Corr	ERMBH8	3.04×10^{-1}	6.15×10^{-3}	8.61×10^{-2}
3	DOUBLE POROSITY		2011/06/11	Double Porosity	ERMBH8	3.29×10^{-1}	6.66×10^{-3}	2.25×10^{-2}
4	THEIS RECOVERY		2011/06/11	AGARWAL + Theis	ERMBH8	8.14×10^{-1}	1.65×10^{-2}	6.92×10^{-3}

Report Date:		2011/04/12 13:51
Report User Name:	User	
Report Computer Name:	USER-PC	

Log File Properties

File Name	Slug test ERM BH 09_2011-04-12_13-51-44-269.wsl	
Create Date		2011/04/12 13:51

Device Properties

Device	Level TROLL 300	
Site	Piet Retief	
Device Name	Obuasi	
Serial Number		127154
Firmware Version		2.04
Hardware Version		2

Log Configuration

Log Name	Slug test ERM BH 09
Created By	User
Computer Name	USER-PC
Application	WinSitu.exe
Application Version	5.6.16.0
Create Date	2011/04/12 13:42
Current Time Zone	South Africa Standard Time(Use Local Time)
Notes Size(bytes)	4096
Overwrite when full	Disabled
Scheduled Start Time	Manual Start
Scheduled Stop Time	No Stop Time
Type	Fast Linear
Interval	Days: 0 hrs: 00 mins: 00 secs: 01

Level Reference Settings At Log Creation

Level Measurement Mode	Level Depth To Water
Specific Gravity	0.999
Level Reference Mode:	Set first logged value to offset
Level Reference Offset:	0 (m)

Other Log Settings

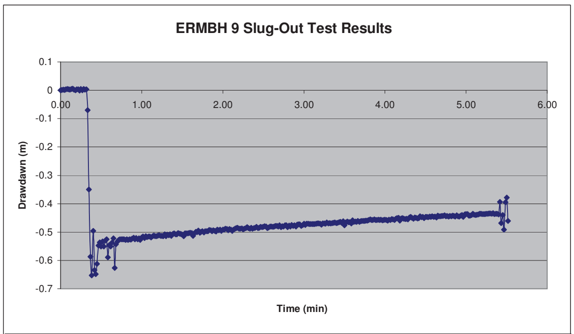
Zero Pressure Offset:	103.142 (kPa)
Depth of Probe:	1.37539 (m)
Head Pressure:	13.4745 (kPa)
Temperature:	19.4612 (C)

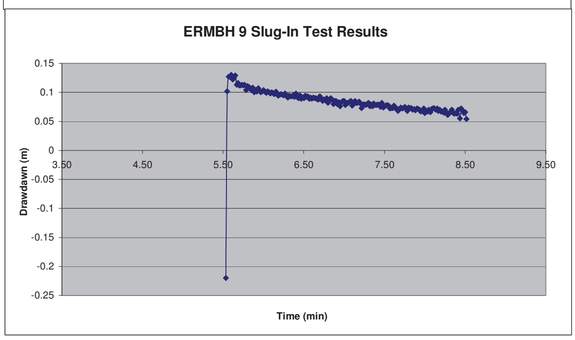
Log Notes:

Date and Time	Note
2011/04/12 13:42	Sensor: 127154 Factory calibration has expired.: 2009/02/09 06:59:44 PM
2011/04/12 13:42	Used Battery: 18% Used Memory: 12% User Name: User
2011/04/12 13:42	Manual Start Command
2011/04/12 13:51	Used Battery: 18% Used Memory: 12% User Name: User
2011/04/12 13:51	Manual Stop Command

Log Data:

Record Count	512
Sensors	1





Time Zone: South Africa Standard Time
SLUG-OUT

Date and Time	Elapsed Time Seconds	Minutes	Sensor: Pres(A) 197.3ft SN#: 127154 Level Depth To Water (m)	Sensor: Pres(A) 197.3ft SN#: 127154 Temperature (C)
2011/04/12 13:42	0	0.00	0	19.218
2011/04/12 13:42	1	0.02	0.001	19.21
2011/04/12 13:42	2	0.03	0.002	19.209
2011/04/12 13:42	3.083	0.05	0.001	19.226
2011/04/12 13:42	4	0.07	0.003	19.203
2011/04/12 13:42	5	0.08	0.004	19.191
2011/04/12 13:42	6	0.10	0.003	19.182
2011/04/12 13:42	7	0.12	0.002	19.172
2011/04/12 13:42	8.092	0.13	0.004	19.195
2011/04/12 13:43	9	0.15	0.006	19.167
2011/04/12 13:43	10	0.17	0.002	19.156
2011/04/12 13:43	11	0.18	0	19.145
2011/04/12 13:43	12	0.20	0.003	19.139
2011/04/12 13:43	13.1	0.22	0.003	19.16
2011/04/12 13:43	14	0.23	-0.001	19.132
2011/04/12 13:43	15	0.25	0.004	19.121
2011/04/12 13:43	16	0.27	0	19.111
2011/04/12 13:43	17	0.28	0.004	19.102
2011/04/12 13:43	18	0.30	0.002	19.096
2011/04/12 13:43	19	0.32	0.003	19.097
2011/04/12 13:43	20	0.33	-0.07	19.087
2011/04/12 13:43	21	0.35	-0.35	19.08
2011/04/12 13:43	22	0.37	-0.587	19.07
2011/04/12 13:43	23	0.38	-0.653	19.062
2011/04/12 13:43	24.138	0.40	-0.496	19.068
2011/04/12 13:43	25	0.42	-0.634	19.055
2011/04/12 13:43	26	0.43	-0.648	19.041
2011/04/12 13:43	27	0.45	-0.612	19.038
2011/04/12 13:43	28.124	0.47	-0.547	19.055
2011/04/12 13:43	29	0.48	-0.536	19.032
2011/04/12 13:43	30	0.50	-0.551	19.023
2011/04/12 13:43	31	0.52	-0.533	19.012
2011/04/12 13:43	32	0.53	-0.551	19.005
2011/04/12 13:43	33.133	0.55	-0.53	19.026
2011/04/12 13:43	34	0.57	-0.525	19.002
2011/04/12 13:43	35	0.58	-0.589	18.988
2011/04/12 13:43	36	0.60	-0.546	18.98
2011/04/12 13:43	37	0.62	-0.551	18.971
2011/04/12 13:43	38	0.63	-0.538	18.969
2011/04/12 13:43	39	0.65	-0.522	18.971
2011/04/12 13:43	40	0.67	-0.627	18.959
2011/04/12 13:43	41	0.68	-0.543	18.949
2011/04/12 13:43	42	0.70	-0.533	18.943
2011/04/12 13:43	43	0.72	-0.528	18.936
2011/04/12 13:43	44	0.73	-0.526	18.94
2011/04/12 13:43	45	0.75	-0.525	18.929
2011/04/12 13:43	46	0.77	-0.526	18.92
2011/04/12 13:43	47	0.78	-0.526	18.909
2011/04/12 13:43	48	0.80	-0.528	18.905
2011/04/12 13:43	49	0.82	-0.526	18.912
2011/04/12 13:43	50	0.83	-0.528	18.9
2011/04/12 13:43	51	0.85	-0.525	18.891
2011/04/12 13:43	52	0.87	-0.527	18.886
2011/04/12 13:43	53	0.88	-0.523	18.876
2011/04/12 13:43	54	0.90	-0.52	18.87
2011/04/12 13:43	55	0.92	-0.525	18.875
2011/04/12 13:43	56	0.93	-0.521	18.863
2011/04/12 13:43	57	0.95	-0.525	18.856
2011/04/12 13:43	58	0.97	-0.522	18.85
2011/04/12 13:43	59	0.98	-0.528	18.844
2011/04/12 13:43	60	1.00	-0.519	18.851
2011/04/12 13:43	61	1.02	-0.516	18.838
2011/04/12 13:43	62	1.03	-0.521	18.827
2011/04/12 13:43	63	1.05	-0.515	18.822
2011/04/12 13:43	64	1.07	-0.518	18.827
2011/04/12 13:43	65	1.08	-0.516	18.816
2011/04/12 13:43	66	1.10	-0.516	18.81
2011/04/12 13:43	67	1.12	-0.519	18.803
2011/04/12 13:43	68	1.13	-0.515	18.797
2011/04/12 13:44	69	1.15	-0.512	18.801
2011/04/12 13:44	70	1.17	-0.515	18.789
2011/04/12 13:44	71	1.18	-0.514	18.782
2011/04/12 13:44	72	1.20	-0.512	18.777
2011/04/12 13:44	73	1.22	-0.511	18.77
2011/04/12 13:44	74	1.23	-0.513	18.777
2011/04/12 13:44	75	1.25	-0.513	18.763
2011/04/12 13:44	76	1.27	-0.514	18.759
2011/04/12 13:44	77	1.28	-0.508	18.751
2011/04/12 13:44	78	1.30	-0.514	18.746
2011/04/12 13:44	79	1.32	-0.509	18.752
2011/04/12 13:44	80	1.33	-0.511	18.741
2011/04/12 13:44	81	1.35	-0.508	18.736
2011/04/12 13:44	82	1.37	-0.513	18.726
2011/04/12 13:44	83	1.38	-0.507	18.722
2011/04/12 13:44	84	1.40	-0.505	18.727
2011/04/12 13:44	85	1.42	-0.508	18.717
2011/04/12 13:44	86	1.43	-0.508	18.708
2011/04/12 13:44	87	1.45	-0.504	18.706
2011/04/12 13:44	88	1.47	-0.506	18.7
2011/04/12 13:44	89	1.48	-0.507	18.706
2011/04/12 13:44	90	1.50	-0.509	18.696
2011/04/12 13:44	91	1.52	-0.514	18.69
2011/04/12 13:44	92	1.53	-0.505	18.682
2011/04/12 13:44	93	1.55	-0.505	18.679
2011/04/12 13:44	94	1.57	-0.505	18.684
2011/04/12 13:44	95	1.58	-0.504	18.67
2011/04/12 13:44	96	1.60	-0.503	18.665
2011/04/12 13:44	97	1.62	-0.504	18.662
2011/04/12 13:44	98	1.63	-0.513	18.658
2011/04/12 13:44	99	1.65	-0.505	18.661
2011/04/12 13:44	100	1.67	-0.499	18.652
2011/04/12 13:44	101	1.68	-0.5	18.644
2011/04/12 13:44	102	1.70	-0.495	18.645
2011/04/12 13:44	103	1.72	-0.503	18.637
2011/04/12 13:44	104	1.73	-0.499	18.642
2011/04/12 13:44	105	1.75	-0.497	18.632
2011/04/12 13:44	106	1.77	-0.501	18.629
2011/04/12 13:44	107	1.78	-0.497	18.623

2011/04/12 13:44	108	1.80	-0.497	18.618
2011/04/12 13:44	109	1.82	-0.497	18.623
2011/04/12 13:44	110	1.83	-0.493	18.615
2011/04/12 13:44	111	1.85	-0.494	18.606
2011/04/12 13:44	112	1.87	-0.497	18.599
2011/04/12 13:44	113	1.88	-0.494	18.597
2011/04/12 13:44	114	1.90	-0.496	18.594
2011/04/12 13:44	115	1.92	-0.498	18.601
2011/04/12 13:44	116	1.93	-0.491	18.592
2011/04/12 13:44	117	1.95	-0.494	18.585
2011/04/12 13:44	118	1.97	-0.492	18.58
2011/04/12 13:44	119	1.98	-0.496	18.588
2011/04/12 13:44	120	2.00	-0.491	18.577
2011/04/12 13:44	121	2.02	-0.491	18.572
2011/04/12 13:44	122	2.03	-0.488	18.567
2011/04/12 13:44	123	2.05	-0.489	18.565
2011/04/12 13:44	124	2.07	-0.494	18.569
2011/04/12 13:44	125	2.08	-0.489	18.559
2011/04/12 13:44	126	2.10	-0.492	18.554
2011/04/12 13:44	127	2.12	-0.496	18.549
2011/04/12 13:44	128	2.13	-0.491	18.548
2011/04/12 13:45	129	2.15	-0.488	18.554
2011/04/12 13:45	130	2.17	-0.486	18.549
2011/04/12 13:45	131	2.18	-0.485	18.54
2011/04/12 13:45	132	2.20	-0.488	18.534
2011/04/12 13:45	133	2.22	-0.488	18.53
2011/04/12 13:45	134	2.23	-0.487	18.539
2011/04/12 13:45	135	2.25	-0.49	18.53
2011/04/12 13:45	136	2.27	-0.488	18.52
2011/04/12 13:45	137	2.28	-0.486	18.519
2011/04/12 13:45	138	2.30	-0.483	18.515
2011/04/12 13:45	139	2.32	-0.486	18.523
2011/04/12 13:45	140	2.33	-0.488	18.512
2011/04/12 13:45	141	2.35	-0.485	18.509
2011/04/12 13:45	142	2.37	-0.488	18.504
2011/04/12 13:45	143	2.38	-0.486	18.5
2011/04/12 13:45	144	2.40	-0.485	18.507
2011/04/12 13:45	145	2.42	-0.482	18.498
2011/04/12 13:45	146	2.43	-0.486	18.492
2011/04/12 13:45	147	2.45	-0.485	18.488
2011/04/12 13:45	148	2.47	-0.482	18.484
2011/04/12 13:45	149	2.48	-0.483	18.493
2011/04/12 13:45	150	2.50	-0.482	18.483
2011/04/12 13:45	151	2.52	-0.479	18.478
2011/04/12 13:45	152	2.53	-0.481	18.472
2011/04/12 13:45	153	2.55	-0.486	18.473
2011/04/12 13:45	154	2.57	-0.484	18.479
2011/04/12 13:45	155	2.58	-0.481	18.468
2011/04/12 13:45	156	2.60	-0.481	18.461
2011/04/12 13:45	157	2.62	-0.482	18.46
2011/04/12 13:45	158	2.63	-0.481	18.455
2011/04/12 13:45	159	2.65	-0.478	18.464
2011/04/12 13:45	160	2.67	-0.478	18.455
2011/04/12 13:45	161	2.68	-0.481	18.448
2011/04/12 13:45	162	2.70	-0.476	18.447
2011/04/12 13:45	163	2.72	-0.483	18.442
2011/04/12 13:45	164	2.73	-0.479	18.449
2011/04/12 13:45	165	2.75	-0.48	18.444
2011/04/12 13:45	166	2.77	-0.476	18.436
2011/04/12 13:45	167	2.78	-0.476	18.432
2011/04/12 13:45	168	2.80	-0.483	18.43
2011/04/12 13:45	169	2.82	-0.477	18.437
2011/04/12 13:45	170	2.83	-0.481	18.425
2011/04/12 13:45	171	2.85	-0.475	18.425
2011/04/12 13:45	172	2.87	-0.478	18.422
2011/04/12 13:45	173	2.88	-0.476	18.422
2011/04/12 13:45	174.029	2.90	-0.48	18.428
2011/04/12 13:45	175	2.92	-0.474	18.417
2011/04/12 13:45	176	2.93	-0.473	18.412
2011/04/12 13:45	177	2.95	-0.473	18.407
2011/04/12 13:45	178	2.97	-0.478	18.404
2011/04/12 13:45	179.114	2.99	-0.475	18.412
2011/04/12 13:45	180	3.00	-0.471	18.406
2011/04/12 13:45	181	3.02	-0.475	18.406
2011/04/12 13:45	182	3.03	-0.471	18.396
2011/04/12 13:45	183	3.05	-0.471	18.395
2011/04/12 13:45	184.039	3.07	-0.472	18.404
2011/04/12 13:45	185	3.08	-0.472	18.395
2011/04/12 13:45	186	3.10	-0.472	18.388
2011/04/12 13:45	187	3.12	-0.472	18.387
2011/04/12 13:45	188	3.13	-0.472	18.383
2011/04/12 13:46	189	3.15	-0.471	18.393
2011/04/12 13:46	190	3.17	-0.469	18.382
2011/04/12 13:46	191	3.18	-0.469	18.379
2011/04/12 13:46	192	3.20	-0.471	18.377
2011/04/12 13:46	193	3.22	-0.474	18.373
2011/04/12 13:46	194	3.23	-0.469	18.383
2011/04/12 13:46	195	3.25	-0.469	18.374
2011/04/12 13:46	196	3.27	-0.471	18.366
2011/04/12 13:46	197	3.28	-0.466	18.361
2011/04/12 13:46	198	3.30	-0.469	18.365
2011/04/12 13:46	199	3.32	-0.468	18.373
2011/04/12 13:46	200	3.33	-0.469	18.361
2011/04/12 13:46	201	3.35	-0.468	18.361
2011/04/12 13:46	202	3.37	-0.467	18.358
2011/04/12 13:46	203	3.38	-0.466	18.354
2011/04/12 13:46	204	3.40	-0.468	18.361
2011/04/12 13:46	205	3.42	-0.467	18.351
2011/04/12 13:46	206	3.43	-0.465	18.349
2011/04/12 13:46	207	3.45	-0.464	18.345
2011/04/12 13:46	208	3.47	-0.467	18.346
2011/04/12 13:46	209	3.48	-0.462	18.354
2011/04/12 13:46	210	3.50	-0.476	18.346
2011/04/12 13:46	211	3.52	-0.466	18.339
2011/04/12 13:46	212	3.53	-0.463	18.337
2011/04/12 13:46	213	3.55	-0.465	18.337

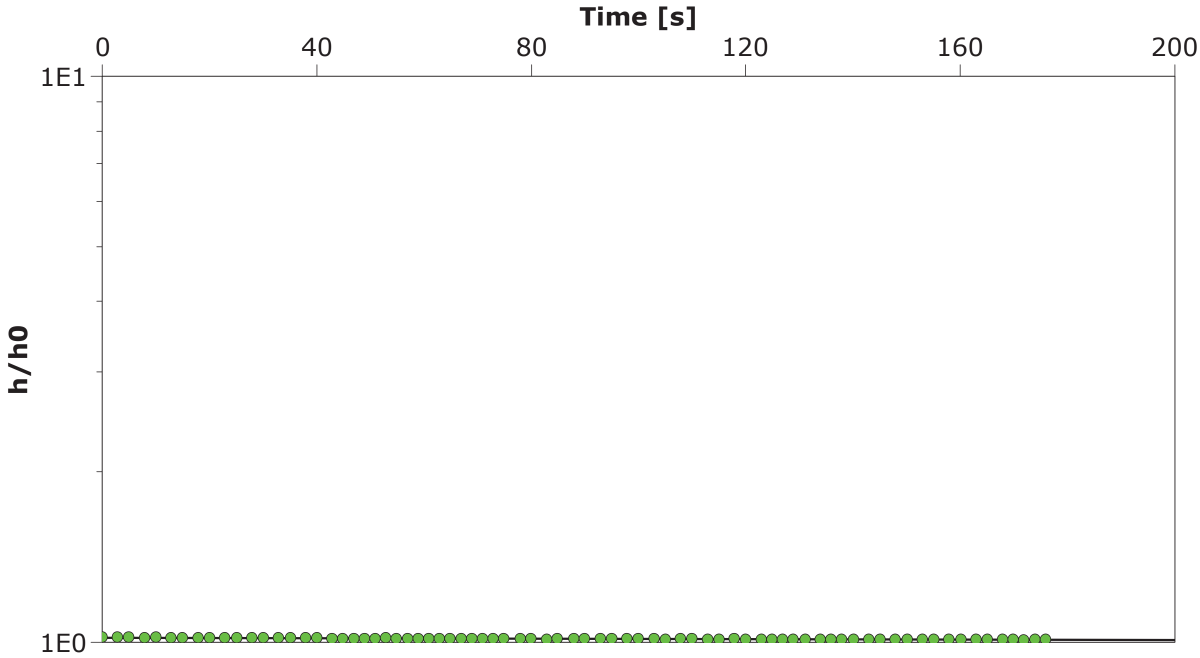
2011/04/12 13:46	214	3.57	-0.465	18.344
2011/04/12 13:46	215	3.58	-0.47	18.335
2011/04/12 13:46	216	3.60	-0.459	18.333
2011/04/12 13:46	217	3.62	-0.464	18.331
2011/04/12 13:46	218	3.63	-0.463	18.327
2011/04/12 13:46	219	3.65	-0.464	18.337
2011/04/12 13:46	220	3.67	-0.461	18.33
2011/04/12 13:46	221	3.68	-0.464	18.326
2011/04/12 13:46	222	3.70	-0.462	18.321
2011/04/12 13:46	223	3.72	-0.461	18.318
2011/04/12 13:46	224	3.73	-0.461	18.329
2011/04/12 13:46	225	3.75	-0.461	18.321
2011/04/12 13:46	226	3.77	-0.46	18.315
2011/04/12 13:46	227	3.78	-0.46	18.315
2011/04/12 13:46	228	3.80	-0.457	18.309
2011/04/12 13:46	229	3.82	-0.455	18.32
2011/04/12 13:46	230	3.83	-0.458	18.312
2011/04/12 13:46	231	3.85	-0.457	18.307
2011/04/12 13:46	232	3.87	-0.455	18.305
2011/04/12 13:46	233	3.88	-0.457	18.306
2011/04/12 13:46	234	3.90	-0.457	18.313
2011/04/12 13:46	235	3.92	-0.456	18.305
2011/04/12 13:46	236	3.93	-0.457	18.3
2011/04/12 13:46	237	3.95	-0.456	18.296
2011/04/12 13:46	238	3.97	-0.459	18.295
2011/04/12 13:46	239	3.98	-0.457	18.305
2011/04/12 13:46	240	4.00	-0.456	18.296
2011/04/12 13:46	241	4.02	-0.457	18.294
2011/04/12 13:46	242	4.03	-0.46	18.289
2011/04/12 13:46	243	4.05	-0.456	18.283
2011/04/12 13:46	244	4.07	-0.457	18.297
2011/04/12 13:46	245	4.08	-0.454	18.289
2011/04/12 13:46	246	4.10	-0.455	18.284
2011/04/12 13:46	247	4.12	-0.458	18.283
2011/04/12 13:46	248	4.13	-0.453	18.281
2011/04/12 13:47	249	4.15	-0.451	18.293
2011/04/12 13:47	250	4.17	-0.45	18.284
2011/04/12 13:47	251	4.18	-0.46	18.281
2011/04/12 13:47	252	4.20	-0.452	18.277
2011/04/12 13:47	253	4.22	-0.451	18.274
2011/04/12 13:47	254.002	4.23	-0.453	18.285
2011/04/12 13:47	255	4.25	-0.454	18.276
2011/04/12 13:47	256	4.27	-0.453	18.271
2011/04/12 13:47	257	4.28	-0.455	18.27
2011/04/12 13:47	258	4.30	-0.449	18.267
2011/04/12 13:47	259	4.32	-0.447	18.279
2011/04/12 13:47	260	4.33	-0.45	18.271
2011/04/12 13:47	261	4.35	-0.453	18.265
2011/04/12 13:47	262	4.37	-0.449	18.263
2011/04/12 13:47	263	4.38	-0.45	18.26
2011/04/12 13:47	264.002	4.40	-0.452	18.273
2011/04/12 13:47	265	4.42	-0.451	18.265
2011/04/12 13:47	266	4.43	-0.444	18.258
2011/04/12 13:47	267	4.45	-0.448	18.257
2011/04/12 13:47	268	4.47	-0.446	18.253
2011/04/12 13:47	269.01	4.48	-0.451	18.267
2011/04/12 13:47	270	4.50	-0.446	18.258
2011/04/12 13:47	271	4.52	-0.447	18.255
2011/04/12 13:47	272	4.53	-0.448	18.25
2011/04/12 13:47	273	4.55	-0.445	18.246
2011/04/12 13:47	274.017	4.57	-0.447	18.258
2011/04/12 13:47	275	4.58	-0.444	18.251
2011/04/12 13:47	276	4.60	-0.447	18.246
2011/04/12 13:47	277	4.62	-0.445	18.244
2011/04/12 13:47	278	4.63	-0.449	18.245
2011/04/12 13:47	279.026	4.65	-0.442	18.255
2011/04/12 13:47	280	4.67	-0.444	18.248
2011/04/12 13:47	281	4.68	-0.444	18.245
2011/04/12 13:47	282	4.70	-0.443	18.242
2011/04/12 13:47	283	4.72	-0.443	18.236
2011/04/12 13:47	284.042	4.73	-0.441	18.251
2011/04/12 13:47	285	4.75	-0.444	18.241
2011/04/12 13:47	286	4.77	-0.443	18.24
2011/04/12 13:47	287	4.78	-0.445	18.235
2011/04/12 13:47	288	4.80	-0.443	18.237
2011/04/12 13:47	289.049	4.82	-0.444	18.248
2011/04/12 13:47	290	4.83	-0.442	18.236
2011/04/12 13:47	291	4.85	-0.443	18.231
2011/04/12 13:47	292	4.87	-0.445	18.232
2011/04/12 13:47	293	4.88	-0.441	18.233
2011/04/12 13:47	294.058	4.90	-0.444	18.241
2011/04/12 13:47	295	4.92	-0.445	18.234
2011/04/12 13:47	296	4.93	-0.442	18.229
2011/04/12 13:47	297	4.95	-0.44	18.231
2011/04/12 13:47	298	4.97	-0.446	18.226
2011/04/12 13:47	299.064	4.98	-0.438	18.237
2011/04/12 13:47	300	5.00	-0.437	18.231
2011/04/12 13:47	301	5.02	-0.437	18.225
2011/04/12 13:47	302	5.03	-0.442	18.224
2011/04/12 13:47	303	5.05	-0.442	18.221
2011/04/12 13:47	304.074	5.07	-0.44	18.235
2011/04/12 13:47	305	5.08	-0.436	18.224
2011/04/12 13:47	306	5.10	-0.439	18.224
2011/04/12 13:47	307	5.12	-0.44	18.22
2011/04/12 13:47	308	5.13	-0.439	18.221
2011/04/12 13:48	309.08	5.15	-0.438	18.23
2011/04/12 13:48	310	5.17	-0.436	18.221
2011/04/12 13:48	311	5.18	-0.436	18.219
2011/04/12 13:48	312	5.20	-0.437	18.217
2011/04/12 13:48	313	5.22	-0.437	18.214
2011/04/12 13:48	314.089	5.23	-0.437	18.225
2011/04/12 13:48	315	5.25	-0.436	18.217
2011/04/12 13:48	316	5.27	-0.435	18.215
2011/04/12 13:48	317	5.28	-0.434	18.215
2011/04/12 13:48	318	5.30	-0.434	18.21
2011/04/12 13:48	319.095	5.32	-0.436	18.222
2011/04/12 13:48	320	5.33	-0.433	18.215
2011/04/12 13:48	321	5.35	-0.437	18.214
2011/04/12 13:48	322	5.37	-0.435	18.213
2011/04/12 13:48	323.001	5.38	-0.436	18.211
2011/04/12 13:48	324.105	5.40	-0.438	18.219
2011/04/12 13:48	325	5.42	-0.394	18.211
2011/04/12 13:48	326	5.43	-0.468	18.208
2011/04/12 13:48	327	5.45	-0.44	18.206
2011/04/12 13:48	328	5.47	-0.491	18.206
2011/04/12 13:48	329.113	5.49	-0.395	18.216
2011/04/12 13:48	330	5.50	-0.379	18.209
2011/04/12 13:48	331	5.52	-0.461	18.204

SLUG-IN				
2011/04/12 13:48	332	5.53	-0.22	18.204
2011/04/12 13:48	333	5.55	0.102	18.2
2011/04/12 13:48	334.121	5.57	0.127	18.214
2011/04/12 13:48	335	5.58	0.127	18.206
2011/04/12 13:48	336	5.60	0.13	18.203
2011/04/12 13:48	337	5.62	0.122	18.201
2011/04/12 13:48	338	5.63	0.124	18.198
2011/04/12 13:48	339.002	5.65	0.129	18.213
2011/04/12 13:48	340	5.67	0.113	18.2
2011/04/12 13:48	341	5.68	0.116	18.199
2011/04/12 13:48	342	5.70	0.112	18.194
2011/04/12 13:48	343	5.72	0.112	18.195
2011/04/12 13:48	344.105	5.74	0.113	18.209
2011/04/12 13:48	345	5.75	0.112	18.202
2011/04/12 13:48	346	5.77	0.113	18.193
2011/04/12 13:48	347	5.78	0.104	18.193
2011/04/12 13:48	348	5.80	0.111	18.193
2011/04/12 13:48	349.05	5.82	0.109	18.205
2011/04/12 13:48	350	5.83	0.107	18.196
2011/04/12 13:48	351	5.85	0.104	18.196
2011/04/12 13:48	352	5.87	0.108	18.192
2011/04/12 13:48	353	5.88	0.1	18.191
2011/04/12 13:48	354.169	5.90	0.104	18.2
2011/04/12 13:48	355	5.92	0.101	18.198
2011/04/12 13:48	356	5.93	0.107	18.191
2011/04/12 13:48	357	5.95	0.103	18.189
2011/04/12 13:48	358	5.97	0.1	18.188
2011/04/12 13:48	359.177	5.99	0.102	18.198
2011/04/12 13:48	360	6.00	0.104	18.193
2011/04/12 13:48	361	6.02	0.101	18.189
2011/04/12 13:48	362	6.03	0.099	18.185
2011/04/12 13:48	363	6.05	0.102	18.187
2011/04/12 13:48	364.185	6.07	0.1	18.195
2011/04/12 13:48	365	6.08	0.098	18.19
2011/04/12 13:48	366	6.10	0.1	18.186
2011/04/12 13:48	367	6.12	0.099	18.185
2011/04/12 13:48	368	6.13	0.097	18.182
2011/04/12 13:49	369.192	6.15	0.101	18.196
2011/04/12 13:49	370	6.17	0.098	18.189
2011/04/12 13:49	371	6.18	0.094	18.185
2011/04/12 13:49	372	6.20	0.096	18.183
2011/04/12 13:49	373	6.22	0.097	18.179
2011/04/12 13:49	374.2	6.24	0.096	18.194
2011/04/12 13:49	375	6.25	0.095	18.188
2011/04/12 13:49	376	6.27	0.098	18.183
2011/04/12 13:49	377	6.28	0.094	18.183
2011/04/12 13:49	378	6.30	0.091	18.183
2011/04/12 13:49	379	6.32	0.094	18.195
2011/04/12 13:49	380	6.33	0.093	18.183
2011/04/12 13:49	381	6.35	0.093	18.179
2011/04/12 13:49	382	6.37	0.095	18.177
2011/04/12 13:49	383	6.38	0.092	18.18
2011/04/12 13:49	384	6.40	0.098	18.194
2011/04/12 13:49	385	6.42	0.092	18.182
2011/04/12 13:49	386	6.43	0.09	18.179
2011/04/12 13:49	387	6.45	0.095	18.178
2011/04/12 13:49	388	6.47	0.089	18.178
2011/04/12 13:49	389	6.48	0.091	18.193
2011/04/12 13:49	390	6.50	0.09	18.182
2011/04/12 13:49	391	6.52	0.094	18.176
2011/04/12 13:49	392	6.53	0.092	18.176
2011/04/12 13:49	393	6.55	0.093	18.174
2011/04/12 13:49	394	6.57	0.089	18.192
2011/04/12 13:49	395	6.58	0.091	18.179
2011/04/12 13:49	396	6.60	0.089	18.177
2011/04/12 13:49	397	6.62	0.091	18.176
2011/04/12 13:49	398	6.63	0.09	18.173
2011/04/12 13:49	399	6.65	0.09	18.185
2011/04/12 13:49	400	6.67	0.088	18.179
2011/04/12 13:49	401	6.68	0.088	18.174
2011/04/12 13:49	402	6.70	0.093	18.174
2011/04/12 13:49	403	6.72	0.089	18.173
2011/04/12 13:49	404.014	6.73	0.085	18.186
2011/04/12 13:49	405	6.75	0.088	18.179
2011/04/12 13:49	406	6.77	0.086	18.172
2011/04/12 13:49	407	6.78	0.09	18.17
2011/04/12 13:49	408	6.80	0.082	18.172
2011/04/12 13:49	409.023	6.82	0.085	18.186
2011/04/12 13:49	410	6.83	0.09	18.176
2011/04/12 13:49	411	6.85	0.088	18.175
2011/04/12 13:49	412.001	6.87	0.08	18.17
2011/04/12 13:49	413	6.88	0.085	18.17
2011/04/12 13:49	414.03	6.90	0.085	18.188
2011/04/12 13:49	415	6.92	0.08	18.174
2011/04/12 13:49	416	6.93	0.083	18.168
2011/04/12 13:49	417	6.95	0.076	18.167
2011/04/12 13:49	418	6.97	0.083	18.169
2011/04/12 13:49	419.039	6.98	0.085	18.185
2011/04/12 13:49	420	7.00	0.085	18.174
2011/04/12 13:49	421	7.02	0.078	18.172
2011/04/12 13:49	422	7.03	0.082	18.168
2011/04/12 13:49	423	7.05	0.082	18.167
2011/04/12 13:49	424.047	7.07	0.084	18.185
2011/04/12 13:49	425	7.08	0.085	18.171
2011/04/12 13:49	426	7.10	0.077	18.167
2011/04/12 13:49	427	7.12	0.08	18.168
2011/04/12 13:49	428	7.13	0.085	18.166
2011/04/12 13:50	429.055	7.15	0.082	18.182
2011/04/12 13:50	430	7.17	0.082	18.172

2011/04/12 13:50	431	7.18	0.084	18.171
2011/04/12 13:50	432	7.20	0.081	18.166
2011/04/12 13:50	433	7.22	0.073	18.161
2011/04/12 13:50	434.077	7.23	0.079	18.178
2011/04/12 13:50	435	7.25	0.079	18.171
2011/04/12 13:50	436	7.27	0.078	18.169
2011/04/12 13:50	437	7.28	0.08	18.164
2011/04/12 13:50	438	7.30	0.082	18.162
2011/04/12 13:50	439.102	7.32	0.076	18.18
2011/04/12 13:50	440	7.33	0.079	18.169
2011/04/12 13:50	441	7.35	0.076	18.167
2011/04/12 13:50	442	7.37	0.081	18.164
2011/04/12 13:50	443	7.38	0.078	18.164
2011/04/12 13:50	444.107	7.40	0.078	18.176
2011/04/12 13:50	445	7.42	0.079	18.167
2011/04/12 13:50	446	7.43	0.078	18.166
2011/04/12 13:50	447	7.45	0.075	18.162
2011/04/12 13:50	448	7.47	0.082	18.16
2011/04/12 13:50	449.114	7.49	0.074	18.177
2011/04/12 13:50	450	7.50	0.076	18.168
2011/04/12 13:50	451	7.52	0.077	18.164
2011/04/12 13:50	452	7.53	0.078	18.161
2011/04/12 13:50	453	7.55	0.077	18.159
2011/04/12 13:50	454.001	7.57	0.072	18.184
2011/04/12 13:50	455	7.58	0.073	18.168
2011/04/12 13:50	456	7.60	0.073	18.163
2011/04/12 13:50	457	7.62	0.077	18.16
2011/04/12 13:50	458	7.63	0.073	18.159
2011/04/12 13:50	459	7.65	0.072	18.186
2011/04/12 13:50	460	7.67	0.068	18.166
2011/04/12 13:50	461	7.68	0.071	18.161
2011/04/12 13:50	462	7.70	0.074	18.16
2011/04/12 13:50	463	7.72	0.072	18.158
2011/04/12 13:50	464	7.73	0.073	18.179
2011/04/12 13:50	465.154	7.75	0.075	18.162
2011/04/12 13:50	466	7.77	0.073	18.162
2011/04/12 13:50	467	7.78	0.068	18.158
2011/04/12 13:50	468	7.80	0.074	18.161
2011/04/12 13:50	469.146	7.82	0.073	18.174
2011/04/12 13:50	470	7.83	0.073	18.165
2011/04/12 13:50	471	7.85	0.07	18.161
2011/04/12 13:50	472	7.87	0.071	18.158
2011/04/12 13:50	473	7.88	0.069	18.156
2011/04/12 13:50	474.154	7.90	0.072	18.171
2011/04/12 13:50	475	7.92	0.071	18.16
2011/04/12 13:50	476	7.93	0.07	18.157
2011/04/12 13:50	477	7.95	0.067	18.159
2011/04/12 13:50	478	7.97	0.069	18.156
2011/04/12 13:50	479.162	7.99	0.072	18.171
2011/04/12 13:50	480	8.00	0.064	18.163
2011/04/12 13:50	481	8.02	0.068	18.16
2011/04/12 13:50	482	8.03	0.067	18.157
2011/04/12 13:50	483	8.05	0.07	18.156
2011/04/12 13:50	484.165	8.07	0.066	18.172
2011/04/12 13:50	485	8.08	0.071	18.161
2011/04/12 13:50	486	8.10	0.072	18.158
2011/04/12 13:50	487	8.12	0.073	18.155
2011/04/12 13:50	488	8.13	0.07	18.153
2011/04/12 13:51	489.172	8.15	0.072	18.168
2011/04/12 13:51	490	8.17	0.068	18.163
2011/04/12 13:51	491	8.18	0.07	18.16
2011/04/12 13:51	492	8.20	0.067	18.153
2011/04/12 13:51	493	8.22	0.067	18.153
2011/04/12 13:51	494.181	8.24	0.065	18.171
2011/04/12 13:51	495	8.25	0.07	18.16
2011/04/12 13:51	496	8.27	0.066	18.156
2011/04/12 13:51	497	8.28	0.061	18.153
2011/04/12 13:51	498	8.30	0.064	18.153
2011/04/12 13:51	499.188	8.32	0.066	18.168
2011/04/12 13:51	500	8.33	0.07	18.16
2011/04/12 13:51	501	8.35	0.065	18.156
2011/04/12 13:51	502	8.37	0.063	18.154
2011/04/12 13:51	503	8.38	0.064	18.154
2011/04/12 13:51	504	8.40	0.063	18.151
2011/04/12 13:51	505	8.42	0.07	18.163
2011/04/12 13:51	506	8.43	0.055	18.156
2011/04/12 13:51	507	8.45	0.072	18.155
2011/04/12 13:51	508	8.47	0.069	18.15
2011/04/12 13:51	509.205	8.49	0.064	18.165
2011/04/12 13:51	510	8.50	0.066	18.158
2011/04/12 13:51	511	8.52	0.054	18.154

City, State/Province **Address** **Contact Info** **Company Name**	**Slug Test Analysis Report** Project: 0129245 Number: Kangra Coal Client: Kangra coal

Location:	Slug Test: Slug Test in	Test Well: ERMBH9
Test conducted by:		Test date: 2011/06/10
Analysis performed by:	Bouwer & rice	Date: 2011/06/10
Aquifer Thickness: 54.43 m		

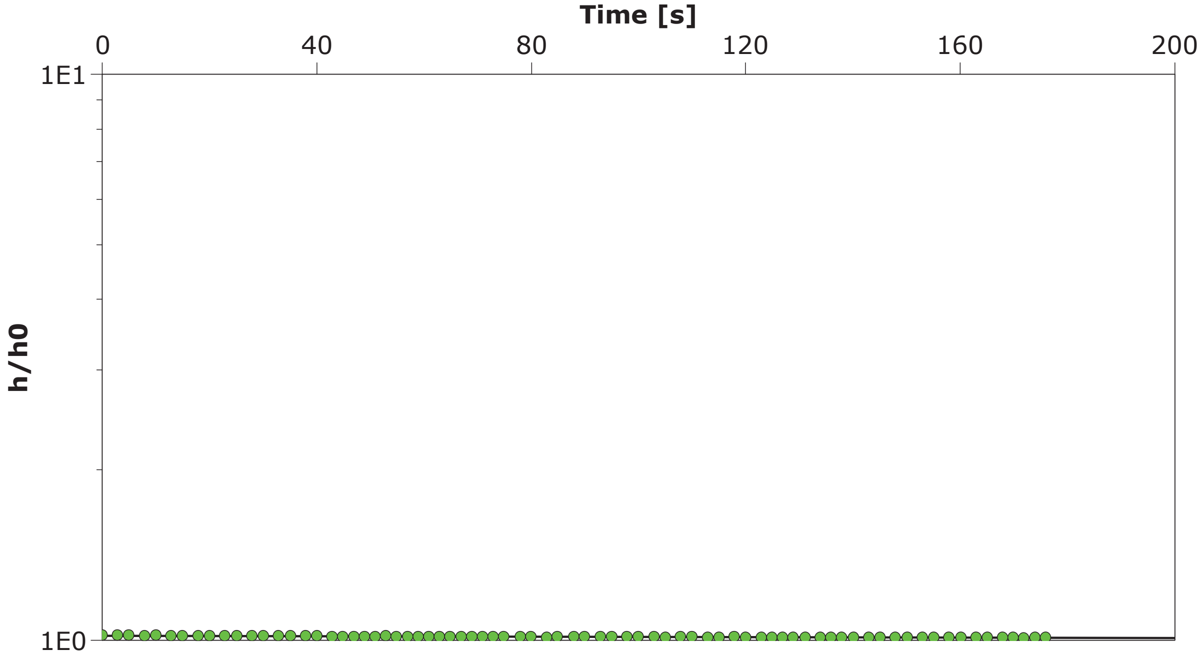


Calculation after Bouwer && Rice

Observation well	K [m/d]	
ERMBH9	1.52×10^{-3}	

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report** Project: 0129245 Number: Kangra Coal Client: Kangra coal

Location:	Slug Test: Slug Test in	Test Well: ERMBH9
Test conducted by:		Test date: 2011/06/10
Analysis performed by:	Hvorslev	Date: 2011/06/10
Aquifer Thickness: 54.43 m		



Calculation after Hvorslev

Observation well	K [m/d]	
ERMBH9	1.84×10^{-3}	

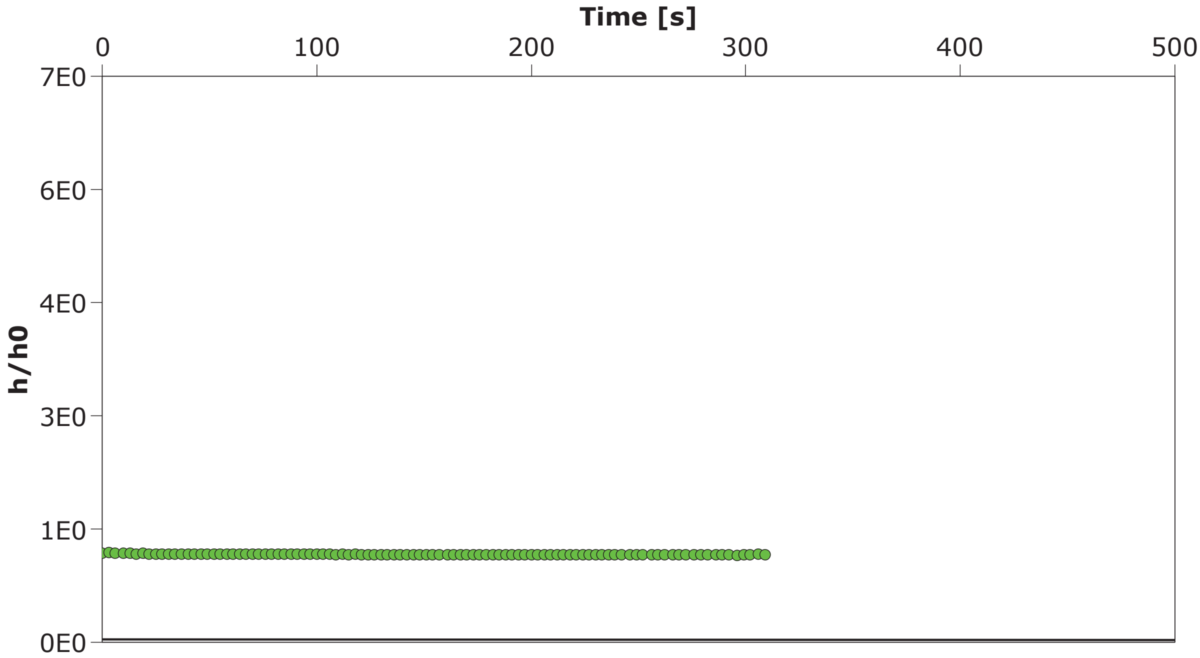
City, State/Province **Address** **Contact Info** **Company Name**	**Slug Test - Analyses Report** Project: 0129245 Number: Kangra Coal Client: Kangra coal

Location:	Slug Test: Slug Test in	Test Well: ERMBH9
Test conducted by:		Test date: 2011/06/10
Aquifer Thickness: 54.43 m		

	Analysis Name	Analysis performed	Date	Method name	Well	T [m²/d]	K [m/d]	S
1	Bouwer & rice		2011/06/10	Bouwer && Rice	ERMBH9		1.52×10^{-3}	
2	Hvorslev		2011/06/10	Hvorslev	ERMBH9		1.84×10^{-3}	
3	cbp		2011/06/10	Cooper-Bredehoeft-I	ERMBH9ılos	8.64×10^{5}	1.59×10^{4}	4.30×10^{-28}
					Average	8.64×10^{5}	5.29×10^{3}	4.30×10^{-28}

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report**	A
	Project: 0129245	
	Number: Kangra Coal	
	Client: Kangra coal	

Location:	Slug Test: Slug Test Out	Test Well: ERMBH9
Test conducted by: AB PUMPS		Test date: 2011/06/10
Analysis performed by: ERM	Bouwer & Rice	Date: 2011/06/10
Aquifer Thickness: 54.43 m		

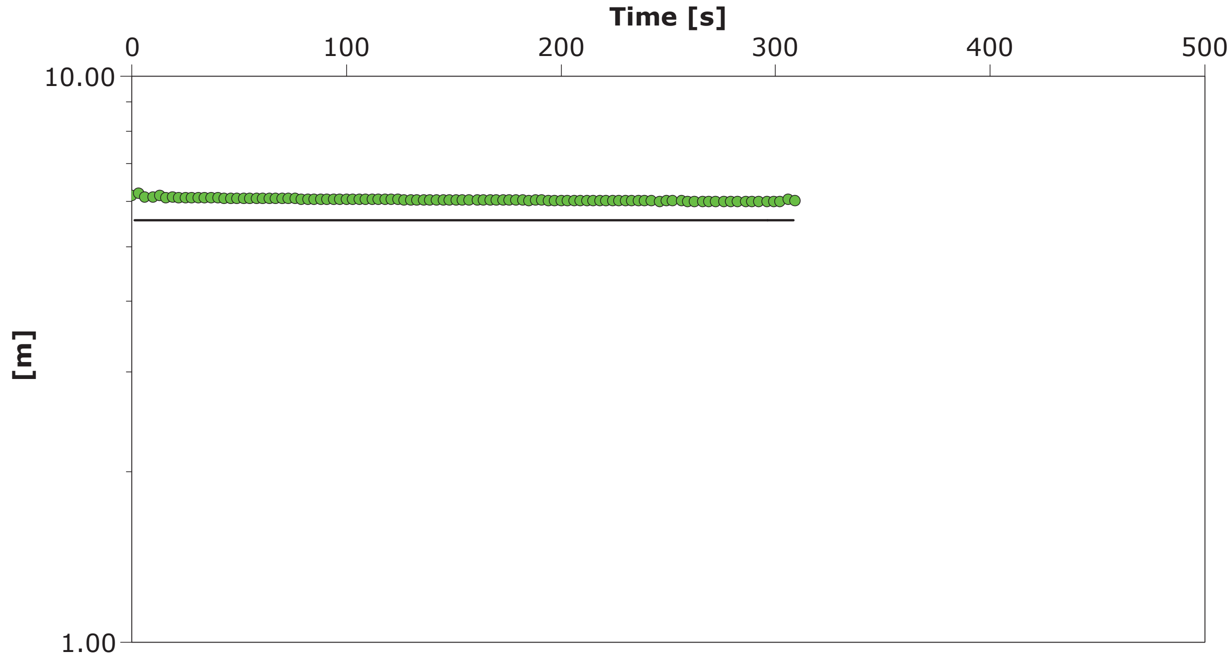


Calculation after Bouwer && Rice

Observation well	K [ft/d]	
ERMBH9	5.73×10^{-3}	

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report**	A
	Project: 0129245	
	Number: Kangra Coal	
	Client: Kangra coal	

Location:	Slug Test: Slug Test Out	Test Well: ERMBH9
Test conducted by: AB PUMPS		Test date: 2011/06/10
Analysis performed by: ERM	CBP	Date: 2011/06/10
Aquifer Thickness: 54.43 m		

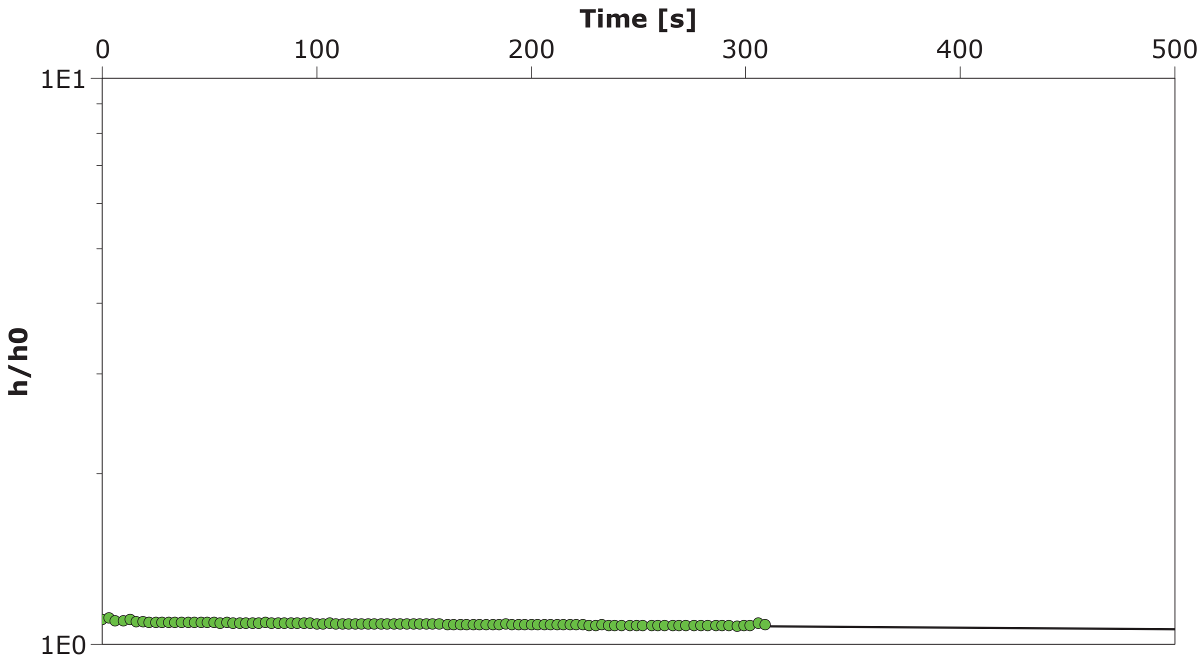


Calculation after Cooper-Bredehoeft-Papadopulos

Observation well	Transmissivity [ft²/d]	K [ft/d]	Well-bore storage coefficient	
ERMBH9	5.48×10^{-3}	3.07×10^{-5}	1.21×10^{-33}	

City, State/Province Address Contact Info Company Name	**Slug Test Analysis Report** A Project: 0129245 Number: Kangra Coal Client: Kangra coal

Location:	Slug Test: Slug Test Out	Test Well: ERMBH9
Test conducted by: AB PUMPS		Test date: 2011/06/10
Analysis performed by: ERM	hVORSLEV	Date: 2011/06/10
Aquifer Thickness: 54.43 m		



Calculation after Hvorslev

Observation well	K [ft/d]	
ERMBH9	6.95×10^{-3}	

City, State/Province
Address
Contact Info
Company Name

Slug Test - Analyses Report	A
Project: 0129245	
Number: Kangra Coal	
Client: Kangra coal	

Location:	Slug Test: Slug Test Out	Test Well: ERMBH9
Test conducted by: AB PUMPS		Test date: 2011/06/10
Aquifer Thickness: 33.43 m		

	Analysis Name	Analysis performed	Date	Method name	Well	T [ft²/d]	K [ft/d]	S
1	Bouwer & Rice	ERM	2011/06/10	Bouwer && Rice	ERMBH9		7.75×10^{-2}	
2	hVORSLEV	ERM	2011/06/10	Hvorslev	ERMBH9		9.47×10^{-2}	
3	CBP	ERM	2011/06/10	Cooper-Bredehoeft-I	ERMBH9ılos	1.61×10^{3}	1.47×10^{1}	5.00×10^{-1}
					Average	1.61×10^{3}	4.95×10^{0}	5.00×10^{-1}

Telephone: 043-732 1211
Fax no: 043-732 1422
Fax to e-mail: 0866 717 732
E mail: office@abpumps.co.za

BOREHOLE TEST RECORD

Ground water solutions t/a AB Pumps CC

PR0JECT #	P943
BBR	MARTIN
PRODUCTION BONUS:	PETER
EC meter number	20

CONSULTANT: ERM

DISTRICT: PIET RETIEF

PROVINCE: MPUMALANGA

FARM / VILLAGE NAME : DONKER POORT

DATE TESTED: 2011/04/10

MAP REFERENCE:

CO-ORDINATES:

FORMAT ON GPS: hddd ° mm ' ss.s " | hddd ' mm.mmm ' | hddd.ddddd °

LATITUDE: ° ' " OR ° ' OR 27.04170 °

LONGITUDE: ° ' " ° ' 30.28849 °

BOREHOLE NO: ERM BH10

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: NEW BOREHOLE

BOREHOLE DEPTH: (mbgl) 100.00

COMMENTS: NONE

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	No	Test for:	macro	bacterio-logical	DATA CAPTURED BY:	AILENE VAN NIEKERK
Date sample taken	2011/04/11		If consultant took sample, give name:			DATA CHECKED BY:	AILENE VAN NIEKERK
Time sample taken	07H48						

CONSULTANT GUIDELINES

BOREHOLE DEPTH:		m	STEP 1:		l/s	WATER STRIKE 1:			m
BLOW YIELD:		m	STEP 2:		l/s	WATER STRIKE 2:			m
STATIC WATER LEVEL:		m	STEP 3:		l/s	WATER STRIKE 3:			m
PUMP INSTALLATION DEPTH:		m	STEP 4:		l/s	COMMENTS:			
RECOVERY:			STEP 5:		l/s				
AFTER STEPS:		h	STEP 6:		l/s	TELEPHONE NUMBERS PHONE : (NAME & TEL)			
AFTER CONSTANT:		h	STEP DURATION:		min				

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	700.00
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M	32.93
CASING DETECTION:	NO	1	SAND/GRAVEL/SILT PUMPED?	YES/NO	NO
SUPPLIED NEW STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	1
BOREHOLE MARKING	NO	0	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	1	LAYFLAT (M):	M	50
LOGGERS FOR WATERLEVEL MONITORING	NO	0	LOGGERS FOR pH AND EC:	NO	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ____________ **SIGNATURE:** ____________

DESIGNATION: ____________ **DATE:** ____________

BOREHOLE TEST CONTROL SHEET
Groundwater Solutions t/a AB PUMPS

Borehole number:	ERM BH10	Old / Alternative number:	
Contractor:	AB PUMPS	Supervisor:	JOHAN
Operator:	MARTIN	Rig number & Type rig:	36 TOYOTA

EXISTING EQUIPMENT

Type pump	Depth	Condition	Drive unit	Condition	Pump house	Condition	Remarks

TESTING EQUIPMENT

Pump type	Depth installed (m)	Date & time (started)	Date & time (completed)
P100	92.80	09/04/2011 07H40	09-04-2011 10H40

MULTI-RATE OR STEPTEST DETAILS

STEP	DURATION (MIN)	RECOVERY (MIN)	YIELD (L/S)		DRAWDOWN (m)
1	60		2.39	l/s	0.06
2	60		8.75	l/s	0.11
3	60		19.49	l/s	0.54
4	53	230	63.00	l/s	0.97
5				l/s	
6				l/s	
7				l/s	
8				l/s	
Calibration:				l/s	
TOTAL:	233	230	93.63	l/s	1.68

COMMENT:

CONSTANT RATE DISCHARGE TEST

Pump type	Depth installed (m)	Date & time (started)		Date & time (completed)	
P100	92.80	10/04/11	07H50	2011-04-11	15H50
Yield l/s	**Drawdown (m)**	**Duration (min)**		**Recovery (min)**	
0.16	8.09	1440		360	
Total: (Multi-rate and Constant Discharge rate)		1673		590	

COMMENT:

MAINTENANCE

Work time: hour	Transport existing equipm. Km	Travelling (To fix); Km

List of parts replaced or repaired:

	Borehole number	Duration (min) CONSTANT	Drawdown (m)	Hand/logger	Distance (m)
Observation Hole 1	ERM BH05	1800	8.09	LOGGER	0
Observation Hole 2	ERM BH07	1800	8.09	LOGGER	0
Observation Hole 3					0
Observation Hole 4					
Observation Hole 5					

GENERAL

ESTABLISHMENT	From:		To:			
Site Move	From project# P943		To #: P943		Travelling km:	3.29
	Village	Borehole no	Village	Borehole no		
	DONKER POORT	ERM BH07	DONKER POORT	ERM BH10		
Maintenance:	Work time hr		Parts repaired/		Travelling km	
After test measurements	Water level	32.93	Borehole depth	700.00	Casing depth m	12.00

Water level before installing test pump:	32.82
Depth before installing test pump:	100.00
Testpump Installed	**Once** /Twice /More — Reason:
Installed Testpump	**<10 l/s** / >10ls/s — Reason:
Was existing equipment re-installed:	**No** — If not where was it left:
GPS Unit number:	
EC Unit number:	20.00

Remarks:

Signed Contractor:	Signed Consultant:

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	0	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH10			DISTRICT:	PIET RETIEF
ALT BH NO:	0			SITE NAME:	DONKER POORT
ALT BH NO:	0				

BOREHOLE DEPTH (m)	100.00	DATUM LEVEL ABOVE CASING (m):	0.28	EXISTING PUMP:	0
WATER LEVEL (mbgl):	29.13	CASING HEIGHT: (magl):	0.30	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	92.80	DIAM PUMP INLET (mm):	165.00	PUMP TYPE:	P100

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 RPM

DATE: 09/04/2011 TIME: 07H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.89		1	
2	0.98		2	
3	1.01		3	
5	1.40		5	
7	1.45		7	
10	1.58		10	
15	1.70	0.06	15	
20	1.93		20	
30	2.05	0.06	30	
40	2.10		40	
50	2.27	0.05	50	
60	2.39		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	9.71		150	
TEMP	19.00	℃	180	
EC	86.00	µS/cm	210	

DISCHARGE RATE 2 RPM

DATE: 09/04/2011 TIME: 08H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	3.37		1	
2	4.55	0.11	2	
3	6.00		3	
5	6.05	0.11	5	
7	6.09		7	
10	6.12	0.10	10	
15	6.14		15	
20	6.15	0.11	20	
30	6.17		30	
40	8.48	0.11	40	
50	8.56		50	
60	8.72	0.11	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	8.06		150	
TEMP	23.20	℃	180	
EC	67.00	µS/cm	210	

DISCHARGE RATE 3 RPM

DATE: 09/07/2011 TIME: 09H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	8.76		1	
2	8.78	0.55	2	
3	9.03		3	
5	10.18	0.55	5	
7	11.21		7	
10	12.33	0.55	10	
15	14.76		15	
20	15.74	0.54	20	
30	17.15		30	
40	18.05	0.55	40	
50	18.93		50	
60	19.49	0.55	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH	6.49		150	
TEMP	25.00	℃	180	
EC	74.00	µS/cm	210	

DISCHARGE RATE 4 RPM

DATE: 09/04/2011 TIME: 10H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	21.16		1	57.63
2	22.92	0.97	2	52.88
3	24.61		3	49.84
5	27.90	0.97	5	47.00
7	30.80		7	42.20
10	34.23	0.97	10	33.36
15	39.77		15	30.07
20	44.24	0.96	20	27.04
30	47.12		30	24.00
40	56.15	0.97	40	17.64
50	63.00		50	11.80
60	63.00	0.61	60	8.41
70	63.00	0.58	70	6.90
80	63.00	0.43	80	6.31
90			90	5.97
100			100	5.75
110			110	5.52
120			120	5.33
pH	7.89		150	4.84
TEMP	23.10	℃	180	4.45
EC	90.00	µS/cm	210	4.09
			230	3.90
			300	
			360	

DISCHARGE RATE 5 RPM

DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		℃	180	
EC		µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 6 RPM

DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		℃	180	
EC		µS/cm	210	
			240	
			300	
			360	

S/W/L: 32.82

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:	27.0417	PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH10		30.28849	DISTRICT:	PIET RETIEF
ALT BH NO:	0			SITE NAME:	DONKER POORT
ALT BH NO:	0				
BOREHOLE DEPTH:	100.00	DATUM LEVEL ABOVE CASING (m):	0.28	EXISTING PUMP:	0
WATER LEVEL (mbgl):	32.16	CASING HEIGHT: (magl):	0.30	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	92.80	DIAM PUMP INLET(mm):	165	PUMP TYPE:	P100

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**					
DATE:	10-04-2011	TIME:	07H50	DATE:		TIME:		TYPE OF PUMP:	P100

DISCHARGE BOREHOLE					OBSERVATION HOLE 1 NR: Distance(m);			OBSERVATION HOLE 2 NR: Distance(m);			OBSERVATION HOLE 3 NR: Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery (m)	TIME: (min)	Drawdown (m)
1	0.52		**1**	4.39	**1**			**1**			**1**	
2	0.65		**2**	3.93	**2**			**2**			**2**	
3	0.68		**3**	3.82	**3**			**3**			**3**	
5	0.69		**5**	3.76	**5**			**5**			**5**	
7	0.70		**7**	3.68	**7**			**7**			**7**	
10	0.72		**10**	3.60	**10**			**10**			**10**	
15	0.98	0.09	**15**	3.58	**15**			**15**			**15**	
20	1.10	0.15	**20**	3.47	**20**			**20**			**20**	
30	2.78		**30**	3.26	**30**			**30**			**30**	
40	3.20	0.15	**40**	3.13	**40**			**40**			**40**	
60	3.80		**60**	2.77	**60**			**60**			**60**	
90	4.04	0.16	**90**	2.42	**90**			**90**			**90**	
120	4.35		**120**	2.10	**120**			**120**			**120**	
150	4.44	0.16	**150**	1.84	**150**			**150**			**150**	
180	4.88		**180**	1.38	**180**			**180**			**180**	
210	4.98	0.15	**210**	0.94	**210**			**210**			**210**	
240	5.02		**240**	0.63	**240**			**240**			**240**	
300	5.47	0.16	**300**	0.26	**300**			**300**			**300**	
360	6.12		**360**	0.11	**360**			**360**			**360**	
420	6.37	0.15	**420**		**420**			**420**			**420**	
480	6.69		**480**		**480**			**480**			**480**	
540	6.81	0.15	**540**		**540**			**540**			**540**	
600	6.94		**600**		**600**			**600**			**600**	
720	7.18	0.16	**720**		**720**			**720**			**720**	
840	7.29		**840**		**840**			**840**			**840**	
960	7.41	0.16	**960**		**960**			**960**			**960**	
1080	7.85		**1080**		**1080**			**1080**			**1080**	
1200	7.69	0.16	**1200**		**1200**			**1200**			**1200**	
1320	7.81		**1320**		**1320**			**1320**			**1320**	
1440	8.09	0.16	**1440**		**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1440		**W/L**			**W/L**			**W/L**
Average yield (l/s):				0.15								

FORM 5 F

BOREHOLE TEST RECORD SHEET

PROJ NO :	P943	MAP REFERENCE:		PROVINCE:	MPUMALANGA
BOREHOLE NO:	ERM BH10			DISTRICT:	PIET RETIEF
ALT BH NO:				SITE NAME:	DONKER POORT
ALT BH NO:					
BOREHOLE DEPTH:	100.00	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	0
WATER LEVEL (mbgl)::	32.16	CASING HEIGHT (magl):	0.00	CONTRACTOR:	AB PUMPS
DEPTH OF PUMP (m):	92.80	DIAM PUMP INLET(mm):	0.00		

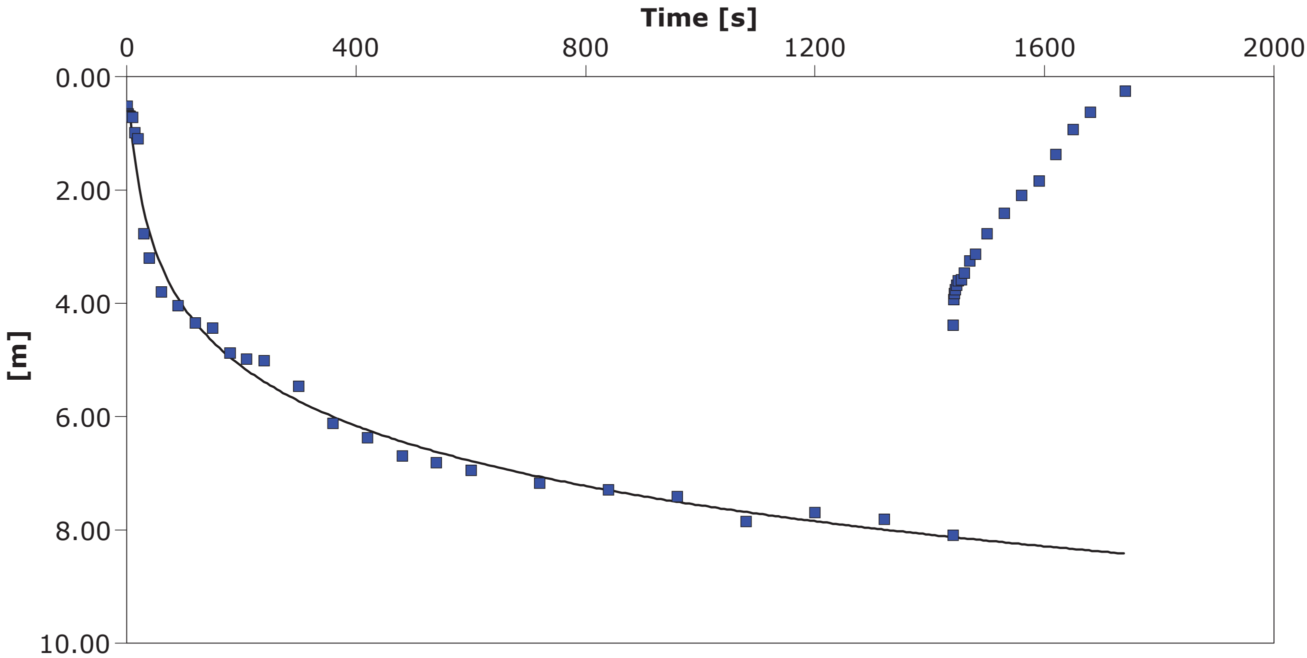
CONSTANT DISCHARGE TEST

DISCHARGE BOREHOLE

TIME (MIN)	REAL TIME	MEASUREMENTS				TIME (MIN)	REAL TIME	MEASUREMENTS		
		pH	TEMP ℃	EC µS/cm				pH	TEMP ℃	EC µS/cm
1		9.19	18.8	95						
120		9.76	20.7	83						
240		10.09	20.05	90						
360		10.1	20	89						
480		9.7	19.3	90						
600		9.7	16.3	89						
720		9.72	16.8	110						
840		9.75	14.6	105						
960		9.76	13.8	115						
1080		9.62	13.3	136						
1200		9.61	13.3	142						
1320		9.65	13	162						
1440		9.74	16.9	196						
1800										
2160										
2520										
2880										
3240										
3600										
3960										
4320										
4680										
5040										
5400										
5760										
6120										
6480										
7200										
7560										
7920										
8280										
8640										
9000										
9360										
9720										
10080										
10440										
10800										
11160										
11520										
11880										
12240										

	Pumping Test Analysis Report A
	Project: Kusipongo EIA GW
	Number: 0129245
	Client: Kangra Coal

Location: Kusipongo	Pumping Test: Constant test	Pumping well: ERMBH10
Test conducted by: AB PUMPS		Test date: 2011/04/09
Analysis performed by: ERM	Theis	Analysis date: 2011/05/10
Aquifer Thickness: 45.00 m	Discharge: variable, average rate 0.11489 [l/s]	

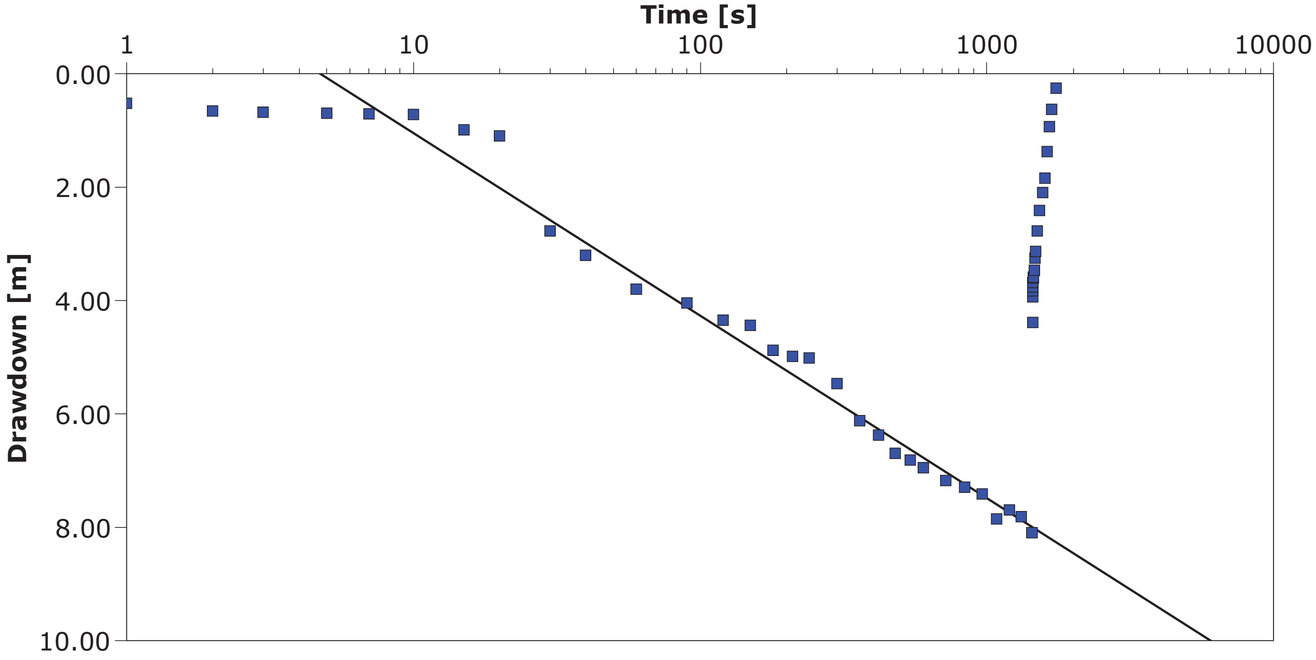


Calculation after Theis

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH10	5.12×10^{-1}	1.14×10^{-2}	1.46×10^{-2}	0.08	

Pumping Test Analysis Report	A
Project: Kusipongo EIA GW	
Number: 0129245	
Client: Kangra Coal	

Location: Kusipongo	Pumping Test: Constant test	Pumping well: ERMBH10
Test conducted by: AB PUMPS		Test date: 2011/04/09
Analysis performed by: ERM	Cooper & Jacob1	Analysis date: 2011/05/10
Aquifer Thickness: 45.00 m	Discharge: variable, average rate 0.11489 [l/s]	

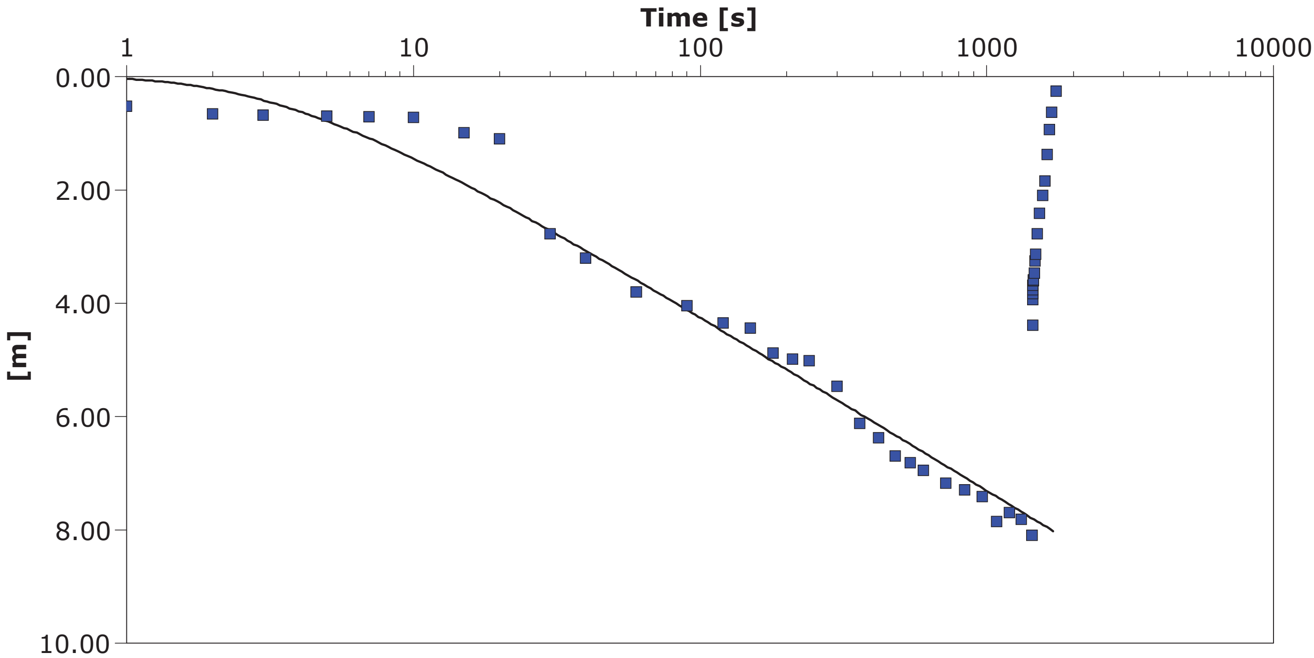


Calculation after Cooper & Jacob

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial distance to PW [m]	
ERMBH10	5.64×10^{-1}	1.25×10^{-2}	1.02×10^{-2}	0.08	

Pumping Test Analysis Report	A
Project: Kusipongo EIA GW	
Number: 0129245	
Client: Kangra Coal	

Location: Kusipongo	Pumping Test: Constant test	Pumping well: ERMBH10
Test conducted by: AB PUMPS		Test date: 2011/04/09
Analysis performed by: ERM	Double Porosity	Analysis date: 2011/05/10
Aquifer Thickness: 45.00 m	Discharge: variable, average rate 0.11489 [l/s]	

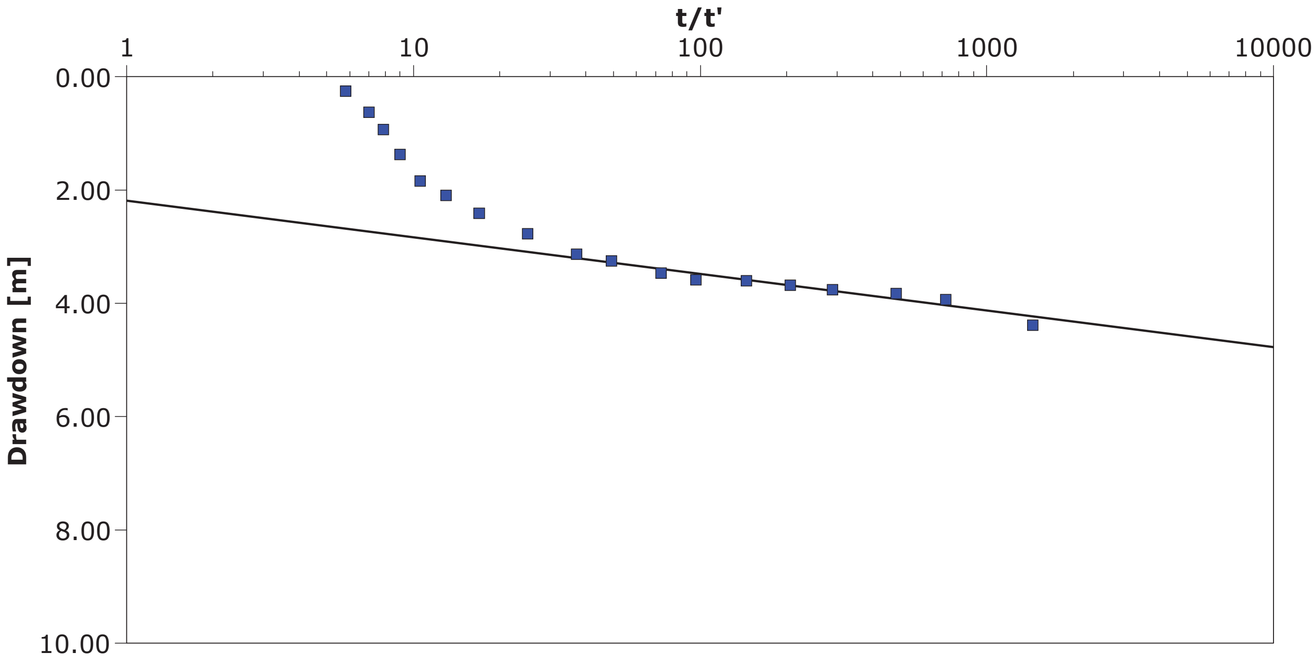


Calculation after Double Porosity

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Specific storage	Sigma	Lambda	Radial distance to PW [m]
ERMBH10	5.90×10^{-1}	1.31×10^{-2}	9.61×10^{-3}	1.00×10^{5}	6.31×10^{-15}	0.08

Pumping Test Analysis Report	A
Project: Kusipongo EIA GW	
Number: 0129245	
Client: Kangra Coal	

Location: Kusipongo	Pumping Test: Constant test	Pumping well: ERMBH10
Test conducted by: AB PUMPS		Test date: 2011/04/09
Analysis performed by: ERM	Theis Recovery	Analysis date: 2011/05/10
Aquifer Thickness: 45.00 m	Discharge: variable, average rate 0.11489 [l/s]	



Calculation after Theis & Jacob

Observation well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Radial distance to PW [m]	
ERMBH10	2.82×10^{0}	6.27×10^{-2}	0.08	

Pumping Test Analysis Report	A
Project: Kusipongo EIA GW	
Number: 0129245	
Client: Kangra Coal	

Location: Kusipongo	Pumping Test: Constant test	Pumping well: ERMBH10
Test conducted by: AB PUMPS		Test date: 2011/04/09
Aquifer Thickness: 45.00 m	Discharge: variable, average rate 0.11489 [l/s]	

	Analysis Name	Analysis performed by	Analysis date	Method name	Well	T [m²/d]	K [m/d]	S
1	Theis	ERM	2011/05/10	Theis	ERMBH10	5.12×10^{-1}	1.14×10^{-2}	1.46×10^{-2}
2	Cooper & Jacob1	ERM	2011/05/10	Cooper & Jacob I	ERMBH10	5.64×10^{-1}	1.25×10^{-2}	1.02×10^{-2}
3	Double Porosity	ERM	2011/05/10	Double Porosity	ERMBH10	5.90×10^{-1}	1.31×10^{-2}	9.61×10^{-3}
4	Theis Recovery	ERM	2011/05/10	Theis Recovery	ERMBH10	2.82×10^{0}	6.27×10^{-2}	3.97×10^{-4}

Jones & Wagener
Consulting Civil Engineers
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
Tel: (011) 519-0200 Fax: (011) 803-1456 email: post@jaws.co.za

Client:	HATCH	Our Ref:	C842
Job:	KANGRA COAL	Set no.:	
Site:	Decline Shaft	Made by:	RR
Tests:	Packer	Date:	22 March 2011

Borehol No.:	BH1	Inclination:	Vertical	Test No.:	1

Date of Test:	2011/03/10	Test Section From:	30 m to 42.3 m
Packer Type:	Bimbar Single	Packer Pressure:	1350 kPa
Bottom of Casing:	9 m	Water Level:	3.4 m
Base of Hole:	42.3 m	Hole Diameter:	75.69 mm
Length of test Pipe:	55 m	Diameter of Pipe:	25 mm

Pressure Gauge Height Above Collar:	0.5 m
Details of Test Equipment:	Water Meter - C - EJA0207, Water Gauge A9444 - cert 1028410
Calibration Curve No.:	5 minutes at 50 kPa = 980l to 1069l = 73 l

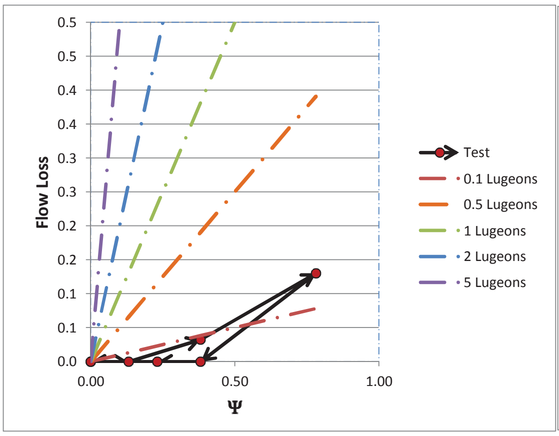
FIRST STAGE		Gauge Pressure:			200 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3506	3507	3507	3507	3507	q (litres/minute)
Water Intake	(litres)	-	1	0	0	0	0.1
SECOND STAGE		Gauge Pressure:			350 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3507	3507	3508	3508	3509	q (litres/minute)
Water Intake	(litres)	-	0	1	0	1	0.2
THIRD STAGE		Gauge Pressure:			750 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3509	3513	3516	3520	3524	q (litres/minute)
Water Intake	(litres)	-	4	3	4	4	1.5
FOURTH STAGE		Gauge Pressure:			350 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3524	3524	3524	3524	3524	q (litres/minute)
Water Intake	(litres)	-	0	0	0	0	0.0
FIFTH STAGE		Gauge Pressure:			200 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3524	3524	3524	3524	3524	q (litres/minute)
Water Intake	(litres)	-	0	0	0	0	0.0

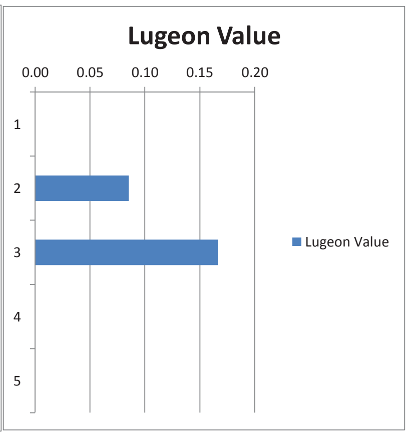
LUGEON VALUES

For BH1 from 30m to 42.3m

Step	P kPa	Q l/min	L m	P_o kPa	Lugeon l/min/m	Ψ	Flow Loss l/min/m
0	0	0			0.00	0.00	0.0
1	131	0	12.3	1000	0.00	0.13	0.0
2	381	0.4	12.3	1000	0.09	0.38	0.0
3	781	1.6	12.3	1000	0.17	0.78	0.1
4	381	0	12.3	1000	0.00	0.38	0.0
5	231	0	12.3	1000	0.00	0.23	0.0
6	0	0			0.00	0.00	0.0

0.05





Jones & Wagener Consulting Civil Engineers	Client: HATCH	Our Ref: C842
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa	Job: KANGRA COAL	Set no.:
Tel: (011) 519-0200 Fax: (011) 803-1456 email: post@jaws.co.za	Site: Decline Shaft	Made by: RR
	Tests: Packer	Date: 22 March 2011

Borehol No.:	BH1	**Inclination:**	Vertical	**Test No.:**	2

Date of Test:	2011/03/10	**Test Section From:**	20 m to 42.3 m
Packer Type:	Bimbar Single	**Packer Pressure:**	1350 kPa
Bottom of Casing:	9 m	**Water Level:**	3.4 m
Base of Hole:	42.3 m	**Hole Diameter:**	75.69 mm
Length of test Pipe:	55 m	**Diameter of Pipe:**	25 mm

Pressure Gauge Height Above Collar:	0.5 m
Details of Test Equipment:	Water Meter - C - EJA0207, Water Gauge A9444 - cert 1028410
Calibration Curve No.:	5 minutes at 50 kPa = 980l to 1069l = 73 l

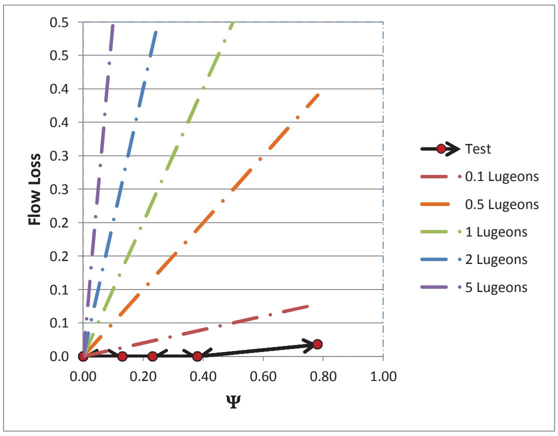
FIRST STAGE		Gauge Pressure:		200 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3545	3546	3546	3546	3546	q (litres/minute)
Water Intake	(litres)	-	1	0	0	0	0.1
SECOND STAGE		Gauge Pressure:		350 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3546	3546	3546	3546	3546	q (litres/minute)
Water Intake	(litres)	-	0	0	0	0	0.0
THIRD STAGE		Gauge Pressure:		750 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3546	3547	3548	3548	3549	q (litres/minute)
Water Intake	(litres)	-	1	1	0	1	0.3
FOURTH STAGE		Gauge Pressure:		350 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3548	3548	3548	3548	3548	q (litres/minute)
Water Intake	(litres)	-	0	0	0	0	0.0
FIFTH STAGE		Gauge Pressure:		200 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	3548	3548	3548	3548	3548	q (litres/minute)
Water Intake	(litres)	-	0	0	0	0	0.0

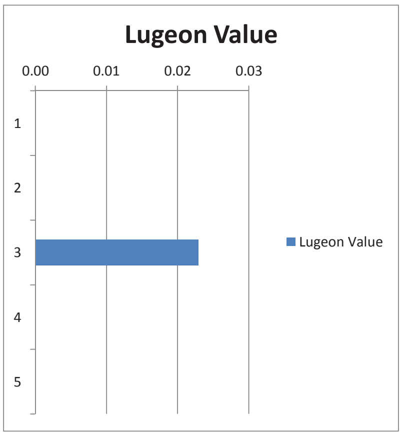
LUGEON VALUES

For BH1 from 20m to 42.3m

Step	P kPa	Q l/min	L m	P_o kPa	Lugeon l/min/m	Ψ	Flow Loss l/min/m
0	0	0			0.00	0.00	0.0
1	131	0	22.3	1000	0.00	0.13	0.0
2	381	0	22.3	1000	0.00	0.38	0.0
3	781	0.4	22.3	1000	0.02	0.78	0.0
4	381	0	22.3	1000	0.00	0.38	0.0
5	231	0	22.3	1000	0.00	0.23	0.0
6	0	0			0.00	0.00	0.0

0.000





Jones & Wagener Consulting Civil Engineers	Client:	HATCH	Our Ref:	C842
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa	Job:	KANGRA COAL	Set no.:	
Tel: (011) 519-0200 Fax: (011) 803-1456 email: post@jaws.co.za	Site:	Decline Shaft	Made by:	RR
	Tests:	Packer	Date:	22 March 2011

Borehol No.:	BH2	Inclination:	Vertical	Test No.:	1

Date of Test:	03/03/2011	Test Section From:	17 m to 26 m
Packer Type:	Bimbar Single	Packer Pressure:	1000 kPa
Bottom of Casing:	9 m	Water Level:	0.25 m
Base of Hole:	26 m	Hole Diameter:	75.69 mm
Length of test Pipe:	55 m	Diameter of Pipe:	25 mm

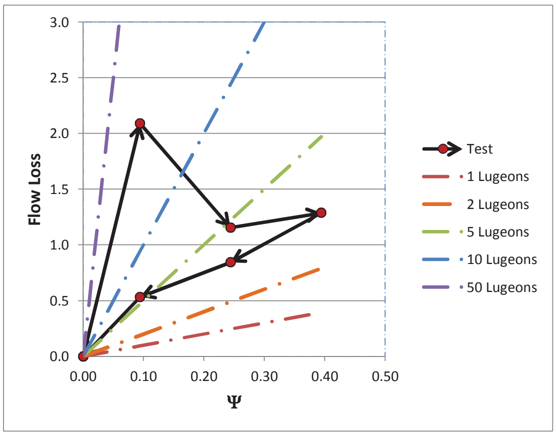
Pressure Gauge Height Above Collar:	0.2 m
Details of Test Equipment:	Water Meter - C - EJA0207, Water Gauge A9444 - cert 1028410
Calibration Curve No.:	5 minutes at 50 kPa = 980l to 1069l = 89 l

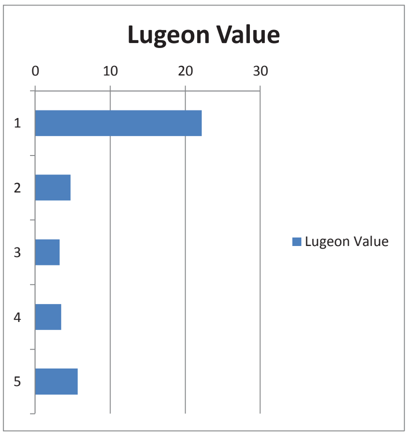
FIRST STAGE		Gauge Pressure:		100 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	1190	1224	1281	1325	1372	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	34	57	44	47	18.2
SECOND STAGE		Gauge Pressure:		250 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	1372	1540	1590	1610	1636	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	168	50	20	26	26.4
THIRD STAGE		Gauge Pressure:		400 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	1636	1663	1686	1714	1743	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	27	23	28	29	10.7
FOURTH STAGE		Gauge Pressure:		250 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	1743	1766	1796	1812	1831	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	23	30	16	19	8.8
FIFTH STAGE		Gauge Pressure:		100 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	1831	1844	1855	1867	1879	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	13	11	12	12	4.8

LUGEON VALUES

For BH2 from 17m to 26m

Step	P kPa	Q l/min	L m	P_o kPa	Lugeon l/min/m	Ψ	Flow Loss l/min/m
0	0	0			0	0.00	0.0
1	94	18.8	9	1000	22	0.09	2.1
2	244	10.4	9	1000	5	0.24	1.2
3	394	11.6	9	1000	3	0.39	1.3
4	244	7.6	9	1000	3	0.24	0.8
5	94	4.8	9	1000	6	0.09	0.5
6	0	0			0	0.00	0.0





Jones & Wagener Consulting Civil Engineers			
Client:	HATCH	Our Ref:	C842
Job:	KANGRA COAL	Set no.:	
Site:	Decline Shaft	Made by:	RR
Tests:	Packer	Date:	22 March 2011

59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
Tel: (011) 519-0200 Fax: (011) 803-1456 email: post@jaws.co.za

Borehol No.:	BH2	**Inclination:**	Vertical	**Test No.:**	2

Date of Test:	03/03/2011	**Test Section From:**	10.5 m to 26 m
Packer Type:	Bimbar Single	**Packer Pressure:**	1000 kPa
Bottom of Casing:	9 m	**Water Level:**	0.25 m
Base of Hole:	26 m	**Hole Diameter:**	75.69 mm
Length of test Pipe:	55 m	**Diameter of Pipe:**	25 mm

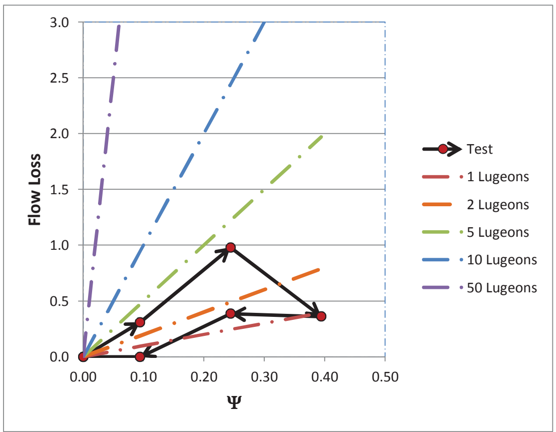
Pressure Gauge Height Above Collar:	0.2 m
Details of Test Equipment:	Water Meter - C - EJA0207, Water Gauge A9444 - cert 1028410
Calibration Curve No.:	5 minutes at 50 kPa = 980l to 1069l = 89 l

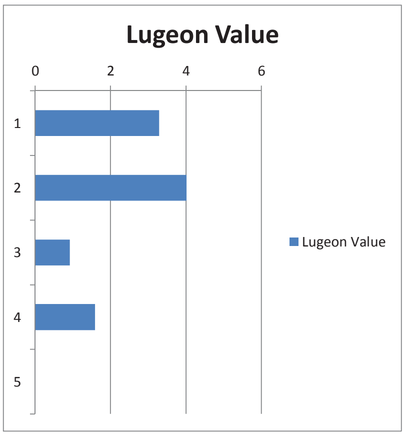
FIRST STAGE		Gauge Pressure:		100 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	1909	1936	1951	1964	1976	q (litres/minute)
Water Intake	(litres)	-	27	15	13	12	6.7
SECOND STAGE		Gauge Pressure:		250 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	1976	2018	2058	2098	2136	q (litres/minute)
Water Intake	(litres)	-	42	40	40	38	16.0
THIRD STAGE		Gauge Pressure:		400 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	2136	2202	2250	2273	2287	q (litres/minute)
Water Intake	(litres)	-	66	48	23	14	15.1
FOURTH STAGE		Gauge Pressure:		250 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	2287	2303	2318	2332	2347	q (litres/minute)
Water Intake	(litres)	-	16	15	14	15	6.0
FIFTH STAGE		Gauge Pressure:		100 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter Dipstick	Reading (litres)	2347	2348	2348	2348	2348	q (litres/minute)
Water Intake	(litres)	-	1	0	0	0	0.1

LUGEON VALUES

For BH2 from 10.5m to 26m

Step	P kPa	Q l/min	L m	P_o kPa	Lugeon l/min/m	Ψ	Flow Loss l/min/m
0	0	0			0	0.00	0.0
1	94	4.8	15.5	1000	3	0.09	0.3
2	244	15.2	15.5	1000	4	0.24	1.0
3	394	5.6	15.5	1000	1	0.39	0.4
4	244	6	15.5	1000	2	0.24	0.4
5	94	0	15.5	1000	0	0.09	0.0
6	0	0			0	0.00	0.0





Jones & Wagener
Consulting Civil Engineers
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
Tel: (011) 519-0200 Fax: (011) 803-1456 email: post@jaws.co.za

Client:	**HATCH**	**Our Ref:**	**C842**
Job:	**KANGRA COAL**	**Set no.:**	
Site:	**Decline Shaft**	**Made by:**	**RR**
Tests:	**Packer**	**Date:**	**22 March 2011**

Borehol No.:	BH2	**Inclination:**	Vertical	**Test No.:**	3

Date of Test:	03/03/2011	**Test Section From:**	17 m to 26 m
Packer Type:	Bimbar Single	**Packer Pressure:**	1000 kPa
Bottom of Casing:	9 m	**Water Level:**	0.25 m
Base of Hole:	26 m	**Hole Diameter:**	75.69 mm
Length of test Pipe:	55 m	**Diameter of Pipe:**	25 mm

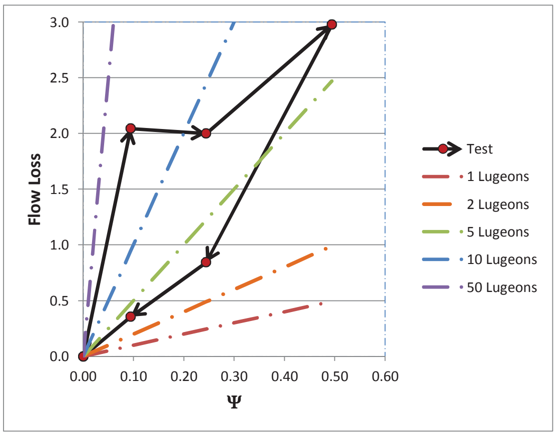
Pressure Gauge Height Above Collar:	0.2 m
Details of Test Equipment:	Water Meter - C - EJA0207, Water Gauge A9444 - cert 1028410
Calibration Curve No.:	5 minutes at 50 kPa = 980l to 1069l = 89 l

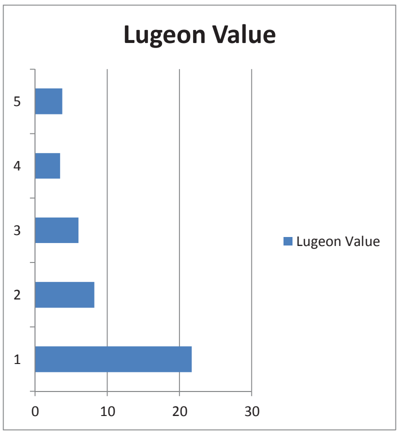
FIRST STAGE		Gauge Pressure:			100 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	2358	2418	2475	2524	2570	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	60	57	49	46	21.2
SECOND STAGE		Gauge Pressure:			250 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	2570	2626	2674	2721	2766	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	56	48	47	45	19.6
THIRD STAGE		Gauge Pressure:			500 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	2766	2840	2911	2979	3046	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	74	71	68	67	28.0
FOURTH STAGE		Gauge Pressure:			250 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	3046	3097	3123	3143	3162	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	51	26	20	19	11.6
FIFTH STAGE		Gauge Pressure:			100 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	3162	3171	3179	3187	3195	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	9	8	8	8	3.3

LUGEON VALUES

For BH2 from 17m to 26m

Step	P kPa	Q l/min	L m	P_o kPa	Lugeon l/min/m	Ψ	Flow Loss l/min/m
0	0	0			0	0.00	0.0
1	94	18.4	9	1000	22	0.09	2.0
2	244	18	9	1000	8	0.24	2.0
3	494	26.8	9	1000	6	0.49	3.0
4	244	7.6	9	1000	3	0.24	0.8
5	94	3.2	9	1000	4	0.09	0.4
6	0	0			0	0.00	0.0





Jones & Wagener
Consulting Civil Engineers
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
Tel: (011) 519-0200 Fax: (011) 803-1456 email: post@jaws.co.za

Client:	HATCH	Our Ref:	C842
Job:	KANGRA COAL	Set no.:	
Site:	Decline Shaft	Made by:	RR
Tests:	Packer	Date:	22 March 2011

Borehol No.:	BH3	Inclination:	Vertical	Test No.:	1

Date of Test:	2011/03/02	Test Section From:	10 m to 20 m
Packer Type:	Bimbar Single	Packer Pressure:	1000 kPa
Bottom of Casing:	6 m	Water Level:	1.2 m
Base of Hole:	20 m	Hole Diameter:	75.69 mm
Length of test Pipe:	55 m	Diameter of Pipe:	25 mm

Pressure Gauge Height Above Collar:	0.25 m
Details of Test Equipment:	Water Meter - C - EJA0207, Water Gauge A9444 - cert 1028410
Calibration Curve No.:	5 minutes at 50 kPa = 980l to 1069l = 76 l

FIRST STAGE		Gauge Pressure:		100 kPa		
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	733	733	733	733	733	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	0	0	0	0	0.0

SECOND STAGE		Gauge Pressure:		200 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	733	737	740	744	747	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	4	3	4	3	1.4

THIRD STAGE		Gauge Pressure:		250 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	747	808	846	886	927	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	61	38	40	41	18.0

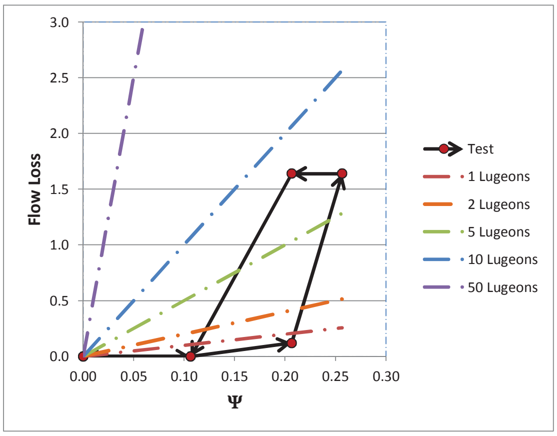
FOURTH STAGE		Gauge Pressure:		200 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	747	808	846	886	927	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	61	38	40	41	18.0

FIFTH STAGE		Gauge Pressure:		100 kPa			
Time	(minutes)	0	2.5	5	7.5	10	Av Flow
Flowmeter	Reading	927	936	939	939	939	q
Dipstick	(litres)						(litres/minute)
Water Intake	(litres)	-	9	3	0	0	1.2

LUGEON VALUES

For BH3 from 10m to 20m

Step	P kPa	Q l/min	L m	P_o kPa	Lugeon l/min/m	Ψ	Flow Loss l/min/m
0	0	0			0	0.00	0.0
1	107	0	10	1000	0	0.11	0.0
2	207	1.2	10	1000	1	0.21	0.1
3	257	16.4	10	1000	6	0.26	1.6
4	207	16.4	10	1000	8	0.21	1.6
5	107	0	10	1000	0	0.11	0.0
6	0	0			0	0.00	0.0



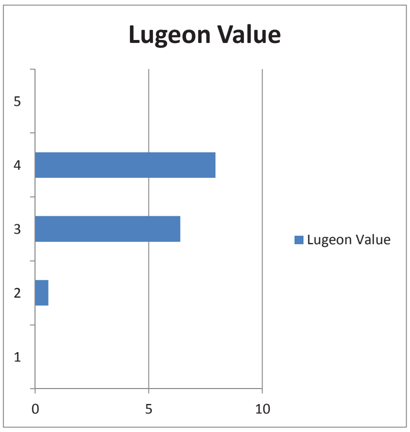


Table 4. Proposed Lugeon interpretation procedure using the flow loss vs. pressure space

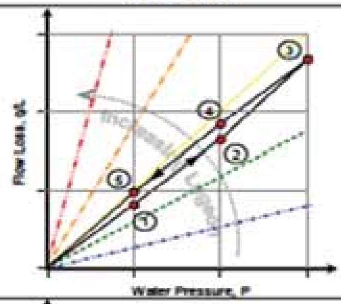
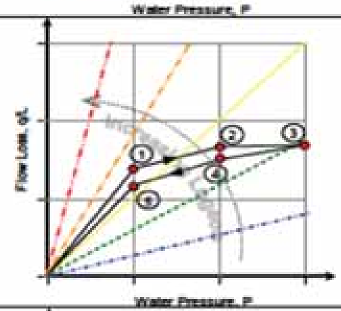
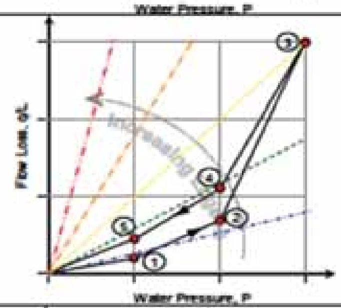
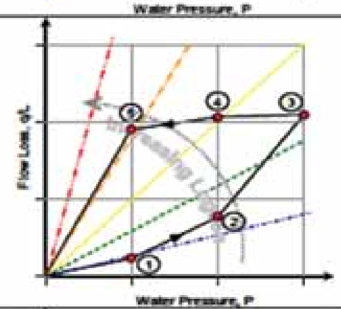
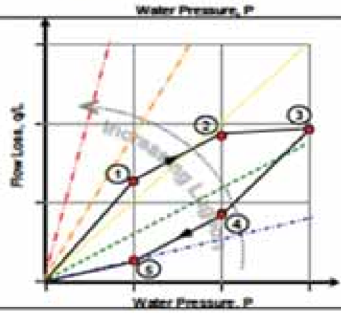
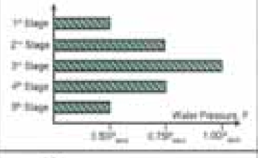
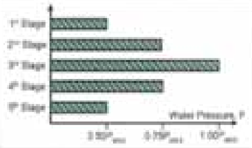
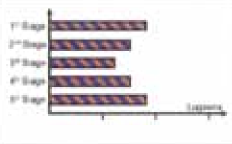
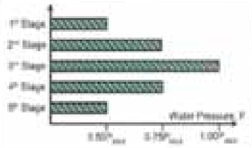
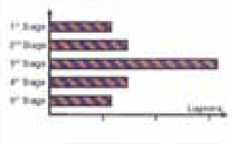
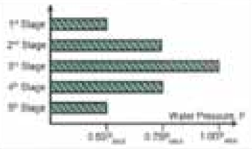
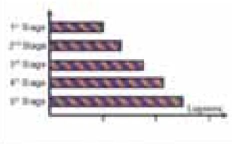
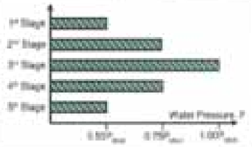
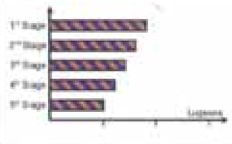
BEHAVIOR	WATER LOSS VS PRESSURE PATTERN	DESCRIPTION	REPRESENTATIVE LUGEON VALUE
LAMINAR		All Lugeon values about equal regardless of the water pressure	Average of Lugeon values for all stages
TURBULENT		Lugeon values decrease as the water pressures increase. The minimum Lugeon value is observed at the stage with the maximum water pressure	Range of Lugeon values observed at water pressures expected during operation. If water pressure expected during operation is unknown use the value corresponding to the medium water pressure (2nd or 4th stage)
DILATION		Lugeon values vary proportionally to the water pressures. The maximum Lugeon value is observed at the stage with the maximum water pressure	Range of Lugeon values observed at water pressures expected during operation. If water pressure expected during operation is unknown use the value corresponding to either low or medium water pressures (1st, 2nd, 4th, or 5th stage)
WASH-OUT		Lugeon values increase as the test proceeds. Discontinuities' infillings are progressively washed-out by the water	Highest Lugeon value recorded (5th stage)
VOID FILLING		Lugeon values decrease as the test proceeds. Either non-persistent discontinuities are progressively being filled or swelling is taking place	Use final Lugeon value (5th stage), provided that presence of non-persistent discontinuities and/or occurrence of swelling is confirmed by observation of rock core.

Table 3. Summary of current Lugeon interpretation practice (as proposed by Houlsby, 1976)

BEHAVIOR	PRESSURE STAGES	LUGEON PATTERN	DESCRIPTION	REPRESENTATIVE LUGEON VALUE
LAMINAR			All Lugeon values about equal regardless of the water pressure	Average of Lugeon values for all stages
TURBULENT			Lugeon values decrease as the water pressures increase. The minimum Lugeon value is observed at the stage with the maximum water pressure	Lugeon value corresponding to the highest water pressure (3rd stage)
DILATION			Lugeon values vary proportionally to the water pressures. The maximum Lugeon value is observed at the stage with the maximum water pressure	Lowest Lugeon value recorded, corresponding either to low or medium water pressures (1st, 2nd, 4th, 5th stage)
WASH-OUT			Lugeon values increase as the test proceeds. Discontinuities' infillings are progressively washed-out by the water	Highest Lugeon value recorded (5th stage)
VOID FILLING			Lugeon values decrease as the test proceeds. Either non-persistent discontinuities are progressively being filled or swelling is taking place	Final Lugeon value (5th stage)

Annex F

Laboratory Test Reports - Water Samples

ANALYTICAL CHAIN OF CUSTODY RECORD

Laboratory:	Clean Stream
Contact person:	Hermie
Tel:	012 348 2813
Fax:	
Address:	Pretoria

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Woodlands Drive, Woodmead, Sandton, JHB, 2148.
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Email: jaco.breytenbach@erm.com

ERM Proj No: **0129245 / xxxx /03**

SAMPLED DATE Yr	Mth	Day	SAMPLE ID	DEPTH (m)	MATRIX: SOIL	MATRIX: WATER		TYPE OF ANALYSIS: Inorganic's:	Metals: ICP OES Scan *(Kwalitative)*	64 Metals: ICP MS Scan *(Kwantitative)*	Turbidity				COMMENTS	Sampler's signature
2011	3	02	**DUP2**	-		x		x	x							
2011	3	01	**FS5**	-		x		x	x							
2011	3	01	**FS6**	-		x		x	x						All Results results must be in mg/l	
2011	3	02	**FS8**	-		x		x	x							
2011	3	02	**FS10**	-		x		x	x						All the samples must be analysed for:	
2011	3	02	**FS11**	-		x		x	x						CSP 06: ICP EOS scan Metals & Inorganics	
2011	3	01	**FB12**	-		x		x	x						CSM 01: Total Alkalinity & M - Alkalinity	
2011	3	02	**FB13**	-		x		x	x						CSM 26: Cations	
2011	3	01	**NGOH83**	-		x		x	x						CSM 26: Anions	
															CSM 26: Cations & Anions balance	
															Biocarbonates HCO3	

Relinquished by: Jaco Breytenbach
Date/time: 2011-03-10

Received by: Sulantie
Date/time: 11-03-2011 @ 10h00

Carrier:
All the Samples condition: Cooled

Erm copy

ANALYTICAL CHAIN OF CUSTODY RECORD

ERM

Building 23, The Woodlands Office Park
Woodlands Drive, Woodmead, Sandton, JHB, 2148.
Tel: +27 11 802 8263
Fax: +27 11 802 8299
Email: jaco.breytenbach@erm.com

Laboratory:	Clean Stream
Contact person:	Hermie
Tel:	012 348 2813
Fax:	
Address:	Pretoria

ERM Proj No: 0129245 / xxxx /03

SAMPLED DATE Yr	Mth	Day	SAMPLE ID	DEPTH (m)	MATRIX: SOIL	MATRIX: WATER		TYPE OF ANALYSIS: Inorganic's:	Metals: ICP OES Scan (Kwalitative)	64 Metals: ICP MS Scan (Kwantitative)	Turbidity				COMMENTS	Sampler's signature
2011	3	23	FS1	-		x		x	x							
2011	3	24	FS2			x		x	x							
2011	3	24	FS3			x		x	x						All Results results must be in mg/l	
2011	3	24	FS4			x		x	x							
2011	3	01	FS7			x		x	x						All the samples must be analysed for:	
2011	3	02	FS9			x		x	x						CSP 06: ICP EOS scan Metals & Inorganics	
2011	3	03	FS13			x		x	x						CSM 01: Total Alkalinity & M - Alkalinity	
2011	3	03	FS15			x		x	x						CSM 26: Cations	
2011	3	03	FS19			x		x	x						CSM 26: Anions	
2011	3	03	FS14			x		x	x						CSM 26: Cations & Anions balance	
2011	3	13	FS15			x		x	x						Biocarbonates HCO3	
2011	3	04	FS16			x		x	x							
2011	3	17	FS17			x		x	x							
2011	3	18	FS23			x		x	x							
2011	3	24	FS24			x		x	x							
2011	3	26	FS25			x		x	x							
2011	3	28	FS26			x		x	x							
2011	3	01	SPRING A			x		x	x							
2011	3	18	SPRING B			x		x	x							
2011	3	02	SPRING C			x		x	x							
2011	3	15	SPRING			x		x	x							

Relinquished by: Jaco Breytenbach Received by:

Date/time: 2011-04-15 Date/time:

Carrier:

All the Samples condition: Cooled

(ERM COPY)

ANALYTICAL CHAIN OF CUSTODY RECORD

Laboratory:	Clean Stream
Contact person:	Hermie
Tel:	012 348 2813
Fax:	
Address:	Pretoria

ERM

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Woodlands Drive, Woodmead, Sandton, JHB, 2148.
Tel: +27 11 802 8263
Fax: +27 11 802 8299
Email: jaco.breytenbach@erm.com

ERM Proj No: 0129245 / xxxx /03

SAMPLED DATE Yr	Mth	Day	SAMPLE ID	DEPTH (m)	MATRIX: SOIL	WATER		TYPE OF ANALYSIS: Inorganic's:	Metals: ICP OES Scan (Kwalitative)	64 Metals: ICP MS Scan (Kwantitative)	Turbidity				COMMENTS	Sampler's signature
2011	3	25	**DUP1**	-		x		x	x							
2011	3	29	**DUP3**			x		x	x							
2011	3	23	**FB1**			x		x	x						All Results results must be in mg/l	
2011	3	23	**FB3**			x		x	x							
2011	3	24	**FB8**			x		x	x						All the samples must be analysed for:	
2011	3	03	**FB14**			x		x	x						CSP 06: ICP EOS scan Metals & Inorganics	
2011	3	04	**FB18**			x		x	x						CSM 01: Total Alkalinity & M - Alkalinity	
2011	3	04	**FB24**			x		x	x						CSM 26: Cations	
2011	3	24	**FB10**			x		x	x						CSM 26: Anions	
2011	3	24	**DH14021**			x		x	x						CSM 26: Cations & Anions balance	
2011	3	24	2730AA00060			x		x	x						Biocarbonates HCO3	
2011	3	24	2730AA00043			x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							
2011	3					x		x	x							

Relinquished by: Jaco Breytenbach Received by:

Date/time: 2011-04-15 Date/time:

Carrier:

All the Samples condition: Cooled

(ERM copy)

ANALYTICAL CHAIN OF CUSTODY RECORD

Laboratory:	Clean Stream
Contact person:	Hermie
Tel:	012 348 2813
Fax:	
Address:	Pretoria

ERM

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Tel: +27 11 802 8263
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Email: jaco.breytenbach@erm.com

ERM Proj No: 0129245 / xxxx /03

SAMPLED DATE Yr	Mth	Day	SAMPLE ID	DEPTH (m)	MATRIX SOIL	WATER		TYPE OF ANALYSIS Inorganic's:	Metals: ICP OES Scan *(Kwalitative)*	64 Metals: ICP MS Scan *(Kwantitative)*	Turbidity			COMMENTS	Sampler's signature
2011	03	30	ERMBH1	-		x		x	x						
2011	04	14	ERMBH2	-		x		x	x						
2011	04	04	ERMBH3	-		x		x	x					All Results results must be in mg/l	
2011	04	14	ERMBH4			x		x	x						
2011	04	04	ERMBH5	-		x		x	x					All the samples must be analysed for:	
2011	04	07	ERMBH7	-		x		x	x					CSP 06: ICP EOS scan Metals & Inorganics	
2011	04	01	ERMBH8	-		x		x	x					CSM 01: Total Alkalinity & M - Alkalinity	
2011	04	14	ERMBH9	-		x		x	x					CSM 26: Cations	
2011	04	11	ERMBH10	-		x		x	x					CSM 26: Anions	
														CSM 26: Cations & Anions balance	
														Biocarbonates HCO3	

Relinquished by: Jaco Breytenbach
Date/time: 2011-04-15

Received by:
Date/time:

Carrier:

All the Samples condition: Cooled

(ERM copy)

ANALYTICAL CHAIN OF CUSTODY RECORD

Laboratory:	Clean Stream
Contact person:	Hermie
Tel:	012 348 2813
Fax:	
Address:	Pretoria

ERM

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Tel: +27 11 802 8263
Fax: +27 11 802 8299
Email: jaco.breytenbach@erm.com

ERM Proj No: 0129245 / xxxx /03

SAMPLED DATE			SAMPLE	DEPTH	MATRIX		TYPE OF ANALYSIS									
Yr	Mth	Day	ID	(m)	SOIL	WATER		Inorganic's:	Metals: ICP OES Scan (Kwalitative)	64 Metals: ICP MS Scan (Kwantitative)	Turbidity				COMMENTS	Sampler's signature
2011	04	13	RP1	—		x		x	x							
〃	〃	〃	RP3	—		x		x	x							
〃	〃	〃	RP9	—		x		x	x						All Results results must be in mg/l	
〃	〃	〃	RP12	—		x		x	x							
〃	〃	〃	RP16	—		x		x	x						All the samples must be analysed for:	
〃	〃	〃	RP20	—		x		x	x						CSP 06: ICP EOS scan Metals & Inorganics	
						x		x	x						CSM 01: Total Alkalinity & M - Alkalinity	
~~2011~~	~~03~~	~~24~~	~~FS2~~	—		x		x	x						CSM 26: Cations	
~~2011~~	~~03~~	~~24~~	~~FS3~~	—		x		x	x						CSM 26: Anions	
~~2011~~	~~03~~	~~24~~	~~FS4~~	—											CSM 26: Cations & Anions balance	
~~2011~~	~~03~~	~~24~~	~~FS1~~	—											Biocarbonates HCO3	

Relinquished by: Jaco Breytenbach
Date/time: 2011-04-15

Received by:
Date/time:

Carrier:
All the Samples condition: Cooled

(ERM copy)

ANALYTICAL CHAIN OF CUSTODY RECORD

ERM

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Laboratory:	iThemba Laboratory
Contact person:	Mike Butler
Tel:	011 351 7025
Fax:	011 3517053
Address:	Wits University Braamfontein Johannesburg

ERM Proj No: **0129245 / xxxx /03**

SAMPLED DATE			SAMPLE	DEPTH	MATRIX		TYPE OF ANALYSIS									
Yr	Mth	Day	ID	(m)	SOIL	WATER		Inorganic's:	Metals: ICP OES Scan (Kwalitative)	64 Metals: ICP MS Scan (Kwantitative)	Turbidity		Deuterium (δD)	Oxygen-18 (δ18O	COMMENTS	Sampler's signature
2011	03	30	ERMBH1	-		x							x	x		
2011	04	02	ERMBH2	-		x							x	x		
2011	04	04	ERMBH3	-		x							x	x		
2011	04	04	ERMBH4	-		x							x	x		
2011	04	10	ERMBH5	-		x							x	x		
2011	04	02	ERMBH7	-		x							x	x		
2011	04	01	ERMBH8	-		x							x	x		
2011	04	10	ERMBH9	-		x							x	x		
2011	04	11	ERMBH10	-		x							x	x		
2011	04	08	RP3	-		x							x	x		
2011	04	08	RP12	-		x							x	x		
2011	04	08	RP16	-		x							x	x		
2011	03	24	DH14021	-		x							x	x		
2011	03	26	FB2	-		x							x	x		
2011	03	02	FB13	-		x							x	x		
2011	03	01	Spring A	-		x							x	x		
2011	03	18	Spring B	-		x							x	x		
2011	03	02	Spring C	-		x							x	x		
2011	03	01	FS5	-		x							x	x		
2011	03	18	FS23	-		x							x	x		
2011	03	24	FS24	-		x							x	x		
2011	03	24	Dup3	-		x							x	x		

Relinquished by: Jaco Breytenbach
Date/time: 2011-05-03

Received by: M. Butler
Date/time: 2011/05/05 11:50

Carrier:
All the Samples condition: Cooled

CLEAN STREAM Scientific Services (Pty.) Ltd.

489 Jacqueline Drive, Garsfontein, Pretoria, 0042
P.O. Box 905008, Garsfontein, 0042
Tel (012) 348 2813/4, Fax 012 348 8575

Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 4998 **Project:** ERM

Date of certificate: 04 Apr 2011
Date accepted: 11 Mar 2011
Date completed: 01 Apr 2011

	Lab no:		55160	55161	55162	55163	55164	55165	55166
	Date sampled:		10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011
	Sample type:		Water	Water	Water	Water	Water	Water	Water
	Locality description		DUP2	FS10	FS11	FB13	FS5	FS6	FS8
	Analyses:	**Method**							
A	pH	CSM 20	6.14	5.65	6.74	7.14	5.86	7.49	6.08
A	Electrical conductivity (EC) mS/m	CSM 20	1.93	1.86	3.55	4.98	10.79	4.34	1.76
A	Total dissolved solids (TDS) mg/l	CSM 06	32	11	21	24	33	30	8
A	Total alkalinity mg/l	CSM 01	8.8	<8.258	18.1	21.7	<8.258	30.4	<8.258
A	Chloride (Cl) mg/l	CSM 02	3.4	2.5	1.6	1.5	18.1	1.5	2.0
A	Sulphate (SO4) mg/l	CSM 03	3.24	<0.132	<0.132	<0.132	<0.132	<0.132	<0.132
A	Nitrate (NO3) mg/l as N	CSM 06	6.435	0.059	0.137	0.579	0.240	0.281	0.128
A	Ammonium(NH4) mg/l as N	CSM 05	1.428	0.047	0.053	0.149	0.104	0.027	0.026
A	Orthophosphate (PO4) mg/l as P	CSM 04	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
A	Fluoride (F) mg/l	CSM 11	<0.183	<0.183	0.367	0.188	0.285	0.270	<0.183
A	Calcium (Ca) mg/l	CSM 30	5.941	1.703	2.987	3.947	1.798	3.765	0.838
A	Magnesium (Mg) mg/l	CSM 30	3.698	0.755	1.069	2.729	1.520	4.200	0.461
A	Sodium (Na) mg/l	CSM 30	3.53	1.28	3.38	1.86	6.27	2.07	1.78
A	Potassium (K) mg/l	CSM 30	0.681	0.307	0.811	0.469	3.762	0.322	0.100
A	Aluminium (Al) mg/l	CSM 31	<0.006	<0.006	<0.006	<0.006	<0.006	0.044	0.007
A	Iron (Fe) mg/l	CSM 31	0.009	0.008	<0.006	0.006	0.015	0.009	<0.006
A	Manganese (Mn) mg/l	CSM 31	0.014	0.008	0.008	0.009	0.002	0.009	0.010
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	<0.002	0.002	0.007	0.007	0.003
A	Copper (Cu) mg/l	CSM 31	0.007	0.002	<0.001	0.003	0.009	0.001	0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003	<0.003	0.032	0.028	0.007	0.006
A	Zinc (Zn) mg/l	CSM 31	<0.004	0.005	<0.004	0.005	0.005	0.004	0.009
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Boron (B) mg/l	CSM 32	0.011	0.008	0.008	0.011	0.013	0.013	0.011
N	Barium (Ba) mg/l	CSM 32	0.001	0.002	<0.001	0.002	0.096	0.012	0.004
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001
N	Molybdenum (Mo) mg/l	CSM 32	0.009	<0.003	0.007	<0.003	<0.003	0.013	0.004
A	Lead (Pb) mg/l	CSM 31	0.04	0.02	0.02	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	<0.004	<0.004	<0.004	0.015	0.018	0.010	0.023

A = Accredited (Included in the SANAS Schedule of Accreditation); N = Not accredited (Excluded from the SANAS Schedule of Accreditation)
OSD = Outsourced; S = Sub-contracted; NR = Not requested; RTF = Results to follow; TNTC = To numerous to count; ND = Not detected
NATD = Not able to determine

sanas Testing Laboratory
T0374

Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

CLEAN STREAM
Scientific Services (Pty.) Ltd.

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P.O. Box 905008, Garsfontein, 0042
Tel (012) 348 2813/4, Fax 012 348 8575

Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 4998 **Project:** ERM

Date of certificate: 04 Apr 2011
Date accepted: 11 Mar 2011
Date completed: 01 Apr 2011

Lab no:			55160	55161	55162	55163	55164	55165	55166
Date sampled:			10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011	10 Mar 2011
Sample type:			Water	Water	Water	Water	Water	Water	Water
Locality description			DUP2	FS10	FS11	FB13	FS5	FS6	FS8
Analyses:		**Method**							
N	Silicon (Si) mg/l	CSM 33	<0.032	<0.032	<0.032	6.180	1.914	4.306	1.705
N	Strontium (Sr) mg/l	CSM 31	<0.001	<0.001	<0.001	0.012	0.026	0.023	0.004
N	Vanadium (V) mg/l	CSM 32	<0.003	<0.003	<0.003	0.015	0.008	0.013	0.009
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087
A	Total hardness mg/l	CSM 26	30	7	12	21	11	27	4
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	8.8	7.3	18.1	21.7	2.8	30.3	4.4
A	Anions	CSM 26	0.80	0.22	0.42	0.52	0.58	0.67	0.16
A	Cations	CSM 26	0.88	0.22	0.41	0.53	0.59	0.64	0.16
A	Difference (%)	CSM 26	4.50	-0.85	-0.96	0.66	0.67	-2.29	2.52

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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T0374

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P.O. Box 905008, Garsfontein, 0042
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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 4998 **Project:** ERM

Date of certificate: 04 Apr 2011
Date accepted: 11 Mar 2011
Date completed: 01 Apr 2011

Lab no:			55167	55168
Date sampled:			10 Mar 2011	10 Mar 2011
Sample type:			Water	Water
Locality description			FB12	NGOH83
Analyses:		**Method**		
A	pH	CSM 20	7.28	3.38
A	Electrical conductivity (EC) mS/m	CSM 20	13.31	236.00
A	Total dissolved solids (TDS) mg/l	CSM 06	65	990
A	Total alkalinity mg/l	CSM 01	59.6	<8.258
A	Chloride (Cl) mg/l	CSM 02	4.3	14.7
A	Sulphate (SO4) mg/l	CSM 03	<0.132	753.56
A	Nitrate (NO3) mg/l as N	CSM 06	<0.057	<0.057
A	Ammonium(NH4) mg/l as N	CSM 05	0.978	0.796
A	Orthophosphate (PO4) mg/l as P	CSM 04	<0.025	<0.025
A	Fluoride (F) mg/l	CSM 11	<0.183	1.936
A	Calcium (Ca) mg/l	CSM 30	13.552	83.087
A	Magnesium (Mg) mg/l	CSM 30	3.094	113.785
A	Sodium (Na) mg/l	CSM 30	5.56	12.84
A	Potassium (K) mg/l	CSM 30	2.961	12.195
A	Aluminium (Al) mg/l	CSM 31	<0.006	1.649
A	Iron (Fe) mg/l	CSM 31	2.020	14.843
A	Manganese (Mn) mg/l	CSM 31	0.003	4.022
A	Total chromium (Cr) mg/l	CSM 31	0.006	0.002
A	Copper (Cu) mg/l	CSM 31	0.001	0.075
A	Nickel (Ni) mg/l	CSM 31	<0.003	7.100
A	Zinc (Zn) mg/l	CSM 31	<0.004	0.533
A	Cobalt (Co) mg/l	CSM 31	<0.002	3.985
A	Cadmium (Cd) mg/l	CSM 31	<0.001	0.004
N	Silver (Ag) mg/l	CSM 32	<0.002	0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	0.006
N	Boron (B) mg/l	CSM 32	0.012	0.048
N	Barium (Ba) mg/l	CSM 32	0.046	0.058
N	Beryllium (Be) mg/l	CSM 32	<0.001	0.011
N	Bismuth (Bi) mg/l	CSM 32	0.01	<0.01
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	0.005	0.178
N	Molybdenum (Mo) mg/l	CSM 32	0.005	0.009
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.030	0.172

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NATD = Not able to determine

Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

sanas Testing Laboratory
T0374

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Scientific Services (Pty.) Ltd.

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Specialists in environmental monitoring

Test Report

Client: **ERM**
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 4998 **Project:** ERM

Date of certificate: 04 Apr 2011
Date accepted: 11 Mar 2011
Date completed: 01 Apr 2011

Lab no:			55167	55168
Date sampled:			10 Mar 2011	10 Mar 2011
Sample type:			Water	Water
Locality description			FB12	NGOH83
Analyses:		**Method**		
N	Silicon (Si) mg/l	CSM 33	3.041	5.951
N	Strontium (Sr) mg/l	CSM 31	0.141	2.810
N	Vanadium (V) mg/l	CSM 32	0.012	0.096
N	Thallium mg/l	CSM 32	<0.087	<0.087
A	Total hardness mg/l	CSM 26	47	676
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	59.5	0.0
A	Anions	CSM 26	1.32	16.11
A	Cations	CSM 26	1.43	15.58
A	Difference (%)	CSM 26	4.05	-1.66

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OSD = Outsourced; S = Sub-contracted; NR = Not requested; RTF = Results to follow; TNTC = To numerous to count; ND = Not detected
NATD = Not able to determine

Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5284 **Project:** ERM

Date of certificate: 17 May 2011
Date accepted: 19 Apr 2011
Date completed: 17 May 2011

	Lab no:		57622	57623	57624	57625	57626	57627
	Date sampled:		19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011
	Sample type:		Water	Water	Water	Water	Water	Water
	Locality description		RP1	RP3	RP9	RP12	RP16	RP20
	Analyses:	**Method**						
A	pH	CSM 20	8.05	8.15	8.39	8.22	8.21	8.09
A	Electrical conductivity (EC) mS/m	CSM 20	7.34	8.19	10.01	9.41	9.10	8.77
A	Total dissolved solids (TDS) mg/l	CSM 06	36	40	38	44	47	41
A	Total alkalinity mg/l	CSM 01	31.2	30.6	33.2	34.6	37.1	33.1
A	Chloride (Cl) mg/l	CSM 02	1.8	3.2	1.5	3.2	3.8	<1.408
A	Sulphate (SO4) mg/l	CSM 03	3.08	3.04	2.84	3.66	1.65	3.09
A	Nitrate (NO3) mg/l as N	CSM 06	0.076	0.163	0.072	0.163	<0.057	<0.057
A	Ammonium(NH4) mg/l as N	CSM 05	0.783	0.450	0.476	0.885	<0.015	<0.015
A	Orthophosphate (PO4) mg/l as P	CSM 04	0.040	0.040	0.039	0.039	<0.025	<0.025
A	Fluoride (F) mg/l	CSM 11	<0.183	<0.183	<0.183	0.252	0.207	0.228
A	Calcium (Ca) mg/l	CSM 30	4.814	5.545	4.827	6.092	5.224	4.642
A	Magnesium (Mg) mg/l	CSM 30	3.012	3.208	3.486	3.372	3.158	2.744
A	Sodium (Na) mg/l	CSM 30	4.57	5.70	5.08	6.44	6.78	6.72
A	Potassium (K) mg/l	CSM 30	0.415	0.477	0.549	0.701	3.821	2.896
A	Aluminium (Al) mg/l	CSM 31	<0.006	<0.006	<0.006	<0.006	0.017	0.016
A	Iron (Fe) mg/l	CSM 31	0.038	0.009	0.062	0.071	0.164	0.108
A	Manganese (Mn) mg/l	CSM 31	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	0.003	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Zinc (Zn) mg/l	CSM 31	<0.004	<0.004	<0.004	<0.004	0.012	<0.004
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Boron (B) mg/l	CSM 32	<0.008	<0.008	<0.008	0.009	0.008	0.009
N	Barium (Ba) mg/l	CSM 32	0.005	0.009	0.020	0.010	0.005	0.005
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01	0.25	<0.01	0.07	0.03
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	<0.023	<0.023	0.026	0.026
N	Lithium (Li) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Molybdenum (Mo) mg/l	CSM 32	<0.003	0.005	<0.003	<0.003	0.008	0.010
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.013	0.012	0.022	0.012	0.156	0.137

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Tel (012) 348 2813/4, **Fax** 012 348 8575

Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5284 **Project:** ERM

Date of certificate: 17 May 2011
Date accepted: 19 Apr 2011
Date completed: 17 May 2011

Lab no:			57622	57623	57624	57625	57626	57627
Date sampled:			19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011
Sample type:			Water	Water	Water	Water	Water	Water
Locality description			RP1	RP3	RP9	RP12	RP16	RP20
Analyses:		**Method**						
N	Silicon (Si) mg/l	CSM 33	9.160	8.857	8.924	8.519	8.118	7.101
N	Strontium (Sr) mg/l	CSM 31	0.019	0.029	0.028	0.030	0.024	0.023
N	Uranium (U) mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Vanadium (V) mg/l	CSM 32	0.006	0.003	<0.003	<0.003	0.011	0.008
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087
A	Total hardness mg/l	CSM 26	24	27	26	29	26	23
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	30.8	30.1	32.4	34.0	36.4	32.7
A	Anions	CSM 26	0.75	0.78	0.77	0.87	0.88	0.76
A	Cations	CSM 26	0.76	0.83	0.80	0.95	0.92	0.83
A	Difference (%)	CSM 26	0.50	3.23	1.62	4.05	2.27	4.26
A	pHs (at 25o C)	CSM 26	9.67	9.62	9.64	9.53	9.57	9.66

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5285 **Project:** ERM

Date of certificate: 13 May 2011
Date accepted: 19 Apr 2011
Date completed: 12 May 2011

	Lab no:		57628	57629	57630	57631	57632	57633	57634
	Date sampled:		19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011
	Sample type:		Water	Water	Water	Water	Water	Water	Water
	Locality description		ERM BH1	ERM BH2	ERM BH3	ERM BH4	ERM BH5	ERM BH7	ERM BH8
	Analyses:	**Method**							
A	pH	CSM 20	7.39	6.87	8.49	8.63	8.19	9.54	8.60
A	Electrical conductivity (EC) mS/m	CSM 20	28.86	23.34	23.29	33.07	10.57	19.19	23.89
A	Total dissolved solids (TDS) mg/l	CSM 06	144	107	133	164	41	95	144
A	Total alkalinity mg/l	CSM 01	131.4	99.1	126.7	139.3	28.3	83.3	112.7
A	Chloride (Cl) mg/l	CSM 02	<1.408	<1.408	<1.408	4.0	3.4	<1.408	10.7
A	Sulphate (SO4) mg/l	CSM 03	2.39	4.74	2.42	5.40	2.94	3.32	2.53
A	Nitrate (NO3) mg/l as N	CSM 06	0.181	0.282	0.105	0.116	0.653	0.206	0.081
A	Ammonium(NH4) mg/l as N	CSM 05	0.067	<0.015	0.281	0.344	0.153	0.209	0.505
A	Orthophosphate (PO4) mg/l as P	CSM 04	0.052	0.049	0.048	0.040	0.039	0.059	0.060
A	Fluoride (F) mg/l	CSM 11	0.366	<0.183	0.405	0.801	0.244	0.879	0.335
A	Calcium (Ca) mg/l	CSM 30	14.795	19.361	22.503	4.900	4.820	5.320	7.634
A	Magnesium (Mg) mg/l	CSM 30	4.089	9.138	4.454	2.248	2.019	1.837	1.701
A	Sodium (Na) mg/l	CSM 30	41.51	10.91	25.01	62.68	7.77	33.80	51.05
A	Potassium (K) mg/l	CSM 30	1.821	2.240	2.115	1.460	1.982	0.489	2.355
A	Aluminium (Al) mg/l	CSM 31	<0.006	<0.006	<0.006	0.016	0.028	0.019	0.009
A	Iron (Fe) mg/l	CSM 31	<0.006	0.125	0.343	0.099	0.417	0.078	0.022
A	Manganese (Mn) mg/l	CSM 31	0.066	0.423	0.148	0.046	<0.001	<0.001	0.035
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Nickel (Ni) mg/l	CSM 31	0.009	<0.003	<0.003	<0.003	<0.003	0.004	<0.003
A	Zinc (Zn) mg/l	CSM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.006
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	0.002	0.010	0.015	0.015	<0.002	0.011
N	Boron (B) mg/l	CSM 32	0.037	0.037	0.013	0.029	<0.008	0.071	0.033
N	Barium (Ba) mg/l	CSM 32	0.139	0.111	0.271	0.127	<0.001	<0.001	0.119
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	0.04	0.01	0.04	<0.01	<0.01	0.04	0.03
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	0.039	0.060	0.059	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	0.015	0.038	<0.001	0.006	0.002	0.010	0.008
N	Molybdenum (Mo) mg/l	CSM 32	0.018	0.011	0.006	0.005	<0.003	0.013	<0.003
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.028	0.034	0.017	0.018	0.015	0.016	0.018

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Report checked by: H. Holtzhausen (Laboratory Manager)

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5285 **Project:** ERM

Date of certificate: 13 May 2011
Date accepted: 19 Apr 2011
Date completed: 12 May 2011

Lab no:			57628	57629	57630	57631	57632	57633	57634
Date sampled:			19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011	19 Apr 2011
Sample type:			Water	Water	Water	Water	Water	Water	Water
Locality description			ERM BH1	ERM BH2	ERM BH3	ERM BH4	ERM BH5	ERM BH7	ERM BH8
Analyses:		**Method**							
N	Silicon (Si) mg/l	CSM 33	13.910	24.692	19.570	13.499	6.085	16.669	10.100
N	Strontium (Sr) mg/l	CSM 31	0.408	0.205	0.606	0.188	0.081	0.025	0.368
N	Vanadium (V) mg/l	CSM 32	0.017	0.025	<0.003	<0.003	<0.003	0.017	<0.003
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087
A	Total hardness mg/l	CSM 26	54	86	75	21	20	21	26
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	131.1	99.0	122.9	133.7	27.8	61.6	108.4
A	Anions	CSM 26	2.72	2.13	2.60	3.02	0.77	1.76	2.62
A	Cations	CSM 26	2.93	2.27	2.68	3.23	0.83	1.92	2.84
A	Difference (%)	CSM 26	3.85	3.19	1.51	3.25	3.70	4.24	4.08

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5285 **Project:** ERM

Date of certificate: 13 May 2011
Date accepted: 19 Apr 2011
Date completed: 12 May 2011

Lab no:			57635	57636
Date sampled:			19 Apr 2011	19 Apr 2011
Sample type:			Water	Water
Locality description			ERM BH9	ERM BH10
Analyses:		**Method**		
A	pH	CSM 20	8.39	8.31
A	Electrical conductivity (EC) mS/m	CSM 20	24.57	11.95
A	Total dissolved solids (TDS) mg/l	CSM 06	122	54
A	Total alkalinity mg/l	CSM 01	121.6	48.6
A	Chloride (Cl) mg/l	CSM 02	<1.408	<1.408
A	Sulphate (SO4) mg/l	CSM 03	2.57	2.57
A	Nitrate (NO3) mg/l as N	CSM 06	0.197	0.523
A	Ammonium(NH4) mg/l as N	CSM 05	0.143	0.206
A	Orthophosphate (PO4) mg/l as P	CSM 04	0.035	0.044
A	Fluoride (F) mg/l	CSM 11	0.221	<0.183
A	Calcium (Ca) mg/l	CSM 30	21.607	12.390
A	Magnesium (Mg) mg/l	CSM 30	11.866	1.992
A	Sodium (Na) mg/l	CSM 30	11.46	6.22
A	Potassium (K) mg/l	CSM 30	1.122	0.860
A	Aluminium (Al) mg/l	CSM 31	<0.006	<0.006
A	Iron (Fe) mg/l	CSM 31	0.344	0.046
A	Manganese (Mn) mg/l	CSM 31	0.280	0.183
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003
A	Zinc (Zn) mg/l	CSM 31	0.006	<0.004
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	0.002	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	0.012	0.011
N	Boron (B) mg/l	CSM 32	<0.008	<0.008
N	Barium (Ba) mg/l	CSM 32	0.168	0.076
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01
N	Tellurium (Te) mg/l	CSM 32	0.053	0.040
N	Lithium (Li) mg/l	CSM 32	<0.001	<0.001
N	Molybdenum (Mo) mg/l	CSM 32	<0.003	0.006
A	Lead (Pb) mg/l	CSM 31	0.03	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.017	0.016

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5285 **Project:** ERM

Date of certificate: 13 May 2011
Date accepted: 19 Apr 2011
Date completed: 12 May 2011

Lab no:			57635	57636
Date sampled:			19 Apr 2011	19 Apr 2011
Sample type:			Water	Water
Locality description			ERM BH9	ERM BH10
Analyses:		**Method**		
N	Silicon (Si) mg/l	CSM 33	20.036	11.985
N	Strontium (Sr) mg/l	CSM 31	0.251	0.120
N	Vanadium (V) mg/l	CSM 32	<0.003	<0.003
N	Thallium mg/l	CSM 32	<0.087	<0.087
A	Total hardness mg/l	CSM 26	103	39
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	118.7	47.6
A	Anions	CSM 26	2.50	1.07
A	Cations	CSM 26	2.62	1.10
A	Difference (%)	CSM 26	2.31	1.29

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OSD = Outsourced; S = Sub-contracted; NR = Not requested; RTF = Results to follow; TNTC = To numerous to count; ND = Not detected
NATD = Not able to determine

Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5302 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 15 Mar 2011
Date completed: 11 May 2011

	Lab no:		57728	57729	57730	57731	57732	57733	57734
	Date sampled:		23 Mar 2011	24 Mar 2011	24 Mar 2011	24 Mar 2011	03 Mar 2011	03 Mar 2011	03 Mar 2011
	Sample type:		Water	Water	Water	Water	Water	Water	Water
	Locality description		FS1	FS2	FS3	FS4	FS13	FS14	FS15
	Analyses:	**Method**							
A	pH	CSM 20	7.53	6.59	7.38	6.98	7.67	7.40	7.51
A	Electrical conductivity (EC) mS/m	CSM 20	21.56	9.56	30.36	2.41	14.45	12.11	5.21
A	Total dissolved solids (TDS) mg/l	CSM 06	121	72	162	10	115	42	11
A	Total alkalinity mg/l	CSM 01	77.2	12.3	38.4	<8.258	16.7	36.7	<8.258
A	Chloride (Cl) mg/l	CSM 02	23.9	37.8	68.8	1.9	56.7	4.2	1.8
A	Sulphate (SO4) mg/l	CSM 03	1.04	<0.132	0.85	<0.132	2.65	<0.132	<0.132
A	Nitrate (NO3) mg/l as N	CSM 06	2.833	0.659	8.561	0.209	4.171	0.732	0.108
A	Ammonium(NH4) mg/l as N	CSM 05	0.214	0.096	0.156	0.185	0.172	0.279	0.151
A	Orthophosphate (PO4) mg/l as P	CSM 04	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
A	Fluoride (F) mg/l	CSM 11	0.257	0.230	0.311	0.440	0.339	0.419	0.325
A	Calcium (Ca) mg/l	CSM 30	25.098	8.688	28.474	0.875	17.635	5.359	1.100
A	Magnesium (Mg) mg/l	CSM 30	12.218	7.459	21.109	1.750	16.190	5.400	1.207
A	Sodium (Na) mg/l	CSM 30	8.51	9.36	9.38	0.63	6.12	3.94	1.32
A	Potassium (K) mg/l	CSM 30	1.113	0.897	2.043	0.169	1.413	0.842	0.128
A	Aluminium (Al) mg/l	CSM 31	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.058
A	Iron (Fe) mg/l	CSM 31	0.011	<0.006	0.063	0.113	0.009	0.009	0.051
A	Manganese (Mn) mg/l	CSM 31	0.022	0.001	0.073	<0.001	0.004	<0.001	<0.001
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	<0.002	0.002	<0.002	0.006	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Zinc (Zn) mg/l	CSM 31	0.018	0.014	0.013	<0.004	0.015	<0.004	<0.004
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Boron (B) mg/l	CSM 32	<0.008	0.008	<0.008	<0.008	<0.008	<0.008	<0.008
N	Barium (Ba) mg/l	CSM 32	0.012	0.014	0.031	0.002	0.017	0.004	0.008
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	<0.001	0.002	0.001	<0.001	0.001	0.001	0.001
N	Molybdenum (Mo) mg/l	CSM 32	<0.003	<0.003	0.006	<0.003	0.003	<0.003	0.003
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.039	0.032	0.046	0.018	0.045	0.036	0.044

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5302 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 15 Mar 2011
Date completed: 11 May 2011

	Lab no:		57728	57729	57730	57731	57732	57733	57734
	Date sampled:		23 Mar 2011	24 Mar 2011	24 Mar 2011	24 Mar 2011	03 Mar 2011	03 Mar 2011	03 Mar 2011
	Sample type:		Water	Water	Water	Water	Water	Water	Water
	Locality description		FS1	FS2	FS3	FS4	FS13	FS14	FS15
	Analyses:	**Method**							
N	Silicon (Si) mg/l	CSM 33	18.598	14.764	23.508	4.708	19.124	17.586	8.285
N	Strontium (Sr) mg/l	CSM 31	0.098	0.064	0.125	0.010	0.086	0.027	0.016
N	Vanadium (V) mg/l	CSM 32	0.019	0.004	0.026	<0.003	0.023	0.012	<0.003
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	77.0	12.3	38.3	8.2	16.6	36.6	8.2
A	Anions	CSM 26	2.44	1.36	3.34	0.23	2.29	0.91	0.22
A	Cations	CSM 26	2.67	1.49	3.64	0.24	2.53	0.93	0.24
A	Difference (%)	CSM 26	4.51	4.32	4.25	1.09	4.98	1.03	2.76

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5302 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 15 Mar 2011
Date completed: 11 May 2011

Lab no:			57735	57736	57737	57738	57739	57740	57741
Date sampled:			04 Mar 2011	17 Mar 2011	03 Mar 2011	19 Apr 2011	19 Apr 2011	18 Mar 2011	01 Mar 2011
Sample type:			Water	Water	Water	Water	Water	Water	Water
Locality description			FS16	FS17	FS19	SPRING C	SPRING A	SPRING B	FS7
Analyses:		Method							
A	pH	CSM 20	6.65	7.02	6.84	7.09	7.66	8.07	7.69
A	Electrical conductivity (EC) mS/m	CSM 20	7.25	6.84	3.93	8.12	15.76	14.42	5.76
A	Total dissolved solids (TDS) mg/l	CSM 06	27	25	22	30	70	60	23
A	Total alkalinity mg/l	CSM 01	14.6	11.7	10.3	14.2	59.3	49.6	16.4
A	Chloride (Cl) mg/l	CSM 02	8.3	8.2	7.1	9.8	5.3	3.1	4.2
A	Sulphate (SO4) mg/l	CSM 03	<0.132	0.17	<0.132	<0.132	3.06	4.91	0.71
A	Nitrate (NO3) mg/l as N	CSM 06	0.109	0.681	0.716	0.876	0.508	0.244	<0.057
A	Ammonium(NH4) mg/l as N	CSM 05	0.322	0.266	0.302	0.251	0.463	<0.015	0.171
A	Orthophosphate (PO4) mg/l as P	CSM 04	<0.025	0.078	0.036	<0.025	0.034	0.030	0.031
A	Fluoride (F) mg/l	CSM 11	0.349	0.402	0.338	0.400	<0.183	0.201	<0.183
A	Calcium (Ca) mg/l	CSM 30	3.317	2.992	1.554	4.048	10.066	10.563	3.112
A	Magnesium (Mg) mg/l	CSM 30	2.426	1.965	1.594	3.806	8.898	5.717	2.355
A	Sodium (Na) mg/l	CSM 30	3.13	3.27	3.10	2.47	5.25	5.01	2.98
A	Potassium (K) mg/l	CSM 30	0.763	0.738	1.611	0.271	1.129	0.709	0.203
A	Aluminium (Al) mg/l	CSM 31	<0.006	0.008	0.823	0.080	0.302	0.056	0.007
A	Iron (Fe) mg/l	CSM 31	0.020	0.029	0.034	0.035	0.096	0.027	0.022
A	Manganese (Mn) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	0.011	<0.001	<0.001
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	<0.002	0.006	<0.002	<0.002	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Zinc (Zn) mg/l	CSM 31	0.018	<0.004	0.009	0.005	0.024	0.008	<0.004
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Boron (B) mg/l	CSM 32	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
N	Barium (Ba) mg/l	CSM 32	0.023	0.009	0.007	0.009	0.004	0.025	0.003
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	0.001	0.003	0.002	<0.001	0.001	0.007	0.001
N	Molybdenum (Mo) mg/l	CSM 32	<0.003	<0.003	<0.003	<0.003	0.006	<0.003	<0.003
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.028	0.038	0.030	0.041	0.031	0.031	0.020

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5302 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 15 Mar 2011
Date completed: 11 May 2011

	Lab no:		57735	57736	57737	57738	57739	57740	57741
	Date sampled:		04 Mar 2011	17 Mar 2011	03 Mar 2011	19 Apr 2011	19 Apr 2011	18 Mar 2011	01 Mar 2011
	Sample type:		Water	Water	Water	Water	Water	Water	Water
	Locality description		FS16	FS17	FS19	SPRING C	SPRING A	SPRING B	FS7
	Analyses:	Method							
N	Silicon (Si) mg/l	CSM 33	11.428	12.950	9.282	17.644	23.704	11.159	7.882
N	Strontium (Sr) mg/l	CSM 31	0.027	0.055	0.015	0.024	0.062	0.071	0.015
N	Vanadium (V) mg/l	CSM 32	<0.003	<0.003	<0.003	0.017	0.030	<0.003	<0.003
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	14.6	11.7	10.2	14.2	59.0	49.0	16.3
A	Anions	CSM 26	0.54	0.52	0.46	0.62	1.44	1.20	0.46
A	Cations	CSM 26	0.55	0.49	0.50	0.66	1.56	1.24	0.50
A	Difference (%)	CSM 26	0.75	-2.94	4.25	2.68	4.24	1.59	3.61

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5302 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 15 Mar 2011
Date completed: 11 May 2011

	Lab no:		57742	57743	57744	57745	57746	57747
	Date sampled:		02 Mar 2011	18 Mar 2011	24 Mar 2011	26 Mar 2011	28 Mar 2011	15 Mar 2011
	Sample type:		Water	Water	Water	Water	Water	Water
	Locality description		FS9	FS23	FS24	FS25	FS26	SPRING
	Analyses:	Method						
A	pH	CSM 20	6.60	7.50	6.87	6.40	6.08	6.95
A	Electrical conductivity (EC) mS/m	CSM 20	6.88	3.70	4.41	3.35	4.24	4.11
A	Total dissolved solids (TDS) mg/l	CSM 06	31	26	19	20	26	40
A	Total alkalinity mg/l	CSM 01	<8.258	16.2	12.0	<8.258	15.6	25.2
A	Chloride (Cl) mg/l	CSM 02	10.8	4.7	3.7	8.2	8.3	9.0
A	Sulphate (SO4) mg/l	CSM 03	3.06	2.21	1.09	0.89	<0.132	1.76
A	Nitrate (NO3) mg/l as N	CSM 06	<0.057	<0.057	0.215	0.238	0.203	0.104
A	Ammonium(NH4) mg/l as N	CSM 05	0.790	<0.015	0.263	0.570	1.191	0.427
A	Orthophosphate (PO4) mg/l as P	CSM 04	0.034	0.031	0.031	0.028	0.109	0.035
A	Fluoride (F) mg/l	CSM 11	0.218	0.274	0.349	0.782	0.769	<0.183
A	Calcium (Ca) mg/l	CSM 30	2.077	2.712	3.043	2.447	2.318	5.832
A	Magnesium (Mg) mg/l	CSM 30	1.141	2.372	1.569	0.986	1.445	4.161
A	Sodium (Na) mg/l	CSM 30	5.32	3.60	2.01	2.95	2.76	3.47
A	Potassium (K) mg/l	CSM 30	3.661	0.736	0.318	0.282	1.536	0.293
A	Aluminium (Al) mg/l	CSM 31	0.007	0.078	<0.006	0.278	0.106	0.278
A	Iron (Fe) mg/l	CSM 31	0.036	0.063	0.087	0.169	1.891	0.027
A	Manganese (Mn) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	0.389	<0.001
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	0.003	<0.002	<0.002	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003	<0.003	<0.003	0.005	<0.003
A	Zinc (Zn) mg/l	CSM 31	<0.004	<0.004	0.028	0.009	0.026	<0.004
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Boron (B) mg/l	CSM 32	0.010	<0.008	<0.008	<0.008	0.009	<0.008
N	Barium (Ba) mg/l	CSM 32	0.009	0.004	0.006	0.024	0.014	0.004
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	<0.001	0.002	0.001	0.002	0.001	0.002
N	Molybdenum (Mo) mg/l	CSM 32	<0.003	0.004	<0.003	<0.003	<0.003	0.003
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.021	0.029	0.049	0.045	0.044	0.034

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Report checked by: H. Holtzhausen (Laboratory Manager)

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5302 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 15 Mar 2011
Date completed: 11 May 2011

Lab no:			57742	57743	57744	57745	57746	57747
Date sampled:			02 Mar 2011	18 Mar 2011	24 Mar 2011	26 Mar 2011	28 Mar 2011	15 Mar 2011
Sample type:			Water	Water	Water	Water	Water	Water
Locality description			FS9	FS23	FS24	FS25	FS26	SPRING
Analyses:		**Method**						
N	Silicon (Si) mg/l	CSM 33	1.134	7.691	5.804	5.676	2.154	7.891
N	Strontium (Sr) mg/l	CSM 31	0.011	0.016	0.018	0.018	0.019	0.023
N	Vanadium (V) mg/l	CSM 32	<0.003	<0.003	<0.003	<0.003	<0.003	0.004
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	8.2	16.1	12.0	7.1	15.6	25.2
A	Anions	CSM 26	0.53	0.50	0.39	0.41	0.57	0.81
A	Cations	CSM 26	0.58	0.52	0.40	0.42	0.61	0.85
A	Difference (%)	CSM 26	4.26	1.32	1.96	0.70	3.20	2.97

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NATD = Not able to determine

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5304 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 24 Mar 2011
Date completed: 10 May 2011

	Lab no:		57748	57749	57750	57751	57752	57753	57754
	Date sampled:		03 Mar 2011	04 Mar 2011	23 Mar 2011	04 Mar 2011	24 Mar 2011	19 Apr 2011	24 Mar 2011
	Sample type:		Water	Water	Water	Water	Water	Water	Water
	Locality description		FB14	FB24	FB3	FB18	FB8	FB1	FB10
	Analyses:	**Method**							
A	pH	CSM 20	7.02	6.83	6.93	6.09	6.64	7.40	7.06
A	Electrical conductivity (EC) mS/m	CSM 20	27.71	22.19	12.19	12.66	7.87	18.11	22.60
A	Total dissolved solids (TDS) mg/l	CSM 06	177	141	77	71	28	87	111
A	Total alkalinity mg/l	CSM 01	87.9	133.1	67.5	<8.258	16.8	62.4	66.6
A	Chloride (Cl) mg/l	CSM 02	32.0	6.5	11.3	<1.408	6.4	11.4	7.4
A	Sulphate (SO4) mg/l	CSM 03	26.94	2.81	2.00	45.41	0.86	3.91	19.36
A	Nitrate (NO3) mg/l as N	CSM 06	0.335	1.476	0.297	0.294	0.358	1.532	2.943
A	Ammonium(NH4) mg/l as N	CSM 05	0.397	0.938	0.792	0.381	0.193	0.386	0.128
A	Orthophosphate (PO4) mg/l as P	CSM 04	0.031	0.027	<0.025	0.030	0.031	0.030	0.031
A	Fluoride (F) mg/l	CSM 11	<0.183	1.433	0.241	0.202	<0.183	<0.183	0.195
A	Calcium (Ca) mg/l	CSM 30	39.708	27.011	8.088	8.650	4.647	17.806	18.678
A	Magnesium (Mg) mg/l	CSM 30	11.939	10.670	3.197	4.714	1.956	7.373	12.423
A	Sodium (Na) mg/l	CSM 30	11.15	10.90	8.01	4.87	2.89	6.43	8.45
A	Potassium (K) mg/l	CSM 30	1.834	1.818	3.776	2.489	0.412	1.528	1.277
A	Aluminium (Al) mg/l	CSM 31	0.020	<0.006	0.359	0.034	<0.006	<0.006	0.039
A	Iron (Fe) mg/l	CSM 31	0.012	0.011	9.568	0.044	0.014	0.009	0.013
A	Manganese (Mn) mg/l	CSM 31	<0.001	0.220	1.593	1.058	0.003	0.003	<0.001
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001	0.001	<0.001	<0.001	0.022	<0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003	<0.003	0.014	<0.003	<0.003	<0.003
A	Zinc (Zn) mg/l	CSM 31	0.021	6.241	0.059	0.030	0.887	0.872	0.065
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
N	Boron (B) mg/l	CSM 32	0.009	<0.008	0.008	<0.008	<0.008	0.009	<0.008
N	Barium (Ba) mg/l	CSM 32	0.131	0.041	0.479	0.047	0.006	0.031	0.068
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	0.016	0.008	0.014	0.007	0.001	0.003	0.001
N	Molybdenum (Mo) mg/l	CSM 32	0.005	<0.003	<0.003	<0.003	<0.003	0.005	0.003
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.058	0.045	0.044	0.047	0.038	0.032	0.014

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NATD = Not able to determine

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: **ERM**
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5304 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 24 Mar 2011
Date completed: 10 May 2011

Lab no:			57748	57749	57750	57751	57752	57753	57754
Date sampled:			03 Mar 2011	04 Mar 2011	23 Mar 2011	04 Mar 2011	24 Mar 2011	19 Apr 2011	24 Mar 2011
Sample type:			Water	Water	Water	Water	Water	Water	Water
Locality description			FB14	FB24	FB3	FB18	FB8	FB1	FB10
Analyses:		**Method**							
N	Silicon (Si) mg/l	CSM 33	18.663	21.465	15.637	6.977	13.837	12.645	26.550
N	Strontium (Sr) mg/l	CSM 31	0.322	0.168	0.289	0.103	0.027	0.121	0.078
N	Vanadium (V) mg/l	CSM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.026
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087	<0.087
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	87.8	133.0	67.5	8.2	16.8	62.3	66.5
A	Anions	CSM 26	3.25	3.01	1.73	1.13	0.56	1.76	2.16
A	Cations	CSM 26	3.53	3.01	1.78	1.17	0.57	1.87	2.37
A	Difference (%)	CSM 26	4.12	0.02	1.37	1.49	0.64	2.87	4.69

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: ERM
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5304 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 24 Mar 2011
Date completed: 10 May 2011

	Lab no:		57755	57756	57757	57758	57759
	Date sampled:		25 Mar 2011	29 Mar 2011	24 Mar 2011	24 Mar 2011	24 Mar 2011
	Sample type:		Water	Water	Water	Water	Water
	Locality description		DUP1	DUP3	2730 AA 00043	2730 AA 00060	DH 14021
	Analyses:	**Method**					
A	pH	CSM 20	7.11	7.50	7.57	7.07	7.52
A	Electrical conductivity (EC) mS/m	CSM 20	28.19	13.73	41.00	11.79	13.85
A	Total dissolved solids (TDS) mg/l	CSM 06	128	70	211	59	69
A	Total alkalinity mg/l	CSM 01	60.7	68.9	92.0	46.5	68.2
A	Chloride (Cl) mg/l	CSM 02	23.9	<1.408	35.3	11.1	<1.408
A	Sulphate (SO4) mg/l	CSM 03	3.93	0.66	26.60	<0.132	0.83
A	Nitrate (NO3) mg/l as N	CSM 06	12.340	0.216	17.876	0.349	0.381
A	Ammonium(NH4) mg/l as N	CSM 05	<0.015	0.234	0.302	0.813	0.370
A	Orthophosphate (PO4) mg/l as P	CSM 04	0.032	0.038	0.031	0.031	0.038
A	Fluoride (F) mg/l	CSM 11	<0.183	<0.183	0.187	1.180	<0.183
A	Calcium (Ca) mg/l	CSM 30	28.260	13.588	44.109	8.607	11.255
A	Magnesium (Mg) mg/l	CSM 30	13.779	6.618	22.910	4.387	7.552
A	Sodium (Na) mg/l	CSM 30	7.92	6.12	9.07	6.13	6.85
A	Potassium (K) mg/l	CSM 30	1.850	0.858	0.366	0.302	0.919
A	Aluminium (Al) mg/l	CSM 31	<0.006	<0.006	0.012	0.059	0.055
A	Iron (Fe) mg/l	CSM 31	0.030	0.654	0.011	0.062	<0.006
A	Manganese (Mn) mg/l	CSM 31	0.002	0.046	0.001	0.106	<0.001
A	Total chromium (Cr) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002
A	Copper (Cu) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001
A	Nickel (Ni) mg/l	CSM 31	<0.003	<0.003	<0.003	<0.003	<0.003
A	Zinc (Zn) mg/l	CSM 31	0.017	<0.004	0.012	6.482	0.057
A	Cobalt (Co) mg/l	CSM 31	<0.002	<0.002	<0.002	<0.002	<0.002
A	Cadmium (Cd) mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001
N	Silver (Ag) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002
N	Gallium (Ga) mg/l	CSM 32	<0.002	<0.002	<0.002	<0.002	<0.002
N	Boron (B) mg/l	CSM 32	0.008	<0.008	<0.008	<0.008	<0.008
N	Barium (Ba) mg/l	CSM 32	0.031	0.010	0.006	0.017	0.004
N	Beryllium (Be) mg/l	CSM 32	<0.001	<0.001	<0.001	<0.001	<0.001
N	Bismuth (Bi) mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01
N	Tellurium (Te) mg/l	CSM 32	<0.023	<0.023	<0.023	<0.023	<0.023
N	Lithium (Li) mg/l	CSM 32	0.001	<0.001	0.001	0.002	<0.001
N	Molybdenum (Mo) mg/l	CSM 32	<0.003	<0.003	<0.003	<0.003	<0.003
A	Lead (Pb) mg/l	CSM 31	<0.01	<0.01	<0.01	<0.01	<0.01
N	Rubidium (Rb) mgl	CSM 31	0.013	0.013	0.039	0.021	0.033

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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

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Specialists in environmental monitoring

Test Report

Client: **ERM**
Address: Building 23, The Woodlands Office Park, Woodlands Drive, Woodmead, Sandton, JHB, 2148
Report No: 5304 **Project:** ERM

Date of certificate: 11 May 2011
Date accepted: 24 Mar 2011
Date completed: 10 May 2011

Lab no:			57755	57756	57757	57758	57759
Date sampled:			25 Mar 2011	29 Mar 2011	24 Mar 2011	24 Mar 2011	24 Mar 2011
Sample type:			Water	Water	Water	Water	Water
Locality description			DUP1	DUP3	2730 AA 00043	2730 AA 00060	DH 14021
Analyses:		**Method**					
N	Silicon (Si) mg/l	CSM 33	26.521	18.724	29.607	15.768	20.967
N	Strontium (Sr) mg/l	CSM 31	0.107	0.053	0.134	0.048	0.060
N	Vanadium (V) mg/l	CSM 32	0.032	0.017	0.046	0.008	0.021
N	Thallium mg/l	CSM 32	<0.087	<0.087	<0.087	<0.087	<0.087
A	Bicarbonate alkalinity mg CaCO3/l	CSM 26	60.6	68.7	91.6	46.4	68.0
A	Anions	CSM 26	2.85	1.42	4.67	1.27	1.41
A	Cations	CSM 26	2.94	1.56	4.51	1.34	1.54
A	Difference (%)	CSM 26	1.47	4.85	-1.67	2.41	4.29

A = Accredited (Included in the SANAS Schedule of Accreditation); N = Not accredited (Excluded from the SANAS Schedule of Accreditation)
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Report checked by: H. Holtzhausen (Laboratory Manager) HHausen

Environmental Isotope Laboratory

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Report

Reference: ERM026

Date: 13th September 2010

Environmental isotope analysis on three (3) water samples

submitted by Mr. Andreas Stoll
ERM
Proj. No. 0120258

— —

M.J. Butler, O.H.T. Malinga, M. Mabitsela

confidential

1. General

Three water samples were submitted by Mr. A. Stoll of ERM for D/H ($^2H/^1H$) and $^{18}O/^{16}O$ analysis. The samples were received on the 8th of September 2010.

2. Stable Isotope Analysis

Water D/H ($^2H/^1H$) and $^{18}O/^{16}O$ ratios were analysed in the laboratory of the Environmental Isotope Group (EIG) of iThemba Laboratories, Gauteng. The equipment used for stable isotope analysis consists of a PDZ Europa GEO 20-20 gas mass–spectrometer connected to peripheral sample preparation devices. A PDZ water equilibration system (WES), working in dual inlet mode is employed for hydrogen and oxygen isotope analysis of water. Equilibration time for the water sample with hydrogen is about one hour and CO_2 is equilibrated with a water sample in about eight hours. Laboratory standards, calibrated against international reference materials, are analysed with each batch of samples. The analytical precision is estimated at 0.1‰ for O and 0.5‰ for H.

Analytical results are presented in the common delta-notation:

$$\delta^{18}O(‰) = \left[\frac{(^{18}O/^{16}O)_{sample}}{(^{18}O/^{16}O)_{standard}} - 1 \right] \times 1000$$

which applies to D/H ($^2H/^1H$), accordingly. These delta values are expressed as per mil deviation relative to a known standard, in this case standard mean ocean water (SMOW) for $\delta^{18}O$ and δD.

3. Results

The analytical results are presented in Tables 1 and 2 and partially illustrated in Figure 1.

The stable isotope analyses for all samples data could be well reproduced within the expected analytical error limits. Figure 1 shows these data in a $\delta^{18}O$ vs. δD space relative to the Global Meteoric Water Line (GMWL, Craig, 1961). The samples plot slightly above the GMWL, possibly the result of local rainfall conditions.

4. References

Craig, H. (1961). Isotopic variations in meteoric waters. *Science*, **133**, 1702–1703.

Table 1: Analytical Results

			Deuterium	Oxygen-18
Lab No	Field Name	Description	δD‰ SMOW	$\delta^{18}O$‰ SMOW
ERM 174	SW A	2010/09/01	-17.4	-3.60
ERM 175	SW B	2010/09/01	-14.8	-3.50
ERM 176	SW C	2010/09/01	-17.7	-3.64

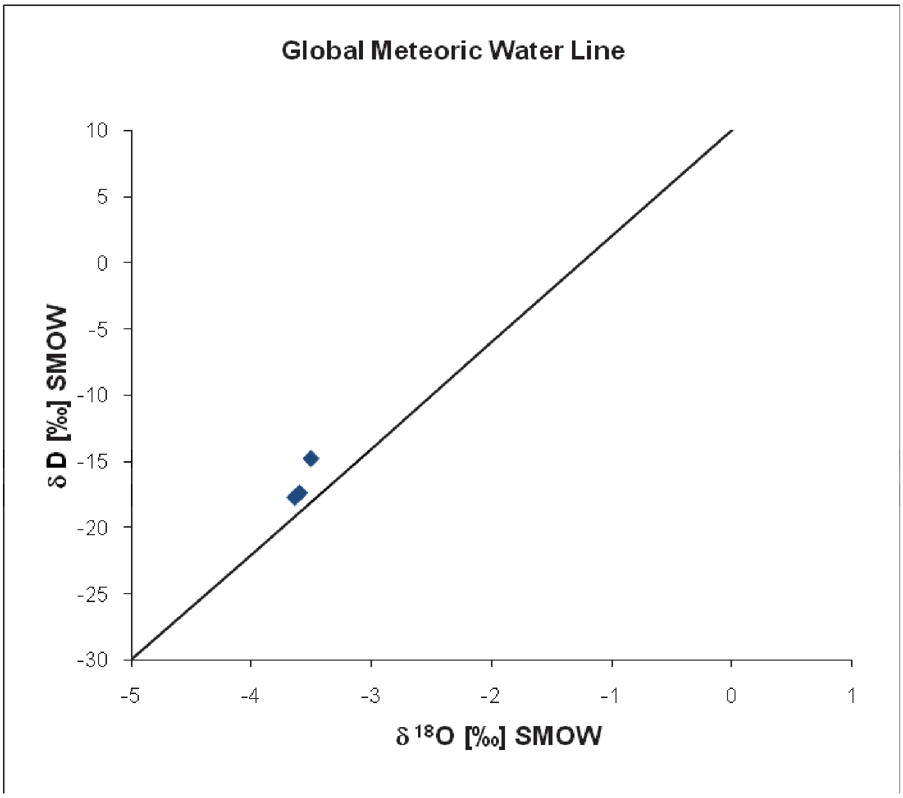

Figure 1: Stable isotope data relative to Global Meteoric Water Line (Craig, 1961).

Table 2: Stable isotope aliquot determinations

Lab No.	Field Name:	Description	Deuterium analysis	Deuterium Batch	δD‰ SMOW	Oxygen-18 analysis	Oxygen-18 Batch	δ^{18}O‰ SMOW
ERM 174	SW A	2010-09-01	a	2010/09/09	-17.4	a	2010/09/10	-3.59
			b		-17.3	b		-3.61
				avg.:	**-17.4**		**avg.:**	**-3.60**
				diff.:	*0.1*		*diff.:*	*0.02*
ERM 175	SW B	2010-09-01	a	2010/09/09	-14.9	a	2010/09/10	-3.51
			b		-14.6	b		-3.50
				avg.:	**-14.8**		**avg.:**	**-3.50**
				diff.:	*0.3*		*diff.:*	*0.01*
ERM 176	SW C	2010-09-01	a	2010/09/09	-17.7	a	2010/09/10	-3.64
			b		-17.7	b		-3.63
				avg.:	**-17.7**		**avg.:**	**-3.64**
				diff.:	*0.0*		*diff.:*	*0.01*

National Research Foundation
iThemba LABS
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Report

Reference: ERM028

Date: 14th July 2011

Environmental isotope analysis on twenty two (22) water samples

submitted by Mr. Jaco Breytenbach

ERM

ERM Proj. No. 0129245

— —

M.J. Butler, O.H.T. Malinga, M. Mabitsela

confidential

1. General

Twenty two water samples were submitted by Mr. J. Breytenbach of ERM for D/H ($^{2}H/^{1}H$) and $^{18}O/^{16}O$ analysis. The samples were received on the 5th of May 2011.

2. Stable Isotope Analysis

Water D/H ($^{2}H/^{1}H$) and $^{18}O/^{16}O$ ratios were analysed in the laboratory of the Environmental Isotope Group (EIG) of iThemba Laboratories, Gauteng. The equipment used for stable isotope analysis consists of a PDZ Europa GEO 20-20 gas mass–spectrometer connected to peripheral sample preparation devices. A PDZ water equilibration system (WES), working in dual inlet mode is employed for hydrogen and oxygen isotope analysis of water. Equilibration time for the water sample with hydrogen is about one hour and CO_2 is equilibrated with a water sample in about eight hours. Laboratory standards, calibrated against international reference materials, are analysed with each batch of samples. The analytical precision is estimated at 0.1‰ for O and 0.5‰ for H.

Analytical results are presented in the common delta-notation:

$$\delta^{18}O(‰) = \left[\frac{(^{18}O/^{16}O)_{sample}}{(^{18}O/^{16}O)_{standard}} - 1\right] \times 1000$$

which applies to D/H ($^{2}H/^{1}H$), accordingly. These delta values are expressed as per mil deviation relative to a known standard, in this case standard mean ocean water (SMOW) for $\delta^{18}O$ and δD.

3. Results

The analytical results are presented in Tables 1 and 2 and partially illustrated in Figure 1.

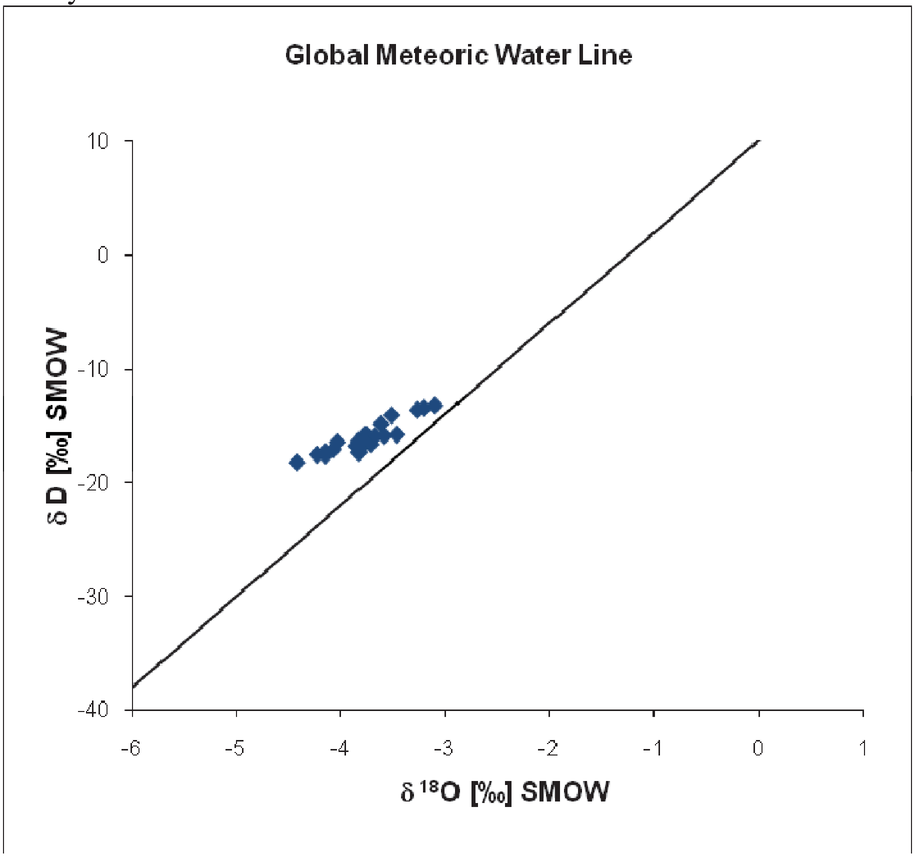

Figure 1: Stable isotope data relative to Global Meteoric Water Line (Craig, 1961).

The stable isotope analyses for all samples data could be well reproduced within the expected analytical error limits. Due to a malfunctioning mass spectrometer, the data took substantially longer to finalise than is the normal. Figure 1 shows these data in a $\delta^{18}O$ vs. δD space relative to the Global Meteoric Water Line (GMWL, Craig, 1961).

4. References

Craig, H. (1961). Isotopic variations in meteoric waters. *Science*, **133**, 1702–1703.

Table 1: Analytical Results

			Deuterium	Oxygen-18
Lab No	Field Name	Description	δD‰ SMOW	δ^{18}O‰ SMOW
ERM 181	ERMBH1	2011/03/30	-16.4	-4.03
ERM 182	ERMBH2	2011/04/02	-17.3	-4.14
ERM 183	ERMBH3	2011/04/04	-17.5	-4.23
ERM 184	ERMBH4	2011/04/14	-18.2	-4.42
ERM 185	ERMBH5	2011/04/10	-17.3	-3.83
ERM 186	ERMBH7	2011/04/02	-16.9	-3.81
ERM 187	ERMBH8	2011/04/01	-17.0	-4.07
ERM 188	ERMBH9	2011/04/10	-15.7	-3.77
ERM 189	ERMBH10	2011/04/11	-17.6	-4.15
ERM 190	RP3	2011/04/08	-13.6	-3.27
ERM 191	RP12	2011/04/08	-13.4	-3.20
ERM 192	RP16	2011/04/08	-13.2	-3.10
ERM 193	DH14021	2011/03/24	-16.3	-3.83
ERM 194	FB2	2011/03/26	-14.0	-3.52
ERM 195	FB13	2011/03/02	-15.8	-3.59
ERM 196	Spring A	2011/03/01	-15.8	-3.76
ERM 197	Spring B	2011/03/18	-14.8	-3.62
ERM 198	Spring C	2011/03/02	-16.6	-3.72
ERM 199	FS5	2011/03/01	-15.9	-3.68
ERM 200	FS23	2011/03/18	-16.3	-3.80
ERM 201	FS24	2011/03/24	-15.7	-3.47
ERM 202	Dup3	2011/03/24	-16.7	-3.85

Table 2: Stable isotope aliquot determinations

Lab No.	Field Name:	Description	Deuterium analysis	Deuterium Batch	δD‰ SMOW	Oxygen-18 analysis	Oxygen-18 Batch	δ^{18}O‰ SMOW
ERM 181	ERMBH1	2011-03-30	a	2011/06/09	-16.8	a	2011/06/07	-4.03
			b		-16.0	b		-4.03
				avg.:	**-16.4**		**avg.:**	**-4.03**
				diff.:	*0.8*		*diff.:*	*0.01*
ERM 182	ERMBH2	2011-04-02	a	2011/06/09	-17.1	a	2011/06/07	-4.13
			b		-17.4	b		-4.16
				avg.:	**-17.3**		**avg.:**	**-4.14**
				diff.:	*0.3*		*diff.:*	*0.03*
ERM 183	ERMBH3	2011-04-04	a	2011/06/09	-17.5	a	2011/06/07	-4.22
			b		-17.5	b		-4.23
				avg.:	**-17.5**		**avg.:**	**-4.23**
				diff.:	*0.0*		*diff.:*	*0.01*
ERM 184	ERMBH4	2011-04-14	a	2011/06/09	-18.0	a	2011/06/07	-4.47
			b		-18.4	b		-4.38
				avg.:	**-18.2**		**avg.:**	**-4.42**
				diff.:	*0.5*		*diff.:*	*0.09*
ERM 185	ERMBH5	2011-04-10	a	2011/06/09	-17.3	a	2011/06/30	-3.78
			b		-17.3	b		-3.88
				avg.:	**-17.3**		**avg.:**	**-3.83**
				diff.:	*0.1*		*diff.:*	*0.10*
ERM 186	ERMBH7	2011-04-02	a	2011/06/09	-16.8	a	2011/06/13	-3.79
			b		-17.0	b	2011/06/30	-3.84
				avg.:	**-16.9**		**avg.:**	**-3.81**
				diff.:	*0.2*		*diff.:*	*0.05*
ERM 187	ERMBH8	2011-04-01	a	2011/06/09	-17.2	a	2011/06/30	-4.04
			b		-16.9	b		-4.09
				avg.:	**-17.0**		**avg.:**	**-4.07**
				diff.:	*0.3*		*diff.:*	*0.05*
ERM 188	ERMBH9	2011-04-10	a	2011/06/09	-15.9	a	2011/06/13	-3.73
			b		-15.6	b		-3.82
				avg.:	**-15.7**		**avg.:**	**-3.77**
				diff.:	*0.4*		*diff.:*	*0.09*
ERM 189	ERMBH10	2011-04-11	a	2011/06/09	-17.3	a	2011/06/13	-4.20
			b	2011/07/05	-17.8	b		-4.09
				avg.:	**-17.6**		**avg.:**	**-4.15**
				diff.:	*0.5*		*diff.:*	*0.11*
ERM 190	RP3	2011-04-08	a	2011/06/09	-13.8	a	2011/06/30	-3.30
			b		-13.4	b		-3.24
				avg.:	**-13.6**		**avg.:**	**-3.27**
				diff.:	*0.4*		*diff.:*	*0.06*
ERM 191	RP12	2011-04-08	a	2011/06/09	-13.7	a	2011/07/13	-3.22
			b		-13.1	b		-3.18
				avg.:	**-13.4**		**avg.:**	**-3.20**
				diff.:	*0.6*		*diff.:*	*0.04*
ERM 192	RP16	2011-04-08	a	2011/06/09	-12.9	a	2011/07/13	-3.11
			b		-13.5	b		-3.08
				avg.:	**-13.2**		**avg.:**	**-3.10**
				diff.:	*0.6*		*diff.:*	*0.03*
ERM 193	DH14021	2011-03-24	a	2011/06/09	-16.1	a	2011/07/13	-3.82
			b		-16.6	b		-3.84
				avg.:	**-16.3**		**avg.:**	**-3.83**
				diff.:	*0.6*		*diff.:*	*0.03*
ERM 194	FB2	2011-03-26	a	2011/06/09	-14.2	a	2011/07/13	-3.50
			b		-13.9	b		-3.53
				avg.:	**-14.0**		**avg.:**	**-3.52**
				diff.:	*0.2*		*diff.:*	*0.03*

ERM 195	FB13	2011-03-02	a	2011/06/09	-16.1	a	2011/07/13	-3.58
			b		-15.6	b		-3.59
				avg.:	**-15.8**		**avg.:**	**-3.59**
				diff.:	*0.6*		*diff.:*	*0.01*
ERM 196	Spring A	2011-03-01	a	2011/06/09	-15.9	a	2011/07/13	-3.75
			b		-15.6	b		-3.76
				avg.:	**-15.8**		**avg.:**	**-3.76**
				diff.:	*0.3*		*diff.:*	*0.01*
ERM 197	Spring B	2011-03-18	a	2011/06/09	-14.9	a	2011/07/13	-3.62
			b		-14.7	b		-3.62
				avg.:	**-14.8**		**avg.:**	**-3.62**
				diff.:	*0.3*		*diff.:*	*0.01*
ERM 198	Spring C	2011-03-02	a	2011/06/09	-16.9	a	2011/07/13	-3.73
			b		-16.3	b		-3.70
				avg.:	**-16.6**		**avg.:**	**-3.72**
				diff.:	*0.7*		*diff.:*	*0.03*
ERM 199	FS5	2011-03-01	a	2011/07/05	-15.8	a	2011/07/13	-3.69
			b		-16.0	b		-3.67
				avg.:	**-15.9**		**avg.:**	**-3.68**
				diff.:	*0.2*		*diff.:*	*0.02*
ERM 200	FS23	2011-03-18	a	2011/06/09	-16.6	a	2011/07/13	-3.81
			b		-15.9	b		-3.79
				avg.:	**-16.3**		**avg.:**	**-3.80**
				diff.:	*0.8*		*diff.:*	*0.02*
ERM 201	FS24	2011-03-24	a	2011/06/09	-15.4	a	2011/07/13	-3.47
			b		-16.1	b		-3.46
				avg.:	**-15.7**		**avg.:**	**-3.47**
				diff.:	*0.6*		*diff.:*	*0.01*
ERM 202	Dup3	2011-03-24	a	2011/06/09	-16.7	a	2011/07/13	-3.85
			b		-16.8	b		-3.85
				avg.:	**-16.7**		**avg.:**	**-3.85**
				diff.:	*0.1*		*diff.:*	*0.01*

Annex G

Details of Geochemical Samples

SUMMARY

	Depth of sample				Volitility States	Depth	ABA Testing Sample ID		
BORE ID	FROM	TO	thick	SEAM	(high =>20, low <20)	(deep >200m , shallow < 200m)	Product	Discard	HUMIDITY CELL TEST
KB15177	247.03	248.58	1.55	GUST	High	Deep	KP101	KD101	KK101
KB15031A	239.52	241.27	1.75	GUST	High	Deep			
KB15033	171.16	172.90	1.74	GUST	High	Shallow	KP102	KD102	KK102
KB15034	170.28	171.80	1.52	GUST	High	Shallow			
BB13020	321.21	322.89	1.68	GUST	High	Deep	not seperated		KK105
BB13018	286.50	287.89	1.39	GUST	High	Deep	not seperated		
BW34020	204.95	205.65	0.70	GUST	Low	Shallow	KP103	KD103	not enough sample
BW34007	232.36	233.37	1.01	GUST	Low	Deep			
Boreholes around Adit A							KP104	KD104	KK104

samples sent in 1st batch

samples sent in 2nd batch

Detailed List

		Cape Lo 31			WGS 84													(Sample lable)	Volitility States	Depth
BORE ID	X	Y	Z	X	Y	Z	FROM	TO	thick	SEAM	FLOAT	YIELD	Moist	Ash	Vol	CV	Sul	Lab Id	high =>20 , low <20	(deep >200m , shallow < 200m)
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	248.58	1.55	GUST	1.40	6.21	3.10	11.70	25.50	28.85	0.762	34982	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	248.58	1.55	GUST	1.50	47.59	3.36	15.79	21.93	26.74	0.452	34983	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	248.58	1.55	GUST	1.60	86.21	3.38	18.30	20.80	25.76	0.566	34984	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	248.58	1.55	GUST	1.70	100.00	3.34	20.15	20.26	25.11	0.722	34985	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	248.58	1.55	GUST	1.80	100.00	3.34	20.15	20.26	25.11	0.722		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	248.58	1.55	GUST	1.90	100.00	3.34	20.15	20.26	25.11	0.722		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	248.58	251.65	3.07	GUSB	1.40	51.18	2.10	10.80	27.20	29.59	1.111	34989	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	248.58	251.65	3.07	GUSB	1.50	77.88	2.24	12.45	25.25	28.92	1.025	34990	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	248.58	251.65	3.07	GUSB	1.60	90.27	2.33	13.72	24.42	28.39	1.015		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	248.58	251.65	3.07	GUSB	1.70	97.05	2.27	15.43	24.14	27.79	1.048	34992	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	248.58	251.65	3.07	GUSB	1.80	100.00	2.25	16.36	24.01	27.45	1.073	34993	High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	248.58	251.65	3.07	GUSB	1.90	100.00	2.25	16.36	24.01	27.45	1.073		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	251.65	4.62	GUS	1.40	37.71	2.15	10.84	27.12	29.55	1.094		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	251.65	4.62	GUS	1.50	68.80	2.47	13.14	24.56	28.47	0.906		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	251.65	4.62	GUS	1.60	89.05	2.63	15.05	23.37	27.63	0.885		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	251.65	4.62	GUS	1.70	97.93	2.60	16.87	22.96	26.97	0.949		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	251.65	4.62	GUS	1.80	100.00	2.58	17.50	22.89	26.75	0.968		High	Deep
KB15177	-66125.314	-2991027.293	1676.623	-66147.120	-2991324.780	1676.620	247.03	251.65	4.62	GUS	1.90	100.00	2.58	17.50	22.89	26.75	0.968		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	241.27	1.75	GUST	1.40	27.30	1.90	11.20	28.80	29.94	0.803	12166	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	241.27	1.75	GUST	1.50	57.90	1.80	14.20	27.60	28.48	0.687	12167	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	241.27	1.75	GUST	1.60	83.40	1.80	16.70	26.10	27.25	0.655	12168	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	241.27	1.75	GUST	1.70	92.20	1.80	18.30	25.40	26.65	0.635		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	241.27	1.75	GUST	1.80	94.40	1.80	18.70	25.20	26.49	0.667	12170	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	241.27	1.75	GUST	1.90	100.00	1.70	20.70	24.30	25.53	0.831		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	241.27	243.23	1.96	GUSB	1.40	41.10	1.50	12.50	26.60	29.78	0.792	12172	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	241.27	243.23	1.96	GUSB	1.50	62.80	1.50	15.10	25.20	28.81	0.775	12173	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	241.27	243.23	1.96	GUSB	1.60	82.50	1.40	17.90	24.10	27.70	0.713	12164	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	241.27	243.23	1.96	GUSB	1.70	90.40	1.40	19.50	23.70	27.04	0.772		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	241.27	243.23	1.96	GUSB	1.80	93.20	1.40	20.60	23.50	26.72	0.766	12176	High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	241.27	243.23	1.96	GUSB	1.90	100.00	1.40	23.20	23.00	25.67	0.750		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	243.23	3.71	GUS	1.40	34.59	1.69	11.89	27.64	29.86	0.797		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	243.23	3.71	GUS	1.50	60.49	1.64	14.68	26.33	28.65	0.733		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	243.23	3.71	GUS	1.60	82.92	1.59	17.33	25.04	27.49	0.686		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	243.23	3.71	GUS	1.70	91.25	1.59	18.93	24.50	26.86	0.707		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	243.23	3.71	GUS	1.80	93.77	1.59	19.70	24.30	26.61	0.719		High	Deep
KB15031A	-66310.500	-2990881.500	1677.500	-66332.310	-2991178.990	1677.500	239.52	243.23	3.71	GUS	1.90	100.00	1.54	22.02	23.61	25.60	0.788		High	Deep
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	172.90	1.74	GUST	1.40	20.45	3.60	9.10	33.90	29.64	1.071	12184	High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	172.90	1.74	GUST	1.50	51.22	3.36	12.58	30.60	27.81	0.861	12185	High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	172.90	1.74	GUST	1.60	82.34	3.22	15.95	28.33	26.49	0.926	12192	High	Shallow

KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	172.90	1.74	GUST	1.70	90.73	3.18	17.42	27.68	25.94	0.949	12188	High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	172.90	1.74	GUST	1.80	93.88	3.14	18.03	27.42	25.74	1.015		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	172.90	1.74	GUST	1.90	100.00	3.04	20.02	26.72	25.04	1.280		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	172.90	175.19	2.29	GUSB	1.40	44.00	4.00	10.00	30.40	29.34	0.984		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	172.90	175.19	2.29	GUSB	1.50	73.93	3.80	12.19	27.89	29.02	0.809	12191	High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	172.90	175.19	2.29	GUSB	1.60	97.56	3.65	14.42	26.03	28.38	0.662	12186	High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	172.90	175.19	2.29	GUSB	1.70	99.39	3.64	14.71	25.94	28.30	0.658	12193	High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	172.90	175.19	2.29	GUSB	1.80	100.00	3.62	14.87	25.97	28.25	0.667		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	172.90	175.19	2.29	GUSB	1.90	100.00	3.62	14.87	25.97	28.25	0.667		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	175.19	4.03	GUS	1.40	35.33	3.91	9.81	31.15	29.40	1.003		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	175.19	4.03	GUS	1.50	65.57	3.67	12.30	28.67	28.67	0.824		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	175.19	4.03	GUS	1.60	91.96	3.51	14.92	26.79	27.76	0.749		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	175.19	4.03	GUS	1.70	96.20	3.48	15.65	26.54	27.48	0.759		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	175.19	4.03	GUS	1.80	97.75	3.45	15.99	26.49	27.36	0.790		High	Shallow
KB15033	-65751.300	-2990480.700	1588.600	-65773.110	-2990778.190	1588.600	171.16	175.19	4.03	GUS	1.90	100.00	3.41	16.76	26.25	27.07	0.893		High	Shallow
																			High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	171.80	1.52	GUST	1.40	31.20	3.90	11.40	27.80	28.58	0.638	12386	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	171.80	1.52	GUST	1.50	65.73	3.79	14.45	24.44	27.08	0.549	12387	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	171.80	1.52	GUST	1.60	86.45	3.75	16.47	23.33	26.37	0.698		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	171.80	1.52	GUST	1.70	96.16	3.66	18.01	22.90	25.80	0.982	12389	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	171.80	1.52	GUST	1.80	98.21	3.63	18.42	22.80	25.65	0.974	12390	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	171.80	1.52	GUST	1.90	100.00	3.60	18.95	22.71	25.47	0.971		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	171.80	174.38	2.58	GUSB	1.40	66.00	3.50	11.80	27.90	28.52	1.032	12392	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	171.80	174.38	2.58	GUSB	1.50	85.04	3.48	13.21	26.83	28.05	0.957	12393	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	171.80	174.38	2.58	GUSB	1.60	93.12	3.39	14.29	26.34	27.68	0.917	12394	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	171.80	174.38	2.58	GUSB	1.70	95.41	3.36	14.85	26.18	27.47	0.917	12395	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	171.80	174.38	2.58	GUSB	1.80	96.61	3.34	15.28	26.10	27.31	0.911	12396	High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	171.80	174.38	2.58	GUSB	1.90	100.00	3.27	16.78	25.85	26.75	0.905		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	174.38	4.10	GUS	1.40	56.24	3.56	11.74	27.88	28.53	0.971		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	174.38	4.10	GUS	1.50	79.63	3.55	13.50	26.27	27.83	0.862		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	174.38	4.10	GUS	1.60	91.25	3.49	14.87	25.54	27.33	0.859		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	174.38	4.10	GUS	1.70	95.62	3.45	15.74	25.26	27.00	0.935		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	174.38	4.10	GUS	1.80	97.06	3.42	16.17	25.16	26.84	0.929		High	Shallow
KB15034	-66105.800	-2990461.500	1604.900	-66127.610	-2990758.990	1604.900	170.28	174.38	4.10	GUS	1.90	100.00	3.36	17.39	24.97	26.39	0.923		High	Shallow
																			High	
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	322.89	1.68	GUST	1.40	3.85	1.50	12.80	32.40	29.96	2.421		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	322.89	1.68	GUST	1.50	7.38	1.50	15.62	31.49	28.83	2.844		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	322.89	1.68	GUST	1.60	11.53	1.46	18.78	28.51	27.45	2.550	RC Drill chi	High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	322.89	1.68	GUST	1.70	21.64	1.39	25.99	23.69	24.28	1.633	in bags	High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	322.89	1.68	GUST	1.80	37.01	1.31	33.18	20.54	21.34	1.222		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	322.89	1.68	GUST	1.90	100.00	0.99	52.91	15.16	14.05	0.804		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	322.89	325.23	2.34	GUSB	1.40	42.48	2.70	9.10	28.80	30.56	0.659		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	322.89	325.23	2.34	GUSB	1.50	79.34	2.42	11.33	28.15	29.25	0.514		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	322.89	325.23	2.34	GUSB	1.60	92.81	2.35	12.95	27.95	28.59	0.474	RC Drill chi	High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	322.89	325.23	2.34	GUSB	1.70	94.79	2.33	13.37	27.90	28.40	0.468	in bags	High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	322.89	325.23	2.34	GUSB	1.80	96.21	2.31	13.74	27.80	28.22	0.464		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	322.89	325.23	2.34	GUSB	1.90	100.00	2.28	15.13	27.52	27.52	0.451		High	Deep

BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	325.23	4.02	GUS	1.40	23.73	2.61	9.39	29.08	30.51	0.798		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	325.23	4.02	GUS	1.50	44.40	2.05	14.30	27.66	27.72	0.591		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	325.23	4.02	GUS	1.60	53.35	2.01	15.74	27.38	27.23	0.600		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	325.23	4.02	GUS	1.70	59.28	1.94	17.57	26.58	26.55	0.592		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	325.23	4.02	GUS	1.80	67.47	1.85	20.64	25.37	25.40	0.593		High	Deep
BB13020	-75112.800	-2993884.280	1772.010	-75134.620	-2994181.700	1772.010	321.21	325.23	4.02	GUS	1.90	100.00	1.52	34.63	21.18	20.32	0.573		High	Deep
																			High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	287.89	1.39	GUST	1.40	5.32	1.90	11.90	31.50	29.83	1.015		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	287.89	1.39	GUST	1.50	10.31	1.80	14.76	29.76	28.88	1.088		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	287.89	1.39	GUST	1.60	20.37	1.75	19.37	25.33	26.74	1.254	RC Drill chi	High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	287.89	1.39	GUST	1.70	29.71	1.70	25.13	22.90	24.53	1.363	in bags	High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	287.89	1.39	GUST	1.80	41.00	1.68	30.27	20.81	22.64	1.603		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	287.89	1.39	GUST	1.90	100.00	1.28	50.35	15.79	15.24	2.001		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	287.89	290.00	2.11	GUSB	1.40	33.99	3.10	9.80	29.20	30.52	0.877		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	287.89	290.00	2.11	GUSB	1.50	79.81	2.53	11.92	26.96	29.15	0.601		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	287.89	290.00	2.11	GUSB	1.60	92.05	2.44	13.15	26.43	28.62	0.637	RC Drill chi	High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	287.89	290.00	2.11	GUSB	1.70	93.85	2.43	13.48	26.35	28.49	0.638	in bags	High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	287.89	290.00	2.11	GUSB	1.80	95.32	2.42	13.83	26.26	28.33	0.686		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	287.89	290.00	2.11	GUSB	1.90	100.00	2.33	15.61	25.97	27.24	0.836		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	290.00	3.50	GUS	1.40	20.31	2.95	10.06	29.49	30.43	0.894		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	290.00	3.50	GUS	1.50	46.65	2.06	13.89	25.54	28.11	0.467		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	290.00	3.50	GUS	1.60	57.86	2.02	15.53	24.86	27.49	0.590		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	290.00	3.50	GUS	1.70	63.25	1.98	17.32	24.30	26.85	0.663		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	290.00	3.50	GUS	1.80	69.40	1.95	19.59	23.57	26.05	0.820		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	286.50	290.00	3.50	GUS	1.90	100.00	1.65	32.96	20.31	21.04	1.305		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	296.08	296.09	0.01	DUNT	1.40	27.87	2.20	8.40	30.80	30.80	1.201		High	Deep
BB13018	-74924.400	-2993348.400	1742.500	-74946.21	-2993645.82	1742.500	296.08	296.09	0.01	DUNT	1.50	55.26	2.05	11.42	28.02	28.66	1.069		High	Deep
																			High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	290.80	1.30	GUST	1.40	4.40	1.90	10.50	29.80	30.58	2.633		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	290.80	1.30	GUST	1.50	13.10	1.70	16.70	27.50	28.30	3.379		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	290.80	1.30	GUST	1.60	22.10	1.80	19.90	25.30	26.82	3.080		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	290.80	1.30	GUST	1.70	31.80	1.90	25.20	22.60	24.78	2.564		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	290.80	1.30	GUST	1.80	46.80	2.00	31.70	20.10	22.22	1.928		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	290.80	1.30	GUST	1.90	100.00	1.70	47.70	16.00	15.82	1.235		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	290.80	293.25	2.45	GUSB	1.40	42.60	3.00	9.60	28.40	30.17	0.863		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	290.80	293.25	2.45	GUSB	1.50	82.50	2.90	14.70	22.20	27.41	0.348		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	290.80	293.25	2.45	GUSB	1.60	91.70	2.80	15.80	22.00	27.01	0.377		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	290.80	293.25	2.45	GUSB	1.70	95.60	2.80	16.70	21.80	26.70	0.404		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	290.80	293.25	2.45	GUSB	1.80	97.90	2.80	17.30	21.70	26.48	0.407		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	290.80	293.25	2.45	GUSB	1.90	100.00	2.80	18.10	21.70	26.09	0.403		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	293.25	3.75	GUS	1.40	29.36	2.62	9.91	28.89	30.31	1.477		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	293.25	3.75	GUS	1.50	58.44	2.48	15.39	24.04	27.72	1.399		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	293.25	3.75	GUS	1.60	67.57	2.45	17.22	23.14	26.94	1.314		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	293.25	3.75	GUS	1.70	73.48	2.49	19.65	22.08	26.03	1.153		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	293.25	3.75	GUS	1.80	80.19	2.52	22.29	21.15	25.00	0.934		High	Deep
BB13035	-75271.427	-2993398.623	1756.040	-75293.24	-2993696.04	1756.040	289.50	293.25	3.75	GUS	1.90	100.00	2.42	28.36	19.72	22.53	0.691		High	Deep

BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	205.65	0.70	GUST	1.40	4.69	1.20	9.90	16.00	31.87	2.310	13728	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	205.65	0.70	GUST	1.50	13.02	1.33	14.12	14.98	30.09	2.169	13729	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	205.65	0.70	GUST	1.60	21.35	1.47	18.13	13.93	28.52	1.713	13730	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	205.65	0.70	GUST	1.70	28.65	1.63	23.50	13.16	26.46	1.699	13731	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	205.65	0.70	GUST	1.80	53.65	1.99	34.96	11.45	21.58	1.173	13732	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	205.65	0.70	GUST	1.90	100.00	2.18	46.89	11.20	16.45	1.186		Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	205.65	208.05	2.40	GUSB	1.40	4.69	1.20	9.90	16.00	31.87	2.310	13735	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	205.65	208.05	2.40	GUSB	1.50	13.02	1.33	14.12	14.98	30.09	2.169	13736	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	205.65	208.05	2.40	GUSB	1.60	21.35	1.47	18.13	13.93	28.52	1.713	13737	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	205.65	208.05	2.40	GUSB	1.70	28.65	1.63	23.50	13.16	26.46	1.699	13738	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	205.65	208.05	2.40	GUSB	1.80	53.65	1.99	34.96	11.45	21.58	1.173	13739	Low	Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	205.65	208.05	2.40	GUSB	1.90	100.00	2.18	46.89	11.20	16.45	1.186			Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	208.05	3.10	GUS	1.40	4.69	1.20	9.90	16.00	31.87	2.310			Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	208.05	3.10	GUS	1.50	13.02	1.33	14.12	14.98	30.09	2.169			Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	208.05	3.10	GUS	1.60	21.35	1.47	18.13	13.93	28.52	1.713			Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	208.05	3.10	GUS	1.70	28.65	1.63	23.50	13.16	26.46	1.699			Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	208.05	3.10	GUS	1.80	53.65	1.99	34.96	11.45	21.58	1.173			Shallow
BW34020	-69108.563	-2992808.047	1701.911	-69130.370	-2993105.500	1701.910	204.95	208.05	3.10	GUS	1.90	100.00	2.18	46.89	11.20	16.45	1.186			Shallow
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	233.37	1.01	GUST	1.40									
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	233.37	1.01	GUST	1.50	8.05	1.10	15.30	6.10	29.74	1.481		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	233.37	1.01	GUST	1.60	19.38	1.20	22.30	5.90	26.95	1.224		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	233.37	1.01	GUST	1.70	34.42	1.24	27.28	6.82	25.01	1.192	19734	Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	233.37	1.01	GUST	1.80	50.45	1.29	32.91	7.07	22.80	1.003		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	233.37	1.01	GUST	1.90	100.00	1.25	45.54	6.93	17.74	0.765		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	233.37	235.60	2.23	GUSB	1.40	3.21	1.20	8.30	8.60	32.50	0.743		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	233.37	235.60	2.23	GUSB	1.50	62.11	1.48	12.47	9.55	30.29	0.765		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	233.37	235.60	2.23	GUSB	1.60	86.57	1.43	14.77	9.42	29.42	0.687		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	233.37	235.60	2.23	GUSB	1.70	92.35	1.42	15.90	9.36	28.99	0.675		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	233.37	235.60	2.23	GUSB	1.80	95.74	1.40	16.87	9.28	28.63	0.689		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	233.37	235.60	2.23	GUSB	1.90	100.00	1.38	18.73	9.27	27.87	0.695		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	235.60	3.24	GUS	1.40	1.92	1.20	8.30	8.60	32.50	0.743		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	235.60	3.24	GUS	1.50	40.38	1.47	12.92	9.31	30.13	0.826		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	235.60	3.24	GUS	1.60	59.56	1.41	15.52	8.99	29.17	0.774		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	235.60	3.24	GUS	1.70	69.06	1.39	17.98	8.88	28.26	0.793		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	235.60	3.24	GUS	1.80	77.54	1.38	20.88	8.73	27.16	0.784		Low	Deep
BW34007	-70807.661	-2993518.717	1735.187	-70829.470	-2993816.150	1735.190	232.36	235.60	3.24	GUS	1.90	100.00	1.33	29.37	8.35	23.84	0.733		Low	Deep
																			Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	222.76	0.96	GUST	1.40								Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	222.76	0.96	GUST	1.50	10.88	1.10	12.40	7.50	30.94	2.165		Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	222.76	0.96	GUST	1.60	24.29	1.21	17.75	7.50	28.96	1.696		Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	222.76	0.96	GUST	1.70	35.42	1.36	23.21	7.34	26.72	1.497		Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	222.76	0.96	GUST	1.80	50.60	1.40	29.03	7.18	24.36	1.338		Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	222.76	0.96	GUST	1.90	100.00	2.04	43.44	5.91	18.00	0.790		Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	222.76	224.80	2.04	GUSB	1.40	5.44	1.20	8.30	8.90	32.37	1.002		Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	222.76	224.80	2.04	GUSB	1.50	72.67	1.29	11.26	9.18	30.90	0.829		Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	222.76	224.80	2.04	GUSB	1.60	90.51	1.27	13.22	8.91	30.24	0.788		Low	Deep

BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	222.76	224.80	2.04	GUSB	1.70	93.81	1.28	13.90	8.87	29.97	0.773	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	222.76	224.80	2.04	GUSB	1.80	95.39	1.28	14.30	8.87	29.81	0.775	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	222.76	224.80	2.04	GUSB	1.90	100.00	1.29	16.43	8.93	28.90	0.750	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	224.80	3.00	GUS	1.40	3.58	1.20	8.30	8.90	32.37	1.002	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	224.80	3.00	GUS	1.50	51.60	1.28	11.57	9.07	30.79	0.919	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	224.80	3.00	GUS	1.60	67.92	1.27	13.94	8.74	30.00	0.894	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	224.80	3.00	GUS	1.70	73.89	1.30	15.58	8.63	29.36	0.887	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	224.80	3.00	GUS	1.80	80.12	1.31	17.62	8.52	28.57	0.893	Low	Deep
BW34009	-70708.110	-2993897.608	1718.776	-70729.930	-2994195.040	1718.780	221.80	224.80	3.00	GUS	1.90	100.00	1.55	25.76	7.90	25.13	0.761	Low	Deep

Annex H

Laboratory Test Reports – Geochemical Samples

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CERTIFICATE OF ANALYSES
ACID – BASE ACCOUNTING
EPA-600 MODIFIED SOBEK METHOD

Date received: 2011 - 02 - 21
Project number: 183

Date completed: 2011 - 03 - 11
Report number: 30036

Client name: ERM SA
Address: Postnet Suite 624, Private Bag X29 Gallo Manor 2052
Telephone: 011 798 4300

Contact person: Mr. J. Breytenbach
Email: jaco.breytenbach@erm.com

Acid – Base Accounting Modified Sobek (EPA-600)	Sample Identification		
	KP101	KD101	KP102
Sample Number	**3124**	**3125**	**3126**
Paste pH	5.8	6.0	5.5
Total Sulphur (%) (LECO)	0.95	3.49	0.87
Acid Potential (AP) (kg/t)	29.69	109.06	27.19
Neutralization Potential (NP)	22.92	16.09	21.04
Nett Neutralization Potential (NNP)	-6.77	-92.97	-6.15
Neutralising Potential Ratio (NPR) (NP : AP)	0.772	0.148	0.774
Rock Type	I	I	I

Acid – Base Accounting Modified Sobek (EPA-600)	Sample Identification		
	KD102	KP103	KD103
Sample Number	**3127**	**3128**	**3129**
Paste pH	4.4	6.1	4.7
Total Sulphur (%) (LECO)	7.75	0.88	2.17
Acid Potential (AP) (kg/t)	242.19	27.50	67.81
Neutralization Potential (NP)	15.67	22.11	28.37
Nett Neutralization Potential (NNP)	-226.52	-5.40	-39.45
Neutralising Potential Ratio (NPR) (NP : AP)	0.065	0.804	0.418
Rock Type	I	I	I

- **Negative NP values are obtained when the volume of NaOH (0.1N) titrated (pH:8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 – 2.5 Any negative NP values are corrected to 0.00.**

Please refer to Appendix (p.2) for a Terminology of terms and guidelines for rock classification

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Contact person: Mr. J. Breytenbach
Email: jaco.breytenbach@erm.com

APPENDIX : TERMINOLOGY AND ROCK CLASSIFICATION

TERMINOLOGY (SYNONYMS)

- Acid Potential (AP) ; *Synonyms*: Maximum Potential Acidity (MPA)
  Method: Total S(%) (Leco Analyzer) x 31.25
- Neutralization Potential (NP) ; *Synonyms:* Gross Neutralization Potential (GNP) ; *Syn*: Acid Neutralization Capacity (ANC) (The capacity of a sample to consume acid)
  Method: Fizz Test ; Acid-Base Titration (Sobek & Modified Sobek (Lawrence) Methods)
- Nett Neutralization Potential (NNP) ; *Synonyms:* Nett Acid Production Potential (NAPP)
  Calculation: NNP = NP – AP ; NAPP = ANC – MPA
- Neutralising Potential Ratio (NPR)
  Calculation: NPR = NP : AP

CLASSIFICATION ACCORDING TO NETT NEUTRALISING POTENTIAL (NNP)

If NNP (NP – AP) < 0, the sample has the potential to generate acid
If NNP (NP – AP) > 0, the sample has the potential to neutralise acid produced

Any sample with NNP < 20 is potentiall acid-generating, and any sample with NNP > -20 might not generate acid (Usher *et al.*, 2003)

ROCK CLASSIFICATION

TYPE I	Potentially Acid Forming	Total S(%) > 0.25% and NP:AP ratio 1:1 or less
TYPE II	Intermediate	Total S(%) > 0.25% and NP:AP ratio 1:3 or less
TYPE III	Non-Acid Forming	Total S(%) < 0.25% and NP:AP ratio 1:3 or greater

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CLASSIFICATION ACCORDING TO NEUTRALISING POTENTIAL RATIO (NPR)

Guidelines for screening criteria based on ABA (Price *et al*., 1997 ; Usher *et al*., 2003)

Potential for ARD	Initial NPR Screening Criteria	Comments
Likely	**< 1:1**	Likely AMD generating
Possibly	**1:1 – 2:1**	Possibly AMD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides
Low	**2:1 – 4:1**	Not potentially AMD generating unless significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP
None	**>4:1**	No further AMD testing required unless materials are to be used as a source of alkalinity

CLASSIFICATION ACCORDING TO SULPHUR CONTENT (%S) AND NEUTRALISING POTENTIAL RATIO (NPR)

For sustainable long-term acid generation, at least 0.3% Sulphide-S is needed. Values below this can yield acidity but it is likely to be only of short-term significance. From these facts, and using the NPR values, a number of rules can be derived:

1) Samples with less than 0.3% Sulphide-S are regarded as having insufficient oxidisable Sulphide-S to sustain acid generation.
2) NPR ratios of >4:1 are considered to have enough neutralising capacity.
3) NPR ratios of 3:1 to 1:1 are consider inconclusive.
4) NPR ratios below 1:1 with Sulphide-S above 3% are potentially acid-generating. (Soregaroli & Lawrence, 1998 ; Usher *et al*., 2003)

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Date received: 2011 - 03 - 30
Project number: 183

Date completed: 2011 - 04 – 20
Report number: 30432

Client name: ERM SA
Address: Building 23, The Woodlands Office Park, Woodlands Drive
Woodmead, Sandton, Johannesburg, 2148
Telephone: 011 802 8263

Contact person: Mr. A. Stoll
Email: andreas.stoll@erm.com
Mobile:

Acid – Base Accounting Modified Sobek (EPA-600)	Sample Identification	
	KD104	KP104
Sample Number	**4899**	**4900**
Paste pH	7	6.9
Total Sulphur (%) (LECO)	0.69	0.75
Acid Potential (AP) (kg/t)	21.56	23.44
Neutralization Potential (NP)	26.83	25.23
Nett Neutralization Potential (NNP)	5.27	1.79
Neutralising Potential Ratio (NPR) (NP : AP)	1.24	1.08
Rock Type	II	II

- **Negative NP values are obtained when the volume of NaOH (0.1N) titrated (pH:8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 – 2.5 Any negative NP values are corrected to 0.00.**

Please refer to Appendix (p.2) for a Terminology of terms and guidelines for rock classification

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KK Solids		Lab ID
Aqua Regia Extr		KK101
Sample Weight		**0.5014**
Sample Volume		**100**
Massa / liter		**5.014**
Element	**mg/l**	**mg/kg**
Ag	1.404	280
Al	6.941	1384
As	0.031	6
B	4.228	843
Ba	6.655	1327
Be	0.000	0
Bi	0.000	0
Ca	67.330	13428
Cd	0.008	2
Co	0.000	0
Cr	0.070	14
Cu	0.122	24
Fe	43.050	8586
K	7.322	1460
Li	0.000	0
Mg	11.720	2337
Mn	0.476	95
Mo	0.000	0
Na	30.170	6017
Ni	0.011	2
P	7.669	1530
Pb	0.086	17
Sb	0.144	29
Se	0.070	14
Si	1.240	247
Sn	0.000	0
Sr	2.318	462
Ti	1.336	266
V	0.101	20
W	0.000	0
Zn	4.609	919
Zr	0.105	21

KK Solids		Lab ID
Aqua Regia Extr		KK102
Sample Weight		**0.5014**
Sample Volume		**100**
Massa / liter		**5.014**
Element	**mg/l**	**mg/kg**
Ag	1.062	212
Al	4.098	817
As	0.043	9
B	4.552	908
Ba	6.968	1390
Be	0.000	0
Bi	0.000	0
Ca	43.840	8744
Cd	0.004	1
Co	0.001	0
Cr	0.014	3
Cu	0.098	20
Fe	56.320	11233
K	6.543	1305
Li	0.033	7
Mg	10.420	2078
Mn	0.362	72
Mo	0.000	0
Na	28.640	5712
Ni	0.028	6
P	0.000	0
Pb	0.058	12
Sb	0.105	21
Se	0.168	34
Si	1.177	235
Sn	0.000	0
Sr	1.385	276
Ti	1.001	200
V	0.024	5
W	0.000	0
Zn	6.479	1292
Zr	0.009	2

KK Solids		Lab ID
Aqua Regia Extr		KK104
Sample Weight		**0.5014**
Sample Volume		**100**
Massa / liter		**5.014**
Element	**mg/l**	**mg/kg**
Ag	0.115	23
Al	23.160	4619
As	0.043	9
B	4.144	826
Ba	7.317	1459
Be	0.000	0
Bi	0.000	0
Ca	66.800	13323
Cd	0.006	1
Co	0.009	2
Cr	0.052	10
Cu	0.126	25
Fe	35.760	7132
K	10.360	2066
Li	0.000	0
Mg	9.054	1806
Mn	0.492	98
Mo	0.000	0
Na	29.130	5810
Ni	0.038	8
P	3.929	784
Pb	0.065	13
Sb	0.078	16
Se	0.180	36
Si	1.267	253
Sn	0.000	0
Sr	1.681	335
Ti	0.068	14
V	0.021	4
W	0.000	0
Zn	4.235	845
Zr	0.050	10

KK Solids		Lab ID
Aqua Regia Extr		KK105
Sample Weight		**0.5014**
Sample Volume		**100**
Massa / liter		**5.014**
Element	**mg/l**	**mg/kg**
Ag	0.752	150
Al	12.640	2521
As	0.044	9
B	3.958	789
Ba	6.453	1287
Be	0.000	0
Bi	0.000	0
Ca	69.600	13881
Cd	0.004	1
Co	0.011	2
Cr	0.054	11
Cu	0.124	25
Fe	47.920	9557
K	9.650	1925
Li	0.000	0
Mg	8.102	1616
Mn	0.376	75
Mo	0.000	0
Na	31.870	6356
Ni	0.087	17
P	5.941	1185
Pb	0.115	23
Sb	0.170	34
Se	0.208	41
Si	1.767	352
Sn	0.000	0
Sr	2.327	464
Ti	0.662	132
V	0.057	11
W	0.000	0
Zn	5.337	1064
Zr	0.118	24

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WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK101

Chemical Parameter (mg/l)	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Sample ID	9647	9651	9655	9659
pH	4.5	6.4	7.2	7.7
Electrical Conductivity (mS/m)	188.0	139.0	107.0	72.4
Total Alkalinity as $CaCO_3$	<5	12	80	88
Ammonia-N	0.6	1.4	0.9	0.6
Nitrate-N	<0.2	<0.2	<0.2	<0.2
Chloride-Cl	20	17	12	9
Sulphate-SO_4	896	704	333	182
Fluoride-F				

Sample mass (g)	1000	1000	1000	1000
Volume Leached (ml)	750	750	750	750
Water Sample Mass + Bottle (g)	725.55	770.39	734.64	728.49
Receiving Bottle Mass (g)	97.32	97.32	97.32	97.32
Leachate Sample Mass (g)	628.23	673.07	637.32	631.17

ICP-MS Scan (mg/l) Sample ID	WEEK 1	WEEK 2	WEEK 3	WEEK 4
	9647	9651	9655	9659
Silver-Ag	0.010	0.002	0.001	0.000
Aluminium-Al	0.195	0.130	0.145	0.038
Arsenic-As	0.000	0.000	0.000	0.000
Boron-B	0.030	0.037	0.027	0.025
Barium-Ba	0.114	0.105	0.102	0.109
Beryllium-Be	0.002	0.005	0.004	0.002
Bismuth-Bi	0.002	0.000	0.000	0.000
Calcium-Ca	152.8	149.4	120.6	74.43
Cadmium-Cd	0.000	0.000	0.001	0.001
Cobalt-Co	0.423	0.295	0.166	0.086
Chromium-Cr	0.000	0.000	0.000	0.000
Copper-Cu	0.000	0.000	0.001	0.002
Iron-Fe	123.5	24.12	5.168	0.380
Potassium-K	5.206	4.459	3.757	2.760
Lithium-Li	0.036	0.030	0.022	0.013
Magnesium-Mg	28.16	23.05	19.48	12.21
Manganese-Mn	1.373	1.185	0.804	0.481
Molybdenum-Mo	0.000	0.000	0.000	0.000
Sodium-Na	176.5	129.0	99.44	56.06
Nickel-Ni	1.193	0.755	0.413	0.217
Phosphorous-P	0.128	0.035	0.040	0.014
Lead-Pb	0.024	0.011	0.004	0.007
Sulphur-S	159.2	101.7	64.17	33.20
Antimony-Sb	0.006	0.005	0.002	0.003
Selenium-Se	0.016	0.002	0.000	0.000
Silicon-Si	0.313	0.286	0.298	0.703
Tin-Sn	0.000	0.000	0.000	0.003
Stronsium-Sr	3.877	3.822	3.335	2.190
Titanium-Ti	0.000	0.000	0.000	0.000
Vanadium-V	0.004	0.002	0.001	0.001
Wolfram-W	0.269	0.247	0.154	0.088
Zinc-Zn	7.974	5.234	2.827	1.437
Zirconium-Zr	0.007	0.001	0.000	0.000

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WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK101

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9663	9667	9671	9675	9679	9683
7.5	7.5	7.9	7.6	7.7	7.6
79.5	50.6	39.0	42.7	33.1	30.6
112	96	88	76	76	80
0.4	0.3	0.3	0.2	0.2	0.2
<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
15	8	6	11	7	7
251	146	87	103	79	63

1000	1000	1000	1000	1000	1000
750	750	750	750	750	750
756.09	775.75	737.06	759.94	642.77	739.69
97.32	97.32	97.32	97.32	97.32	97.32
658.77	678.43	639.74	662.62	545.45	642.37

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9663	9667	9671	9675	9679	9683
0.000	0.000	0.000	0.000	0.000	0.000
0.037	0.053	0.037	0.071	0.066	0.083
0.003	0.000	0.001	0.003	0.003	0.000
0.032	0.026	0.024	0.024	0.021	0.036
0.070	0.106	0.102	0.074	0.097	0.099
0.003	0.003	0.003	0.002	0.003	0.001
0.001	0.002	0.003	0.000	0.000	0.004
83.61	59.60	46.44	54.54	46.43	41.41
0.000	0.000	0.000	0.000	0.000	0.000
0.066	0.042	0.028	0.024	0.019	0.012
0.000	0.000	0.000	0.000	0.000	0.000
0.001	0.000	0.000	0.000	0.002	0.001
0.065	0.232	0.090	0.369	0.413	0.610
2.737	2.115	1.737	1.881	1.640	1.568
0.013	0.009	0.005	0.005	0.004	0.003
14.75	9.646	7.320	9.142	7.320	7.088
0.433	0.300	0.228	0.227	0.181	0.159
0.002	0.001	0.002	0.001	0.001	0.002
59.38	31.16	17.50	19.06	12.12	7.917
0.151	0.098	0.066	0.055	0.041	0.030
0.009	0.022	0.011	0.036	0.025	0.030
0.004	0.004	0.003	0.003	0.002	0.005
34.29	17.46	11.65	15.07	9.184	7.474
0.003	0.002	0.004	0.004	0.005	0.005
0.001	0.000	0.002	0.000	0.000	0.000
0.980	1.052	0.988	1.173	0.969	1.184
0.006	0.004	0.006	0.004	0.001	0.004
2.594	1.848	1.537	1.844	1.559	1.497
0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.001	0.001	0.001
0.076	0.050	0.032	0.034	0.021	0.013
1.253	0.831	0.517	0.461	0.334	0.253
0.000	0.000	0.000	0.000	0.000	0.000

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WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK102

Chemical Parameter (mg/l)	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Sample ID	9648	9652	9656	9660
pH	4.2	6.2	7.2	7.7
Electrical Conductivity (mS/m)	367.0	144.0	95.6	67.8
Total Alkalinity as $CaCO_3$	<5	16	72	76
Ammonia-N	0.6	0.7	0.4	0.2
Nitrate-N	<0.2	<0.2	<0.2	<0.2
Chloride-Cl	54	23	10	7
Sulphate-SO_4	2010	768	399	227
Fluoride-F				

Sample mass (g)	1000	1000	1000	1000
Volume Leached (ml)	750	750	750	750
Water Sample Mass + Bottle (g)	789.46	774.85	755.47	767.72
Receiving Bottle Mass (g)	113.85	113.85	113.85	113.85
Leachate Sample Mass (g)	675.61	661	641.62	653.87

ICP-MS Scan (mg/l)	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Sample ID	9648	9652	9656	9660
Silver-Ag	0.035	0.003	0.002	0.001
Aluminium-Al	1.279	0.398	0.555	0.101
Arsenic-As	0.000	0.000	0.000	0.000
Boron-B	0.082	0.060	0.041	0.038
Barium-Ba	0.067	0.114	0.128	0.128
Beryllium-Be	0.003	0.004	0.002	0.002
Bismuth-Bi	0.007	0.001	0.000	0.005
Calcium-Ca	385.8	218.6	138.2	96.77
Cadmium-Cd	0.000	0.000	0.001	0.000
Cobalt-Co	0.870	0.226	0.087	0.046
Chromium-Cr	0.000	0.000	0.000	0.000
Copper-Cu	0.009	0.004	0.007	0.001
Iron-Fe	335.0	27.67	10.55	1.541
Potassium-K	6.013	2.871	1.976	1.441
Lithium-Li	0.032	0.014	0.007	0.004
Magnesium-Mg	125.7	50.33	24.74	14.71
Manganese-Mn	4.158	1.205	0.550	0.307
Molybdenum-Mo	0.000	0.000	0.000	0.000
Sodium-Na	148.6	56.46	28.79	16.50
Nickel-Ni	2.803	0.610	0.237	0.119
Phosphorous-P	0.488	0.172	0.217	0.041
Lead-Pb	0.084	0.009	0.008	0.011
Sulphur-S	346.8	123.8	58.30	32.82
Antimony-Sb	0.016	0.004	0.006	0.000
Selenium-Se	0.064	0.000	0.000	0.000
Silicon-Si	0.647	0.343	0.332	0.632
Tin-Sn	0.000	0.000	0.000	0.008
Stronsium-Sr	8.712	5.174	4.019	3.086
Titanium-Ti	0.000	0.000	0.000	0.000
Vanadium-V	0.013	0.002	0.002	0.001
Wolfram-W	0.450	0.221	0.081	0.046
Zinc-Zn	32.40	7.628	2.358	0.981
Zirconium-Zr	0.024	0.002	0.001	0.000

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WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK102

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9664	9668	9672	9676	9680	9684
7.6	7.7	7.9	7.7	7.7	7.7
84.1	33.5	28.7	39.6	19.7	17.5
64	56	56	52	40	44
0.2	<0.2	<0.2	<0.2	<0.2	<0.2
<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
15	5	5	9	<5	<5
329	107	72	125	42	34

1000	1000	1000	1000	1000	1000
750	750	750	750	750	750
810.23	775.98	733.92	782.31	669.72	716.53
113.85	113.85	113.85	113.85	113.85	113.85
696.38	662.13	620.07	668.46	555.87	602.68

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9664	9668	9672	9676	9680	9684
0.001	0.000	0.001	0.000	0.001	0.000
0.161	0.136	0.162	0.150	0.106	0.188
0.000	0.001	0.000	0.001	0.000	0.000
0.059	0.041	0.035	0.046	0.029	0.044
0.090	0.143	0.155	0.115	0.114	0.139
0.004	0.004	0.003	0.004	0.003	0.001
0.000	0.002	0.000	0.004	0.005	0.002
112.2	44.15	34.13	50.96	22.72	21.74
0.001	0.000	0.000	0.001	0.000	0.000
0.031	0.010	0.006	0.007	0.003	0.003
0.000	0.000	0.000	0.000	0.000	0.000
0.002	0.002	0.002	0.003	0.002	0.003
1.951	1.903	2.316	2.077	1.429	3.153
1.637	0.940	0.818	0.973	0.563	0.560
0.007	0.003	0.002	0.003	0.001	0.001
25.02	8.835	7.213	11.94	5.100	4.965
0.300	0.112	0.079	0.091	0.042	0.041
0.000	0.000	0.000	0.000	0.000	0.000
33.45	11.15	8.389	13.42	5.118	4.108
0.082	0.027	0.018	0.019	0.009	0.011
0.072	0.076	0.082	0.064	0.040	0.104
0.007	0.004	0.004	0.007	0.004	0.006
44.55	12.98	9.026	15.06	4.398	3.567
0.002	0.003	0.002	0.002	0.006	0.004
0.000	0.000	0.002	0.000	0.002	0.000
0.698	0.707	0.613	0.673	0.581	0.888
0.001	0.000	0.000	0.000	0.000	0.000
3.454	1.731	1.381	1.877	0.902	0.842
0.000	0.000	0.000	0.000	0.000	0.000
0.001	0.001	0.001	0.001	0.001	0.001
0.032	0.011	0.009	0.011	0.003	0.000
0.545	0.222	0.157	0.150	0.084	0.136
0.001	0.001	0.000	0.000	0.000	0.000

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WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK104

Chemical Parameter (mg/l)	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Sample ID	9649	9653	9657	9661
pH	7.5	7.6	7.7	7.8
Electrical Conductivity (mS/m)	53.4	32.7	19.1	13.6
Total Alkalinity as $CaCO_3$	44	44	52	40
Ammonia-N	0.8	0.5	0.4	0.3
Nitrate-N	<0.2	<0.2	<0.2	<0.2
Chloride-Cl	80	42	15	7
Sulphate-SO_4	100	39	21	13
Fluoride-F				

Sample mass (g)	1000	1000	1000	1000
Volume Leached (ml)	750	750	750	750
Water Sample Mass + Bottle (g)	719.41	825.41	754.15	760.77
Receiving Bottle Mass (g)	93.39	93.39	93.39	93.39
Leachate Sample Mass (g)	626.02	732.02	660.76	667.38

ICP-MS Scan (mg/l)	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Sample ID	9649	9653	9657	9661
Silver-Ag	0.001	0.001	0.000	0.000
Aluminium-Al	0.658	0.439	0.465	0.104
Arsenic-As	0.003	0.000	0.002	0.000
Boron-B	0.004	0.002	0.000	0.009
Barium-Ba	0.451	0.484	0.413	0.280
Beryllium-Be	0.003	0.004	0.002	0.002
Bismuth-Bi	0.003	0.004	0.001	0.000
Calcium-Ca	62.95	41.87	25.90	15.03
Cadmium-Cd	0.001	0.001	0.001	0.000
Cobalt-Co	0.018	0.010	0.006	0.002
Chromium-Cr	0.000	0.000	0.000	0.000
Copper-Cu	0.004	0.002	0.002	0.000
Iron-Fe	2.030	1.355	1.481	0.278
Potassium-K	4.729	3.518	2.525	2.023
Lithium-Li	0.015	0.009	0.005	0.002
Magnesium-Mg	13.88	8.802	4.783	3.044
Manganese-Mn	0.206	0.147	0.112	0.051
Molybdenum-Mo	0.008	0.005	0.004	0.004
Sodium-Na	15.81	9.679	4.665	2.410
Nickel-Ni	0.034	0.019	0.010	0.006
Phosphorous-P	0.159	0.093	0.127	0.038
Lead-Pb	0.011	0.004	0.010	0.007
Sulphur-S	13.79	7.636	2.773	1.585
Antimony-Sb	0.005	0.004	0.003	0.003
Selenium-Se	0.009	0.000	0.000	0.000
Silicon-Si	1.815	1.462	1.342	1.355
Tin-Sn	0.009	0.004	0.000	0.000
Stronsium-Sr	3.927	2.488	1.426	0.978
Titanium-Ti	0.000	0.000	0.000	0.000
Vanadium-V	0.001	0.001	0.001	0.001
Wolfram-W	0.022	0.015	0.005	0.003
Zinc-Zn	0.917	0.520	0.355	0.103
Zirconium-Zr	0.001	0.001	0.001	0.000

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WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK104

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9665	9669	9673	9677	9681	9685
7.7	7.8	7.9	7.5	7.7	7.7
18.8	11.4	11.5	14.2	9.8	9.3
48	40	44	44	40	36
0.3	0.3	0.3	0.3	0.3	0.2
<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
16	5	5	9	<5	<5
15	7	7	11	<5	<5

1000	1000	1000	1000	1000	1000
750	750	750	750	750	750
805.9	760.27	730.92	788.51	672.87	724.9
93.39	93.39	93.39	93.39	93.39	93.39
712.51	666.88	637.53	695.12	579.48	631.51

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9665	9669	9673	9677	9681	9685
0.000	0.000	0.000	0.000	0.000	0.001
0.160	0.128	0.223	0.146	0.172	0.168
0.001	0.001	0.000	0.002	0.004	0.002
0.011	0.013	0.011	0.011	0.011	0.027
0.326	0.249	0.279	0.293	0.231	0.218
0.002	0.003	0.003	0.002	0.003	0.002
0.001	0.000	0.002	0.003	0.003	0.002
21.09	15.06	14.75	16.74	12.45	12.19
0.000	0.000	0.000	0.001	0.000	0.000
0.003	0.002	0.002	0.002	0.002	0.001
0.000	0.000	0.000	0.000	0.000	0.000
0.001	0.000	0.001	0.001	0.005	0.001
0.452	0.380	0.714	0.435	0.502	0.551
2.509	1.874	1.939	1.973	1.664	1.587
0.005	0.002	0.002	0.002	0.001	0.001
5.182	3.154	3.096	3.926	2.748	2.772
0.067	0.047	0.055	0.052	0.042	0.042
0.007	0.004	0.002	0.004	0.002	0.001
3.790	1.631	1.354	1.618	0.896	0.757
0.006	0.002	0.004	0.005	0.004	0.004
0.042	0.036	0.066	0.034	0.053	0.040
0.005	0.005	0.008	0.005	0.005	0.003
2.242	0.973	0.925	1.436	0.560	0.406
0.005	0.002	0.000	0.005	0.005	0.003
0.001	0.001	0.000	0.002	0.000	0.000
1.749	1.592	1.678	1.646	1.532	1.907
0.000	0.000	0.000	0.005	0.004	0.005
1.463	0.927	0.950	1.144	0.817	0.795
0.000	0.000	0.000	0.000	0.000	0.000
0.001	0.001	0.001	0.001	0.001	0.001
0.009	0.003	0.011	0.006	0.003	0.004
0.142	0.096	0.133	0.097	0.099	0.096
0.000	0.000	0.000	0.000	0.000	0.000

Att: Mr. A. Stoll : ERM
Humidty Cells

WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK105

Chemical Parameter (mg/l)	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Sample ID	9650	9654	9658	9662
pH	4.2	5.1	6.2	7.1
Electrical Conductivity (mS/m)	464.0	243.0	170.0	114.0
Total Alkalinity as $CaCO_3$	<5	<5	<5	20
Ammonia-N	0.9	0.9	0.8	0.5
Nitrate-N	<0.2	0.3	<0.2	<0.2
Chloride-Cl	41	22	12	7
Sulphate-SO_4	2394	1332	856	373
Fluoride-F				

Sample mass (g)	1000	1000	1000	1000
Volume Leached (ml)	750	750	750	750
Water Sample Mass + Bottle (g)	701.22	715.9	730.04	752.73
Receiving Bottle Mass (g)	93.33	93.33	93.33	93.33
Leachate Sample Mass (g)	607.89	622.57	636.71	659.4

ICP-MS Scan (mg/l)	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Sample ID	9650	9654	9658	9662
Silver-Ag	0.044	0.010	0.004	0.000
Aluminium-Al	4.375	0.838	0.788	0.032
Arsenic-As	0.000	0.000	0.000	0.000
Boron-B	0	0.007	0.009	0.013
Barium-Ba	0.035	0.050	0.057	0.068
Beryllium-Be	0.013	0.006	0.004	0.003
Bismuth-Bi	0.011	0.001	0.000	0.000
Calcium-Ca	292.0	225.1	169.9	136.3
Cadmium-Cd	0.000	0.000	0.000	0.000
Cobalt-Co	1.370	0.615	0.328	0.183
Chromium-Cr	0.000	0.000	0.000	0.000
Copper-Cu	0.030	0.005	0.005	0.000
Iron-Fe	423.1	99.11	27.60	2.572
Potassium-K	7.549	5.021	3.959	3.157
Lithium-Li	0.125	0.067	0.040	0.022
Magnesium-Mg	114.1	63.50	38.03	23.95
Manganese-Mn	5.911	2.760	1.585	0.986
Molybdenum-Mo	0.000	0.000	0.000	0.000
Sodium-Na	490.9	251.9	137.7	64.37
Nickel-Ni	3.558	1.322	0.674	0.385
Phosphorous-P	0.578	0.155	0.118	0.018
Lead-Pb	0.109	0.031	0.014	0.003
Sulphur-S	470.6	212.0	120.0	72.07
Antimony-Sb	0.019	0.006	0.003	0.003
Selenium-Se	0.096	0.015	0.006	0.004
Silicon-Si	1.505	0.851	0.872	0.858
Tin-Sn	0.000	0.000	0.000	0.004
Stronsium-Sr	6.835	6.032	5.055	4.172
Titanium-Ti	0.000	0.000	0.000	0.000
Vanadium-V	0.023	0.006	0.004	0.000
Wolfram-W	0.958	0.515	0.339	0.189
Zinc-Zn	55.92	25.09	12.31	6.845
Zirconium-Zr	0.029	0.007	0.002	0.000

Att: Mr. A. Stoll : ERM
Humidty Cells

WEEKS : 1-10
Report : 31462

HUMIDITY CELL SAMPLE: KK105

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9666	9670	9674	9678	9682	9686
7.2	7.2	7.4	7.0	7.3	7.4
130.0	84.9	67.7	71.5	44.9	30.7
60	48	48	48	36	44
0.5	0.4	0.3	0.3	0.2	0.2
<0.2	<0.2	0.2	<0.2	<0.2	<0.2
16	<5	<5	8	<5	<5
637	341	239	259	156	106

1000	1000	1000	1000	1000	1000
750	750	750	750	750	750
781.22	745.86	711.22	786.12	634.8	721.07
93.33	93.33	93.33	93.33	93.33	93.33
687.89	652.53	617.89	692.79	541.47	627.74

WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
9666	9670	9674	9678	9682	9686
0.005	0.001	0.001	0.001	0.001	0.001
0.354	0.177	0.368	0.204	0.292	0.412
0.001	0.003	0.001	0.000	0.000	0.000
0.015	0.012	0.012	0.012	0.011	0.027
0.069	0.089	0.102	0.078	0.119	0.166
0.003	0.003	0.003	0.003	0.003	0.002
0.000	0.001	0.000	0.000	0.000	0.001
166.7	126.0	102.8	108.7	68.12	44.78
0.000	0.000	0.000	0.000	0.000	0.000
0.162	0.089	0.059	0.050	0.028	0.016
0.001	0.000	0.000	0.000	0.000	0.000
0.002	0.001	0.002	0.001	0.002	0.003
1.828	1.090	2.425	1.115	1.781	2.991
3.881	2.920	2.986	2.934	2.183	1.980
0.025	0.011	0.010	0.009	0.005	0.005
30.75	16.90	12.80	13.40	7.066	4.445
1.074	0.614	0.423	0.398	0.226	0.140
0.000	0.000	0.000	0.001	0.000	0.000
73.10	23.45	16.10	16.39	6.353	3.448
0.308	0.174	0.120	0.090	0.054	0.031
0.033	0.038	0.051	0.021	0.031	0.057
0.008	0.005	0.010	0.007	0.010	0.011
76.66	47.43	32.52	32.71	18.44	10.35
0.003	0.004	0.006	0.003	0.002	0.004
0.007	0.000	0.000	0.000	0.000	0.000
1.225	1.007	1.004	1.056	1.036	1.495
0.007	0.003	0.006	0.003	0.000	0.001
4.848	3.728	3.296	3.514	2.391	1.736
0.000	0.000	0.000	0.000	0.000	0.000
0.001	0.001	0.002	0.001	0.001	0.002
0.164	0.094	0.067	0.054	0.029	0.017
4.320	2.594	1.679	1.239	0.767	0.557
0.001	0.001	0.001	0.000	0.000	0.001

XRD Results

Sample : KK101

Mineral	Composition (%)	Error (%)
Calcite	7.03	1.44
Dolomite	17.93	1.92
Kaolinite	41.51	2.46
Pyrite	4.78	0.96
Quartz	26.6	2.55
Rutile	2.15	0.78
Total	100	

Mineral	Carbonaceous Included (%)	Error (%)
Calcite	1.77	0.3
Dolomite	4.01	0.51
Carbonaceous	73.35	1.95
Kaolinite	13.06	0.96
Pyrite	1.35	0.17
Quartz	6.31	0.63
Rutile	0.14	0.16
Total	99.99	

Sample : KK102

Mineral	Composition (%)	Error (%)
Calcite	10.16	1.53
Dolomite	16.48	1.8
Kaolinite	29.83	2.43
Pyrite	1.29	0.72
Quartz	40.65	2.7
Rutile	1.58	0.78
Total	99.99	

Mineral	Carbonaceous Included (%)	Error (%)
Calcite	1.68	0.29
Dolomite	3.43	0.39
Carbonaceous	75.87	1.47
Kaolinite	9	0.63
Pyrite	0.8	0.13
Quartz	9.14	0.66
Rutile	0.09	0.1
Total	100.01	

Sample : KK104

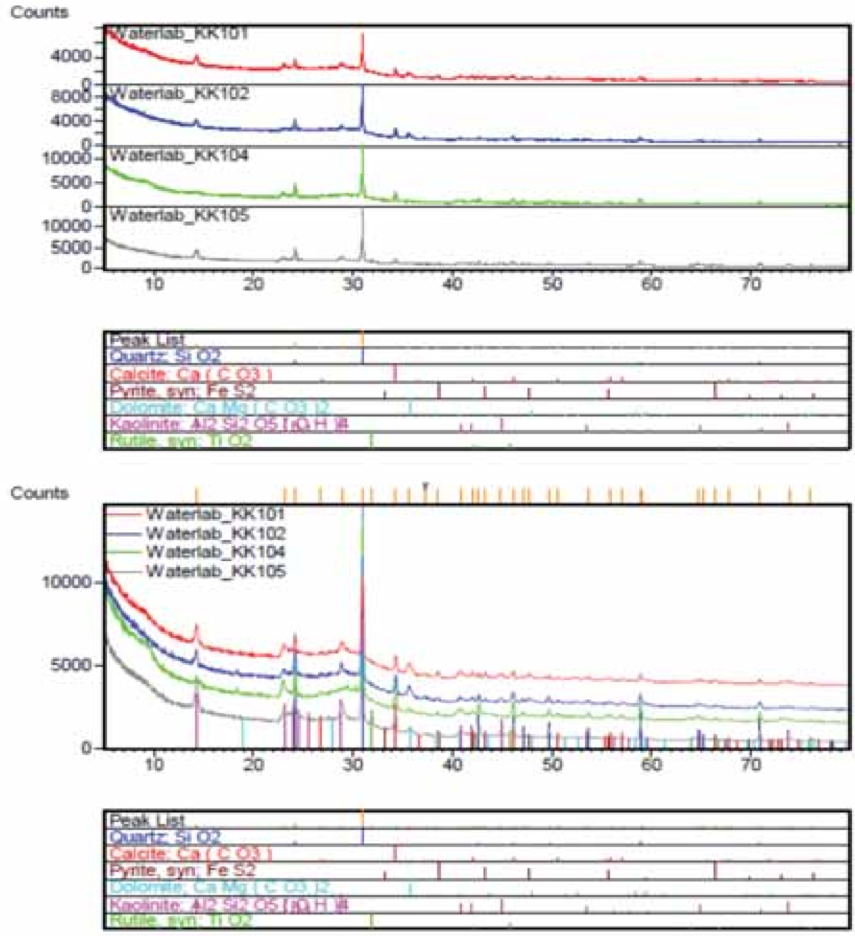
Mineral	Composition (%)	Error (%)
Calcite	12.8	1.65
Dolomite	0	0
Kaolinite	28.7	3.6
Pyrite	1.97	0.96
Quartz	53.2	3.3
Rutile	3.33	1.05
Total	100	

Mineral	Carbonaceous Included (%)	Error (%)
Calcite	3.34	0.39
Dolomite	0.49	0.27
Carbonaceous	76	1.44
Kaolinite	6.19	0.48
Pyrite	0.67	0.13
Quartz	13.03	0.87
Rutile	0.29	0.19
Total	100.01	

Sample : KK105

Mineral	Composition (%)	Error (%)
Calcite	7.37	1.02
Dolomite	4.09	1.26
Kaolinite	37.14	1.86
Pyrite	3.57	0.57
Quartz	45.01	1.92
Rutile	2.81	0.84
Total	99.99	

Mineral	Carbonaceous Included (%)	Error (%)
Calcite	2.97	0.42
Dolomite	2.36	0.51
Carbonaceous	58.9	3.3
Kaolinite	16	1.29
Pyrite	1.26	0.19
Quartz	17.82	1.47
Rutile	0.71	0.22
Total	100.02	



Counts
Waterlab_KK101
Waterlab_KK102
Waterlab_KK104
Waterlab_KK105
Peak List
Quartz; Si O2
Calcite; Ca (C O3)
Pyrite, syn; Fe S2
Dolomite; Ca Mg (C O3)2
Kaolinite; Al2 Si2 O5 (O H)4
Rutile, syn; Ti O2

CLIENT: Waterlab (Dr Louis de Wet)

DATE: 22 September 2011

SAMPLES: 4 Samples (Order No WL 6407)

ANALYSIS: Qualitative and quantitative XRD

After splitting and milling, the samples were prepared for XRD analysis using a back loading preparation method.
They were analysed with a PANalytical X'Pert Pro powder diffractometer with X'Celerator detector and variable divergence- and fixed receiving slits with Fe filtered Co-Kα radiation. The phases were identified using X'Pert Highscore plus software.
The relative phase amounts (weight %) were estimated using the Rietveld method (Autoquan program). Errors are on the 3 sigma level in the column to the right of the amount (in weight per cent).

Comment:

- In case the results do not correspond to results of other analytical techniques, please let me know for further fine tuning of XRD results.
- Errors reported for phases occurring in minor amounts are sometimes larger than that of the quantity reported, indicating the possible absence of those phases.
- Due to preferred orientation effects results may not be as accurate as shown in the table.
- Samples may contain some smectite
- All samples seem to be coal samples and an rough approximation of the carbonateous material was made in the second column of each analysis
- Amorphous phases, if present, were not taken into account in the quantification.

If you have any further queries, kindly contact me.

Verryn.

Dr. Sabine Verryn (Pr.Sci.Nat)

Results of major (wt%) and trace (ppm) elements analysed by X-ray fluorescence spectrometry

12/76 is a secondary amphibolite reference material
while GSS-1 is a soil reference material from IGGE, China.

Sample	KK101	KK102	KK104	KK105
SiO_2	9.39	8.15	15.60	22.73
TiO_2	0.22	0.23	0.40	0.35
Al_2O_3	4.35	2.64	4.67	6.84
Fe_2O_3(t)	1.42	1.06	1.03	1.65
MnO	0.010	0.009	0.010	0.009
MgO	0.47	0.44	0.39	0.42
CaO	1.82	1.81	1.99	2.32
Na_2O	0.14	0.14	0.19	0.30
K_2O	0.24	0.13	0.26	0.59
P_2O_5	0.151	0.149	0.096	0.148
CoO	0.002	0.002	0.002	0.003
Cr_2O_3	0.004	0.004	0.007	0.010
CuO	0.002	0.001	0.002	0.001
NiO	<0.001	0.001	0.001	0.002
PbO	<0.001	<0.001	<0.001	<0.001
SO_3	0.008	0.027	0.041	0.050
V_2O_5	0.009	0.006	0.010	0.010
L.O.I.	82.00	85.04	74.84	64.37
Total	100.23	99.84	99.55	99.79
H_2O^-	2.56	3.85	2.25	2.69

	KK101	KK102	KK104	KK105
	mg/kg	mg/kg	mg/kg	mg/kg
Si	43895.287	38092.262	72938.094	106234.09
Ti	1295.1783	1357.8876	2422.4625	2068.0234
Al	11507.424	6990.7286	12365.649	18093.388
Fe	4971.4818	3700.2675	3590.1501	5753.537
Mn	79.517189	66.060287	79.890871	72.821192
Mg	2813.7526	2656.7878	2332.6298	2549.5606
Ca	12998.794	12910.925	14206.626	16594.6
Na	519.6094	531.67889	717.00782	1097.7179
K	977.85034	548.00339	1089.2741	2453.4764
P	329.73771	324.71026	208.64533	322.16116
Co	14.524659	13.781276	14.894752	21.058538
Cr	14.975861	12.347712	22.585642	33.901267
Cu	12.22193	8.9589799	14.372954	10.695163
Ni	#VALUE!	6.3890031	9.5492321	13.859944
Pb	#VALUE!	#VALUE!	#VALUE!	#VALUE!
S (after LOI)	30.205613	108.4586	162.8289	198.93064
V	25.630889	17.668064	29.350611	28.03339

	KK101	KK102	KK104	KK105
As	<4	<4	12	<4
Ba	434	336	647	435
Bi	<3	<3	<3	<3
Br	5.6	7.3	1 258	2.4
Ce	34	38	46	47
Co	3.8	5.9	6.8	7.7
Cr	35	33	54	73
Cs	<5	<5	<5	<5
Cu	2.9	2.8	6.1	5.1
Ga	8.5	5.9	9.0	9.8
Ge	2.1	2.1	1.6	1.3
Hf	4.7	<3	4.5	5.7
La	23	26	34	34
Mo	<2	<2	<2	<2
Nb	5.2	5.0	8.1	7.8
Nd	17	16	24	23
Ni	5.0	11	13	18
Pb	7.9	7.7	9.0	15
Rb	11	6.7	14	22
Sc	7.0	4.6	7.6	6.9
Se	<1	<1	<1	<1
Sm	<10	<10	<10	<10
Sr	468	482	425	551
Ta	<2	<2	<2	<2
Th	4.8	3.9	7.1	6.2
Tl	<3	<3	<3	<3
U	<2	<2	<2	<2
V	33	20	34	31
W	<3	<3	<3	<3
Y	17	13	21	18
Yb	<3	<3	<3	<3
Zn	92	114	42	181
Zr	74	62	112	163

Annex I

Regional Numerical Groundwater Flow Model – Technical Report

I1 REGIONAL STEADY STATE GROUNDWATER FLOW MODEL

I1.1 MODEL SETUP

This section details the setup of the regional groundwater flow model.

I1.1.1 *Model Domain and Boundary Conditions*

The regional model domain was agreed on with the client to include existing mining areas and the planned Kusipongo expansion as well as future project expansions.

The model domain extends from the Vaal River in the north-west to the Heyshope dam in the east. The southern model boundary is located approximately 10km north of the town of Wakkerstrom (*Figure 1.1*). The total model area is approximately 3,100km^2 (310,000ha).

The model boundaries were chosen in order to centralise the area of interest and follow real hydrogeological and hydrological boundaries. Quaternary catchment [(1)] boundaries were followed as well as dams and major rivers.

The following boundary conditions were selected for the model domain (*Figure* 1.2):

- *Constant head boundary* condition (1st order) along the Vaal River in the north-west;
- *Constant head boundary* condition (1st order) along the Morgenstond Dam in the north-east;
- *Constant head boundary* condition (1st order) along the Heyshope Dam in the east;
- *Outflow boundary* condition (2nd order or Neumann Boundary) simulated using the well package where the Hlelo Stream leaves the model area in the east; and
- *No flow boundary* condition (2nd order or Neumann Boundary) along the rest of the model boundary simulating water sheds.

(1) [1] http://www4.dwaf.gov.za/wma/

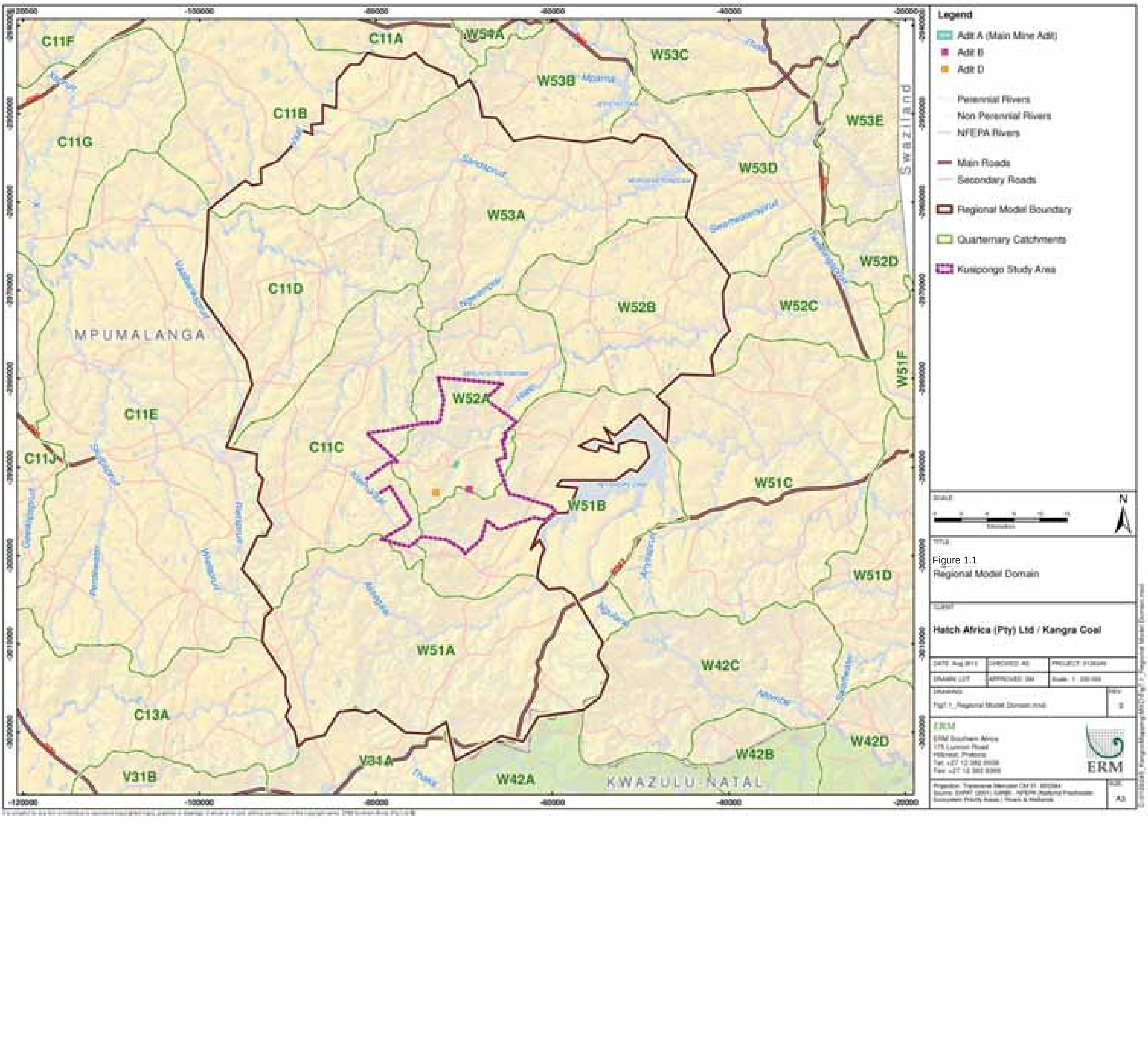


Figure 1.1
Regional Model Domain

Figure 1.2 Boundary Conditions Regional Model

I1.1.2 Discretization

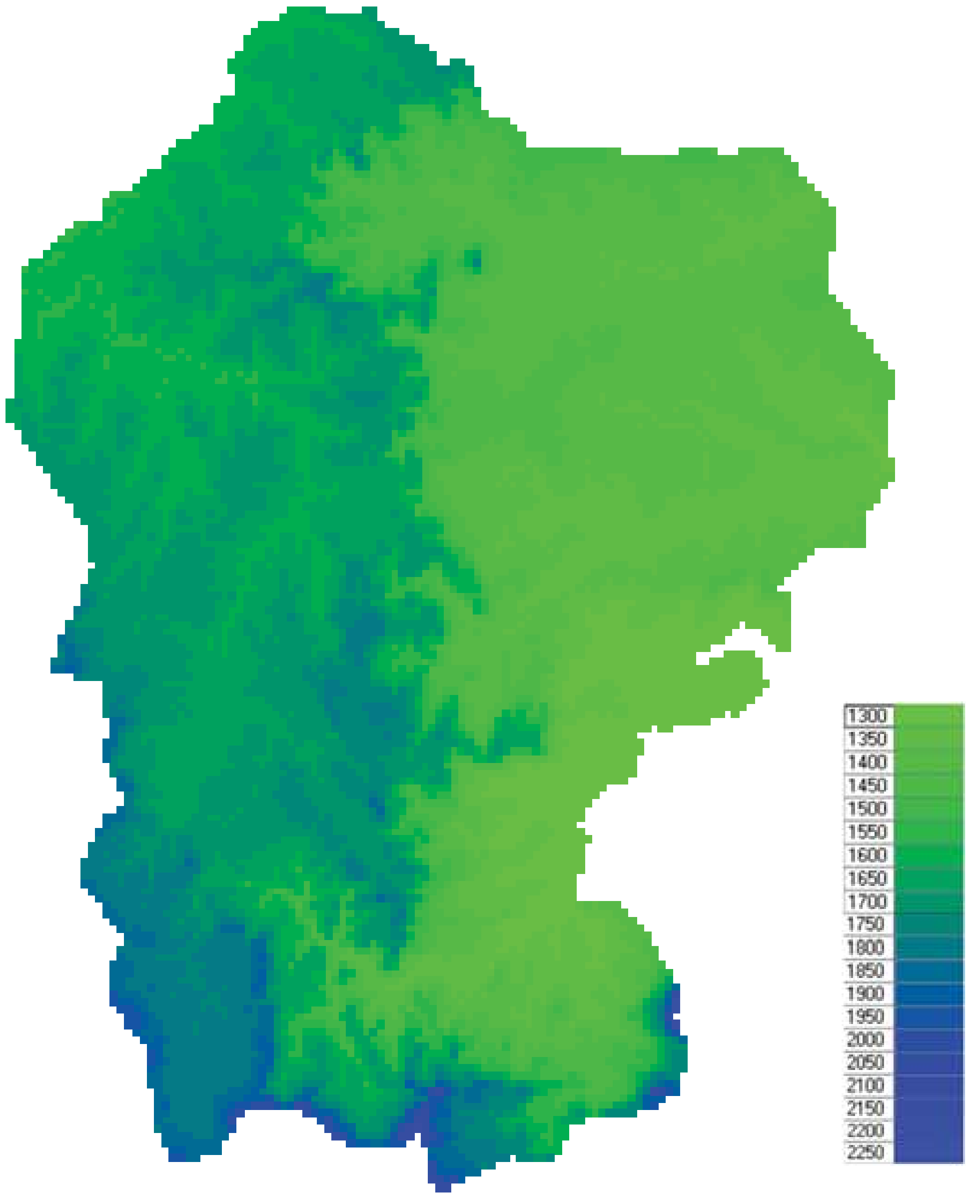
The numerical simulation of groundwater flow and transport by a block-centred finite difference method requires a spatial discretization of the aquifer parameters across a rectangular grid that can be orientated to correspond to the general flow direction. The cell size in the regional groundwater flow model grid is 500m in both horizontal and vertical directions (north / south and west / east).

I1.1.3 Model Top, Bottom and Aquifer Thickness

Topography data was available in the Kusipongo Reserve at an accuracy of 2m and in the rest of the model domain at an accuracy of 20m. The data was provided by the NGI (Chief Directorate National Geo-Spatial Information). The data was combined and interpolated to the model grid using surfer (version 9.x). The topography elevation ranges roughly from 1,300 to 2,250mamsl (*Figure 1.3*).

Due to the lack of data pertaining to the base of the modelled aquifer (no boreholes drilled to intersect the base), a flat model base was chosen at 1250mamsl, which is 50m deeper than the topographically lowest point within the model domain.

Figure 1.3 Regional Model Topography



I1.1.4 Aquifer Type

Detailed geological data (dolerite sills) was only available in the Kusipongo Reserve area. However, the Kusipongo Reserve only represents 4% of the total model domain area. Therefore the different aquifers were modelled as one layer.

The one layer approach assumes hydraulic continuity between the various aquifers within the model area. The aquifer was modelled as a confined aquifer for steady state conditions. The aquifers modelled include the alluvial water bearing horizons along rivers/streams, the weathered and the fractured rock water bearing horizons present mostly in the Karoo sediments.

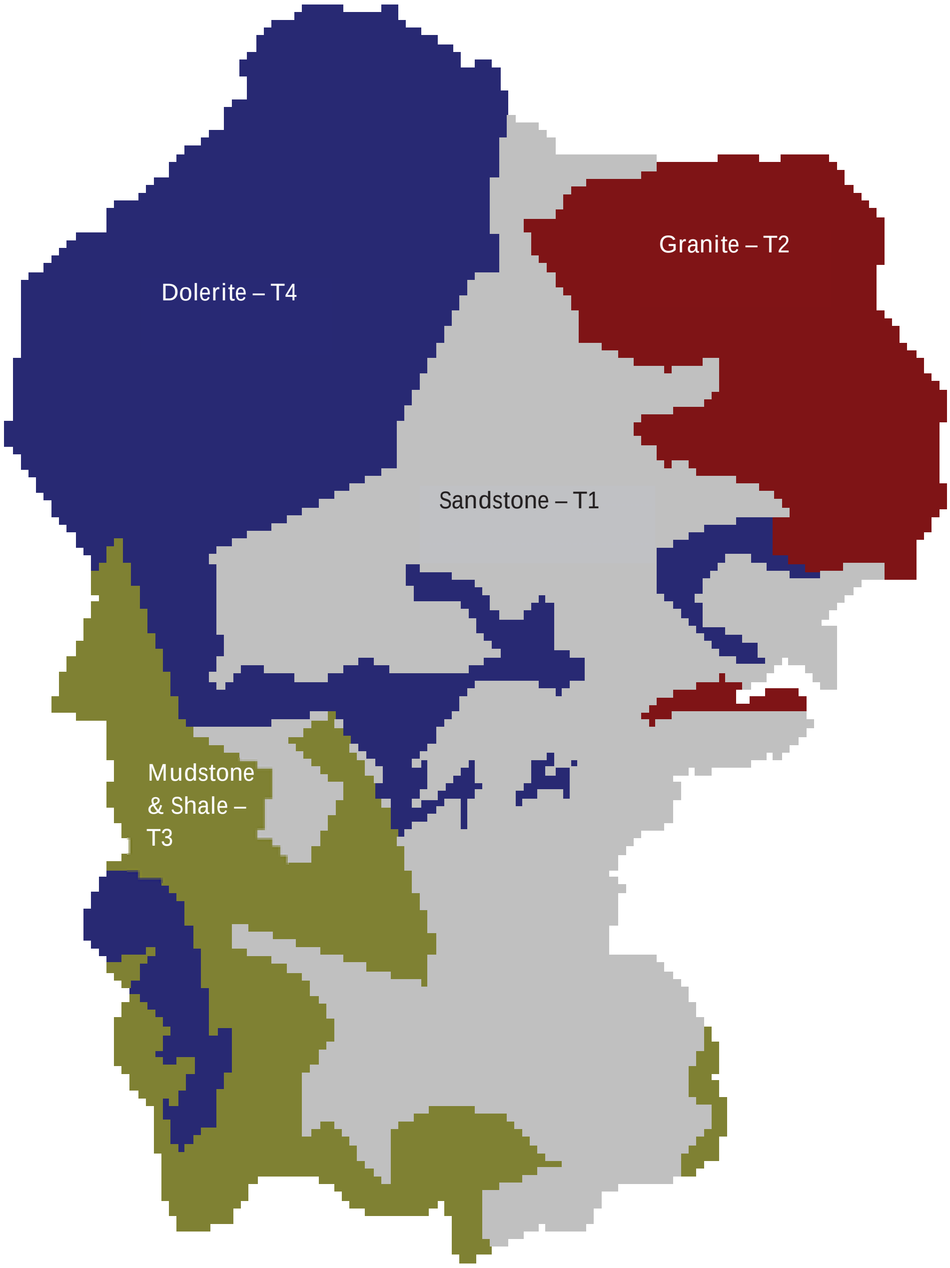
I1.1.5 Transmissivity

Transmissivity (T) zones were based on geological units sourced from the following geological maps:

- Geological map series 1:250 000 of the Republic of South Africa, sheet 2630 – Mbabane; and
- Geological map series 1:250 000 of the Republic of South Africa, sheet 2730 – Vryheid.

T zones are depicted in *Figure 1.4*. At the regional scale of the groundwater flow model, geological structures such as faults and dykes were not included individually in the model. Therefore the estimated T values represent a combination of matrix and structures.

Figure 1.4 Transmissivity Zones



I1.1.6 Recharge

Groundwater recharge represents infiltration of rainwater through the overlying geology into the modelled aquifer. Recharge is usually the most uncertain parameter in the model because the collection of direct field measurements is difficult.

For this model recharge was estimated using rainfall and other published data (DWAF, 2006). Rainfall data in the model area is scarce. However, available data suggests, a fairly homogeneous distribution over the model domain. On a regional scale, groundwater recharge was therefore assumed constant over the entire model area. The following two recharge scenarios were simulated:

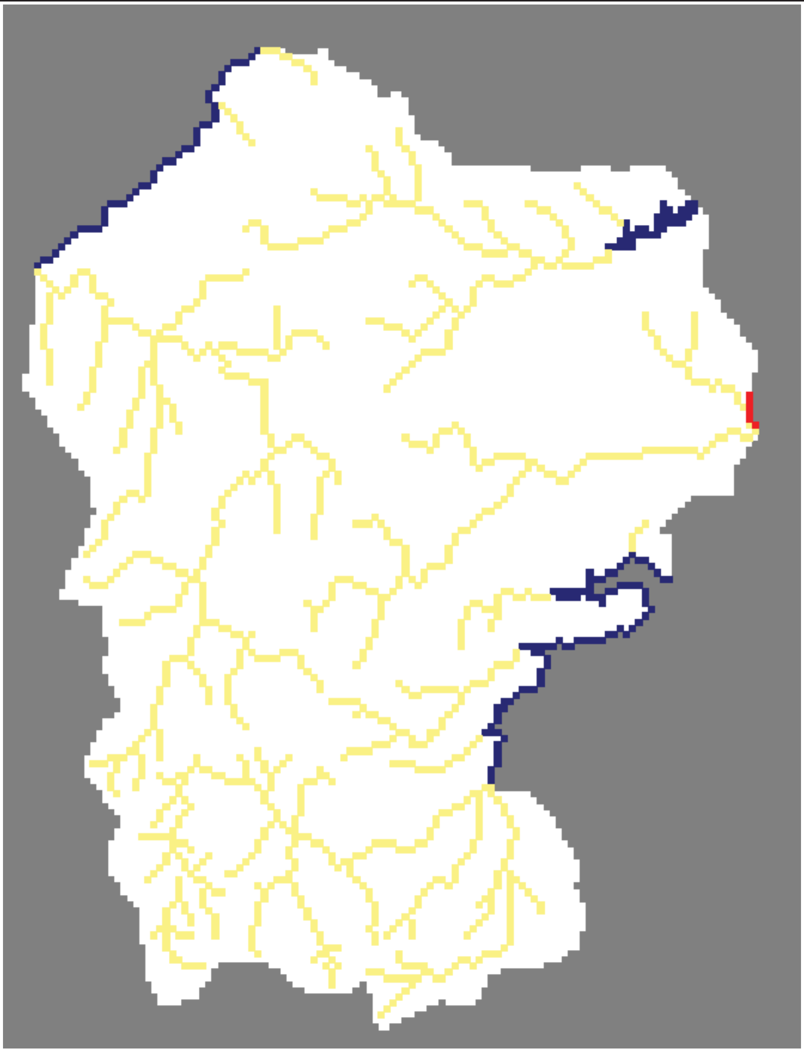
- Low recharge scenario: 2% of the average mean annual precipitation (MAP) of the quaternary catchments within the model area; and
- High recharge scenario: 5% MAP.

I1.1.7 Rivers and Streams

Base flow is an important component in the groundwater budget in the project area (DWAF, 2006). Due to the lack of data pertaining to the rivers and streams (i.e. water levels, riverbed elevation, riverbed hydraulic conductivity etc.) the implementation in the model had to be simplified.

Therefore, the perennial rivers within the model domain were implemented using the drain package (*Figure 1.5*). The drain elevation was set 15m lower than the topography value assigned to the individual cells. The drain conductance was calibrated.

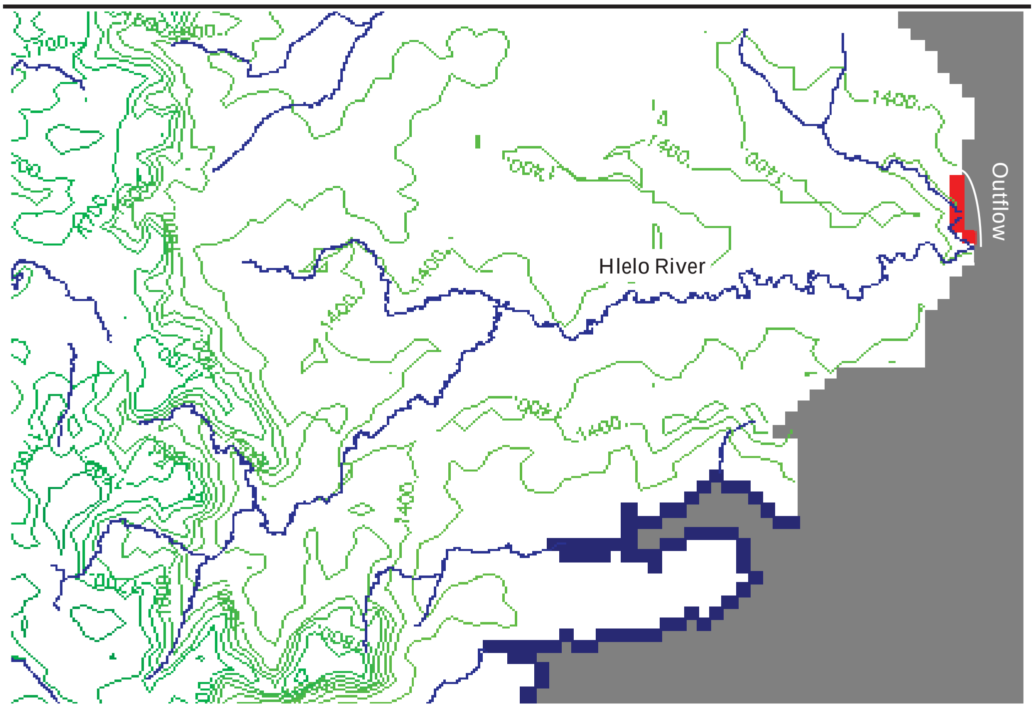
Figure 1.5 Perennial Rivers and Streams- Drain Package (yellow cells)



I1.1.8 Groundwater Outflow – Hlelo River

The Hlelo River leaves the model domain in the east, north of the Heyshope dam. It is assumed that some groundwater flow is taking place across the model boundary in the Hlelo River valley. *Figure 1.6* shows the location of the Hlelo River leaving the model domain.

Figure 1.6 Groundwater Outflow Location – Hlelo River (Topographic Map)



The groundwater darcy flow leaving the model domain was calculated using using the Darcy equation (i):

(i) $v_f = k_f \cdot i$ *Darcy Equation*

Where v_f is the groundwater Darcy velocity, k_f is the hydraulic conductivity of the matrix and *i* is the hydraulic gradient.

Flow volumes (Q) were calculated using the following equation (ii):

(ii) $$Q = v_f \cdot \frac{1}{n_e} \cdot A$$

Where v_f is the groundwater Darcy velocity, n_e is the effective porosity of the matrix and *A* is the flow area, which equals water level elevation minus aquifer bottom times the width of the flow section. Parameters and flow volumes are detailed in *Table 1.1*.

Table 1.1 *Groundwater Outflow – Hlelo River*

Parameter	Unit	Low Recharge Scenario	High Recharge Scenario
Hydraulic Conductivity	m/d	0.7	2.1
Groundwater Gradient	-	0.006	0.006
Effective Porosity	-	0.25	0.25
Flow Area	m^2	230,100	230,100
Total Flow volume	m^3/d	4,308	12,250
Number of Cells	-	6	6
Flow Volume per Cell	m^3/d	718	2,042

Notes: NM Not measured

I1.2 STEADY STATE CALIBRATION

During model calibration, T values for the four T zones detailed in *Figure 1.4* were estimated using the automatic parameter estimation programme PEST (Doherty et al., 1994) for the two recharge scenarios detailed in *Section I1.1*. Drain conductance was calibrated manually.

I1.2.1 *Observation Borehole Selection*

Available borehole data was studied carefully and suitable boreholes were selected as observations for model calibration. Water level data was available from National Groundwater Archive (NGA), ERM hydrocensus, ERM drilling and GCS (2009). The selection criteria were as follows:

- Recent water level measurements were selected, where available in undisturbed areas (i.e. no mining);
- Only boreholes tapping the regional aquifer were selected, where information was available;
- In areas, where the water level is impacted by mining, pre-mining water levels were used where available;
- Abstraction wells were not used as observations unless steady state water levels were available; and
- Where more than one borehole is located in one model cell, only one water level was used.

In total 110 observations were used for the steady state calibration of the regional groundwater flow model. The data sources are as follows:

- 75 NGA boreholes (DWA, National Groundwater Archive (2); water level data from different years and seasons);
- 14 Exploration boreholes (GCS, 2009);
- 6 ERM hydrocensus boreholes;
- 6 ERM recently drilled percussion boreholes; and
- 9 GCS monitoring wells (GCS, 2009).

(2) [2] Data supplied by the Department of Water Affairs (DWA), who is the proprietor of the relevant copyright.

The observation boreholes and water levels used in the model calibration are detailed in *Table 1.2*.

Table 1.2 Observation Boreholes Regional Model

BHID	X	Y	Water Level (mamsl)	Data Source
8128	-59336	-2963824	1441.8	NGA
2630CA00005	-77157	-2944532	1630.6	NGA
2630CA00053	-83803	-2956760	1652.4	NGA
2630CA00085	-78811	-2958458	1535.6	NGA
2630CB00009	-74232	-2953129	1481.0	NGA
2630CB00012	-62963	-2956331	1434.0	NGA
2630CB00021	-71304	-2957180	1441.7	NGA
2630CB00054	-73686	-2946728	1684.8	NGA
2630CB00057	-55684	-2958913	1412.7	NGA
2630CB00095	-52067	-2957729	1388.0	NGA
2630CB00105	-56279	-2955500	1454.0	NGA
2630CC00001	-89424	-2975021	1634.0	NGA
2630CC00008	-93598	-2970434	1635.4	NGA
2630CC00024	-88164	-2961623	1707.8	NGA
2630CC00028	-98005	-2966481	1600.0	NGA
2630CC00046	-94888	-2963798	1612.4	NGA
2630CC00051	-77827	-2975376	1627.8	NGA
2630CC00054	-89106	-2968927	1597.3	NGA
2630CC00058	-87716	-2982397	1712.7	NGA
2630CC00064	-84792	-2978252	1677.6	NGA
2630CC00069	-93910	-2976350	1716.4	NGA
2630CC00075	-90669	-2970781	1618.5	NGA
2630CC00076	-93652	-2970802	1658.8	NGA
2630CC00078	-92438	-2970487	1694.8	NGA
2630CC00083	-89065	-2975018	1606.9	NGA
2630CD00001	-57490	-2968657	1408.0	NGA
2630CD00003	-63579	-2971478	1456.0	NGA
2630CD00005	-62383	-2961778	1410.9	NGA
2630CD00009	-52838	-2971613	1392.4	NGA
2630CD00012	-62723	-2960454	1416.5	NGA
2630CD00015	-55937	-2964026	1410.9	NGA
2630CD00019	-57961	-2962095	1414.5	NGA
2630CD00023	-55894	-2967688	1422.0	NGA
2630DC00015	-47622	-2978640	1403.9	NGA
2630DC00023	-46186	-2971588	1388.4	NGA
2630DC00046	-46276	-2969710	1351.5	NGA
2630DC00047	-46282	-2967894	1373.9	NGA
2630DC00053	-46124	-2973403	1361.2	NGA
2630DC00055	-49380	-2973570	1392.4	NGA
2630DC00059	-46199	-2960229	1440.9	NGA
2630DC00060	-45036	-2961087	1404.2	NGA
2730AA00009	-85392	-2992165	1677.0	NGA
2730AA00023	-84305	-2997394	1686.0	NGA
2730AA00035	-89412	-3015228	1833.9	NGA
2730AA00040	-75717	-3000418	1734.9	NGA
2730AA00041	-81935	-2997441	1720.0	NGA
2730AA00043	-83609	-2990188	1667.2	NGA
2730AA00044	-92111	-2992433	1730.7	NGA
2730AA00045	-91324	-2994612	1710.0	NGA
2730AA00047	-92696	-3010229	1906.8	NGA
2730AA00055	-84997	-3000817	1676.7	NGA
2730AA00056	-87038	-3000492	1718.7	NGA
2730AA00057	-82407	-3005263	1749.4	NGA

BHID	X	Y	Water Level (mamsl)	Data Source
2730AA00058	-82684	-3004957	1661.0	NGA
2730AA00059	-77354	-2998612	1735.3	NGA
2730AA00060	-82733	-2999454	1722.5	NGA
2730AA00064	-89120	-2994319	1670.5	NGA
2730AA00066	-79061	-3011767	1517.0	NGA
2730AA00067	-81829	-3005228	1649.0	NGA
2730AA00068	-91628	-3005543	1843.7	NGA
2730AA00070	-89453	-3013346	1835.5	NGA
2730AA00074	-88178	-2991234	1685.0	NGA
2730AA00075	-86340	-2989929	1613.0	NGA
2730AB00007	-55264	-2991388	1311.0	NGA
2730AB00010	-58965	-3007315	1371.2	NGA
2730AB00011	-54587	-2988488	1309.3	NGA
2730AB00015	-57340	-3007462	1413.9	NGA
2730AB00026	-62826	-3000500	1326.3	NGA
2730AB00027	-56567	-3007950	1438.0	NGA
2730AB00028	-56756	-3008751	1473.8	NGA
2730AB00037	-63266	-2995147	1298.7	NGA
2730AB00038	-64595	-2999217	1359.3	NGA
2730AB00040	-67823	-3003574	1366.7	NGA
2730AB00046	-61110	-3007757	1350.3	NGA
2730AB00047	-60490	-3010801	1363.7	NGA
2730AB00048	-58023	-2990720	1325.0	NGA
AC00058	-86178	-3017325	1815.4	GCS
BW34005	-70912	-2992667	1661.3	GCS
BW34020	-69130	-2993106	1651.4	GCS
DH10003	-73178	-2988975	1683.6	GCS
DH10016	-75170	-2990940	1746.7	GCS
DH10018	-76231	-2991195	1769.1	GCS
DH14005	-73951	-2992208	1692.2	GCS
DH14032	-72742	-2989845	1651.4	GCS
DH14046	-73954	-2991055	1783.3	GCS
ERMBH2	-71021	-2989659	1499.3	ERM
ERMBH3	-70738	-2989014	1475.7	ERM
ERMBH4	-68883	-2994432	1427.9	ERM
ERMBH7	-74623	-2993168	1736.9	ERM
ERMBH8	-70830	-2989598	1499.1	ERM
ERMBH9	-71538	-2990606	1531.3	ERM
FB16	-57969	-2987544	1318.4	ERM
FB18	-60033	-2990395	1364.1	ERM
FB3	-68561	-2978590	1448.6	ERM
FB5	-66600	-2978823	1400.6	ERM
GCS1	-64405	-2988862	1461.0	GCS
GCS2	-65095	-2989524	1474.4	GCS
GCS3	-63187	-2989607	1408.4	GCS
GCS4	-63003	-2990297	1394.6	GCS
GCS5	-64412	-2991853	1518.1	GCS
GCS6	-61557	-2991595	1340.2	GCS
GCS7	-61889	-2990823	1355.2	GCS
GCS8	-62328	-2990380	1370.4	GCS
GCS9	-62793	-2990047	1377.6	GCS
KB15042	-66070	-2993084	1648.6	GCS
MWG-B4+	-62528	-2990602	1380.7	GCS
NG026	-64710	-2990066	1534.1	GCS
NG034	-65268	-2990951	1614.2	GCS
NGOH83	-66193	-2988924	1484.3	GCS
NGOH85	-65917	-2989555	1479.8	GCS

Notes: All coordinates in WGS84, LO31

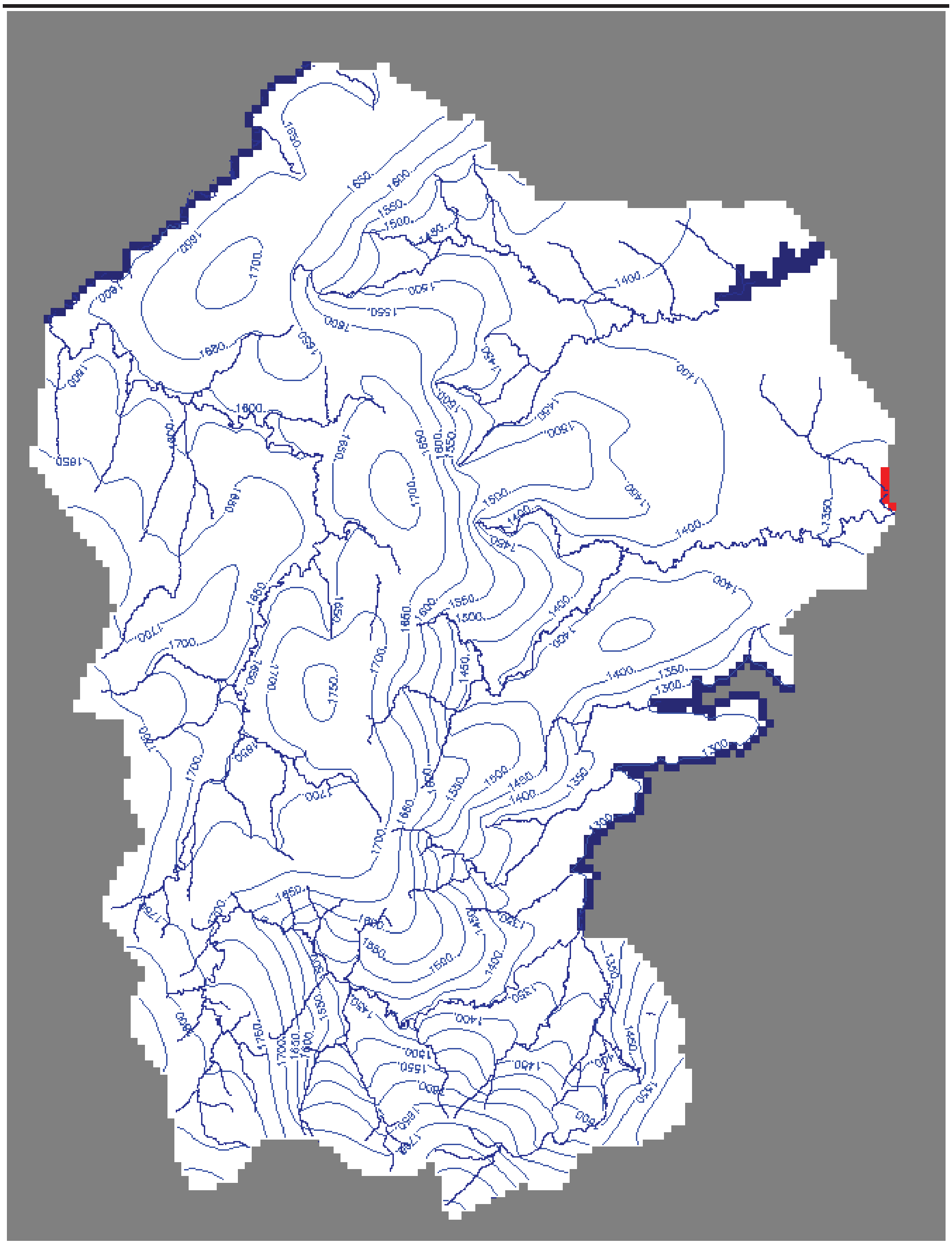
I1.3 CALIBRATION RESULTS

The steady state calibration results of the regional groundwater flow model are detailed in the following paragraphs.

I1.3.1 *Groundwater Levels and Flow Direction*

Figure 1.7 depicts the steady state piezometric head distribution within the model domain. Note that the difference in piezometric heads between the two recharge scenarios is not significant since they were both calibrated to the same set of observations. Therefore only the heads for the low recharge scenario are displayed here.

Figure 1.7 Steady State Head Distribution (mamsl)



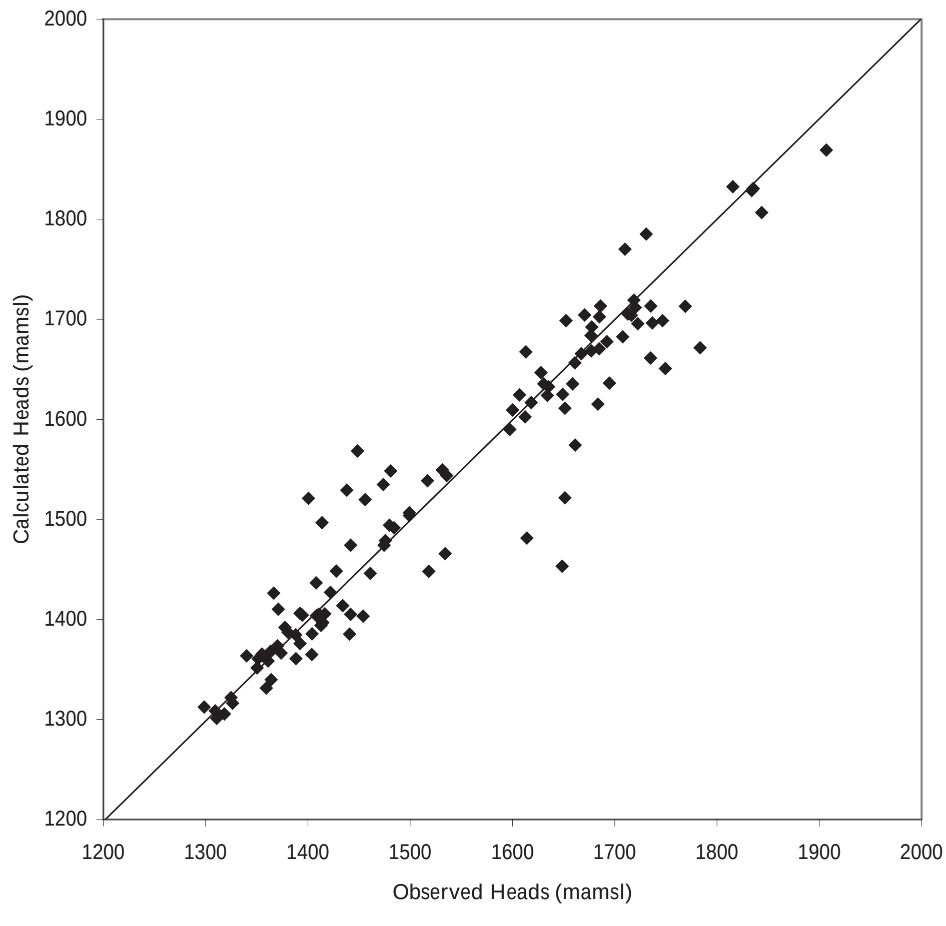
The regional groundwater flow direction is from west to east. However, local flow directions can differ significantly from the regional flow direction due to the nature of the topography in the model domain (refer to *Section I1.1.3*).

I1.3.2 Scatter Diagram

The scatter diagram of observed and calculated heads of the calibrated model is presented in *Figure 1.8*. No systematic deviation is visible. Note that the difference between the two recharge scenarios is not significant and therefore only the scatter diagram for the low recharge scenario is displayed here.

The root mean square error of the model calibration of 46m is considered to be sufficiently small, given the big model area, limited data and given that the maximum head difference over the model area is over 600m.

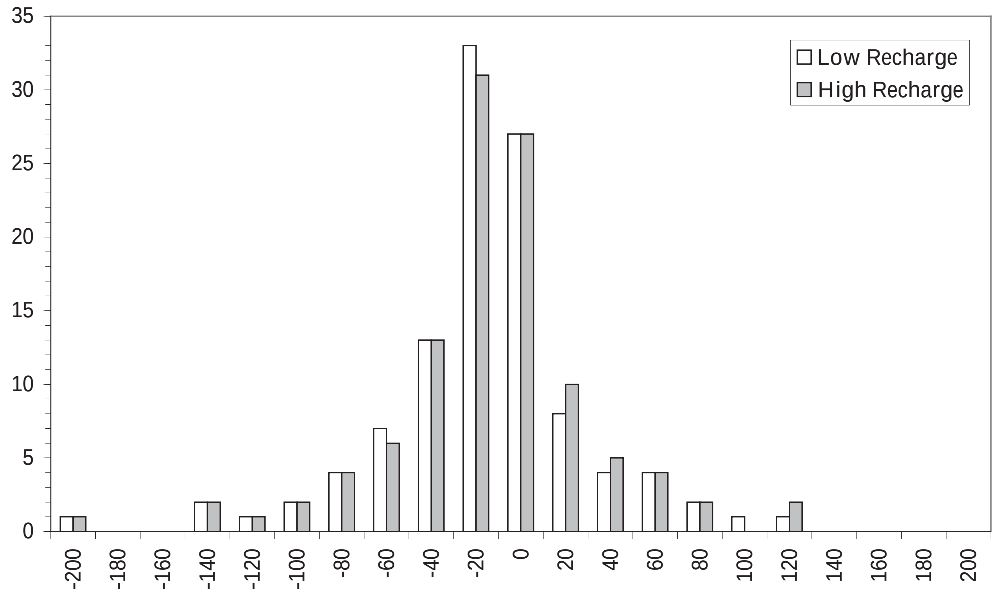
Figure 1.8 Scatter Diagram of Calculated vs. Observed Heads after PEST Calibration



In *Figure 1.9* the histogram of the differences between observed and calculated head values (residuals) is plotted for both recharge scenarios. Class “0”, for example indicates how many residuals were beween -20 and 0.

Most of the residuals (65-66%) are situated between -20 and 20m. The histogram shows that the model slightly under-predicts, rather than over-predicts water levels. This is more pronounced for the low recharge scenario.

Figure 1.9 *Histogram of Residuals (Observed Minus Calculated Heads)*



I1.3.3 Transmissivity

Calibrated transmissivity values range from $3{\cdot}10^0$ to $6{\cdot}10^1$ m²/d for the low recharge scenario and from $6{\cdot}10^0$ to $2{\cdot}10^2$ m²/d for the high recharge scenario. The calibrated T values for each recharge scenario are detailed in *Table 1.3*.

Transmissivity data was only available from a number of constant discharge pump tests carried out by ERM in the Kusipongo Reserve. Calibrated T values for the low recharge scenario are in the same order of magnitude range than those obtained from pump tests, which were between $2{\cdot}10^{-1}$ and $4{\cdot}10^1$ m²/d. Calibrated T values for the high recharge scenario are up to approximately one order of magnitude higher than T values obtained from pump tests. No tested boreholes are within the T zones for the granites, mudstones and shales.

Table 1.3 *Calibrated T values (m^2/d) - Regional Model*

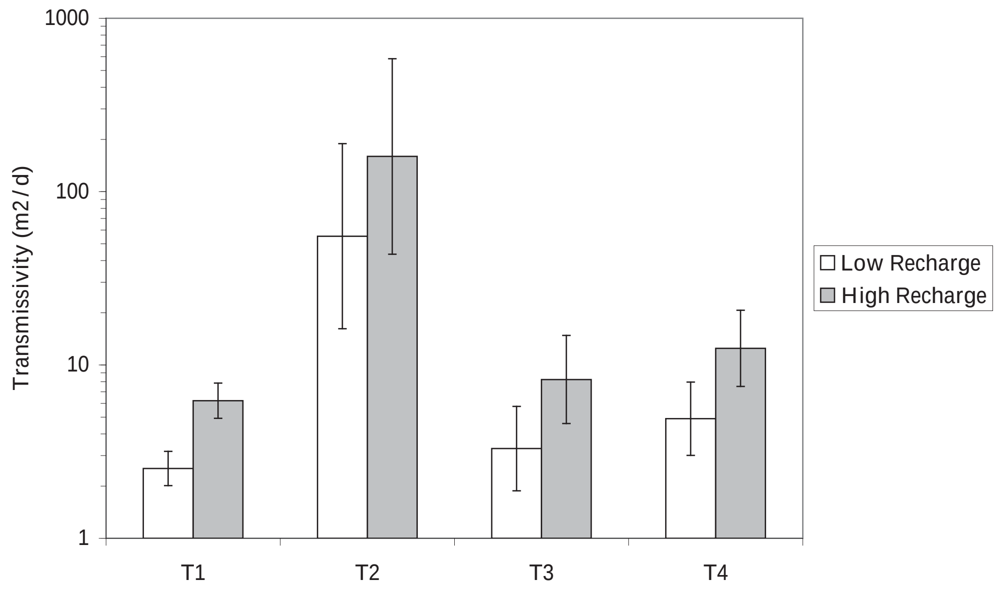
Parameter	Low Recharge Scenario	High Recharge Scenario	Transmissivity Derived from Aquifer Tests min	max	geomean	Tested Boreholes
T1 – Sandstone	3E+00	6E+00	2E-01	4E+01	2E+00	ERMBH1, 3, 4, 8
T2 – Granite	6E+01	2E+02	-	-	-	-
T3 – Mudstone and Shale	3E+00	8E+00	-	-	-	-
T4 - Dolerite	5E+00	1E+01	5E-01	3E+00	7E-01	ERMBH7, 10

Notes: - No aquifer tests performed

PEST provides 95% confidence limits for estimated parameter values, which are displayed in *Figure 1.10*. Confidence limits only give an indication of the parameter uncertainty.

95% confidence limits for the calibrations are within one order of magnitude for each of the parameters. The most uncertain transmissivity parameter is T2 – Granite, which means that further field investigations should focus on gathering data about this parameter.

Figure 1.10 Transmissivities – 95% Confidence Limits



Parameter Correlation Coefficient Matrix

The parameter correlation coefficient matrix (also covariance matrix) contains important information about parameter correlation. A high correlation coefficient between two values means that the values depend on each other, i.e. the same heads can be reproduced by changing the two values accordingly. Only for small non-diagonal values of the correlation coefficient are the calibrated parameters independent.

Parameter correlation coefficient matrices are presented in *Table 1.4* and *Table 1.5*, which are not significantly different from each other. The highest correlation coefficient for both scenarios is -0.117, substantially lower than 0.95, which would indicate non-unique parameters.

The calibration is therefore also satisfactory with respect to the uniqueness of the result, if recharge is assumed correct.

Table 1.4 Parameter Correlation Coefficient Matrix - Low Recharge

	T1	T2	T3	T4
T1	1	-8.99E-02	-9.33E-02	-1.17E-01
T2	-8.99E-02	1	8.93E-03	4.03E-03
T3	-9.33E-02	8.93E-03	1	-7.34E-02
T4	-1.17E-01	4.03E-03	-7.34E-02	1

Table 1.5 Parameter Correlation Coefficient Matrix - High Recharge

	T1	T2	T3	T4
T1	1	-8.69E-02	-9.21E-02	-1.17E-01
T2	-8.69E-02	1	8.53E-03	4.19E-03
T3	-9.21E-02	8.53E-03	1	-7.69E-02
T4	-1.17E-01	4.19E-03	-7.69E-02	1

I1.3.4 Drain Conductance

The calibrated value for drain conductance (one value for the entire model domain) is of $4.5 \cdot 10^1 m^2/d$.

I1.3.5 Water Balance

The steady state water budgets of the whole model domain for both recharge scenarios are shown in *Table 1.6*.

Recharge

As described in *Section I1.1*, two recharge scenarios were modelled:

- Low recharge scenario: 2% of the average mean annual precipitation (MAP) of the quaternary catchments within the model area; and
- High recharge scenario: 5% MAP.

Base Flow Rivers, Streams and Dams

The constant head component represents the volume of water flowing from the modelled aquifer into Heyshope Dam, Morgenstond Dam and the Vaal River. The drain component indicates the volume of water being drained from the aquifer by perennial rivers and streams within the model domain, simulated as drain cells. This represents 90% of the total groundwater flux in the system.

The total amount of base flow to rivers and streams (flow to dams excluded) amounts to 132,870m^3/d and 335,540m^3/d for the low and high recharge scenarios respectively. This equals to approximately 1.9 and 4.5% MAP respectively, which compares relatively well to literature values, which suggest base flow of between 1.1 and 2.6% MAP (DWAF, 2006).

Groundwater Out Flux

The groundwater out flux where the Hlelo Stream leaves the model domain indicates that the model setup assumes regional groundwater flow out of the model domain in this area.

Table 1.6 Water Budget for both Recharge Scenarios

Component	Low Recharge Scenario		High Recharge Scenario	
	In Flux [m³/d]	Out Flux [m³/d]	In Flux [m³/d]	Out Flux [m³/d]
Recharge	149,480	0	372,930	0
Constant Head – Heyshope Dam	0	4,810	0	12,370
Constant Head – Morgenstond Dam	0	3,630	0	12,770
Constant Head – Vaal River	0	3,880	0	10,070
Drains (Rivers and streams within model domain)	0	132,870	0	335,540
Groundwater Out Flux Hlelo	0	4,310	0	12,250
SUM	149,480	149,480	372,930	372,930

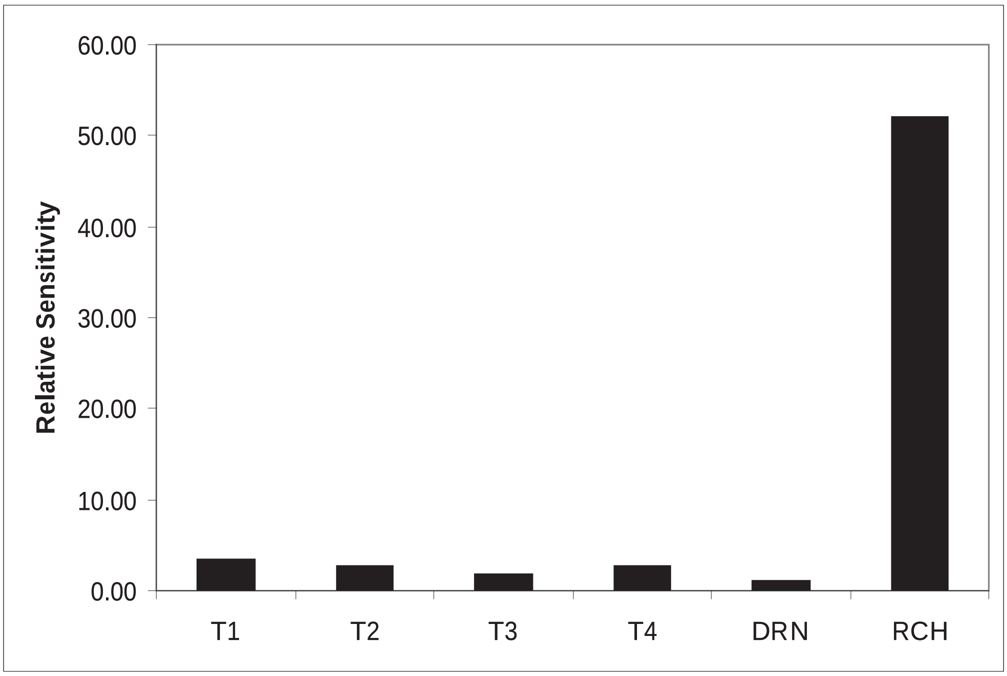
In a steady state system total inflow and total outflow fluxes are equal.

I1.3.6 Sensitivity Analysis

The automatic sensitivity analysis provided in PEST was used to quantify the uncertainty in the calibrated model caused by input parameters. Input parameters were varied within a factor of 0.01 and 100 of the calibrated value respectively.

Figure 1.11 presents the relative sensitivities of calculated heads for the parameters transmissivity, drain conductance and recharge. The most sensitive parameter is the recharge. Changes in this parameter will have a greater impact on the model output than other less sensitive parameters and therefore any further data collection and calibration effort should be aimed at recharge.

Figure 1.11 Sensitivity Analysis for Transmissivity (T1-T4), Drain Conductance (DRN) and Recharge (RCH)



Annex K

Setup and Calibration of Local Numerical Groundwater Flow and Transport Models – Technical Report

K1 LOCAL GROUNDWATER FLOW AND TRANSPORT MODELS

This annex provides the complete technical detail pertaining to the setup of the local numerical groundwater flow and transport models as well as the calibration (steady state and transient) of the flow models.

The regional model was used to determine suitable model boundaries and boundary conditions for the detailed local model, which was then used to simulate the planned mine workings and associated potential impacts.

K1.1 MODEL SETUP

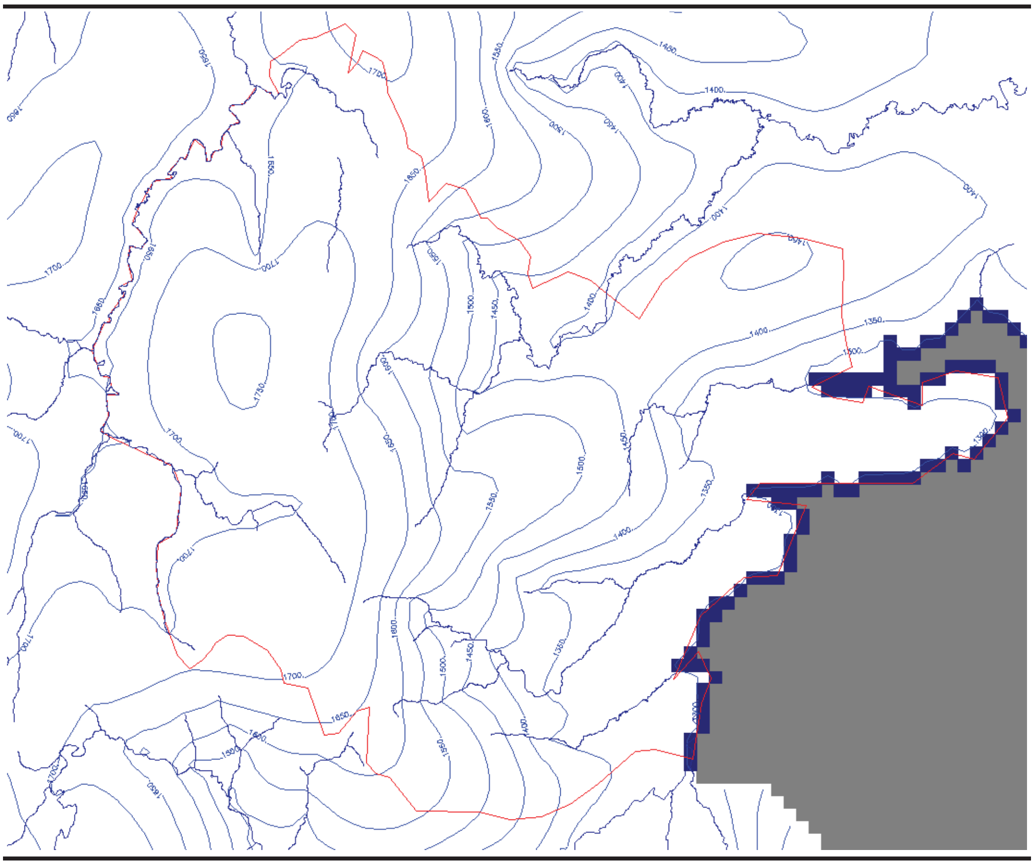
This section details the setup of the local steady state groundwater flow model.

K1.1.1 Model Domain and Boundary Conditions

The local model domain extends from the Kleinvaal River in the west to the Heyshope dam in the east (*Figure 1.2*). The total model area is approximately 600km^2 (60,000ha).

The regional model was used to help determining suitable model boundaries and boundary conditions for the detailed two layer local model. *Figure 1.1* shows a zoom-in to the local model boundary of the calculated steady state groundwater contours of the regional model.

Figure 1.1 Regional Model Groundwater Contours and Local Model Boundary (red line)



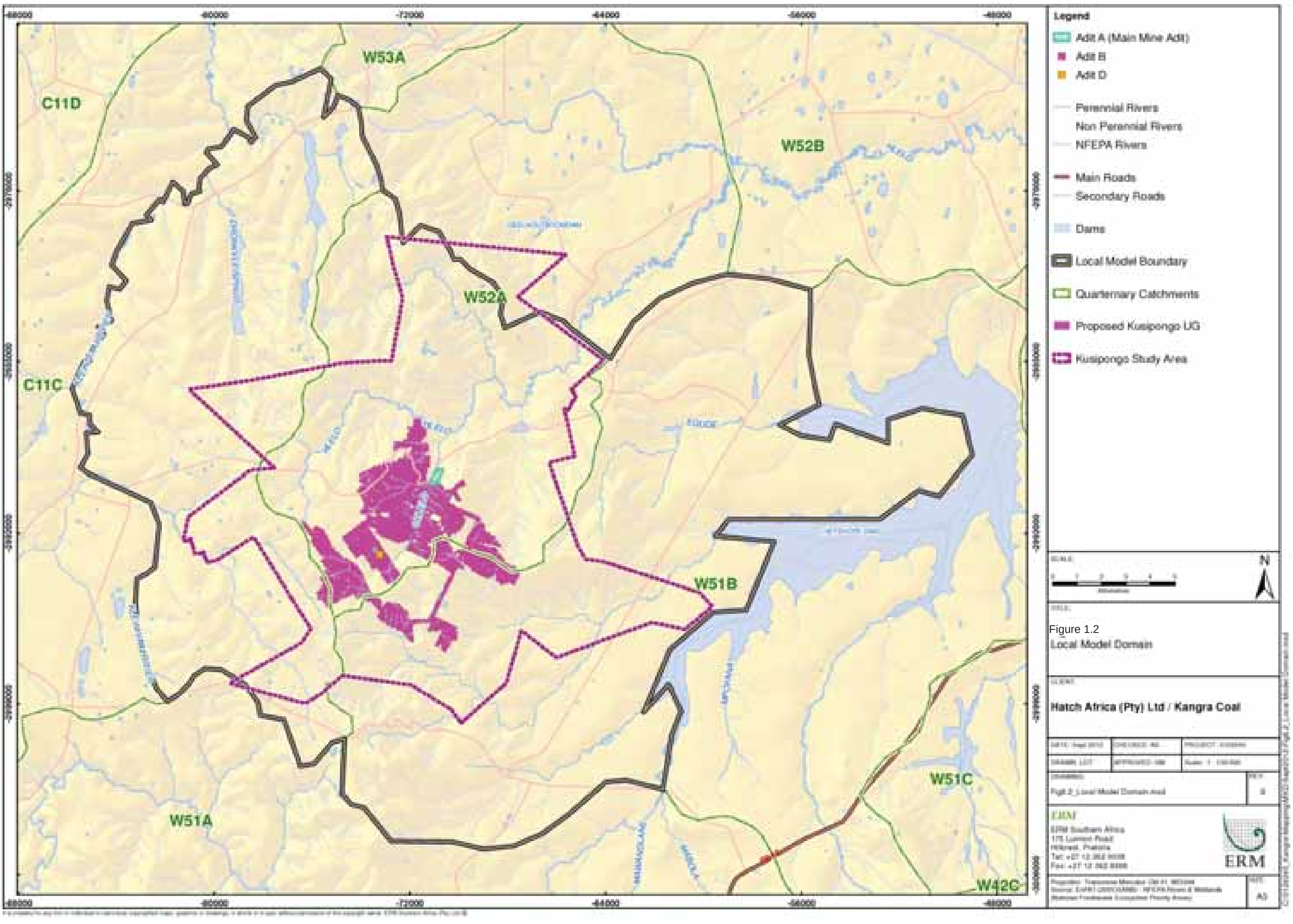


Figure 1.2
Local Model Domain

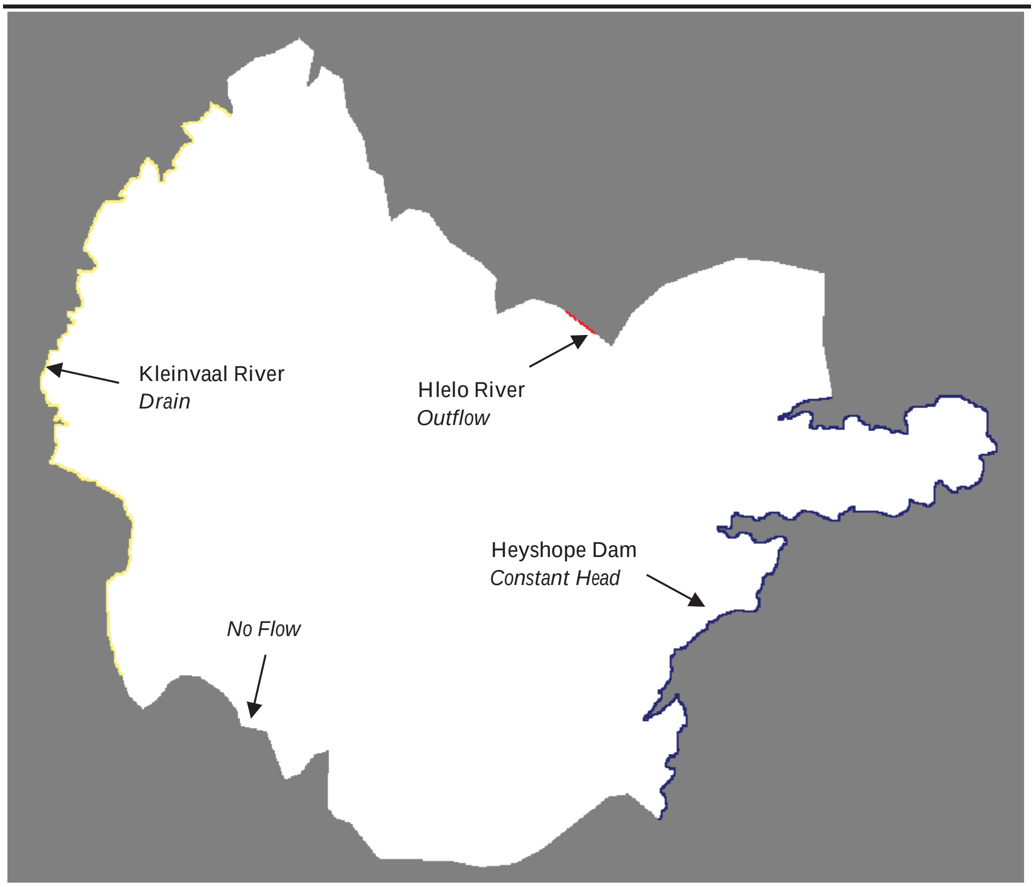
The model boundaries were chosen in order to centralise the area of interest (Kusipongo Reserve) and follow real hydrogeological and hydrological boundaries. Quaternary catchment (Midgley et al. 1994) boundaries were followed as well as dams and major rivers. The calculated heads of the regional model were used to help determining boundary conditions (i.e. along rivers) and to verify no flow boundaries (i.e. catchment boundaries).

The following boundary conditions were selected for the model domain (*Figure 1.3*) for the top model layer:

- *Constant head boundary* condition (1st order) along the Heyshope Dam in the east;
- *Outflow boundary* condition (2nd order or Neumann Boundary) simulated using the well package where the Hlelo Stream leaves the model area in the north-east;
- *Drain boundary* condition (3rd order or Cauchy Boundary) along the Kleinvaal River in the east; and
- *No flow boundary* condition (2nd order or Neumann Boundary) along the rest of the model boundary simulating water sheds.

For the second model layer only the *constant head boundary* condition along the Heyshope Dam was considered and a *no flow boundary* was implemented along the rest of the model boundary.

Figure 1.3 Boundary Conditions - Local Model Top Layer



K1.1.2 *Discretization*

The numerical simulation of groundwater flow and transport by block-centred finite difference method as used in MODFLOW requires a spatial discretization of the aquifer parameters across a rectangular grid that can be orientated to correspond to the general flow direction. The cell size in the local groundwater model grid was defined to be 50m in both horizontal directions (north / south and west / east). The rectangular grid has side lengths of 52km corresponding to 1,040 cells (west / east) and 40km corresponding to 800 cells (north / south).

The groundwater system was initially modelled as one layer. After calibration, the vertical discretisation was refined and the layer was split into two separate layers of various thickness depending on the coal seam depths in order to calculate mine inflows in both Gus and Dun seam separately.

K1.1.3 *Aquifer Type*

Following a simplified approach, both layers were modelled as being confined. The aquifers modelled include the alluvial aquifers along rivers and streams, the weathered and the fractured rock aquifers present mostly in the Karoo sediments.

K1.1.4 *Model Top, Bottom and Aquifer Thickness*

Topography data was available in the Kusipongo Reserve at an accuracy of 2m and in the rest of the model domain at an accuracy of 20m. The data was provided by the client and NGI (Chief Directorate National Geo-Spatial Information). The data was combined and interpolated to the model grid using Surfer (version 9.11.947). The topography elevation ranges roughly from 1,300 to 1,900mamsl (*Figure 1.4*).

A flat model base was chosen at 980mamsl, which is roughly 500m deeper than the average elevation of the coal seams, because no data was available concerning the bottom of the aquifer. The thickness of the aquifers was chosen deep enough to avoid boundary effects caused by the bottom of the model being a no flow boundary.

For the refined model, the interface between the two layers (*Figure 1.5*) was computed using different methods. Within the mining area, where data for the coal seam elevations was available, the interface elevation was set two meters below the Gus seam floor elevation, which is on average in the middle between the two seams. For the rest of the model the interface elevation was set to 1,480mamsl, which corresponds roughly to the average Gus seam floor elevation within the mining area.

Wherever the topographical elevation would drop below 1,510mamsl, the interface elevation was set to 30m below the surface elevation, in order to guarantee a minimal layer thickness of 30m.

Figure 1.4 Local Model Topography (mamsl)

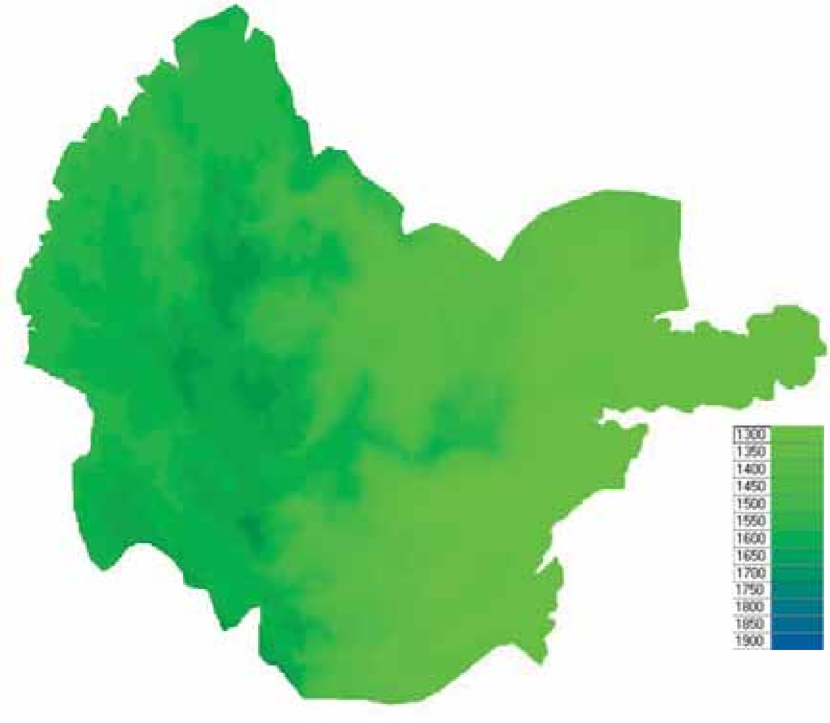
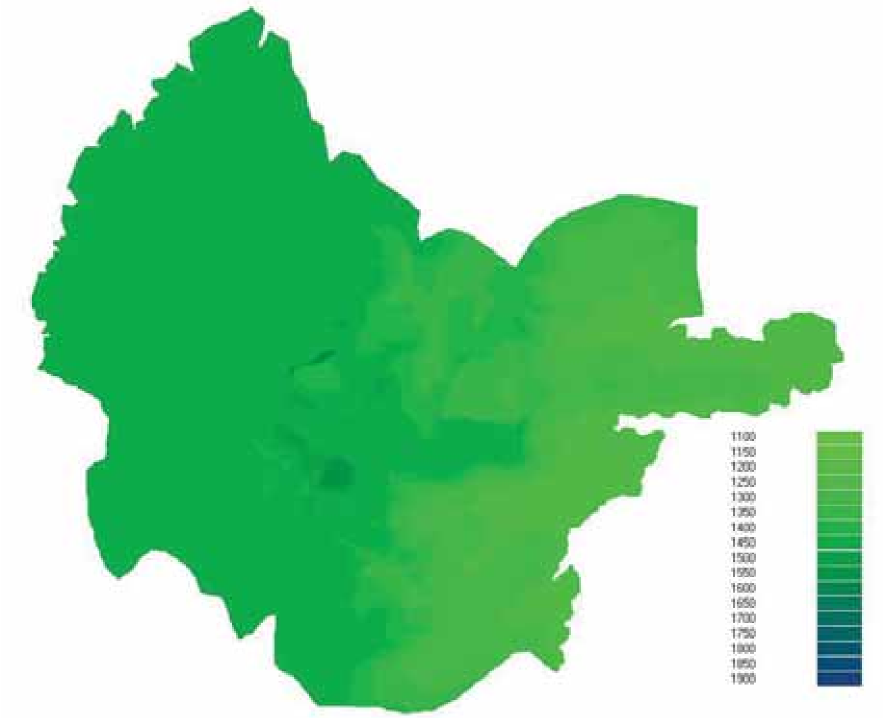


Figure 1.5 Elevation of Interface between the Two Layers (mamsl)



K1.1.5 Transmissivity

Transmissivity (T) zones were based on a detailed geological map of the project area (Jones & Wagener, 2010), which was provided by Hatch. Some of these transmissivity zones were refined and calibrated in the area of the Kusipongo Reserve based on the findings of the ERM drilling campaign.

Geological discontinuities such as faults and dykes were provided by Hatch in two separate data sets:

- Local discontinuities modelled by Golder at coal seam level, limited to the Kusipongo reserve; and
- A regional set of discontinuities, as provided by Hatch.

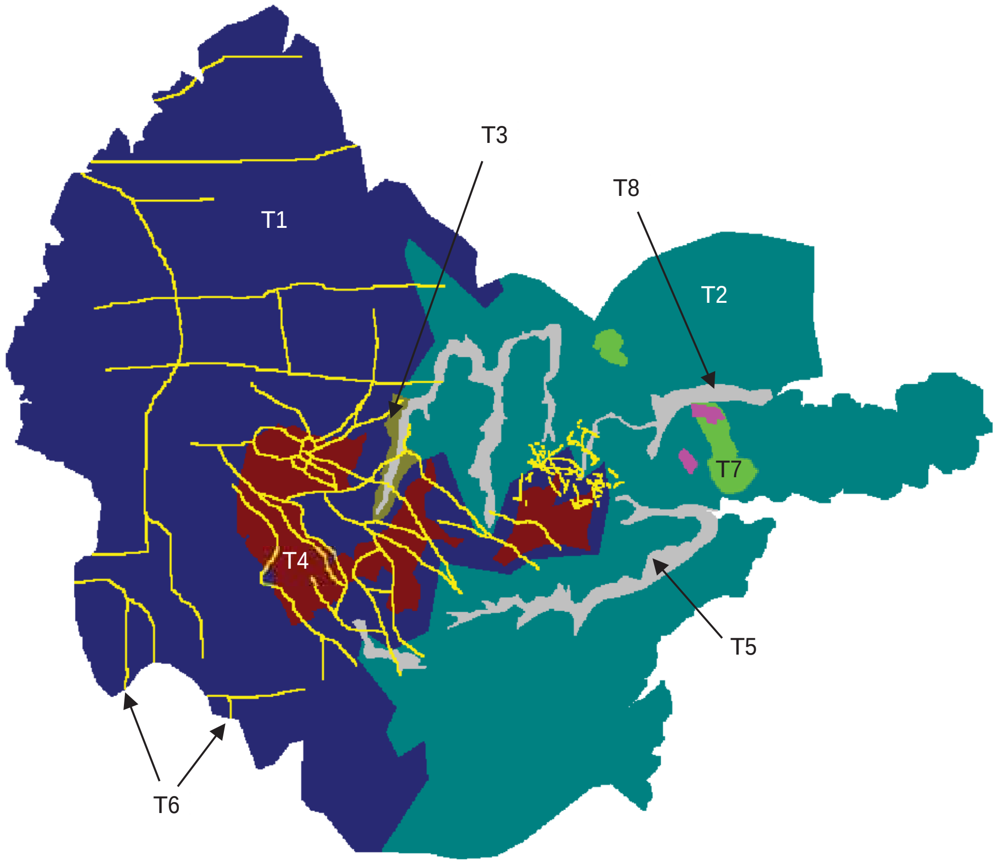
T zones are detailed in *Table 1.1* and depicted in *Figure 1.6*. Due to limited data availability, the same transmissivity zones and values were used for both layers.

Table 1.1 Transmissivity Zones - Local Model

Zone Number	Description	Calibration Method
T1	Sandstone – high elevation	PEST
T2	Sandstone – low elevation	PEST
T3	Dolerite Sill – mid elevation	PEST
T4	Dolerite Sill – high elevation	PEST
T5	Alluvial	Manual
T6	Structures	Manual
T7	Existing, closed underground mines	Manual
T8	Existing, closed open cast mines	Manual

PEST Automated parameter estimation method incorporated in PMWIN
Manual Manual parameter estimation

Figure 1.6 Transmissivity Zones



K1.1.6 Recharge

Groundwater recharge represents infiltration of rainwater through the overlying geology into the modelled aquifer. Sensitivity analysis suggested that recharge is amongst the most sensible parameters in the model, and at the same time it is one of the most uncertain parameters because the collection of direct field measurements is difficult.

In the model, recharge values (geographic distribution) for two different scenarios were estimated during model calibration. Consistent with the regional model (refer to *Annex I*), the following two recharge scenarios were simulated:

- Low recharge scenario: 2% of the average mean annual precipitation (MAP) of the study area; and
- High recharge scenario: 5% MAP.

During the calibration process, different recharge zones were determined in line with the conceptual site model, using the following criteria:

- Differences in topographical elevation and slope;
- ERM field investigation results (CSM); and
- Current and historical mining activities.

The refinement is more detailed in areas, where there was more field data available, i.e. in the Kusipongo Reserve. The recharge zones are displayed in *Figure 1.7*. Descriptions and reasoning behind the zone selection is shown in *Table* 1.2.

Figure 1.7 Recharge Zones - Local Model

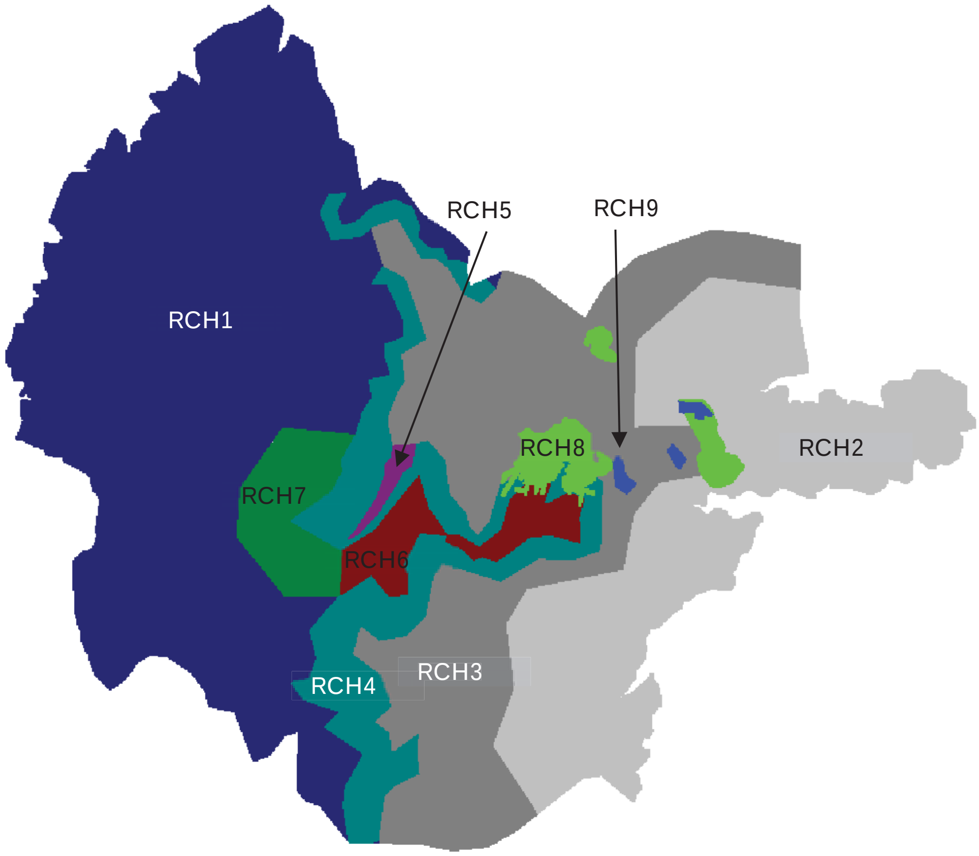


Table 1.2 Recharge Zones - Local Model

Zone	Description	Calibration
RCH1	High Altitude Flat – low runoff component	Calibrated
RCH2	Low Altitude Flat – very low runoff component	Calibrated
RCH3	Low Altitude Slope – moderate runoff component	Calibrated
RCH4	Slope – high runoff component	Calibrated
RCH5	Mid Altitude oHlelo valley – low runoff component, weathering	Calibrated
RCH6	High Altitude East - recharge zone, vertical structures (CSM)	Calibrated
RCH7	High Altitude West - recharge zone, vertical structures (CSM)	Calibrated
RCH8	Existing Underground – increased recharge (subsidence)	Specified
RCH9	Existing Open Pit – increased recharge, direct rainfall and pit inflow	Specified

Recharge into Existing Mines

Recharge into mines in Mpumalanga has been extensively studied over the years. Overriding factors are the method of mining, depth of mining and the surface hydrology (i.e. wetlands and streams). High extraction methods invariably disturb the overlying strata more than bord-and-pillar methods. A summary of the percentage influx to be expected for the various mining methods is as follows (Vermeulen, 2011):

- Shallow bord-and-pillar 5-10% MAP;
- Deep bord-and-pillar with no subsidence 1% MAP;
- Stooping 4-12% MAP;
- Longwall 6-15% MAP; and
- Opencast 14-20% MAP.

Therefore, recharge values used for existing mines within the model area was based on the reported extraction method (*Table 1.4*). Recharge rates for existing mines are detailed in *Table 1.3*.

Table 1.3 Recharge Values Existing Mines

Mining Operation	Low Recharge Scenario	High Recharge Scenario
Open Cast Mines (Maquasa East and Maquasa West)	$3.4 \cdot 10^{-4}$ m/d (14% MAP)	$4.8 \cdot 10^{-4}$ m/d (20% MAP)
Underground Mines (Maquasa East, Maquasa West and Rooikop)	$9.6 \cdot 10^{-5}$ m/d (4% MAP)	$2.9 \cdot 10^{-4}$ m/d (12% MAP)

K1.1.7 Rivers and Streams

Stream data (water level elevations and stream bed elevations) was collected for the oHlelo Stream only, which runs through the Kusipongo Reserve. The oHlelo Stream, is considered the most important surface water feature, which will potentially be affected by future mining activities in the Kusipongo Reserve.

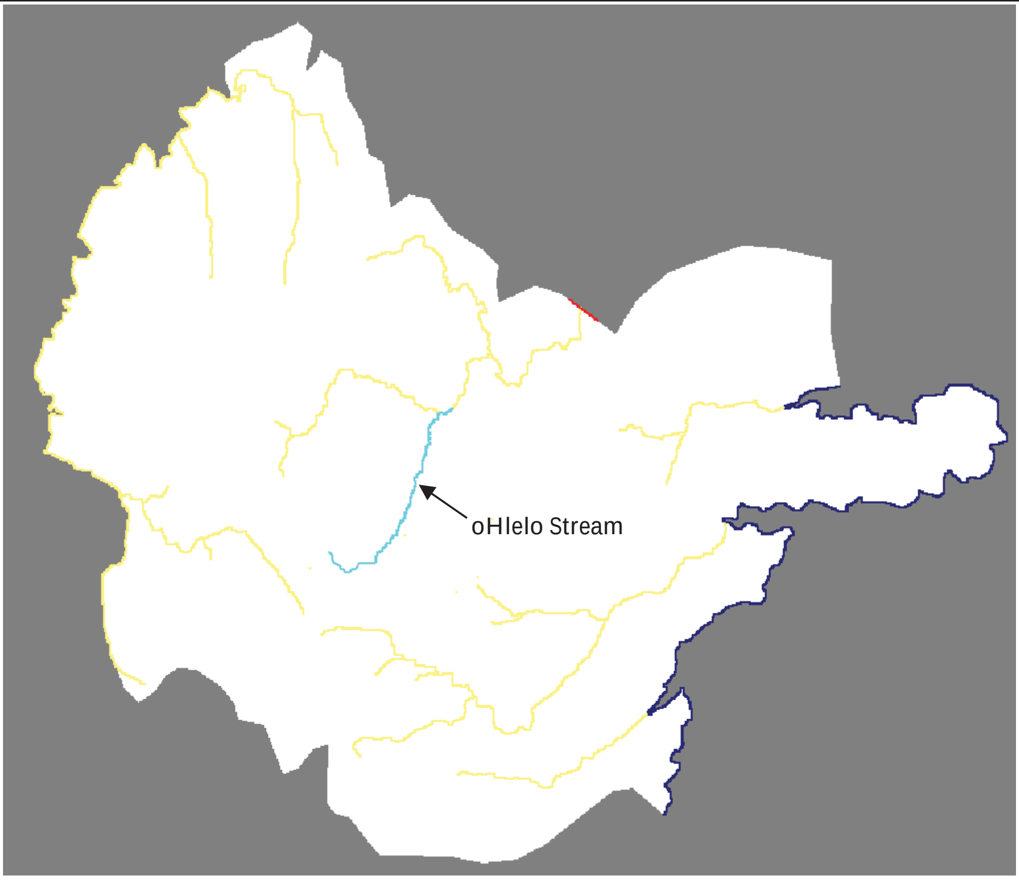
The oHlelo Stream was therefore implemented in the model using the river package. Stream water elevations and stream bed elevations were linearly interpolated between the 12 survey points. A river conductance value of $10 m^2/d$ was assumed, representing a streambed consisting mostly of silty sand with a hydraulic conductivity of 10^{-2}m/d (Freeze and Cherry, 1979).

Due to the lack of data pertaining to the other rivers and streams (i.e. water levels, riverbed elevation, riverbed hydraulic conductivity etc.) the implementation in the model had to be simplified. Therefore, the perennial rivers and streams within the model domain were implemented using the drain package which implements that they can only remove water from the model but not supply any water to the model.

The drain elevation was set 15m lower than the topography value assigned to the individual cells taking into account the cell size. A drain conductance of $7 m^2/d$ was assumed, representing a streambed consisting mostly of silty sand with a hydraulic conductivity of 10^{-2}m/d (Freeze and Cherry, 1979).

The model implementation of perennial rivers and streams is depicted in *Figure 1.8*.

Figure 1.8 Perennial Streams – River Package (light blue cells) and Drain Package (yellow cells)



K1.1.8 Wetlands

In the absence of field data, wetlands data was sourced from SANBI / CSIR (2010), who published National Freshwater Ecosystem Priority Areas (NFEPA) and NSS (2011) who undertook a wetland assessment focussed on the proposed adit locations.

It is assumed, that only wetlands located in low lying areas, i.e. below the 2nd dolerite sill, would potentially be affected by mine dewatering. Reason for this assumption is the presence of dolerite sills, which, on a local scale, are thought to separate the overlying wetlands from the underlying aquifer and act as layers with low hydraulic conductivity. It was assumed that planned mining activities should therefore not affect the upper wetlands. This assumption should, however, be verified with monitoring data.

These wetlands were implemented in the model using the drain package. The drain elevation was set 5m lower than the topography value assigned to the individual cells. A drain conductance of $5 \cdot 10^{-1} m^2/d$ was assumed, representing a wetland floor consisting mostly of silt with a hydraulic conductivity of $10^{-3} m/d$ (Freeze and Cherry, 1979).

K1.1.9 *Existing Mines*

Kangra Coals currently operating and closed mines within the model area are detailed in *Table 1.4* and depicted in *Figure 1.9*.

Table 1.4 Kangra Coal Mines within the Model Area

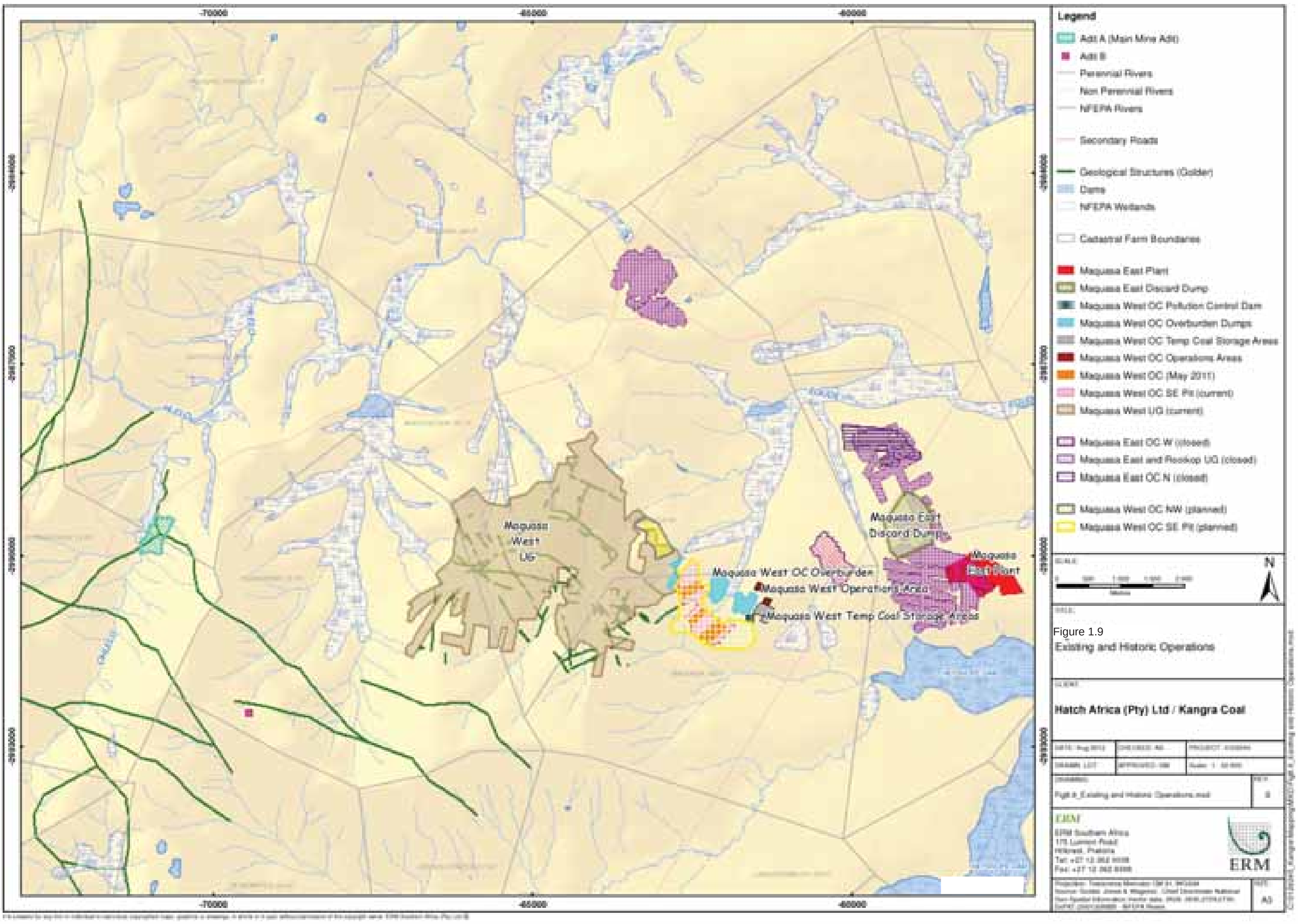
Reserve	Mining Method	Current Status
Maquasa West U/G	Underground, B&P, stooping	Active
Maquasa West O/C	Open Cast, roll-over method	Active and planned
Maquasa East U/G	Underground, B&P, stooping	Closed
Maquasa East O/C 1	Open Cast, roll-over method	Closed
Maquasa East O/C 2	Open Cast, roll-over method	Closed
Rooikop U/G	Underground, B&P, stooping	Closed

The existing mining operations (currently operating and closed open pit and underground mines) were included in the model in the steady state calibration phase. This was necessary because most of the available water levels used as observations to calibrate the model were taken recently and represent current conditions rather than pre-mining conditions for the existing mines. However, the implementation of the existing operations in the model had to be simplified for the following reasons.

Available information pertaining to the existing mines was limited. Only information compiled for the environmental approval process, environmental management plan reports (EMPRs), and anecdotal information provided by Kangra Coal, were available. Mine water inflows are currently not monitored by Kangra Coal and therefore only estimations of inflow volumes were available for the currently operating mines in the Maquasa West area from anecdotal information provided by Kangra Coal and groundwater modelling results (GCS, 2002). Furthermore, only plans detailing the current situation and mining extent were made available by Kangra Coal (no schedules i.e. mine footprint and depth expansion over time made available).

A maximum inflow from the current open cast operations was estimated at 110m^3/d, taking into account anecdotal information that the pollution control dam (volume of 14,000m^3) doesn't overflow in the dry season [(1)], and available evaporation data from Piet Retief weather station (ERM, 2011). Maximum inflows into the current underground mining operations were estimated to be 1,440m^3/d (GCS, 2002).

(1) [1] Email conversation with Ramon Silva (Kangra Coal). 29 September 2011. (Forwarded by Shelley Willock (Hatch), 29 September 2011).


-70000
-65000
-60000
Maquasa West UG
Maquasa West OC Overburden
Maquasa West Operations Area
Maquasa West Temp Coal Storage Areas
Maquasa East Discard Dump
Maquasa East Plant
Legend
Adit A (Main Mine Adit)
Adit B
Perennial Rivers
Non Perennial Rivers
NFEPA Rivers
Secondary Roads
Geological Structures (Golder)
Dams
NFEPA Wetlands
Cadastral Farm Boundaries
Maquasa East Plant
Maquasa East Discard Dump
Maquasa West OC Pollution Control Dam
Maquasa West OC Overburden Dumps
Maquasa West OC Temp Coal Storage Areas
Maquasa West OC Operations Areas
Maquasa West OC (May 2011)
Maquasa West OC SE Pit (current)
Maquasa West UG (current)
Maquasa East OC W (closed)
Maquasa East and Rooikop UG (closed)
Maquasa East OC N (closed)
Maquasa West OC NW (planned)
Maquasa West OC SE Pit (planned)
N
Figure 1.9
Existing and Historic Operations
Hatch Africa (Pty) Ltd / Kangra Coal
ERM

The currently operating Maquasa West underground mine was implemented in the model using the drain package. The March 2011 mining extent was used and kept constant. The drain elevation was set equal to the DUN seam floor elevation and the drain conductance value was calibrated using the estimated inflow volumes detailed above. Groundwater recharge over the underground mine was increased as detailed in *Table 1.3*.

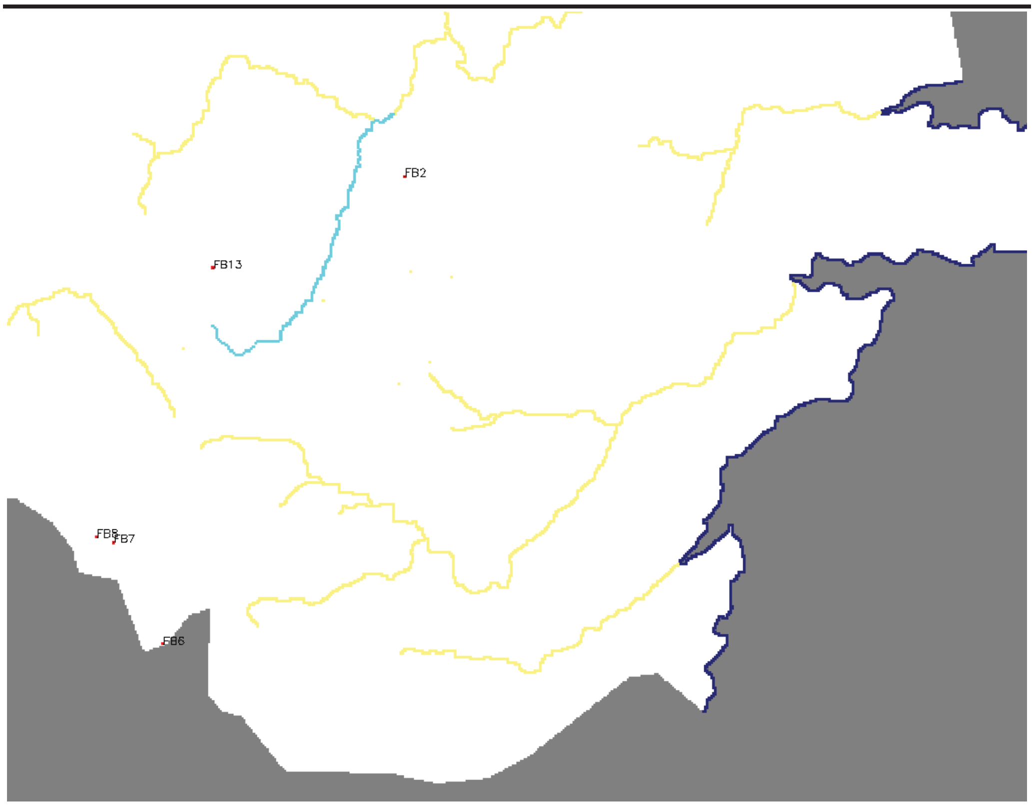
The current open cast operations at Maquasa West were implemented using constant head cells for the mining extent as of March 2011. Groundwater recharge over the open cast mine was increased as detailed in *Table 1.3*.

For closed mines (Maquasa East and Rooikop), transmissivity and recharge were increased in and around mining operations. Transmissivities were increase by a factor 2 for underground mines and by a factor 3 for open cast mines. Model recharge values for the existing mines are detailed in *Table 1.3* and transmissivity values in *Table 2.2*.

K1.1.10 Existing Groundwater Abstraction

A total of five private abstraction wells, which were identified during the hydrocensus (refer to *Section Error! Reference source not found.*), are located within the model domain. They were implemented in the model using the well package. *Figure 1.10* shows the location of these private boreholes.

Figure 1.10 Abstraction Well Locations (red dots)



Details pertaining to the modelled private abstraction wells are presented in *Table 1.5*. Abstraction rates were estimated based on information obtained from the well owners. The much higher abstraction rate of the wind pumps are related to the fact that wind pumps continuously pump groundwater through-out day and night as the wind blows.

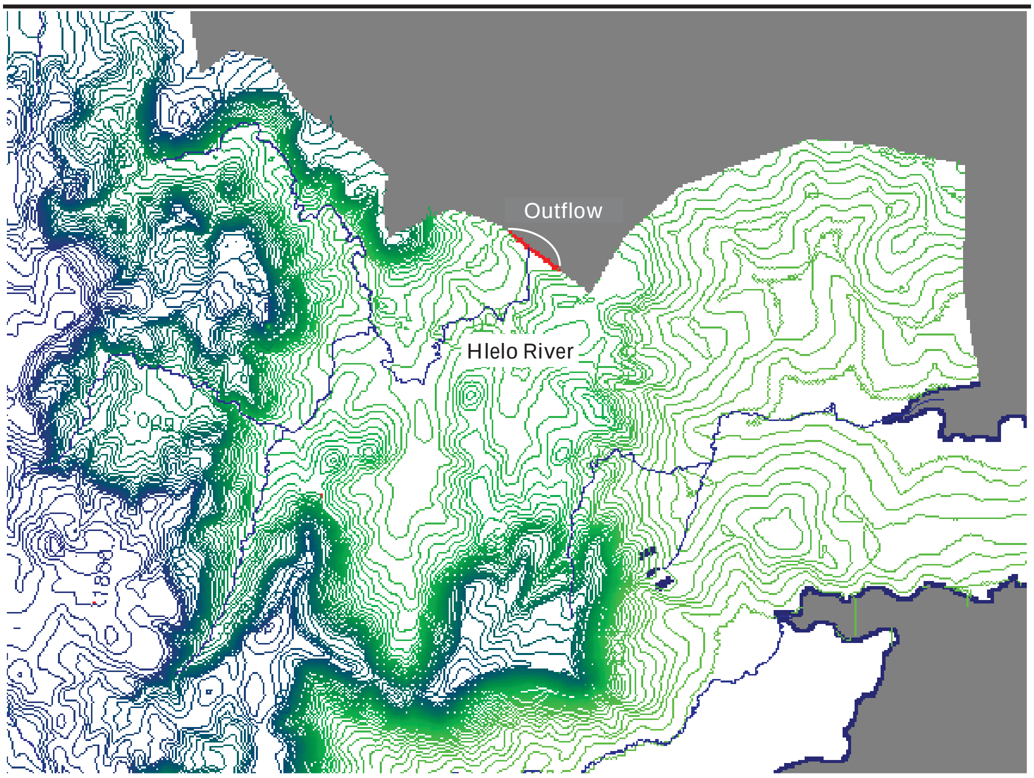
Table 1.5 Abstraction Well Details

Name	Pump Equipment	Abstraction Rate (m^3/d)	Owner
FB2	Hand Pump	0.7	Yende Community (Twyfelhoek school)
FB6	Submersible	0.6	C.L. Greyling
FB7	Wind Pump	56.8	C.L. Greyling
FB8	Wind Pump	56.8	C.L. Greyling
FB13	Wind Pump	56.8	C.J.F. Greyling

K1.1.11 Groundwater Outflow – Hlelo River

The Hlelo River leaves the model domain in the north-east. It is assumed that some groundwater flow is taking place across the model boundary in the Hlelo valley. *Figure 1.11* shows the location of the Hlelo River leaving the model domain.

Figure 1.11 Groundwater Outflow Location – Hlelo River (Topographic Map)



The groundwater darcy flow leaving the model domain was calculated using using the Darcy equation (i):

(i) $v_f = k_f \cdot i$ *Darcy Equation*

Where v_f is the groundwater Darcy velocity, k_f is the hydraulic conductivity of the matrix and i is the hydraulic gradient.

Flow volumes (Q) were calculated using the following equation (ii):

(ii) $$Q = v_f \cdot \frac{1}{n_e} \cdot A$$

Where v_f is the groundwater Darcy velocity, n_e is the effective porosity of the matrix and A is the flow area, which equals water level elevation minus aquifer bottom times the width of the flow section.

Parameters and flow volumes are detailed in *Table 1.6*.

Table 1.6 Groundwater Outflow – Hlelo River

Parameter	Unit	Low Recharge Scenario	High Recharge Scenario
Hydraulic Conductivity	m/d	1E-02	3E-02
Groundwater Gradient	-	6E-03	6E-03
Effective Porosity	-	0.25	0.25
Flow Area	m^2	129,360	129,360
Total Flow volume	m^3/d	42.8	92.2
Number of Cells	-	21	21
Flow Volume per Cell	m^3/d	2.0	4.4

Notes: NM Not measured

K1.2 STEADY STATE CALIBRATION

A steady state calibration was performed for both recharge scenarios detailed in *Section K1.1.6*. During the model calibration phase, the following parameters were optimized in order to obtain an acceptable fit of calculated versus observed water levels:

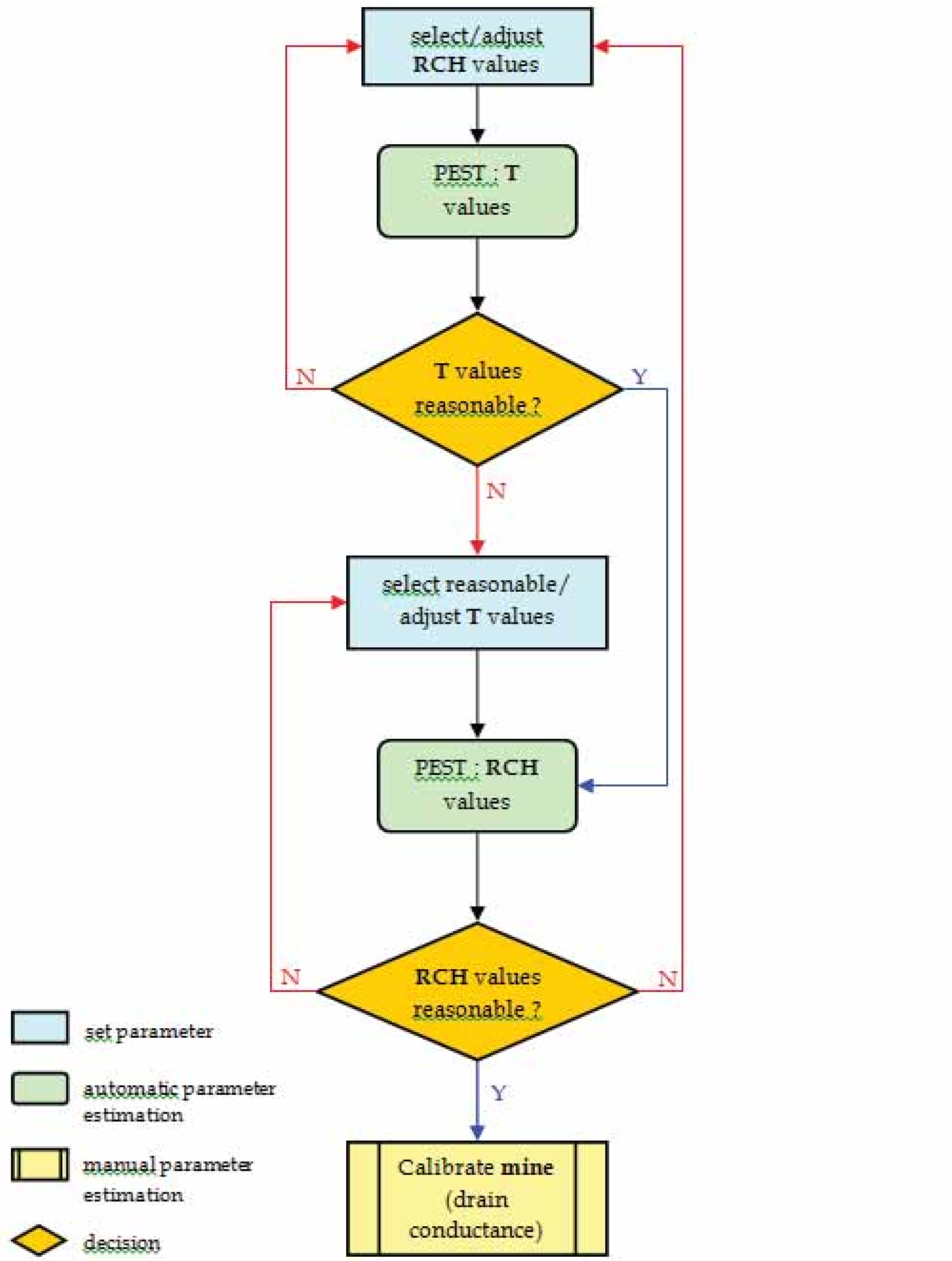
- Transmissivity (eight T zones, *Table 1.1*);
- Recharge distribution (seven RCH zones, *Table* 1.2); and
- Drain conductance (Maquasa West underground mine).

Calibration was performed using both manual and automated methods. PMWIN includes a number of automated parameter estimation methods of which PEST (Doherty et al. 1994) was used.

Mine inflow volumes (Maquasa West) calculated by the model were manually calibrated against available information (refer to *Section K1.1.9*). Base flow to rivers and streams was also compared with literature values (DWAF, 2006).

Transmissivities and recharge parameters were never optimized simultaneously. Each of these parameter groups were optimized separately, in several iterations. An example flow chart of the parameter optimization process is depicted in *Figure 1.12*.

Figure 1.12 Parameter Optimization Process



K1.2.1 Observation Borehole Selection

Available borehole data was studied carefully and suitable boreholes were selected as observations for model calibration. Water level data was available from the National Groundwater Archive (NGA), ERM hydrocensus, ERM drilling and GCS (2009).

The selection criteria were as follows:

- Recent water level measurements (ERM hydrocensus and drilling) were given priority;
- Only boreholes tapping the regional aquifer were selected, i.e. boreholes located on top of the mountains, intersecting shallow perched aquifers, were excluded (ERMBH5, ERMBH6, ERMBH10);
- In areas, where the water level is impacted by mining (i.e. in proximity to Maquasa West mine), only current water levels were used where available;
- Abstraction wells were not used as observations unless steady state water levels were available; and
- Where more than one borehole was located in one model cell, only one water level was used.

In total 31 observations were used for the steady state calibration of the local groundwater flow model. The data sources (observed water levels) are as follows:

- 11 NGA boreholes (DWA, National Groundwater Archive (1));
- 13 ERM hydrocensus boreholes;
- 7 ERM recently drilled percussion boreholes.

The observation boreholes and water levels used in the model calibration are detailed in *Table* 1.7. The observation points have been grouped as follows with regards to different criteria including location and data source:

- Group 1: ERM boreholes Kusipongo
- Group 2: Kusipongo exploration boreholes, high altitude;
- Group 3: Maquasa West boreholes; and
- Group 4: ERM hydrocensus and NGA data points.

The group number also details the hierarchy of importance of the observations for the model calibration, with group 1 being the most important both in terms of the project and data quality.

(2) [1] Data supplied by the Department of Water Affairs (DWA), who is the proprietor of the relevant copyright.

Table 1.7 *Observation Boreholes Local Model*

BHID	Date	X	Y	Z	DOH (m)	WL (mamsl)	Source	Group
ERMBH1	11-Mar	-70939	-2989957	1532	60	1520	ERM	1
ERMBH2	11-Mar	-71021	-2989659	1502	40	1499	ERM	1
ERMBH3	11-Mar	-70738	-2989013	1489	46	1476	ERM	1
ERMBH4	11-Mar	-68883	-2994432	1429	70	1428	ERM	1
ERMBH7	11-Mar	-74623	-2993168	1742	100	1737	ERM	1
ERMBH8	11-Mar	-70830	-2989598	1510	60	1499	ERM	1
ERMBH9	11-Mar	-71538	-2990606	1537	60	1531	ERM	1
BW34005	11-Mar	-70912	-2992667	1741	117	1660	ERM	2
DH14005	11-Mar	-73951	-2992208	1790	113	1692	ERM	2
DH14032	11-Mar	-72742	-2989845	1733	185	1668	ERM	2
DH14046	11-Mar	-73955	-2991056	1792	96	1780	ERM	2
FB12	11-Mar	-66417	-2987818	1460	-	1452	ERM	3
GCS1	11-Mar	-64406	-2988863	1476	-	1418	ERM	3
GCS3	11-Mar	-63186	-2989606	1417	-	1414	ERM	3
NGOH83	11-Mar	-66193	-2988924	1488	13	1478	ERM	3
NGOH85	11-Mar	-65894	-2989255	1486	-	1472	ERM	3
NGOH87	11-Mar	-65820	-2989376	1467	45	1459	ERM	3
FB16	11-Mar	-57969	-2987544	1327	-	1318	ERM	4
FB18	11-Mar	-60033	-2990395	1376	19	1364	ERM	4
FB19	11-Mar	-59966	-2990336	1381	-	1361	ERM	4
2630CC00051	-	-77827	-2975376	1640	43	1628	NGA	4
2730AA00040	-	-75717	-3000418	1740	80	1735	NGA	4
2730AA00041	-	-81935	-2997441	1730	20	1720	NGA	4
2730AA00059	-	-77354	-2998612	1750	80	1735	NGA	4
2730AB00007	-	-55264	-2991388	1320	100	1311	NGA	4
2730AB00011	-	-54587	-2988488	1320	67	1309	NGA	4
2730AB00026	-	-62826	-3000500	1330	26	1326	NGA	4
2730AB00037	-	-63266	-2995147	1310	12	1299	NGA	4
2730AB00038	-	-64595	-2999217	1360	12	1359	NGA	4
2730AB00040	-	-67823	-3003574	1370	40	1367	NGA	4
2730AB00041	-	-68079	-3001935	1380	100	1347	NGA	4

Notes: All coordinates in WGS84, LO31

BHID Borehole ID
DOH Depth of hole
WL Water level
mamsl Metres above mean sea level
\- Not measured or unknown

K1.3 *LOCAL TRANSIENT GROUNDWATER FLOW MODEL*

During model setup, the steady state groundwater flow model is converted into a transient ("time-dependent") groundwater flow model in order to run a number of simulations and predictive model scenarios.

The geometry of the model domain, boundaries, top and bottom of the layers, discretization and layer type were taken from the steady state model as well as the optimized time-independent parameters like transmissivities, recharge values, drain- and river conductance etc. The solution of the calibrated steady state model was used as initial hydraulic head distribution.

K1.3.1 Transient Calibration

Transient simulations require an additional parameter, specific storage, which needs to be calibrated. Specific storage is the amount of water per unit volume of a saturated formation that is stored or expelled from storage owing to compressibility of the mineral skeleton and the pore water per unit change in head. No field measurements were available for this parameter.

During the transient calibration specific storage was optimized in order to reproduce the water levels measured during the aquifer tests (including recovery phase) of the following boreholes:

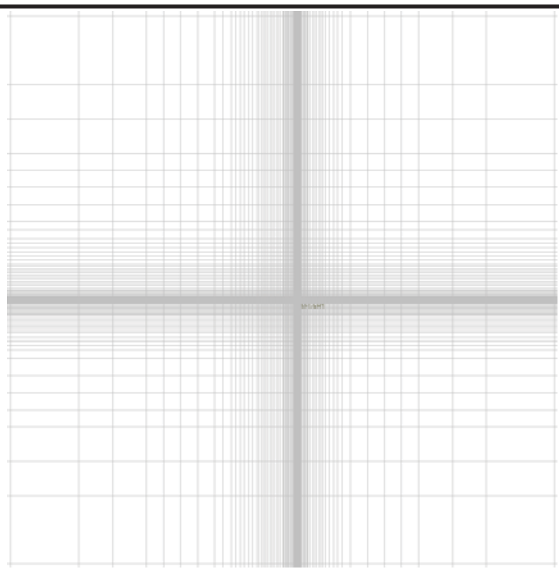
- ERMBH1;
- ERMBH3;
- ERMBH4;
- ERMBH7;
- ERMBH8; and
- ERMBH10.

Grid Refinement

A different model was created for each of the boreholes. In a first step, the model grid needs to be gradually refined around the tested borehole. The cell size within which the tested well is located should ideally represent the borehole diameter (165mm). However, due to model restrictions, the grid could only be refined to a cell size of 195mm, which is considered sufficiently accurate. As an example, *Figure 1.13* details the grid refinement around ERMBH1, where the biggest cells (in the corners) are 50m by 50m in size.

Then a steady state run was performed with the refined grid in order to re-calculate the initial head distribution and rule out any interpolation errors, created due to the refinement.

Figure 1.13 Grid Refinement ERMBH1



Stress Periods and Time Steps

Time unit (minutes), stress periods and time steps were chosen in order to accurately represent the pump tests for the respective boreholes. An example of the time discretization is presented in *Table 1.8*.

Table 1.8 Stress Periods and Time Steps - ERMBH1: 24 Hour Pump Test

Stress Period Number	Length (min)	Total Time (min)	Number of Time Steps	Notes
1	525,600	525,600	12	1 year dry run
2	3	525,603	3	Pump test (24hrs)
3	4	525,607	2	
4	3	525,610	1	
5	10	525,620	2	
6	20	525,640	2	
7	20	525,660	1	
8	180	525,840	6	
9	360	526,200	6	
10	840	527,040	7	
11	3	527,043	3	Recovery (24hrs)
12	4	527,047	2	
13	3	527,050	1	
14	10	527,060	2	
15	20	527,080	2	
16	20	527,100	1	
17	180	527,280	6	
18	360	527,640	6	
19	840	528,480	7	
20	840	529,320	1	Post-recovery (6 x 14hrs)
21	840	530,160	1	
22	840	531,000	1	
23	840	531,840	1	
24	840	532,680	1	
25	840	533,520	1	

Observation Boreholes

For each pump test the closest monitoring boreholes were monitored using water level loggers. However, no water level fluctuations were recorded in any of the boreholes that were monitored. Therefore only water levels measured in the tested boreholes could be used as observations for the calibration process.

Observation data is detailed in *Annex L*.

K1.3.2 Mining Groundwater Flow Model Setup

The model setup for the mining models is detailed in the following sections.

Stress Periods and Time Steps

Mining progress plans (mining schedule) provided by the client indicate the stages of the proposed mine on an annual basis over a time period of 19 years, starting in year 2014 and ending in 2032 independently for both coals seams. Each year was represented by an individual stress period in the model.

Kusipongo Underground Mine

The planned underground mine was implemented using the drain package. The drain elevation was computed using the elevation data for the coal seam floors provided by the client. The mining schedule is displayed in *Figure 1.14* for the GUS seam and in *Figure 1.15* for the DUN seam.

Recharge

Based on information provided by Hatch it was assumed that the currently proposed mining at the Kusipongo site will not have any significant influence on groundwater recharge and therefore recharge was kept constant throughout mining and post-closure.

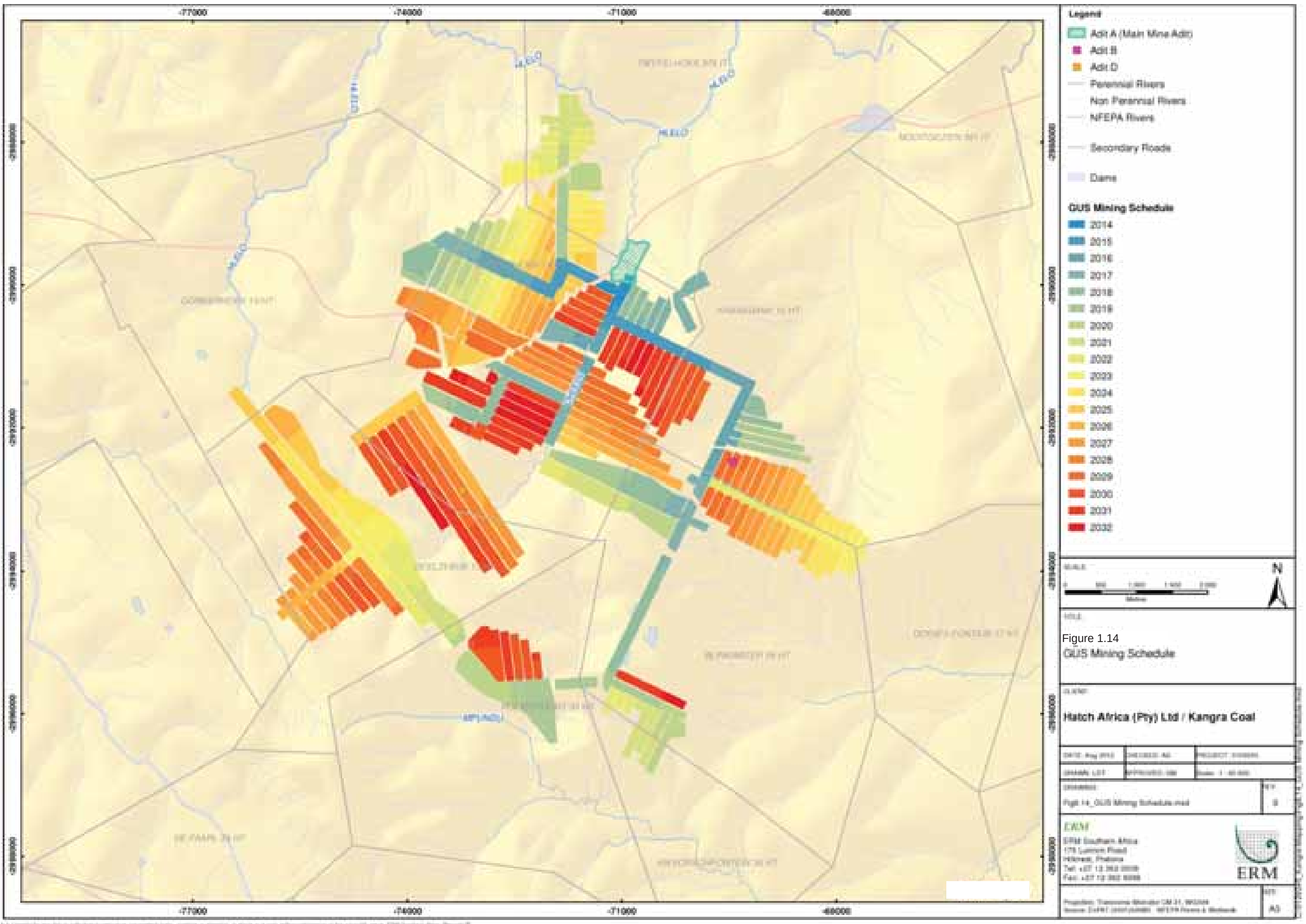


Figure 1.14
GUS Mining Schedule

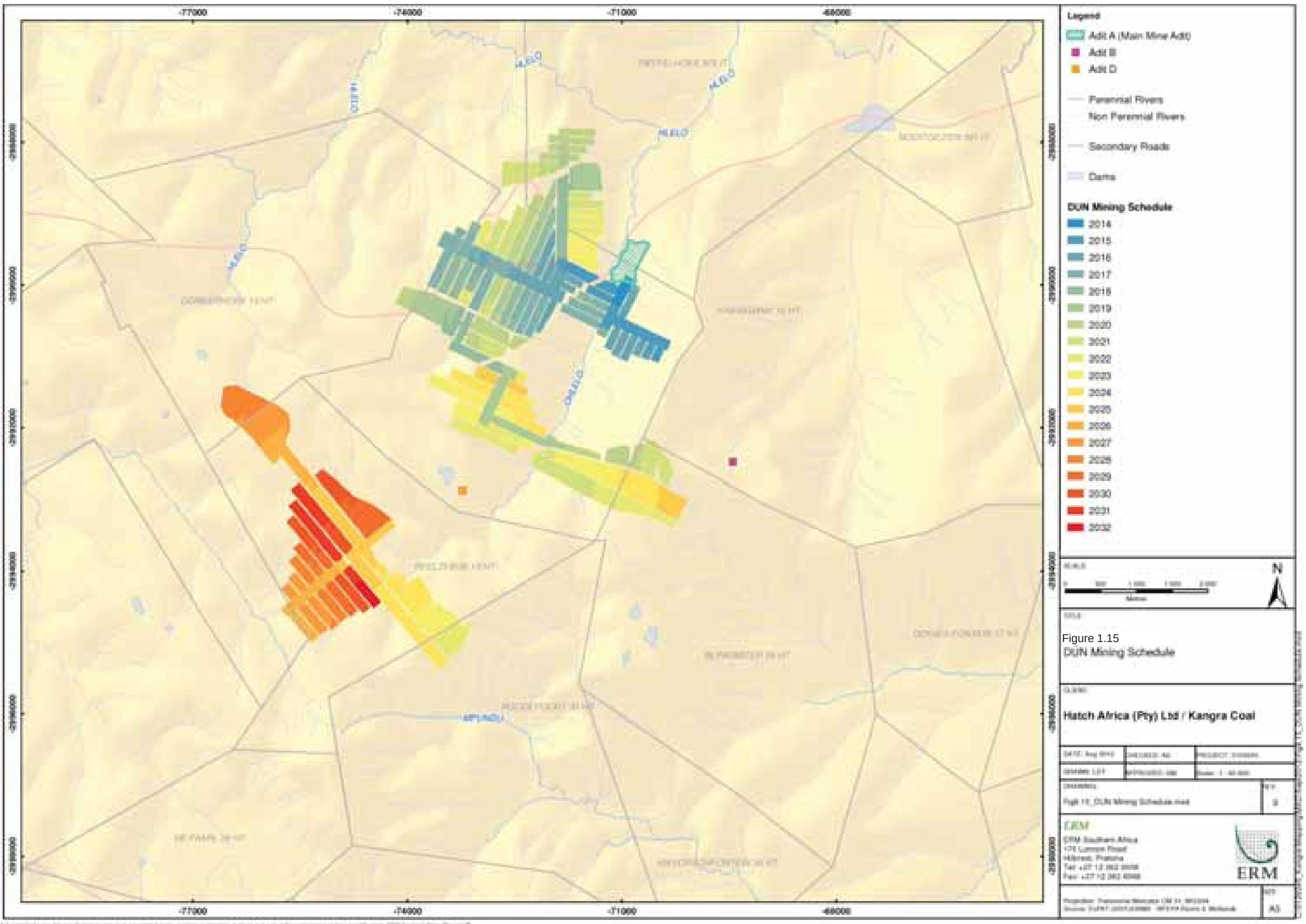


Figure 1.15
DUN Mining Schedule

K1.3.3 Post Closure Groundwater Flow Model Setup

This paragraph details the set-up of the post closure models.

Scenarios

Since the coal seams were not modelled as individual layers based on available data, the post closure models had to be simplified. As detailed by Hatch, the underground mine was designed for zero subsidence. Therefore, the final mine void will stay open and inter-connected with the adit and will act as a drain if the adit is located at an elevation lower than the recovery water level. Pre-mining groundwater elevations in the mining area are between 1,450mamsl in the east to 1,800mamsl in the west.

It was further assumed that no water storage will take place underground and therefore the entire mine will be kept dry during mining (as per discussions with Hatch). Furthermore, it was assumed that there will be no water, sludge of waste rock (backfill) pumped or deposited underground during mining and after mine closure.

Two different post-closure scenarios were therefore modelled to outline the potential range of post-closure groundwater impacts including (i) drawdown and radius of influence, and (ii) mine water decant:

I. *Worst Case:* Adit located where currently planned (elevation: 1,520mamsl); and
II. *Best Case:* Adit located above highest pre-mining waterlevel elevation within the planned mining footprint (elevation of 1,810mamsl).

Hatch provided following total volumes mined for each of the coal seams:

- GUS: 75,138,600m^3; and
- DUN: 20,642,400m^3.

Scenario I: After mine closure, groundwater flow is expected to remain towards the mine. As soon as pumping activities, sustained during mining to keep the mine dry, will cease, mine voids will start to fill up. Water will start to pond in low lying areas of the mine voids and the water level in the mine void will rise accordingly. Once the water level in the mine void is above the adit elevation of 1,520mamsl, groundwater is expected to start decanting from the adit opening.

For this scenario, the drains representing the underground mine were left active during the entire post closure model to represent the filling up of mined voids for each coal seam respectively and to calculate the generated decant volumes.

Scenario II: After mine closure, groundwater flow is expected to be towards the mine and drawdowns are expected to increase until the mined voids are completely filled with water. For this simulation, the drains were left active only until the total additional drain volume reached the total volumes mined for each coal seam respectively (filling up of mined out voids), where after the drains were switched off to simulate the recovery of groundwater levels.

Stress Periods and Time Steps

In order to assure numerical stability of the model, 1-year time steps were implemented until both mine voids were full, which was reached after 14 years. Thereafter, stress period lengths were increased exponentially, which resulted in a total of 142 years of post-closure modelling.

Table 1.9 Stress Periods - Post Closure Modelling

Stress Period Number	Stress Period Length (days)	Year	Notes
1	365	2033	
2	365	2034	
3	365	2035	
4	365	2036	
5	365	2037	
6	365	2038	
7	365	2039	
8	365	2040	
9	365	2041	DUN full
10	365	2042	
11	365	2043	
12	365	2044	
13	365	2045	
14	365	2046	GUS full
15	365	2047	
16	365	2048	
18	730	2050	
22	1460	2054	
30	2920	2062	
46	5840	2078	
78	11680	2110	
142	23360	2174	

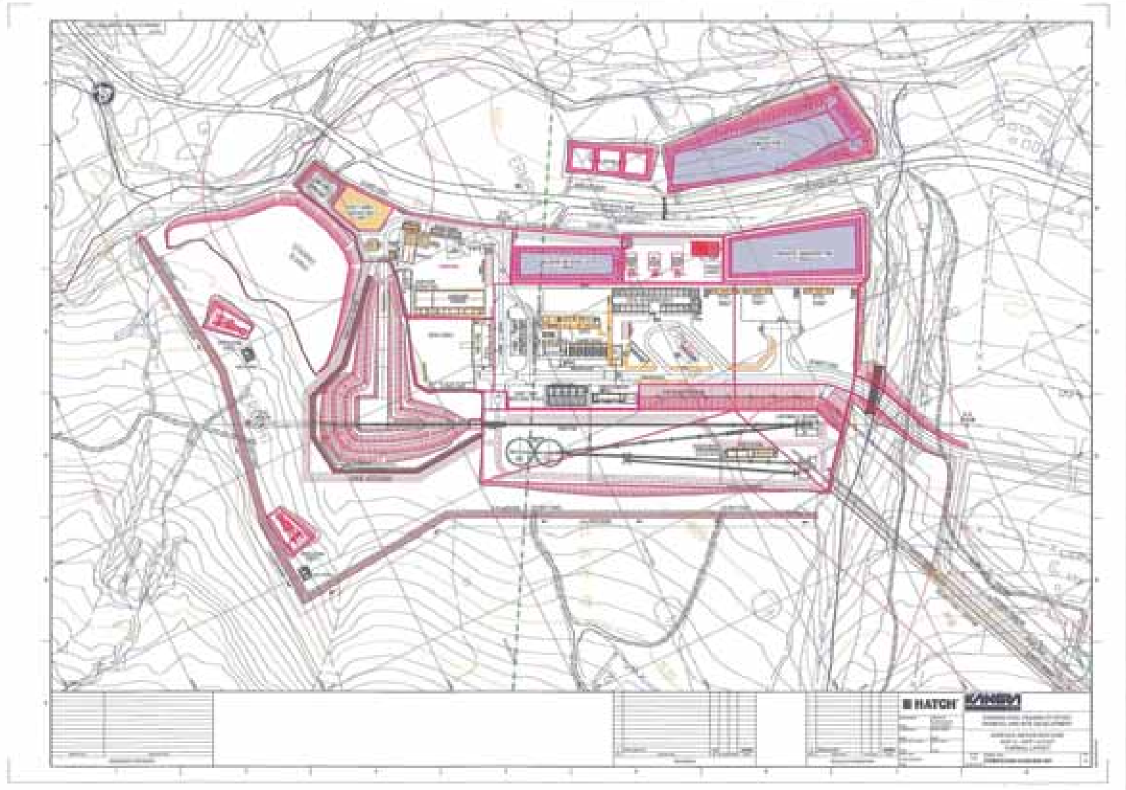
K1.4 *TRANSIENT MODEL – SOLUTE TRANSPORT MODEL SETUP*

This section details the setup of the solute transport models. Groundwater quality impacts of the proposed project were assessed using the MT3DMS package to simulate solute transport in the model. Contamination sources identified in the conceptual model were considered for the transport model. Data on the adit layout is currently only available for the Adit A location in the oHlelo valley and therefore the transport modelling was solely based on this configuration as communicated by Hatch (*Figure 1.16*).

The primary mechanisms that control the transport of solutes (contaminants) in porous aquifers are *advection* and *hydrodynamic dispersion*. Advection is the mass transport caused by the bulk movement of flowing groundwater. Contaminant transport influenced by advection only, will move in the direction of the groundwater flow at the rate of the mean groundwater flow velocity. Hydrodynamic dispersion occurs as a result of mechanical dispersion and molecular diffusion.

Dispersive spreading causes a gradual dilution of the contaminant plume within and transverse to the main flow direction. Solutes that are controlled primarily by advection and dispersion are termed *conservative*. Anions, such as chloride, sulphate or nitrates are conservative tracers and its migration in groundwater is therefore primarily controlled by advective and dispersive flux.

Figure 1.16 Proposed Site Layout for Adit A



K1.4.1 Source Location and Input Concentration

Each of the contamination sources identified in the conceptual model were considered for the transport model, including:

- Leachate from the overburden dump; and
- Leachate from dust deposition within the crushing and conveyor belt area.

The location of the contamination sources as implemented in the model is shown in *Figure 1.17.*

As the storm water management ponds will be lined (Hatch, 2010), contamination is assumed to be insignificant compared to the other sources and therefore they were not included in the transport model. Contaminated water resulting from mine inflows into the underground workings is also not considered, as this water will be treated prior to release into the natural water course (Hatch, 2010).

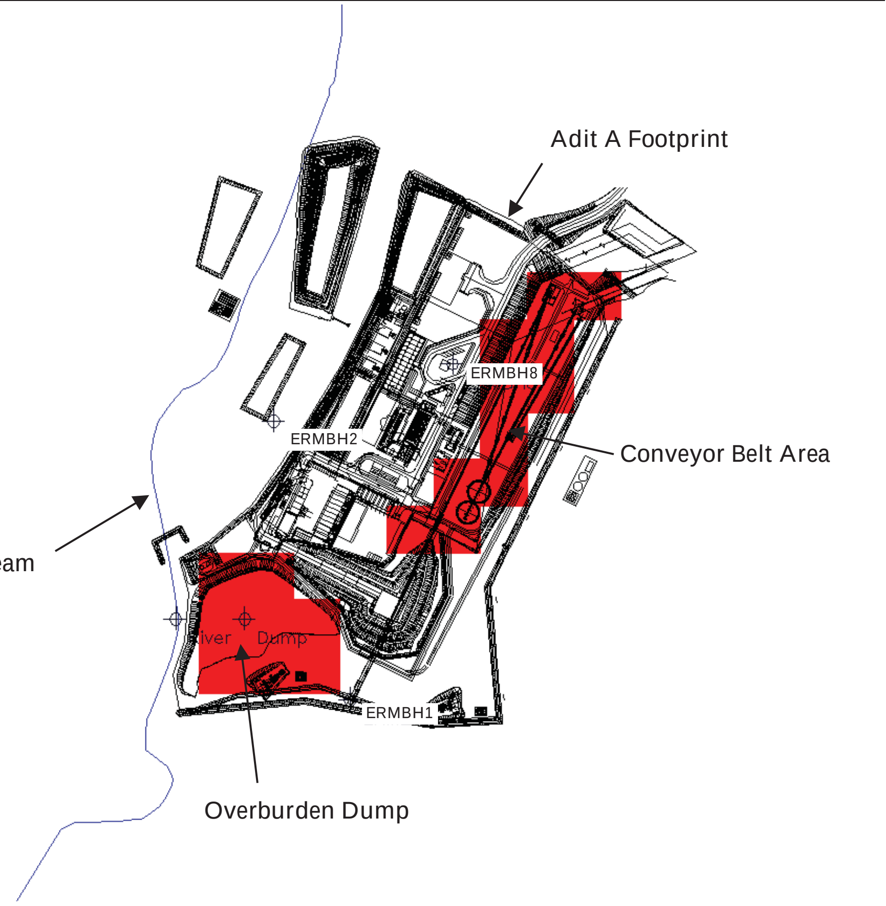
Sulphate (SO_4) was selected as an indicator of contamination for the transport model. Sulphate it is a conservative tracer (transported via advection and dispersion), providing an indication of the maximum potential contaminant extent.

Baseline SO_4 groundwater concentrations were not implemented into the model, in order to assess the impact strictly in relation to additional contamination emerging from mining activities. The actual concentration can be estimated by adding the predicted value from the model to the measured baseline concentration (2.7mg/L in groundwater, 2.9mg/L in surface water).

Sulphate input concentrations calculated by geochemical modelling were used as groundwater contaminant recharge concentrations on the selected areas. A concentration of 1,530 mg/L was used for the overburden dump and 510mg/L for the conveyor belt section.

Leaching was assumed to take place over a duration of 64 years. The duration was based on geochemical modelling and rounded up to the nearest stress period following a conservative approach. Afterwards the source of contamination was removed from the model.

Figure 1.17 *Location of Contamination for Solute Transport Model (red color): Overburden Dump and Conveyor Belt Area*



K1.4.2 *Transport Parameters*

A number of reasonable assumptions for transport parameters had to be made because of the lack of site specific data. A sensitivity analysis was conducted in order to assess the relative sensitivity of the model with respect to a number of input parameters.

Due to the increased porosity and hydraulic conductivity of the overburden dump material, an increase in groundwater recharge in the area of the overburden dump is expected. This was modelled by increasing the recharge to a value corresponding to 20% of the MAP (based on Vermeulen et al. 2006).

No site specific field measurements are available for dispersivity. As a conservative assumption, the horizontal longitudinal dispersivity (α_L) is approximately 0.1 of the advective travel distance of the plume. Therefore a model was run with only advection to determine the relevant plume extent, which is approximately 1km. Therefore an α_L of 100m was used in the models. Horizontal transversal dispersivity (α_T) was assumed at one tenth of α_L and the vertical dispersivity at one tenth of α_T.

No site specific field measurements are available for molecular diffusion either. The molecular diffusion coefficient (D) is generally very small and negligible compared to the mechanical dispersion and is only important when groundwater velocity is very low. For major ions in water, D ranges from $1*10^{-9}$ to $2*10^{-9}$ m^2/s (Fetter, 2001). A conservative, effective diffusion coefficient (D*) of $1*10^{-11}$ m^2/s ($8.64*10^{-7}$ m^2/d) was used in the models [(3)].

Table 1.10 shows the set of transport parameters used in the model.

Table 1.10 Transport Parameters used in Solute Transport Model

Transport Parameter	Unit	Value
Recharge concentration	mg/l	1,530 for overburden dump 510 for conveyor belt section
Horizontal longitudinal dispersivity	m	100
Horizontal transversal dispersivity	m	10
Vertical dispersivity	m	1
Molecular diffusivity	m^2/day	9E-07

K1.4.3 Observation Boreholes

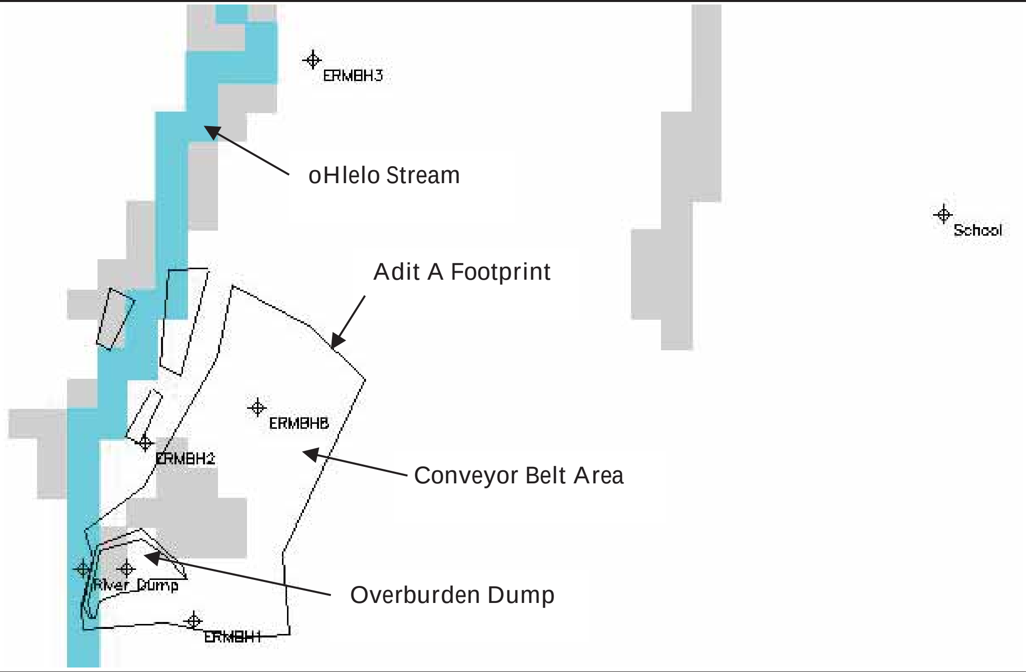
A number of observation points were selected in order to assess the temporal variation in contaminant concentration for the solute transport model and potential water quality impacts on groundwater users. Refer to *Table 1.11* and *Figure 1.18* for a description and location of the concentration observation points.

Table 1.11 Description of Contaminant Concentration Observation Points

Observation Point Name	Description	Notes
ERMBH01	Located within Adit A complex, close to mine entrance shaft.	Real boreholes, which can be monitored and sampled in order to assess accuracy of the model predictions.
ERMBH02	Located 50m outside Adit A complex, between Adit A complex and oHlelo Stream.	
ERMBH03	Located approximately 500m north of Adit A complex. Hatch is considering to use this borehole for water supply to the Adit (Hatch, 2011).	
ERMBH08	Located within Adit A complex, close to conveyor belt section.	
School	Borehole FB2 located at the Twyfelhoek School approximately 1km north-east of Adit A.	
Dump	Located right on top of the overburden dump.	Virtual concentration observation points.
River	Located in river cell, monitors concentration of contaminant in groundwater in close proximity to the oHlelo Stream (virtually below the river).	

(1) [3] Freeze and Cherry (1979) determined D* = ω D, with ω ranging from 0.5 to 0.01 for species that are not absorbed onto the mineral surface. A conservative value of 0.01 was therefore assumed for ω.

Figure 1.18 Location of Concentration Observation Points for Solute Transport Model



K1.4.4 Sensitivity Analysis

A sensitivity analysis was conducted to investigate the sensitivity of the model output with respect to different input parameters. The different scenarios were then evaluated by comparing the concentration over time calculated at different observation points (see *Section K1.4.3*) with regards to a reference scenario.

It should be noted that the sensitivity analysis is not a worst-case / best-case scenario evaluation. It is strictly set to see how strong each parameter affects the model result.

Table 1.12 Parameters used for Sensitivity Analysis

Scenario Name	**Parameter changed**	**Reasoning for parameter value**
High Concentration Scenario	Recharge concentration on overburden dump: 6,340mg / l Recharge concentration on conveyor belt section: 1,170mg / l	The uncertainty of the input concentration arises from the assumptions related to the geochemical modelling. The elevated concentration for the overburden dump represents the highest calculated concentration under non-equilibrium conditions. The elevated recharge concentration for the conveyor belt section represents a high estimate under equilibrium conditions.

Scenario Name	Parameter changed	Reasoning for parameter value
Low Concentration Scenario	Recharge concentration on overburden dump: 180mg/l Recharge concentration on conveyor belt section: 30mg/l	The low concentrations represent low estimates under equilibrium conditions.
High Recharge Scenario	Recharge on overburden dump: $2 \cdot 10^{-3}$ m/day (=30%MAP)	High estimate of groundwater recharge on overburden dump.
Low Recharge Scenario	Recharge on overburden dump: $3 \cdot 10^{-4}$ m/day (=5%MAP)	Value corresponding to the groundwater recharge value of surrounding area, assuming no change in recharge takes place because of the overburden dump.
High Dispersivity Scenario	Horizontal dispersivity: 1,000m	Increase by factor 10.
Low Dispersivity Scenario	Horizontal dispersivity: 10m	Decrease by factor 1.
Infinite Leaching Scenario	No termination of contaminant recharge to the model	Investigate the influence of an increased leaching duration
Short Leaching Scenario	Termination of contaminant recharge to the model at end of mining	Investigate the influence of a decreased leaching duration

Annex L

Local Numerical Groundwater Flow and Transport Model Results

L1 MODELLING RESULTS – LOCAL MODEL

The following sections detail the results of the local model including steady state calibration, transient calibration, mine- and post-closure models and solute transport models. This annex completes the modelling results included in the main report.

L1.1 STEADY STATE GROUNDWATER FLOW MODEL CALIBRATION

This section details the steady state calibration results of the local groundwater flow model.

L1.1.1 Scatter Diagram

Calculated piezometric heads are compared to observed heads for both recharge scenarios in *Figure 1.1* and *Figure 1.2*. The observation points have been grouped with regards to different criteria including location and data source.

Calibration mainly focused on the group one and two observations (ERM boreholes Kusipongo and Kusipongo exploration boreholes, high altitude), which are deemed the most important boreholes in terms of the data quality and model objectives. Therefore the calibration is better for these boreholes.

In the Maquasa West area for both scenarios, the model calculated water levels are mainly lower than the observed values. For the hydrocensus and NGA data points located far away from the study area (Kusipongo reserve) there is no clear trend visible on the graphs.

The root mean square error of the model calibrations are 19m and 18m for the low and the high recharge scenarios respectively, which is considered to be sufficiently small, given the big model area, limited data and given that the maximum head difference over the model area is nearly 500m.

Figure 1.1 Scatter Diagram of Calculated vs. Observed Heads – Low Recharge Scenario

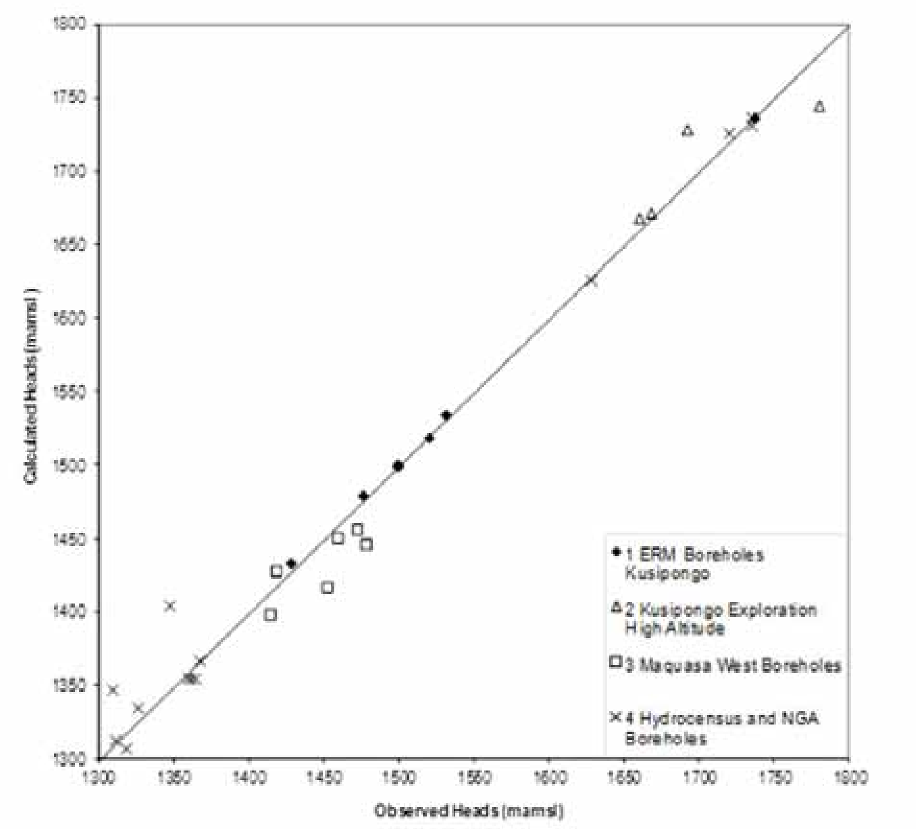
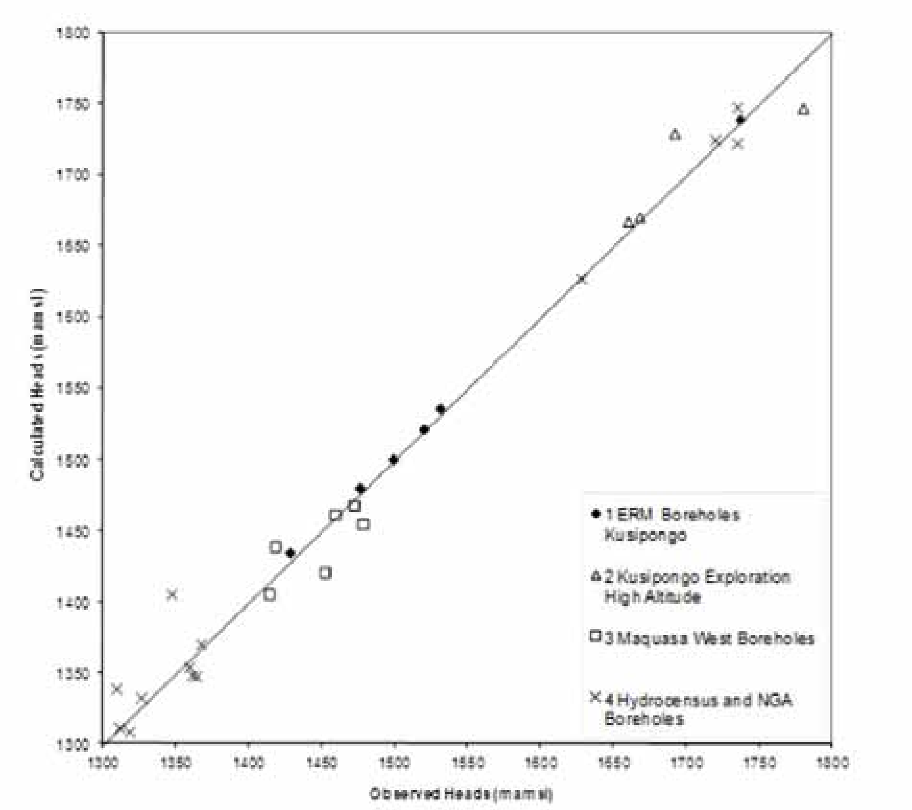
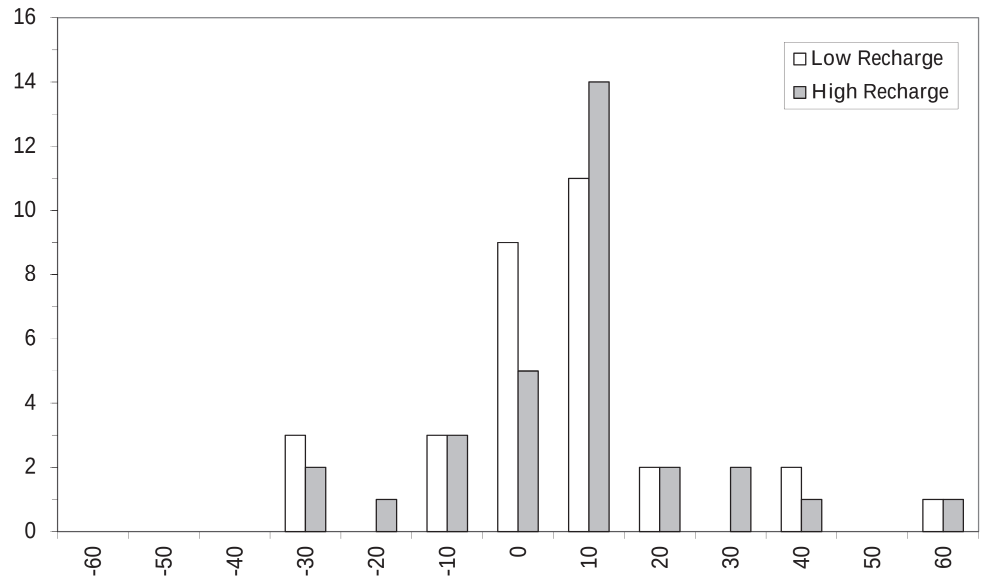


Figure 1.2 Scatter Diagram of Calculated vs. Observed Heads – High Recharge Scenario



In *Figure 1.3* the histogram of the differences between observed and calculated head values (residuals) is plotted for both recharge scenarios. Class "0", for example indicates how many residuals were between -10 and zero. The histogram shows that the model slightly over-predicts, rather than under-predicts water levels.

Figure 1.3 Histogram of Residuals (Observed Minus Calculated Heads)



L1.1.2 Parameter Correlation Coefficient Matrix

The parameter correlation coefficient matrix (also covariance matrix) contains important information about parameter correlation. A high correlation coefficient between two values (>0.95) means that the values depend on each other, i.e. the same heads can be reproduced by changing the two values accordingly. Only for small non-diagonal values of the correlation coefficient are the calibrated parameters independent.

Parameter correlation coefficient matrices are presented in *Table 1.1* and *Table 1.2* for the low recharge scenario and in *Table 1.3* and Table 1.4 for the high recharge scenario.

Table 1.1 Transmissivity Parameter Correlation Coefficient Matrix - Low Recharge

	T1	T2	T3	T4
T1	1	-0.10	-0.34	-0.13
T2	-0.10	1	-0.11	-0.08
T3	-0.34	-0.11	1	-0.11
T4	-0.13	-0.08	-0.11	1

Table 1.2 Recharge Parameter Correlation Coefficient Matrix - Low Recharge

	RCH1	RCH2	RCH3	RCH4	RCH5	RCH6	RCH7
RCH1	1	0.02	0.13	**-0.93**	-0.04	0.62	0.78
RCH2	0.02	1	0.29	-0.03	0.09	0.14	0.03
RCH3	0.13	0.29	1	-0.23	0.03	0.19	0.20
RCH4	**-0.93**	-0.03	-0.23	1	0.04	-0.65	-0.84
RCH5	-0.04	0.09	0.03	0.04	1	-0.17	0.03
RCH6	0.62	0.14	0.19	-0.65	-0.17	1	0.63
RCH7	0.78	0.03	0.20	-0.84	0.03	0.63	1

Table 1.3 Transmissivity Parameter Correlation Coefficient Matrix - High Recharge

	T1	T2	T3	T4
T1	1	-0.14	-0.34	-0.17
T2	-0.14	1	-0.09	-0.09
T3	-0.34	-0.09	1	-0.09
T4	-0.17	-0.09	-0.09	1

Table 1.4 Recharge Parameter Correlation Coefficient Matrix - High Recharge

	RCH1	RCH2	RCH3	RCH4	RCH5	RCH6	RCH7
RCH1	1	-0.05	0.04	**-0.93**	0.06	0.62	0.72
RCH2	-0.05	1	0.32	0.05	0.03	0.06	-0.02
RCH3	0.04	0.32	1	-0.13	0.02	0.14	0.12
RCH4	**-0.93**	0.05	-0.13	1	-0.06	-0.64	-0.78
RCH5	0.06	0.03	0.02	-0.06	1	-0.09	0.20
RCH6	0.62	0.06	0.14	-0.64	-0.09	1	0.61
RCH7	0.72	-0.02	0.12	-0.78	0.20	0.61	1

Each of the correlation coefficients for both scenarios are lower than 0.95. There are, however, a few parameters with correlation coefficient close to 0.95, which are the following (indicated in bold in the tables):

- Recharge zones 1 and 4 (both scenarios), correlation coefficient of 0.93; and
- Recharge zones 4 and 7 (low recharge scenario), correlation coefficient of 0.78.

The dependencies are acceptable, as in each of the cases it indicates that between adjacent zones some redistribution of the total influx is feasible without changing the flow field appreciably. The sums of the fluxes from the respective 2 zones are, however, certain. The calibration is therefore not only satisfactory with respect to the reproduction of measured heads but also with respect to the uniqueness of the result.

L1.1.3 95% Confidence Limits

PEST provides 95% confidence limits for estimated parameter values, which are displayed in *Table 1.5*and *Table 1.6*. Confidence limits are available exclusively for parameters estimated using PEST. Confidence limits give an indication of the parameter uncertainty where high confidence limit intervals indicate uncertain parameters.

Table 1.5 Low Recharge Scenario - 95% Confidence Limits

Parameter	Unit	Estimated Value	95% Confidence Limits	
			Lower Limit	Upper Limit
T1	m²/d	7.E-01	6.E-01	9.E-01
T2	m²/d	8.E-01	4.E-01	1.E+00
T3	m²/d	5.E-01	2.E-02	1.E+01
T4	m²/d	2.E+00	5.E-01	5.E+00
DRN Mine	m²/d	4.E-03	9.E-17	2.E+11
RCH1	m/d	3.E-05	2.E-05	6.E-05
RCH2	m/d	8.E-05	1.E-05	5.E-04
RCH3	m/d	8.E-06	4.E-13	2.E+02
RCH4	m/d	1.E-06	3.E-68	4.E+55
RCH5	m/d	1.E-04	2.E-07	6.E-02
RCH6	m/d	3.E-04	2.E-04	6.E-04
RCH7	m/d	2.E-04	8.E-05	4.E-04

Table 1.6 High Recharge Scenario - 95% Confidence Limits

Parameter	Unit	Estimated Value	95% Confidence Limits	
			Lower Limit	Upper Limit
T1	m²/d	2.E+00	2.E+00	3.E+00
T2	m²/d	3.E+00	2.E+00	4.E+00
T3	m²/d	1.E+00	6.E-02	2.E+01
T4	m²/d	4.E+00	1.E+00	1.E+01
DRN Mine	m²/d	4.E-03	2.E-24	9.E+18
RCH1	m/d	8.E-05	4.E-05	2.E-04
RCH2	m/d	2.E-04	5.E-05	7.E-04
RCH3	m/d	2.E-05	1.E-12	3.E+02
RCH4	m/d	3.E-06	5.E-78	2.E+66
RCH5	m/d	3.E-04	2.E-07	3.E-01
RCH6	m/d	8.E-04	4.E-04	1.E-03
RCH7	m/d	4.E-04	2.E-04	1.E-03

95% confidence limits for transmissivity values are mostly within one order of magnitude. However, high 95% confidence limit intervals for a number of recharge parameters, including RCH3, RCH4 and RCH5 indicate that these are potentially very uncertain parameters.

L1.1.4 Sensitivity Analysis

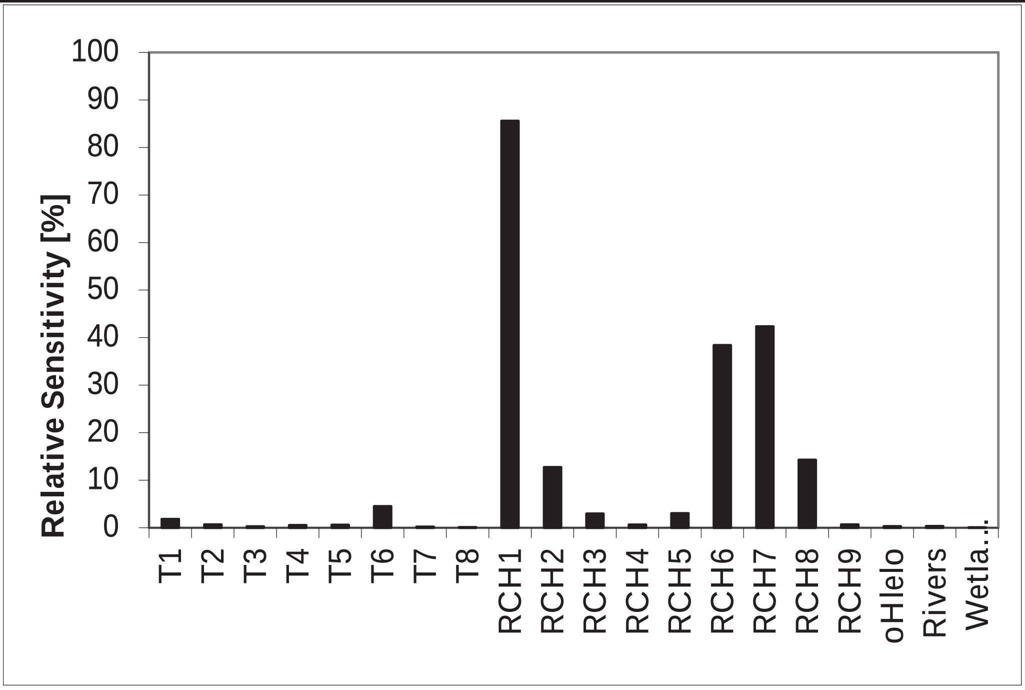
Sensitivity analysis was carried out in two different ways for different parameter groups:

- The automatic sensitivity analysis provided in PEST was used to quantify the uncertainty in the calibrated model with regards to transmissivity and recharge parameters; and
- The sensitivity of mine inflows at the Maquasa West underground mine with regards to change in drain conductance was investigated manually, varying the parameter within two orders of magnitude.

Figure 1.4 presents the relative sensitivities (% change of calculated heads compared to change in parameter) for the parameters transmissivity, drain conductance (rivers and wetlands), recharge and river conductance (oHlelo Stream). Regarding the two different recharge scenarios, recharge parameters are generally more sensitive for the low recharge scenario than for the high recharge scenario and transmissivities are more sensitive for the high recharge scenario than for the low recharge scenario.

The most sensitive parameters are RCH1, followed by RCH7, RCH6, RCH 8 and RCH2. The most sensitive transmissivity parameters are T6 and T1.

Figure 1.4 *Sensitivity Analysis for Transmissivity (T1-T8), Drain Conductance (Rivers and Wetlands), Recharge (RCH1-RCH9) and River Conductance (oHlelo)*



The sensitivity of the drain conductance of the Maquasa West underground mine is detailed in *Table 1.7*. Drain conductance was changed by a factor 100, which resulted in inflow rate changes by a factor 2 to 3, which equals a relative sensitivity of 2-3%.

Table 1.7 *Sensititvity of Drain Conductance - Maquasa West U/G*

Calibration	**Mine Inflows (m^3/d) - Low Recharge Scenario**	**Mine Inflows (m^3/d) - High Recharge Scenario**
Initial Value 0.004m2/d	1,010	1,800
High Value 0.4m2/d	1,720	4,000
Low Value 0.00004m2/d	560	1,260

L1.1.5 *Water Balance*

The steady state water budgets of the whole model domain for both recharge scenarios are shown in *Table 1.8*.

Recharge

Two average recharge scenarios were modelled:

- Low recharge scenario: 2% MAP (28,640m^3/d); and
- High recharge scenario: 5% MAP (68,300m^3/d).

Base Flow to Dams, Rivers, Streams and Wetlands

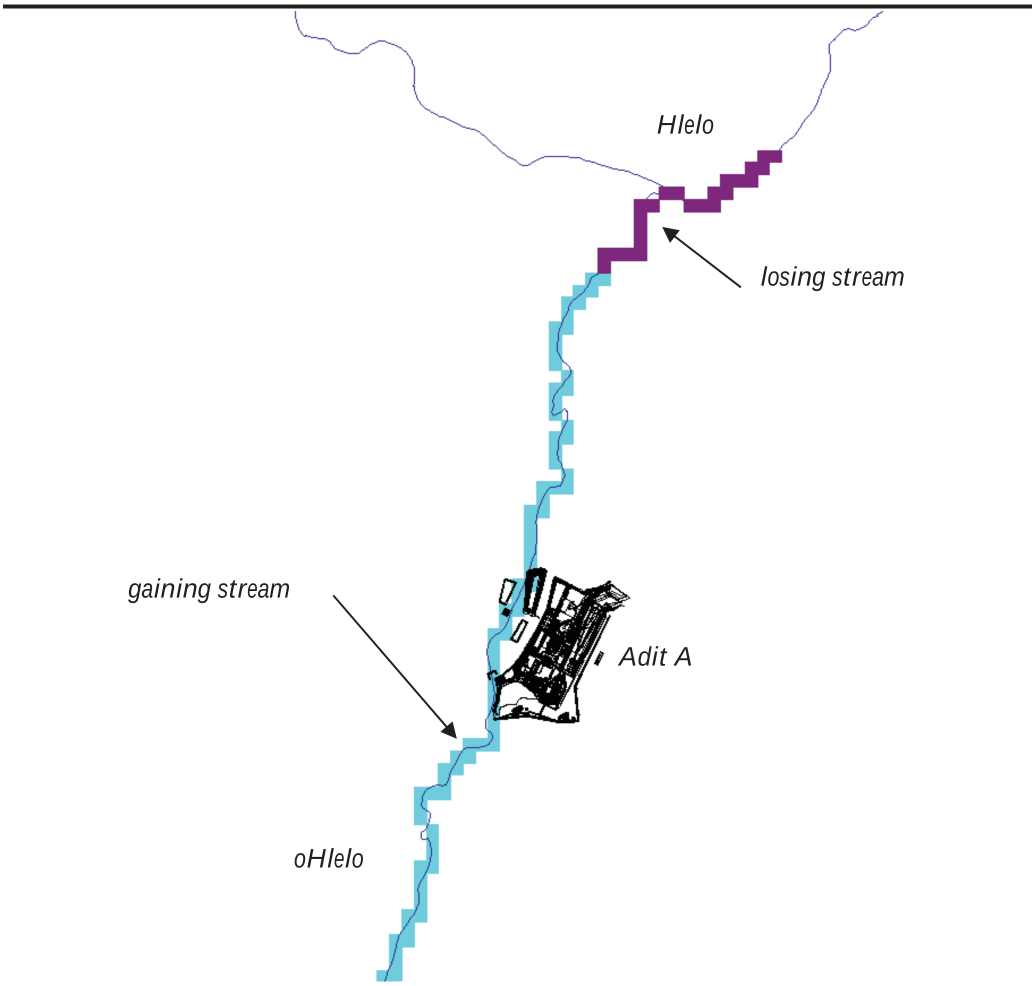
The constant head component represents the volume of water flowing from the modelled aquifer into Heyshope Dam. The baseflow to rivers and streams component indicates the volume of water being drained from the aquifer by perennial rivers and streams within the model domain. This represents approximately 60% of the total groundwater flux in the system.

The models suggest, that a small component of this baseflow is recharging the aquifer (representing a losing stream), where the oHlelo Stream meets the Hlelo Stream approximately 2km downstream of the proposed Adit A location (*Figure 1.5*). Only rivers/streams implemented using the river package (oHlelo) are able to recharge the aquifer. However, compared to the volume of water discharged from groundwater into the oHlelo the loss is of less than 1% and therefore insignificant.

The total flow to the wetlands included in the models amounts to 5,630m^3/d and 13,240m^3/d for the low and high recharge scenarios respectively.

The total amount of base flow to rivers and streams (flow to dams and wetlands excluded) amounts to 17,420m^3/d and 41,840m^3/d for the low and high recharge scenarios respectively. This equals to approximately 1.3 and 3.1% MAP respectively, which compares relatively well to literature values, which suggest base flow of between 1.1 and 2.6% MAP in the region (DWAF, 2005).

Figure 1.5 Modelled Groundwater - Surface Water Interaction



Groundwater Out Flux

The groundwater out flux where the Hlelo Stream leaves the model domain indicates that the model setup assumes regional groundwater flow out of the model domain in this area.

Table 1.8 Water Budget for both Recharge Scenarios

Component	**Low Recharge Scenario**		**High Recharge Scenario**	
	In Flux [m³/d]	**Out Flux [m³/d]**	**In Flux [m³/d]**	**Out Flux [m³/d]**
Recharge	28640	0	68300	0
Constant Head – Heyshope Dam	1	4320	0	11150
Baseflow to Rivers and Streams	140	17550	150	42000
Baseflow to Wetlands	0	5630	0	13240
Mine dewatering (Maquasa West)	0	1010	0	1800
Groundwater Abstraction	0	170	0	170
Groundwater Out Flux Hlelo	0	40	0	40
SUM	**28780**	**28730**	**68450**	**68400**
% Discrepancy		0.17		0.07

In a steady state system total inflow and total outflow fluxes should be equal. The difference of 50m³/d for both scenarios represent numerical errors which are, however, insignificant being less than 0.2% of the total flux.

L1.2 TRANSIENT GROUNDWATER FLOW MODEL

L1.2.1 Transient Model Calibration Results Figures

Figure 1.6 ERMBH1 - Low Recharge

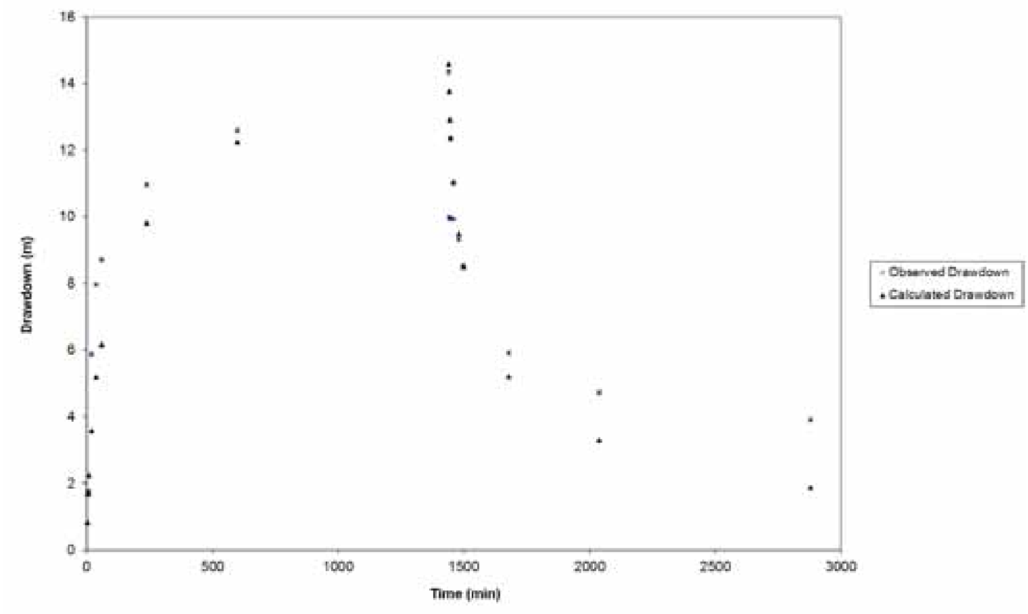


Figure 1.7 ERMBH1 - High Recharge

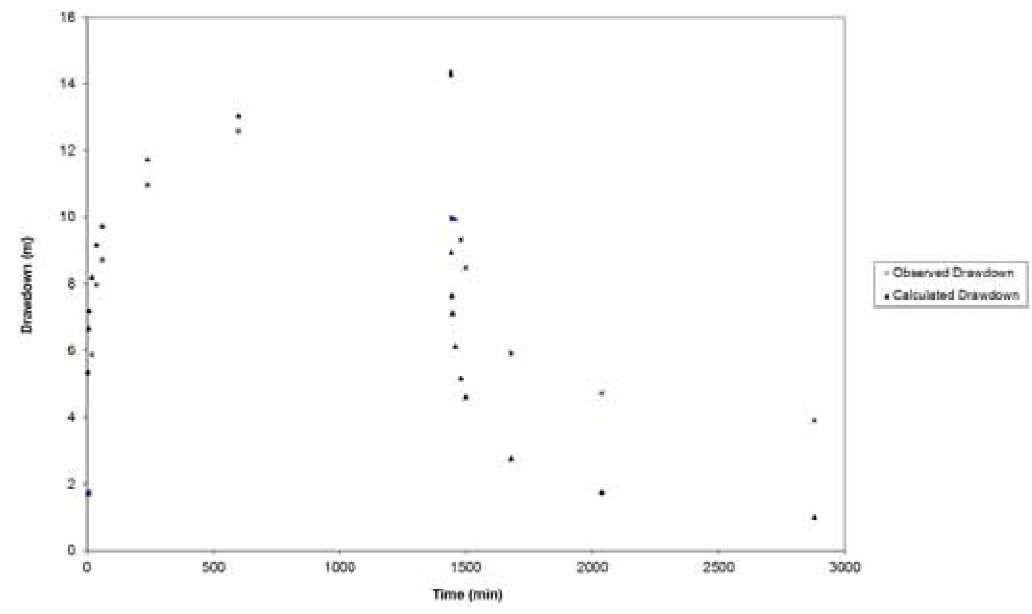


Figure 1.8 ERMBH3 - Low Recharge

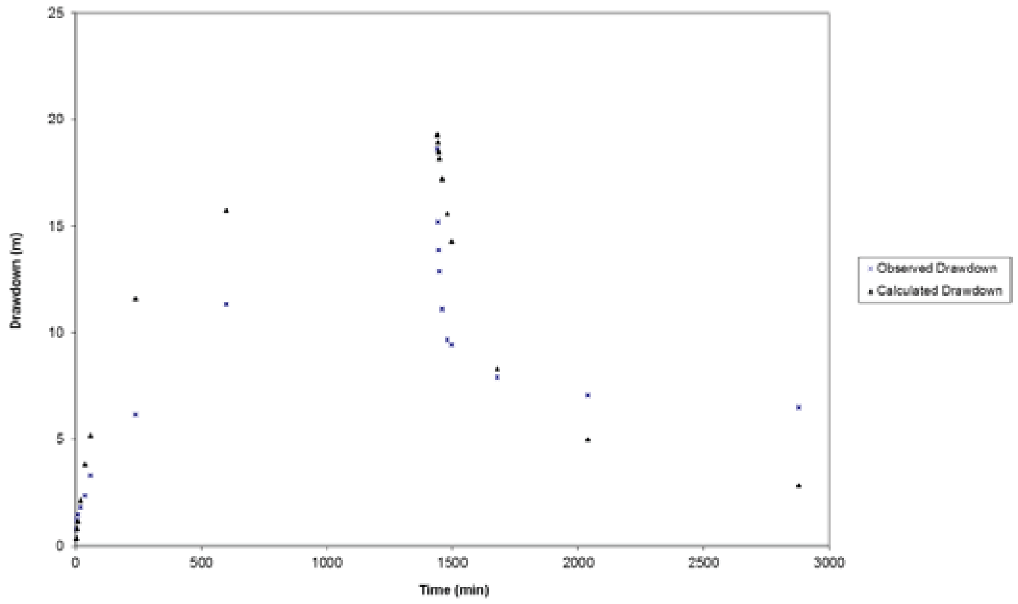


Figure 1.9 ERMBH3 - High Recharge

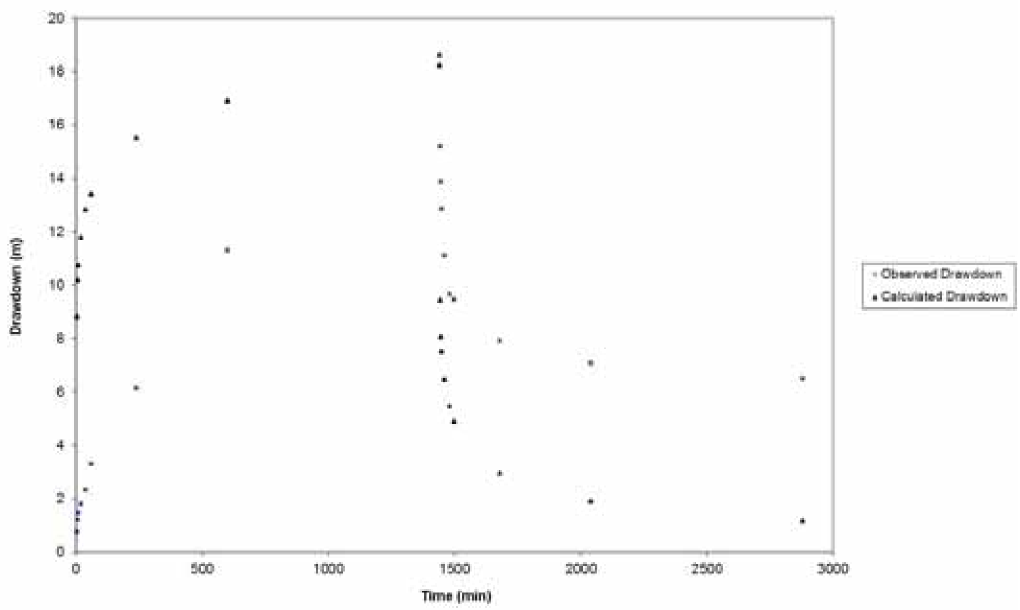


Figure 1.10 ERMBH4 - Low Recharge

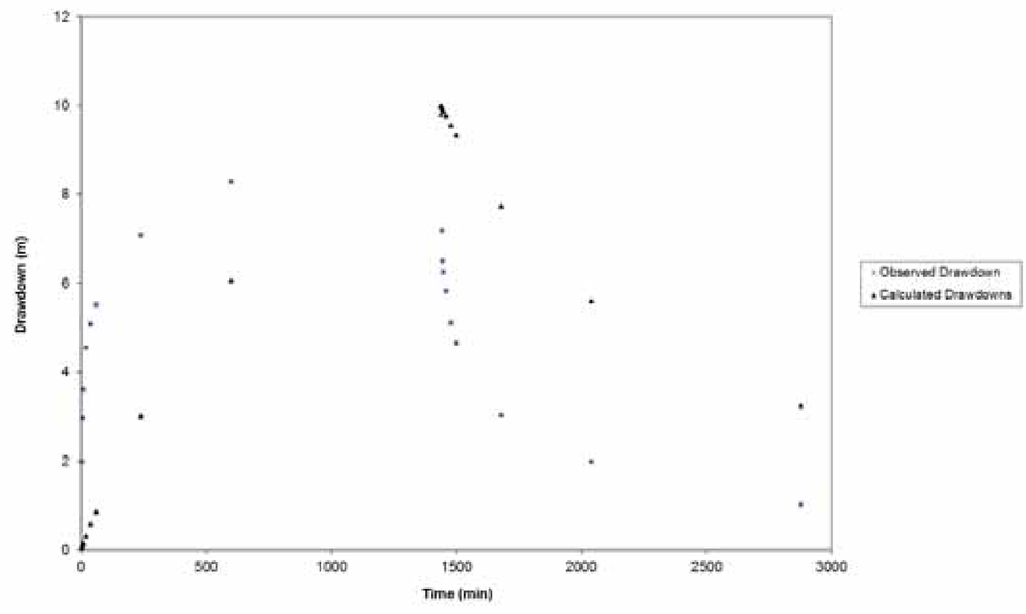


Figure 1.11 ERMBH4 - High Recharge

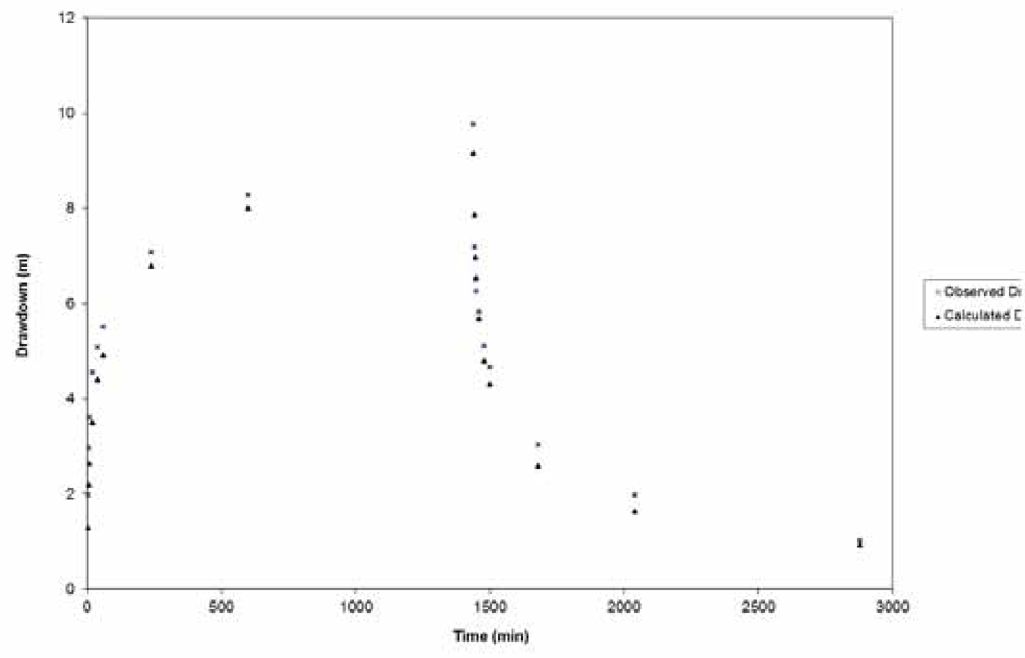


Figure 1.12 ERMBH8 - Low Recharge

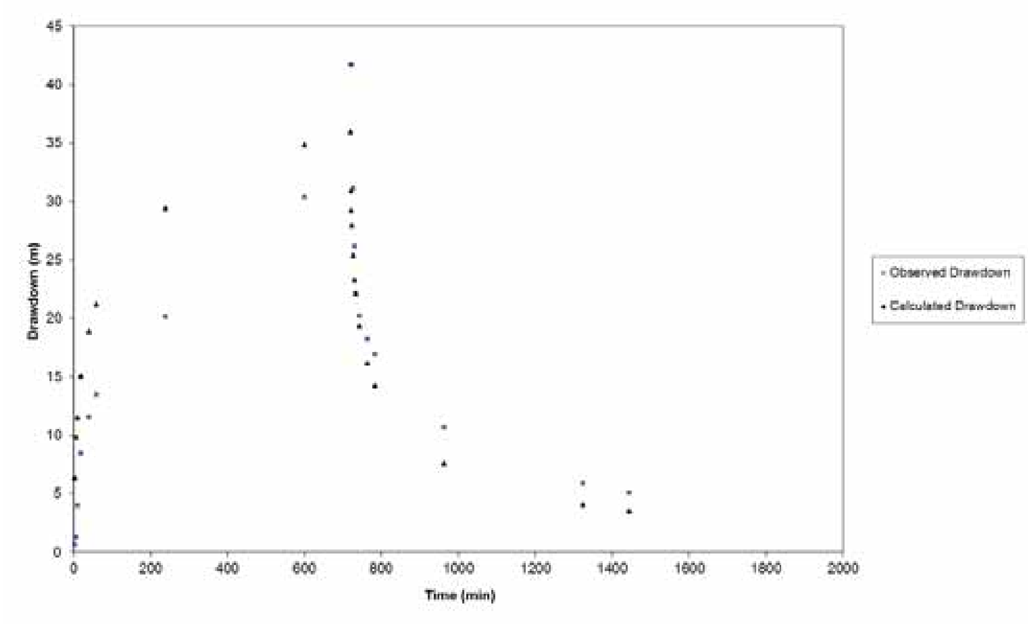


Figure 1.13 ERMBH10 - Low Recharge

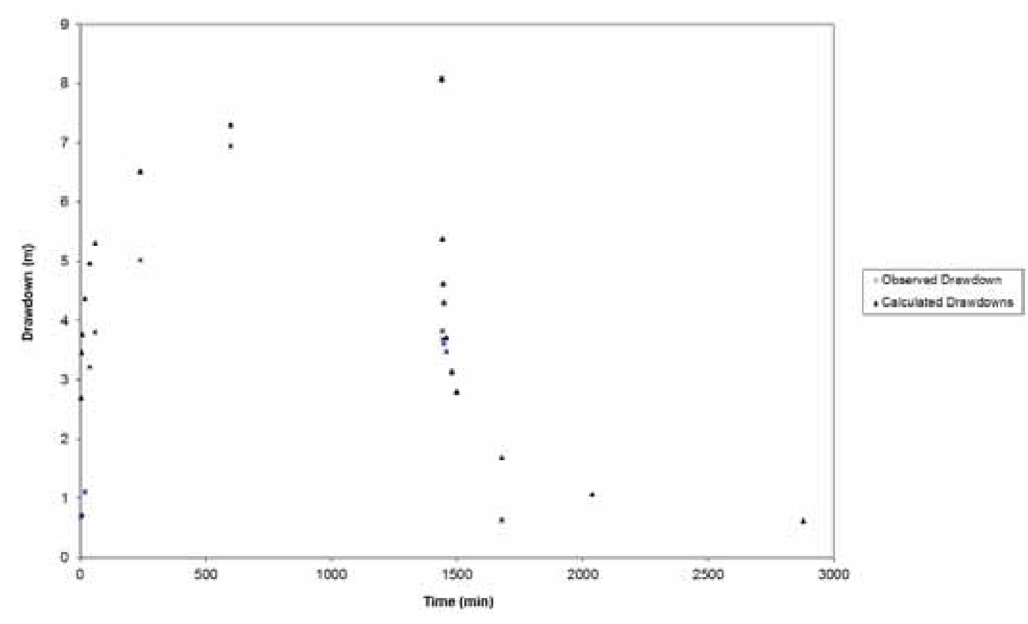
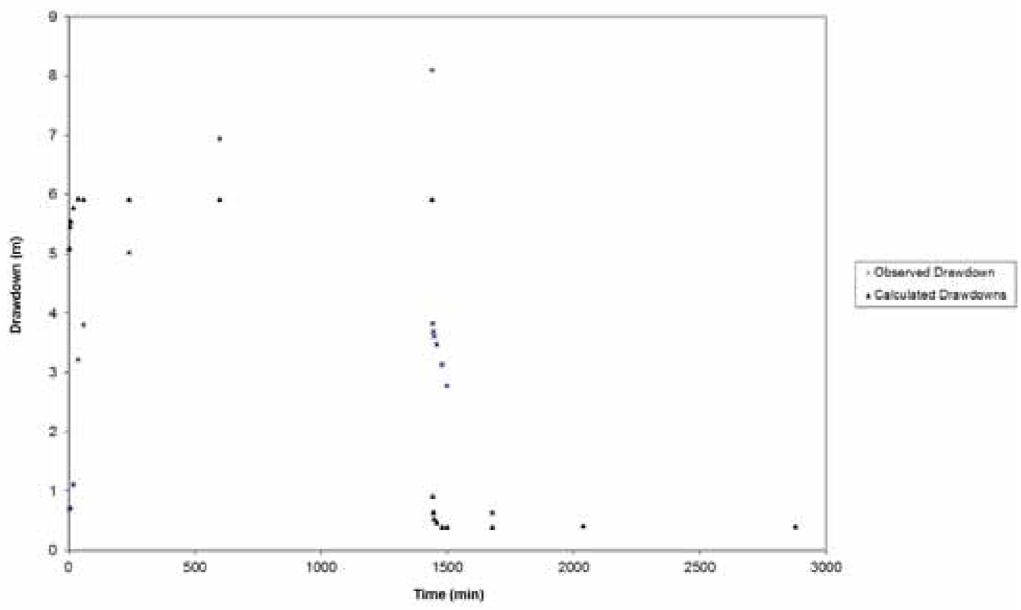


Figure 1.14 ERMBH10 - High Recharge



L1.2.2 *Sensitivity Analysis*

A sensitivity analysis was performed to assess the relative importance of model parameters with regards to mine inflow volumes. Evaluated parameters include recharge, drain hydraulic conductance, vertical conductivity and specific storage.

Each of these parameters was changed by approximately two orders of magnitude except for recharge. The high recharge scenario was used the reference case and the low recharge scenario was tested during the sensitivity analysis. The values of the tested parameters are detailed in *Table 1.9*.

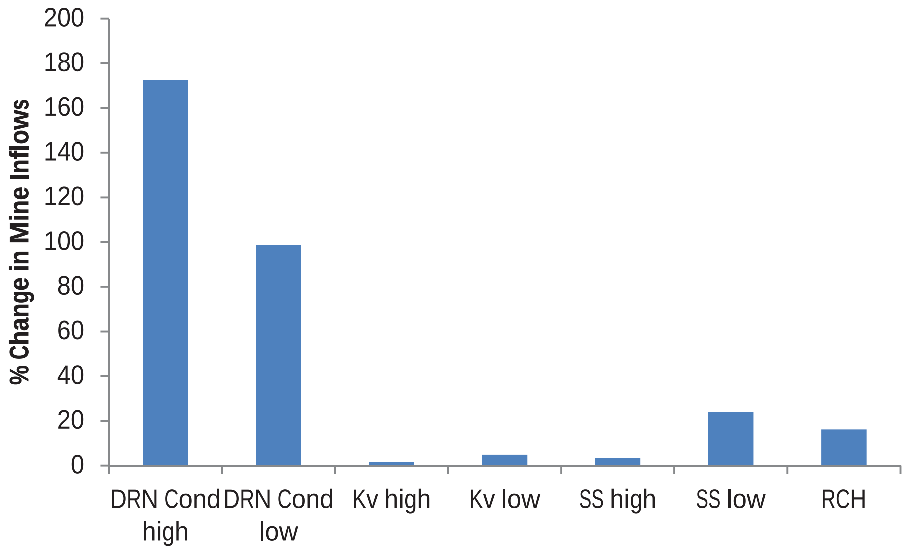
Table 1.9 Sensitivity Analysis Parameters and Respective Values

Parameter	**Unit**	**Default High Recharge Scenario**	**Tested Values**	
			low	**high**
Hydraulic Drain Conductance	m^2/day	4.E-03	**4.E-01**	**4.E-05**
Vertical Hydraulic Conductivity	m/day	1.E-03	**1.E-01**	**1.E-05**
Specific Storage	1/m	5.E-06	**5.E-04**	**5.E-08**
Recharge	High (5%MAP)	High (5%MAP)	**Low** (2%MAP)	NA

Notes: High, Low… Recharge Parameters
NA Not applicable

Results of the sensitivity analysis are shown in *Figure 1.15*. It was found that drain hydraulic conductance is the most sensitive parameter followed by recharge and specific storage, which have both much lower sensitivities.

Figure 1.15 *Sensitivity Analysis Results*



Notes:	DRN Cond	Drain hydraulic conductance
	Kv	Vertical hydraulic conductivity
	SS	Specific Storage
	RCH	Recharge

Therefore, different scenarios of drain hydraulic conductance were run instead of recharge for the mining models. Following a conservative approach, parameters of the high recharge scenario were used in the mining and post-closure models.

L1.2.3 Drain Conductance Data Review and Modelled Scenarios

Packer Test Results

Packer tests performed by Jones & Wagener suggest ranges of hydraulic conductivity (*K*) for coal and adjacent lithologies at Adit A. *K* and resulting drain hydraulic conductance (C_d) are detailed in *Table 1.10*.

Table 1.10 *Packer Test Data*

BH ID	**K (m/day)**		**C_d (m^2/day)**	
	from	**to**	**from**	**to**
GTBH1		<9.E-03		<5.E-01
GTBH2	9E-03	5E-02	5E-01	3E+00
GTBH3	9E-03	5E-02	5E-01	3E+00

Notes: K Hydraulic Conductivity
C_d Drain Hydraulic Conductance

Literature Values

Hydraulic conductivity values for coal sourced from literature are presented in *Table 1.11*. Rehm et al. (1980) give a range of *K* values for coal, whereas Hegazy et al. (2004) give an average value.

Table 1.11 Summary of Literature Values

Source	Description	K_{Coal} (m/day)	C_d (m²/day)
[Hegazy et al. 2004]	Average	3E-02	1E+00
[Rehm et al. 1980]	Low	7E-02	3E+00
[Rehm et al. 1980]	High	2E-01	9E+00

Notes: K Hydraulic Conductivity
C_d Drain Hydraulic Conductance

Modelled Drain Hydraulic Conductance Scenarios

Three scenarios were modelled using the different drain hydraulic conductance values detailed in *Table 1.12*. These values cover the possible range of values based on the findings of the packer tests and literature values.

Table 1.12 Drain Hydraulic Conductance Scenarios

	C_d (m²/day)
Scenario 1 – low	4.E-02
Scenario 2 – likely	4.E-01
Scenario 3 - high	3.E+00

Notes: C_d Drain Hydraulic Conductance

Scenario number two ($4 \cdot 10^{-1} m^2$/day) is considered to be the most likely case. The simulated impacts on receptors as well as the post-closure study are therefore based on this scenario.

L1.2.4 Expected Groundwater Inflows into the Planned Underground Mine

Groundwater inflows into the underground workings were estimated for both GUS and DUN seam individually over the entire life of mine at a one year interval. Inflows were quantified for each of the three scenarios detailed in *Section Error! Reference source not found.*.

Average Annual Inflow Rates for the Life of Mine

Figure 1.17 to *Figure 1.16* show the calculated average annual mine inflow rates for the three scenarios (minimum, likely and maximum inflows). The three scenarios show similar results, with an initial quick increase of inflows, a slower increase phase and a phase where inflows decrease trending towards a stabilisation. These trends are more pronounced for the GUS seam than for the DUN seam.

However, Scenario 1 seems to reach the turning points between the different phases one to two years after Scenarios 2 and 3. Maximum inflows are approximately 22,300m^3/d for Scenario 1, 28,600m^3/d for Scenario 2 and 30,000m^3/d for Scenario 3. *Table 1.13* details the inflow rates for each scenario per year.

Figure 1.16 Total (GUS+DUN) Average Annual Mine Inflow Rates in Cubic Metres per Day

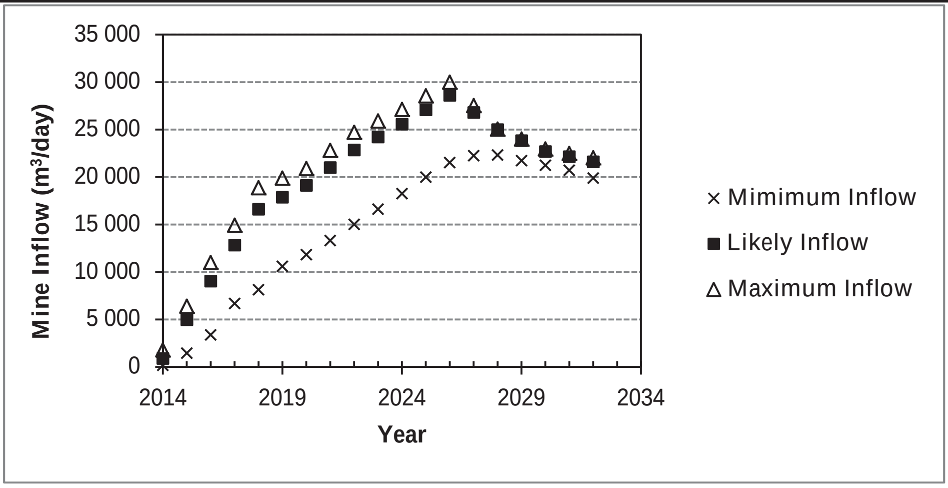


Figure 1.17 GUS Seam Average Annual Mine Inflow Rates in Cubic Metres per Day

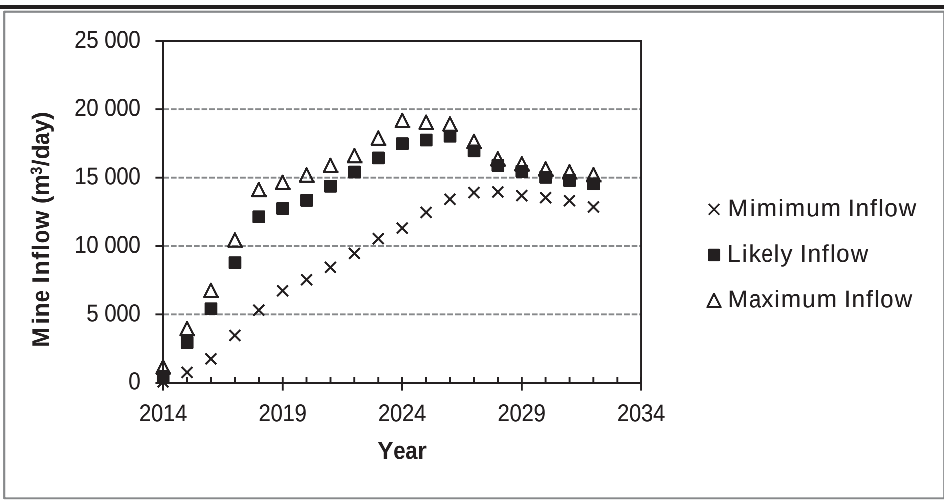


Figure 1.18 DUN Seam Average Annual Mine Inflow Rates in Cubic Metres per Day

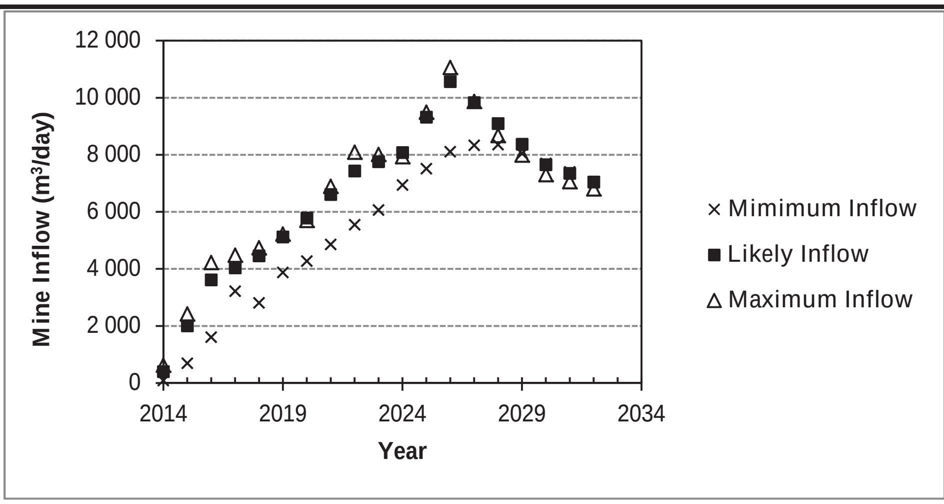


Table 1.13 Average Annual Mine Inflow Rates in m³/day for the 3 Scenarios for the Life of Mine

	Minimum Inflows			Likely Inflows			Maximum Inflows		
Year	GUS	DUN	Total	GUS	DUN	Total	GUS	DUN	Total
2014	80	90	200	500	400	900	1,200	600	1,800
2015	800	700	1,500	3,000	2,000	5,000	4,000	2,400	6,400
2016	1,800	1,600	3,400	5,400	3,600	9,000	6,800	4,200	11,000
2017	3,500	3,200	6,700	8,800	4,000	12,800	10,400	4,500	14,900
2018	5,300	2,800	8,100	12,200	4,500	16,600	14,100	4,700	18,900
2019	6,700	3,900	10,600	12,700	5,100	17,900	14,700	5,200	19,900
2020	7,500	4,300	11,800	13,300	5,800	19,100	15,200	5,700	20,900
2021	8,500	4,900	13,300	14,400	6,600	21,000	15,900	6,900	22,800
2022	9,500	5,500	15,000	15,400	7,400	22,900	16,600	8,100	24,700
2023	10,500	6,100	16,600	16,500	7,800	24,200	17,900	8,000	25,900
2024	11,300	6,900	18,300	17,500	8,100	25,600	19,200	7,900	27,100
2025	12,500	7,500	20,000	17,800	9,300	27,100	19,100	9,500	28,600
2026	13,400	8,100	21,500	18,000	10,600	28,600	18,900	11,100	30,000
2027	13,900	8,300	22,200	17,000	9,800	26,800	17,700	9,900	27,500
2028	14,000	8,400	22,300	15,900	9,100	25,000	16,400	8,700	25,100
2029	13,700	8,000	21,700	15,500	8,400	23,800	16,000	8,000	24,000
2030	13,500	7,700	21,200	15,000	7,700	22,700	15,600	7,300	22,900
2031	13,300	7,400	20,700	14,800	7,400	22,100	15,400	7,100	22,500
2032	12,900	7,000	19,900	14,600	7,000	21,600	15,200	6,800	22,000

Notes: Inflow rates in m³/day

Cumulative Inflows

Estimated cumulative mine inflows over the entire life of mine are presented in *Figure 1.19* and *Table 1.14* for scenarios 1 to 3. Total inflows at the end of mining equal approximately 100, 135 and 145 million m³ for scenario 1, 2 and 3 respectively.

Figure 1.19 Cumulative Mine Inflows for Scenario 1, 2 and 3 in Million Cubic Metres

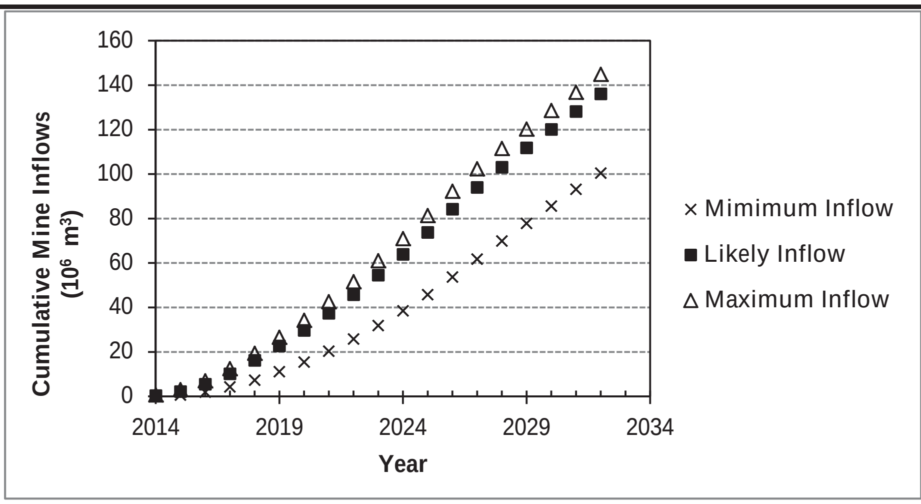


Table 1.14 Cumulative Mine Inflows in m^3 for the 3 Scenarios for the First Five Years of Mining

	Minimum Inflows			Likely Inflows			Maximum Inflows		
Year	**GUS**	**DUN**	**Total**	**GUS**	**DUN**	**Total**	**GUS**	**DUN**	**Total**
2014	28 900	31 100	60 100	179 600	145 300	324 900	427 100	227 400	654 400
2015	305 900	284 600	590 500	1 258 900	878 600	2 137 400	1 876 100	1 111 800	2 987 500
2016	949 900	871 200	1 821 100	3 237 900	2 199 900	5 437 800	4 346 800	2 652 800	6 999 200
2017	2 214 800	2 045 300	4 260 100	6 444 800	3 674 500	10 119 300	8 160 700	4 289 100	12 449 100
2018	4 155 500	3 071 000	7 226 500	10 879 600	5 302 700	16 182 300	13 317 400	6 020 300	19 337 000
2019	6 609 900	4 485 000	11 094 900	15 532 900	7 171 900	22 704 800	18 668 700	7 926 300	26 594 300
2020	9 361 200	6 045 900	15 407 100	20 405 000	9 282 300	29 687 300	24 214 100	10 007 200	34 220 600
2021	12 446 000	7 818 900	20 264 900	25 655 100	11 694 200	37 349 700	30 018 000	12 524 600	42 541 800
2022	15 900 100	9 843 600	25 743 700	31 283 800	14 408 000	45 692 200	36 080 300	15 478 600	51 558 100
2023	19 747 700	12 057 600	31 805 300	37 289 500	17 239 700	54 529 500	42 611 900	18 402 900	61 014 500
2024	23 877 300	14 590 200	38 467 500	43 672 600	20 189 200	63 862 200	49 613 000	21 298 100	70 910 700
2025	28 427 100	17 333 400	45 760 600	50 155 700	23 592 100	73 748 300	56 568 800	24 764 500	81 333 000
2026	33 324 900	20 292 400	53 617 300	56 738 900	27 448 400	84 187 300	63 479 300	28 802 200	92 281 100
2027	38 401 300	23 333 600	61 734 900	62 930 700	31 036 300	93 967 100	69 923 800	32 404 300	102 327 400
2028	43 494 000	26 383 900	69 877 800	68 731 700	34 355 600	103 087 300	75 901 800	35 570 700	111 471 700
2029	48 488 800	29 320 400	77 809 200	74 376 100	37 412 100	111 788 200	81 745 400	38 487 400	120 231 700
2030	53 431 000	32 131 300	85 562 400	79 863 800	40 205 800	120 069 700	87 454 400	41 154 100	128 607 400
2031	58 290 500	34 832 700	93 123 200	85 264 700	42 889 000	128 153 700	93 086 000	43 729 600	136 814 400
2032	62 983 600	37 395 900	100 379 500	90 578 800	45 461 100	136 040 200	98 639 800	46 214 100	144 852 800

Notes: Inflow rates in m^3

L1.3 SOLUTE TRANSPORT MODEL

This section presents and discusses the results of the solute transport model sensitivity analysis.

L1.3.1 *Sensitivity Analysis*

Table 1.15 shows the results of the sensitivity analysis. Note that the sensitivity analysis does not represent a worst-case / best-case simulation. It only investigates the relative importance of input parameters with regards to model output.

The sensitivity analysis shows, that the most sensitive parameters include SO_4 input concentrations (source terms), duration of leaching and the dispersivity.

Table 1.15 Discussion of Results of Sensitivity Analysis

Scenario Name	Parameter Changed	Discussion of Results	Qualitative Assessment of Sensitivity
High Concentration Scenario	SO_4 concentration on overburden dump: 6,344mg / l SO_4 concentration on conveyor belt	Change in recharge contaminant concentration reflects fairly proportionally on the calculated groundwater concentration at	Very significant

Scenario Name	Parameter Changed	Discussion of Results	Qualitative Assessment of Sensitivity
	section: 1,174mg/l	all observed locations.	
Low Concentration Scenario	SO_4 concentration on overburden dump: 175mg/l SO_4 concentration on conveyor belt section: 28mg/l		
High Recharge Scenario	Recharge on overburden dump: 0.002m/day (=30%MAP)	Effect varies across the observed points. At some points more pronounced than at others.	Generally moderate
Low Recharge Scenario	Recharge on overburden dump: 0.0003m/day (=5%MAP)		
High Dispersivity Scenario	Horizontal dispersivity: 1,000m	Increased dispersivity results in increased SO_4 concentrations in boreholes far away from the sources and decreased SO_4 peaks in boreholes close to the sources.	Significant (particularly for distant boreholes). Effect strongly related with location of the observation with respect to the source and the groundwater flow direction.
Low Dispersivity Scenario	Horizontal dispersivity: 10m		
Infinite Leaching Scenario	No termination of contaminant recharge to the model	If the contaminant leaching is not interrupted, concentrations seems to tend towards a state of equilibrium, which is reached quicker at boreholes located closer to the sources. The further away the borehole, the longer the time which the contaminant requires to reach the location, and the longer the time required to reach a state of equilibrium. For shorter leaching time the drop in observed concentration occurs sooner.	Significant
Short Leaching Scenario	Termination of contaminant recharge to the model at end of mining		
Rehab Scenario	Overburden dump shifted back into Adit A after end of mining, contamination source removed from conveyor belt section after end of mining.	The observed concentration resembles very similar to the short leaching scenario, indicating that removing the source at the conveyor section (although being small compared to the overburden dump) belt has significant effect on SO_4 concentrations in observation boreholes.	Significant

Concentration time series for each of the monitoring points are detailed in the figures below.

Figure 1.20 *SO4 Concentration in Groundwater below Overburden Dump*

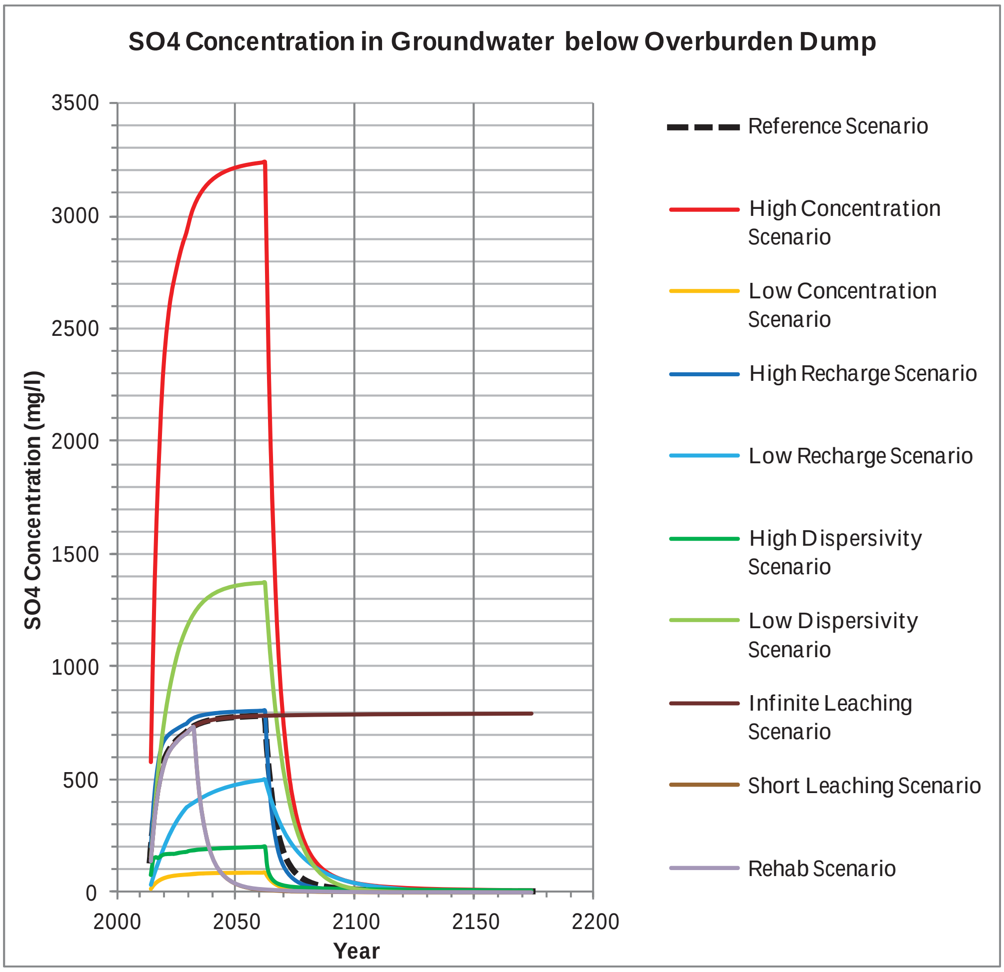


Figure 1.21 SO4 Concentration at ERMBH01

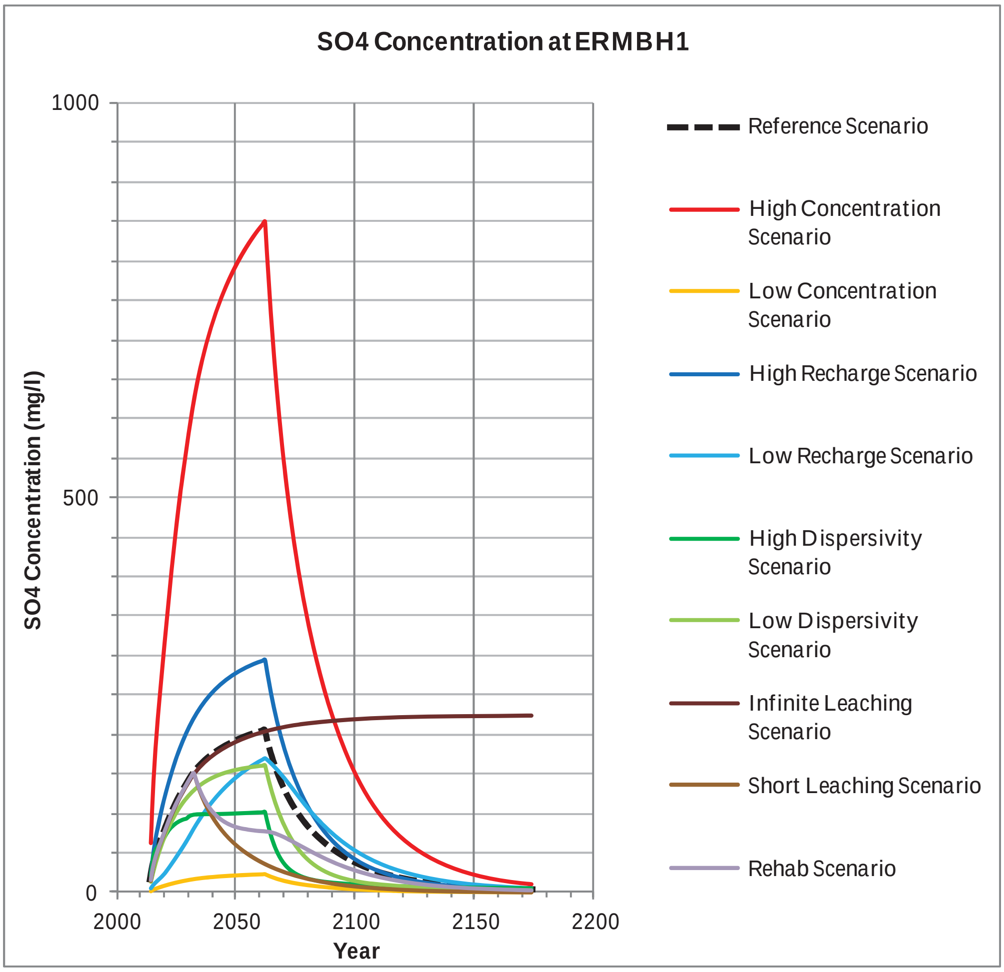


Figure 1.22   SO4 Concentration at ERMBH02

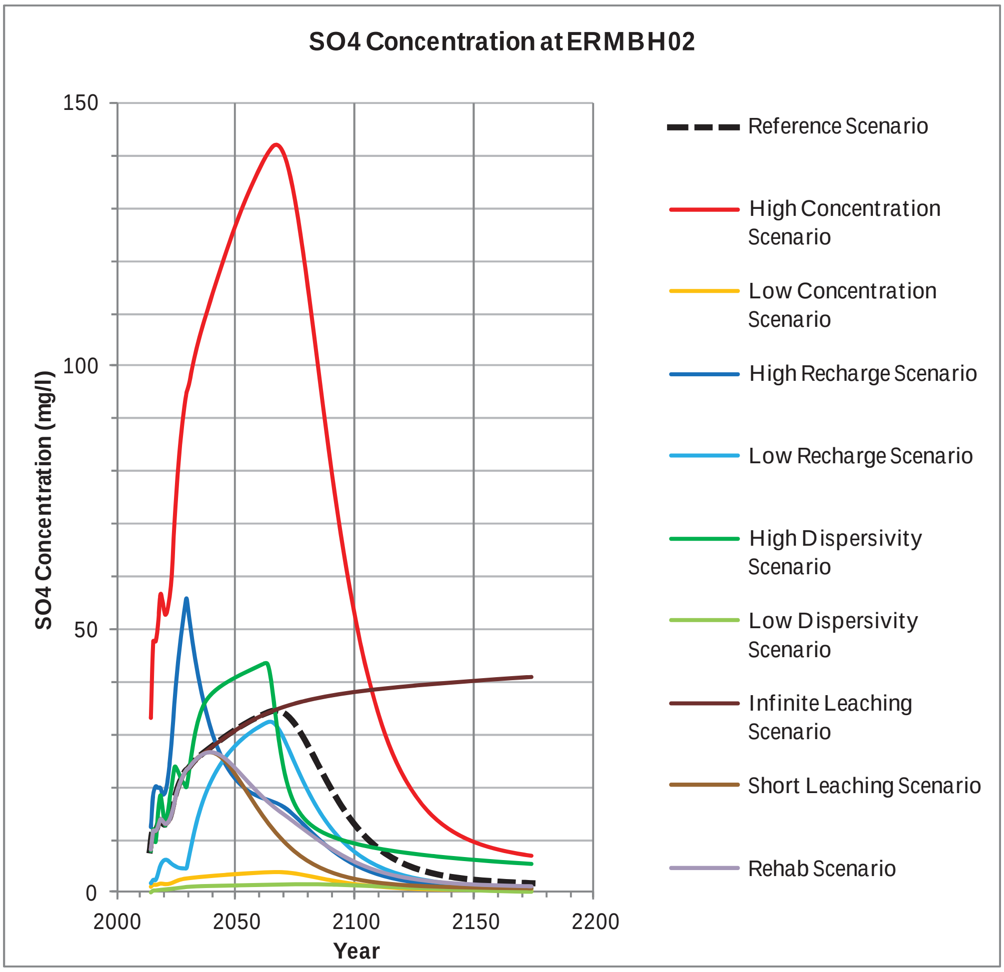


Figure 1.23 SO4 Concentration at ERMBH03

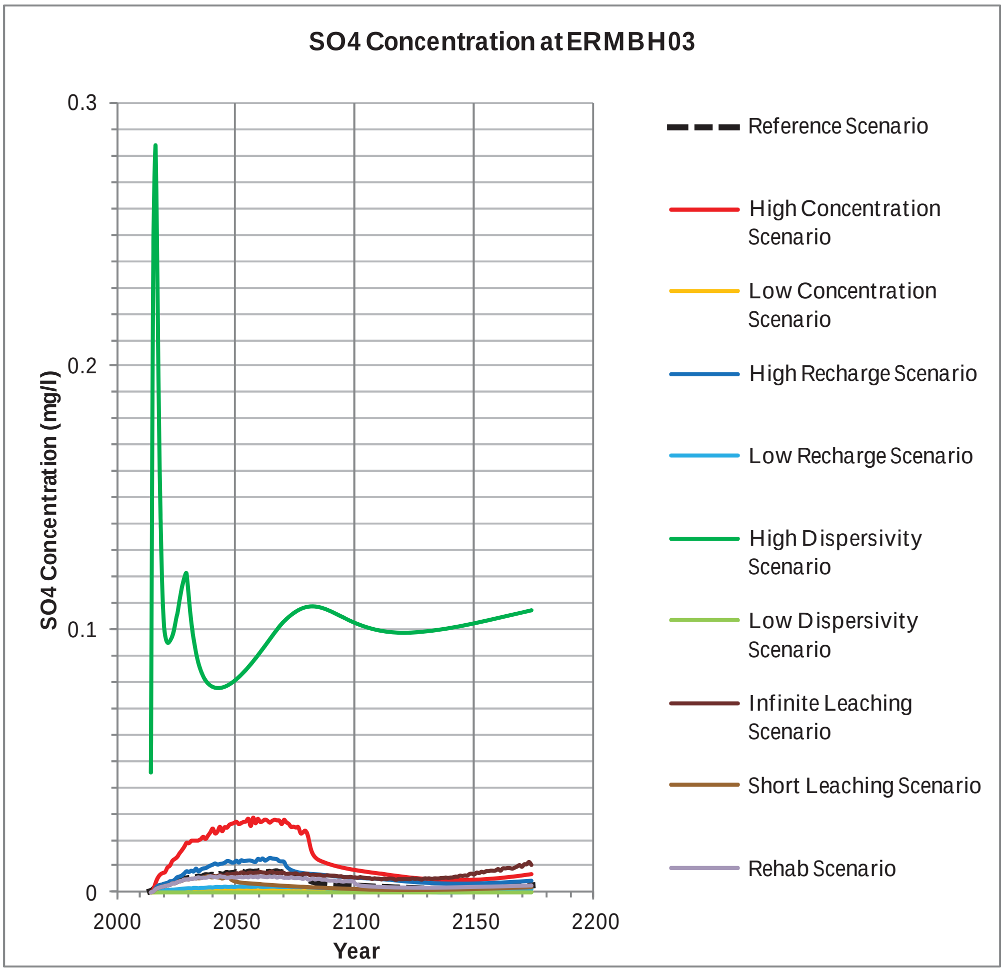


Figure 1.24 SO4 Concentration at ERMBH3 (Zoom)

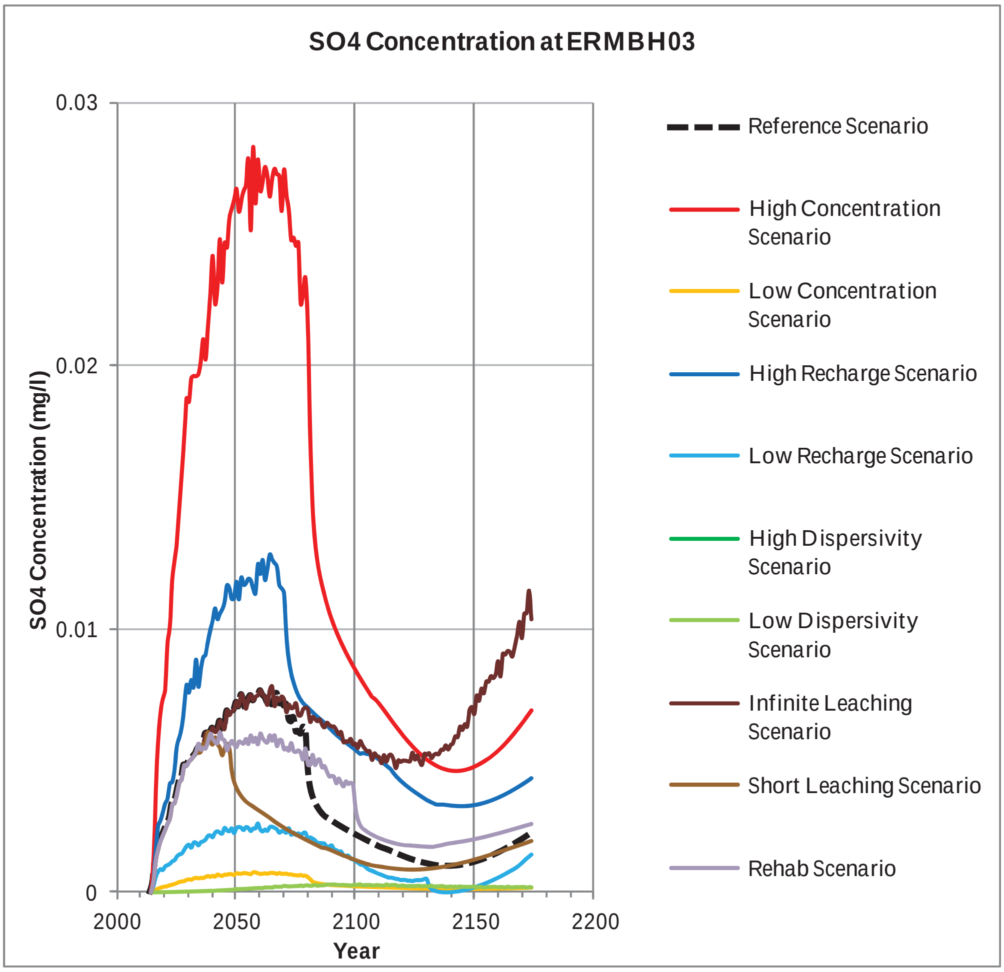


Figure 1.25   SO4 Concentration at ERMBH08

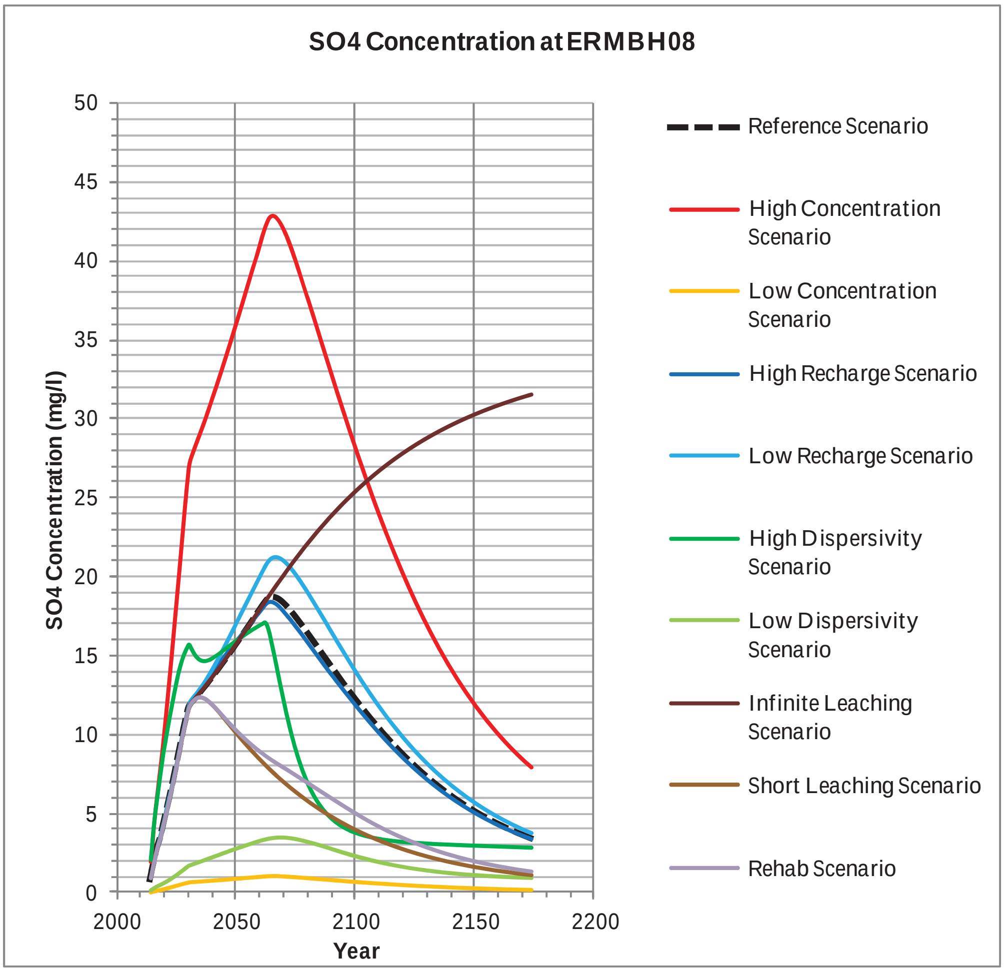


Figure 1.26 SO4 Concentration in Groundwater below River

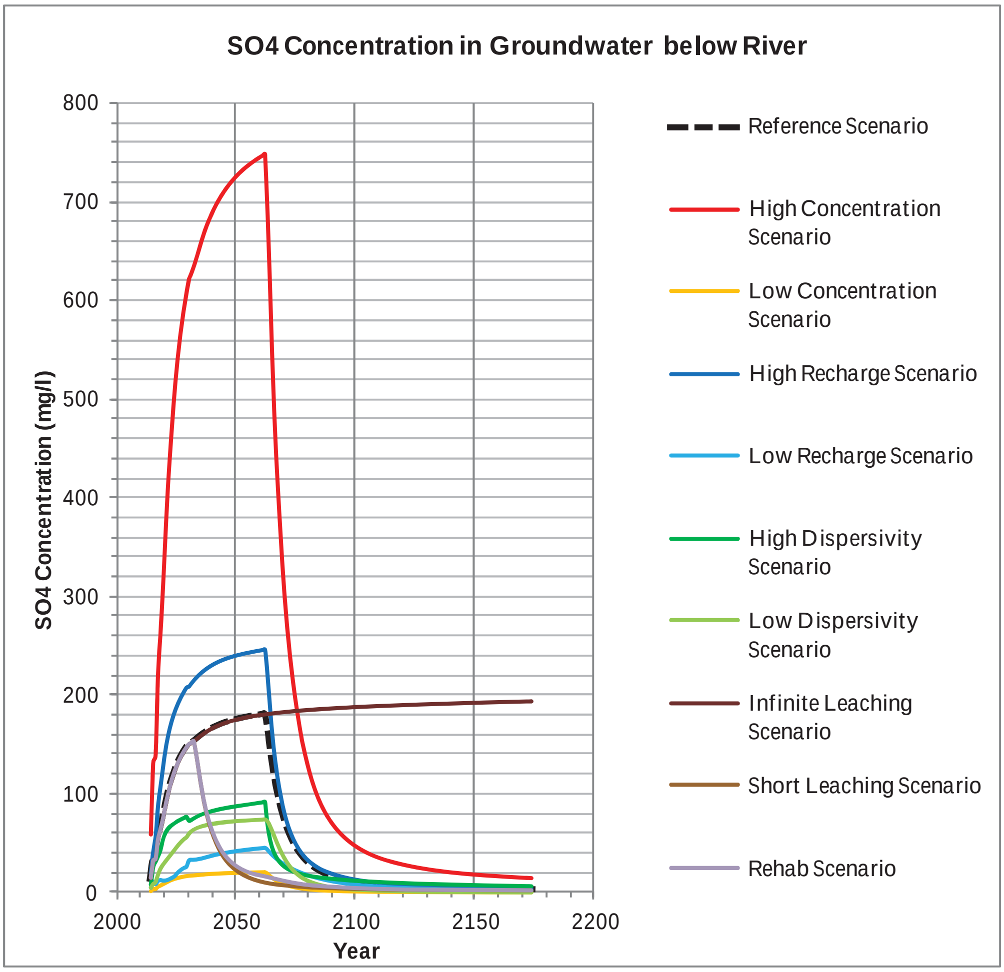
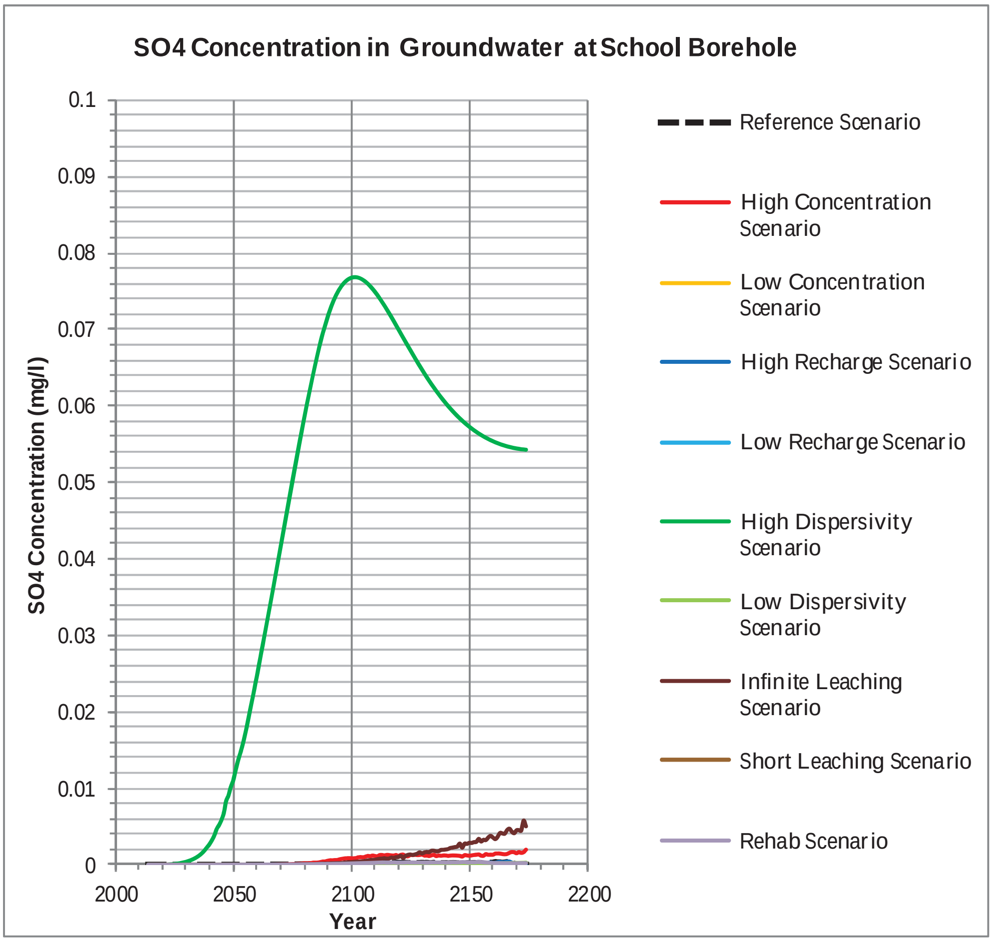


Figure 1.27 SO4 Concentration in Groundwater at School Borehole



Annex M

Groundwater Monitoring Plan Details

BHID	Latitude (DMS)	Longitude (DMS)	X (LO31 WGS84)	Y (LO31 WGS84)	Elevation	Depth	Type	Owner	Primary Purpose	Secondary Purpose	Water Level Monitoring Frequency	Flow Rate (Yield) Monitoring Frequency	Water Quality Monitoring Frequency	WQ Parameters		
														Constituents	Major Metals	Hydrocarbons
ERMBH1	27° 1' 9.072" S	30° 17' 6.628" E	-70939	-2989957	1532.43	60	Monitoring BH	Kangra Coal	Upstream of OBD (background)	Conceptual Model	Monthly		Quarterly	X	X	X
ERMBH2	27° 0' 59.350" S	30° 17' 3.715" E	-71021	-2989659	1502.33	40	Monitoring BH	Kangra Coal	Adit A	Conceptual Model	Continual		Quarterly	X	X	X
ERMBH3	27° 0' 38.446" S	30° 17' 14.113" E	-70738	-2989013	1488.71	46	Monitoring BH	Kangra Coal	Adit A	Conceptual Model	Monthly		Quarterly	X	X	X
ERMBH4	27° 3' 34.807" S	30° 18' 20.306" E	-68883.2	-2994432	1428.66	70	Monitoring BH	Kangra Coal	SE Boundary	Conceptual Model	Monthly		Quarterly	X	X	
ERMBH5	27° 3' 27.620" S	30° 14' 25.436" E	-75356.9	-2994248	1782.81	90	Monitoring BH	Kangra Coal	SW Boundary	Conceptual Model	Monthly		Quarterly	X	X	
ERMBH6	27° 2' 28.635" S	30° 15' 23.420" E	-73769.7	-2992423	1795.06	124	Monitoring BH	Kangra Coal	Adit D	FB13	Monthly		Quarterly	X	X	
ERMBH7	27° 2' 52.688" S	30° 14' 52.285" E	-74623.4	-2993168	1741.57	100	Monitoring BH	Kangra Coal	Structure on top of mountain	Conceptual Model	Continual		Quarterly	X	X	
ERMBH8	27° 0' 57.421" S	30° 17' 10.664" E	-70829.7	-2989598	1510.12	60	Monitoring BH	Kangra Coal	Crushing and Conveyor	Conceptual Model	Continual		Quarterly	X	X	X
ERMBH9	27° 1' 30.048" S	30° 16' 44.775" E	-71537.7	-2990606	1537.45	60	Monitoring BH	Kangra Coal	oHlelo Stream Interaction	Conceptual Model	Monthly		Quarterly	X	X	
ERMBH10	27° 2' 24.606" S	30° 17' 18.488" E	-70598.9	-2992280	1751.45	100	Monitoring BH	Kangra Coal	Structure on top of mountain	Conceptual Model	Continual		Quarterly	X	X	
RMBH1	27° 0' 29.091" S	30° 14' 41.397" E	-74950	-2988750	NA	NA	Recommended Monitoring BH	Kangra Coal	NW Boundary	Conceptual Model	Monthly		Quarterly	X	X	
RMBH2	26° 59' 47.261" S	30° 15' 57.838" E	-72850	-2987450	NA	NA	Recommended Monitoring BH	Kangra Coal	N Boundary	Conceptual Model	Monthly		Quarterly	X	X	
FB2	27° 0' 47.072" S	30° 17' 52.651" E	-69674	-2989273	1517	NA	Abstraction BH	Yende Community (Twyfelhoek School)	Risk Management	Conceptual Model			6-monthly	X	X	
FB6	27° 7' 18.660" S	30° 14' 4.014" E	-75904	-3001363	1770	NA	Abstraction BH	C.L. Greyling	Risk Management	Conceptual Model			6-monthly	X	X	
FB7	27° 5' 52.446" S	30° 13' 18.210" E	-77182	-2998717	1748	NA	Abstraction BH	C.L. Greyling	Risk Management	Conceptual Model			6-monthly	X	X	
FB8	27° 5' 48.103" S	30° 13' 2.558" E	-77614	-2998586	1746	NA	Abstraction BH	C.L. Greyling	Risk Management	Conceptual Model			6-monthly	X	X	
FB13	27° 2' 3.142" S	30° 14' 52.958" E	-74614	-2991643	1805	NA	Abstraction BH	C.J.F. Greyling	Risk Management	Conceptual Model			6-monthly	X	X	
Point1	27° 0' 9.462" S	30° 17' 16.035" E	-70690	-2988121	NA	NA	SW Abstraction Point	Yende Community	Risk Management	Impact on oHlelo Stream (downstream of Adit A)		Monthly	6-monthly	X	X	
Point2	27° 2' 2.744" S	30° 18' 26.647" E	-68724	-2991597	NA	NA	SW Abstraction Point	Kanluka Community	Risk Management	Kransbank		Monthly	6-monthly	X	X	
Point3	27° 1' 9.672" S	30° 18' 16.344" E	-69017	-2989965	NA	NA	SW Abstraction Point	Kanluka Community	Risk Management	Kransbank		Monthly	6-monthly	X	X	
FS5	27° 2' 11.105" S	30° 18' 35.665" E	-68474	-2991853	1501	NA	Spring	Kanluka Community	Risk Management	Kransbank		Monthly	6-monthly	X	X	
FS6	27° 2' 6.169" S	30° 17' 56.658" E	-69550	-2991707	1562	NA	Spring	Kanluka Community	Risk Management	Kransbank		Monthly	6-monthly	X	X	
FS7	27° 0' 40.772" S	30° 16' 29.772" E	-71960	-2989092	1623	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS8	27° 2' 49.469" S	30° 17' 9.982" E	-70829	-2993047	1735	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS9	27° 3' 7.414" S	30° 16' 59.491" E	-71115	-2993601	1746	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS10	27° 2' 54.270" S	30° 16' 43.102" E	-71569	-2993199	1717	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS11	27° 3' 23.532" S	30° 16' 3.580" E	-72653	-2994106	1715	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS12	27° 3' 37.687" S	30° 14' 23.769" E	-75401	-2994558	1767	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS16	27° 6' 8.022" S	30° 17' 0.847" E	-71046	-2999160	1478	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS17	27° 1' 33.198" S	30° 12' 38.317" E	-78331	-2990744	1773	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS18	27° 2' 8.386" S	30° 11' 58.744" E	-79415	-2991834	1740	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS19	27° 3' 6.159" S	30° 12' 29.140" E	-78566	-2993607	1722	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS23	27° 3' 22.677" S	30° 18' 15.923" E	-69006	-2994059	1474	NA	Spring	Jurie Wessels	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS25	27° 3' 6.477" S	30° 18' 58.005" E	-67849	-2993554	1637	NA	Spring	Kanluka Community	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
FS26	27° 2' 34.173" S	30° 15' 36.798" E	-73400	-2992591	1793	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
Spring.	27° 1' 48.527" S	30° 17' 4.854" E	-70981	-2991172	1610	NA	Spring	Yende Community	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
Spring A	27° 1' 2.224" S	30° 17' 35.581" E	-70142	-2989742	1599	NA	Spring	Kanluka Community	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
Spring B	27° 3' 40.496" S	30° 17' 46.383" E	-69817	-2994612	1540	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	
Spring C	27° 3' 10.464" S	30° 14' 24.098" E	-75397	-2993720	1769	NA	Spring	C.J.F. Greyling	Risk Management	Conceptual Model		Monthly	6-monthly	X	X	

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Volume III Annex C.4

Heritage Impact Assessment Report

Version 5.0

May 2013

Document Ref.	Prepared By	Reviewed By	Date Submitted to Kangra Coal for Review
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CONTENTS

LIST OF APPENDICESS

LIST OF ACRONYMS

Abbreviation	Full Definition
AIA	Archaeological Impact Assessment
BA	Bachelor of Arts
BP	Before Present
BSc	Bachelor of Science
CRM	Cultural Resources Management
EA	Environmental Authorization
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ERM	Environmental Resources Management
ESA	Early Stone Age
ESIA	Environmental and Social Impact Assessment
HIA	Heritage Impact Assessment
HRA	Heritage Resources Authority
HRM	Heritage Resources Management
GNR	Government Notice Regulation
GRP	Grave Relocation Process
GS-IDP	Gert Sibanda Integrated Development Plan
I&APs	Interested and Affected Parties
ICOMOS	International Council on Monuments and Sites
IDP	Integrated Development Plan
Ka	Thousand years ago
LoM	Life of Mine
LSA	Later Stone Age
MGDP	Mpumalanga Growth and Development Plan
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
MSA	Middle Stone Age
MSc	Master of Science
Mtpa	Million tons per annum
Mya	Million years ago
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEMPA	National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)
NHRA	National Heritage Resources Act, 1999 (Act No. 25 of 1999)
OES	Ostrich eggshell
OHTL	Overhead Transmission Line
PHRA	Provincial Heritage Resources Authority
PIA	Palaeontological Impact Assessment
RoD	Record of Decision
RoM	Run of Mine
SACNASP	South African Council for Natural Scientific Professionals
SAHRA	South African Heritage Resources Agency
SAPS	South African Police Service
SoW	Scope of Work
ToR	Term of Reference
VIA	Visual Impact Assessment
WHCA	World Heritage Convention Act, 1999 (Act No. 49 of 1999)

1 INTRODUCTION

1.1 BACKGROUND

Kangra Coal (Pty) Ltd commissioned Environmental Resources Management Southern Africa (Pty) Ltd (ERM) to conduct an Environmental and Social Impact Assessment (ESIA) for the proposed Kusipongo Resource Mining Expansion Project (proposed Project) in accordance with the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA). ERM subsequently appointed Digby Wells Environmental (Digby Wells) to conduct the Heritage Impact Assessment (HIA), which is one of the specialist studies required for the ESIA.

The proposed Project is situated near Ermelo in the Mpumalanga Province. The regional setting of the Project Area is illustrated in *Figure 1.2*.

1.2 TERMS OF REFERENCE

1.2.1 *Heritage Resources Assessment Terms of Reference*

ERM completed a Scoping Report in terms of the MPRDA and NEMA and submitted this report SAHRA. Subsequently, SAHRA commented on the Scoping Report in a letter dated 22 January 2013 and stipulated that a HIA must be completed. The HIA needs to include:

- An Archaeological Impact Assessment (AIA);
- A palaeontological study; and
- An assessment of impacts of the proposed development on any other heritage resources such as built structures over 60 years old, sites of cultural significance associated with oral histories, burial grounds and graves, graves of victims of conflict, and significant cultural landscapes or viewscapes must also be assessed.

1.2.2 *Scope of Work*

As per the specialists Scope of Work (SoW) and to comply with the above-mentioned Terms of Reference (ToR), the following heritage work was required and is now presented in this HIA report:

- Collation of a heritage Baseline Section inclusive of:
    - A literature review;
    - Archival and relevant database research;

- An update and integration of previous heritage baseline reports;
- A cartographic survey and historical layering; and
- An institutional and legal review.

- A collation of a HIA Section inclusive of:

  - Fieldwork;
  - An integration of specialist studies;
  - Statement of heritage value; and
  - An impact assessment.

1.2.3 *Aims and Objectives*

The aim of this HIA was to assist the client in identifying, documenting and managing heritage resources found in the proposed Project Area in a responsible manner and in compliance with relevant legislative frameworks. The specific objectives of the study were to:

- Identify, record and document sites of cultural significance, archaeological, palaeontological, cultural and historic sites including graves and cemeteries within the proposed Project Area;

- Evaluate whether proposed activities will have any negative impacts on these heritage resources during the construction, operation and decommissioning phases of the proposed Project;

- Recommend Project-related mitigation and management measures to avoid or ameliorate any negative impacts on structures, objects or sites of cultural significance. Where Project-related mitigation may not reduce impacts, appropriate mitigation of heritage resources were recommended; and

- Promote the overall conservation and protection of natural and cultural resources in the proposed Project area and its surroundings.

1.3 PROJECT DESCRIPTION

1.3.1 *Current Operations*

Kangra Coal have been mining and washing coal at the Savemore Colliery adjacent to the Driefontein community since the late 1990s. The Savemore Colliery currently operates on three properties:

- Maquasa East;
- Maquasa West; and
- Maquasa West Extension.

Both underground and open pit mining methods characterise current operations at the Savemore Colliery. Production is less than five million tons per annum (Mtpa) and Run of Mine (RoM) comprises 70% product and 30% discard. At present, mined coal is transported to the washing plant by means of a conveyor. The expected remaining life of the current mining operations is estimated to be a further three to five years.

1.3.2 Description of the Proposed Project

The scope of the proposed Project involves the development of an underground working in the Kusipongo Resource with associated surface infrastructure at the Main Mine Adit (Adit A), which is situated westwards of existing operations, a ventilation Adit (Adit B), and a new overland conveyor system.

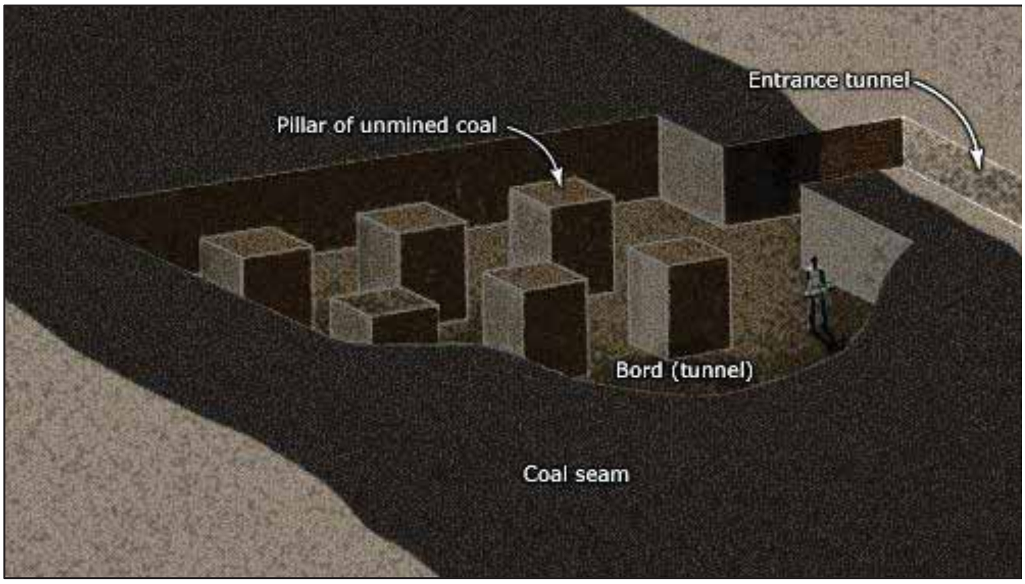
The proposed Main Mine Adit, Adit B and the overland conveyor route will be located on the following farm portions (*Table 1.1*):

Table 1.1 Farm Portions within the Footprint of the Proposed Project

Property	Title Deed Number
Adit A	
Donkerhoek No. 14-HT, Portion 4	T102893 / 2005
Twyfelhoek No. 379-IT, Portion 3	T53617 / 1998
Twyfelhoek No. 379-IT, Portion 2	T53617 / 1998
Adit B	
Kransbank No. 15-HT, Portion 2	T16193 / 1989
Kransbank No. 15-HT, Portion Remainder	T16193 / 1989
Conveyor Route	
Twyfelhoek No. 379-IT, Portion 3	T53617 / 1998
Twyfelhoek No.379-IT, Portion 2Re	T53617 / 1998
Twyfelhoek No.379-IT, Remainder	T53617 / 1998
Nooitgezien No. 381-IT, Remainder	T36896 / 2006
Rooikop No. 18-HT, Remainder	T78816 / 2004

The proposed Project will be restricted to underground mining. The anticipated RoM production volume is expected to be between approximately 3.6 Mtpa and 3.8 Mtpa, should both seams be mined concurrently. The proposed Project is estimated to have a lifespan of approximately 10 to 20 years. The means of underground mining will employ bord and pillar methods, using continuous mining equipment (*Figure 1.1*).

Figure 1.1 Schematic Example of Proposed Underground Bord and Pillar Mining Method



Source: (www.teara.gov.nz/en/coal-and-coal-mining/6/2)

The majority of the surface infrastructure associated with the proposed Project, such as a coal beneficiation plant and material handling facilities, is located on the existing Maquasa East, Maquasa West and Maquasa West Extension properties. This infrastructure will continue to be used for the processing of coal reserves from the proposed Kusipongo Resource. It is proposed to transport coal via an overland conveyor from the proposed Main Mine Adit in the Kusipongo Resource to the existing Maquasa West Adit. From there it is proposed that the new overland conveyor system will feed into the existing overland conveyor system, which will then transport coal to the existing Maquasa East Coal beneficiation plant. Included in the proposed conveyor corridor will be overhead transmission lines (OHTL), a gravel service road and a security fence (fenced width of 32 m).

1.4 EXPERTISE OF CULTURAL HERITAGE SPECIALISTS

Johan Nel has completed a Bachelor of Arts (BA) degree in archaeology and anthropology and a BA Honours degree in archaeology at the University of Pretoria. He has over 10 years' experience in Cultural Resources Management (CRM) as a consulting archaeologist. Johan holds the position of Unit Manager for Heritage Resource Management (HRM) in the Social Science Department at Digby Wells. Johan is a member of the Association of Southern African Professional Archaeologists (ASAPA).

Shahzaadee Karodia has completed a BA degree in archaeology and anthropology, a Bachelor of Science (BSc) Honours degree in palaeontology, and a Master of Science (MSc) degree in archaeology. Shahzaadee has academic experience n palaeoanthropology and historical archaeology. She currently holds the position of Archaeology Consultant at Digby Wells. Shahzaadee is a member of ASAPA.

See *Appendix A* for specialists Curriculum Vitae.

1.5 CLIENT, CONSULTANT AND LAND OWNER CONTACT DETAILS

The contact details of the client, consultant and landowners are presented respectively below.

Table 1.2 Client Contact Details

ITEM	COMPANY CONTACT DETAILS
Company	Kangra Coal (Pty) Ltd
Contact person	Mr Marcos Moledo
Tel no	011 684 0149
Cell no	082 861 1331
E-mail address	marcos@kangracoal.co.za
Postal address	5 De Wet Street, Piet Retief

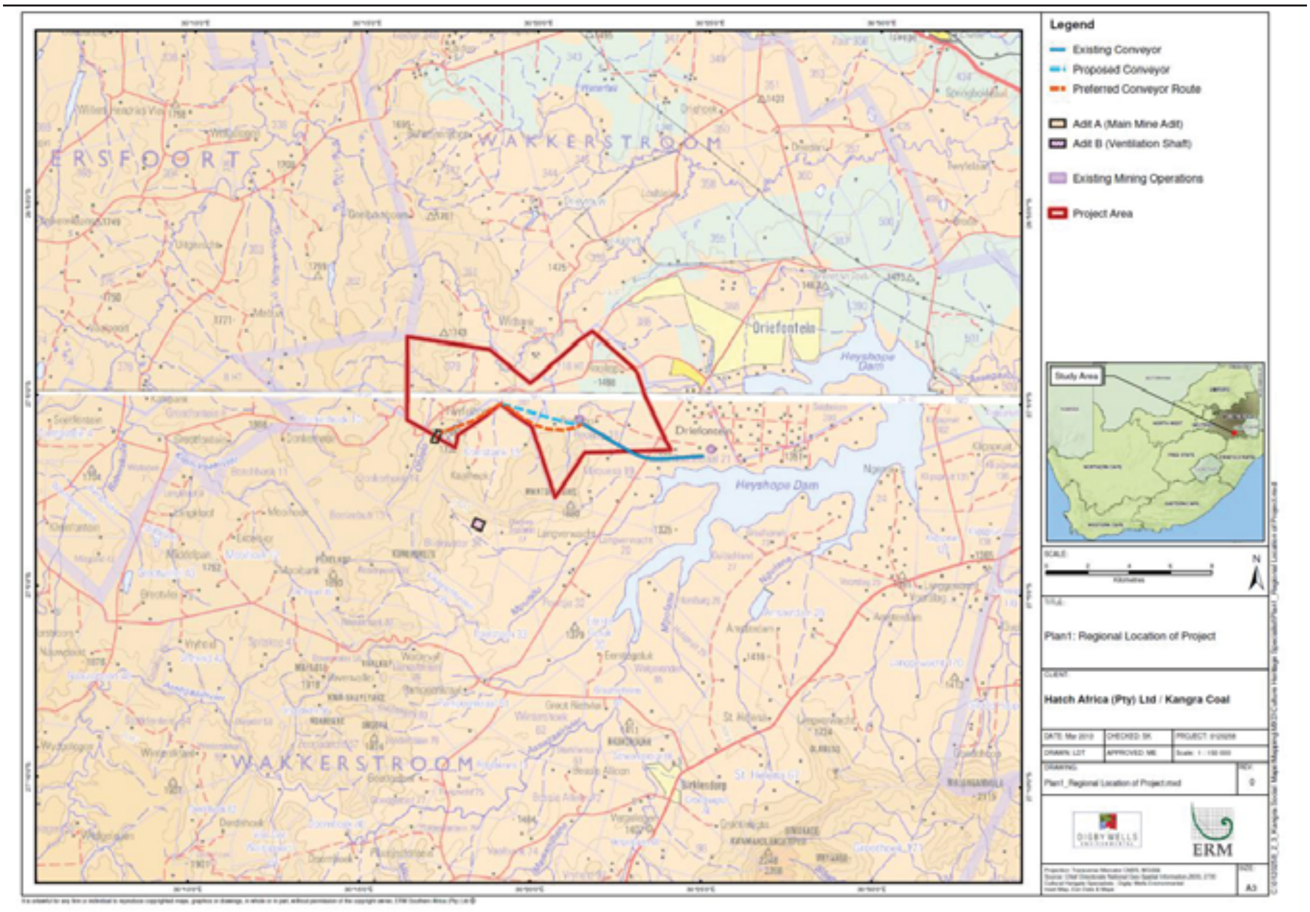
Table 1.3 Consultant Contact Details

ITEM	COMPANY CONTACT DETAILS
Company	Environmental Resources Management South Africa (Pty) Ltd
Contact person	Mr Mike Everett
Tel no	031 767 2080
Fax no	031 764 3643
E-mail address	Mike.everett@erm.com
Postal address	Unit 6, St Heliers Office Park, Corner St Helier Road and Forbes Drive, Gillitts, KwaZulu-Natal, 3610

Table 1.4 Directly Affected Landowner Contact Details

FARM	CONTACT	CONTACT NUMBER
Twyfelhoek 379 IT Portion 3	Yende Community	072 155 0434
Twyfelhoek 379 IT Portion 2		
Twyfelhoek 379 IT RE	Thuthukani	076 997 4895
Nooitgezien 381 IT RE	Kangra Coal	011 684 0149
Rooikop 18 HT Portion 1		
Rooikop 18 HT RE		
Donkerhoek 14 HT Portion 4	C. G. F. Greyling	017 730 0375 / 082 773 2310
Donkerhoek 14 HT Portion 22		
Kransbank 15 HT	Kanluka Community	072 554 9897
Kransbank 15 HT RE		

Figure 1.2 Regional Setting of the Project Area 1:250 000



2 LEGAL FRAMEWORK AND GOOD PRACTICE STANDARDS

This section will discuss the national legislation and standards and international guidelines that are relevant to the this Study. These include the MPRDA, the NEMA, and the NHRA. Each of these legislations is discussed separately below.

2.1 DEVELOPMENT CONTEXT OF STUDY AREA

The Study Area refers to the cultural landscape in an approximately 100 km radius of the siteb of the proposed Project within the borders of South Africa.

The proposed Project is located in the Gert Sibande District Municipality and the Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities. The 2012 Gert Sibande District Municipality Integrated Development Plan (GS-IDP) was reviewed to gain a more detailed understanding of the development context within which the proposed Project site is situated (Gert Sibande District Municipality IDP, 2012). The GS-IDP represented a five-year plan to guide socio-economic development within the district municipality. The proposed socio-economic development of the municipality was considered in order to better identify and assess cumulative environmental impacts on heritage resources in the Study Area.

Cumulative impacts on heritage resources were addressed and are presented in *Section* 6 of this report.

Overall, the mining sector was identified as a key sector for facilitating economic growth and promoting job creation. The mining sector primarily involves infrastructure development, social development, municipal financial viability, economic development and institutional development.

The Mpumalanga Growth and Development Path (MGDP) – included in the GS-IDP - promotes local economic growth through the following sectors (Gert Sibande District Municipality IDP, 2012):

1. Agriculture and forestry;
2. Mining and energy; and
3. Tourism and cultural interests.

Each identified sector above comprises specific types or categories of development that may impact on heritage resources in various manners. The development context in Study Area must therefore be taken into account. The identified sectors are briefly discussed below.

Agriculture and Forestry

According to the GS-IDP, growth within the agriculture sector will include a massive drive on infrastructure development that may include, among other things:

- Dams;
- Irrigation;
- Farm roads;
- Silos;
- Pack houses;
- Mechanisation;
- Electricity; and
- Infrastructure for agro-processing.

Mining and Energy

The key areas that were identified within the mining sector to facilitate economic growth included:

- The upgrading and maintenance of the coal haulage network;
- The expansion of the water network and increased reliance on water transfer schemes;
- The increase of South Africa's energy load and the improvement of alternative energy supply;
- The establishment of a mining supplier park to enhance enterprise development in the province;
- The resolution of land claims to release land for development; and
- The provision of comprehensive support to small-scale mining enterprises.

Tourism and Culture

The GS-IDP also identified key areas to facilitate growth in the tourism and cultural industries. These included broadening and diversifying primarily nature-based tourism product offerings in Mpumalanga into more mainstream market segments such as sports event, business/conference meetings, and theme or amusement parks.

2.2 NATIONAL REGULATORY FRAMEWORK

2.2.1 Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996)

Summary of Act

The Constitution of the Republic of South Africa (the Constitution) enshrines the basic, fundamental and inalienable rights of the citizens of the Republic.

Applicability to Project

The Constitution stipulates under Section 24 that everyone has a right to an environment that is not harmful to their health or well-being. This right extends to protecting the environment for the benefit of present an future generations through legislative and other measures that are aimed at preventing pollution and ecological degradation, promoting conservation and secure ecologically sustainable development and use of natural resources. Sustainable development and use of natural [(1)] resources must promote justifiable economic and social development.

2.2.2 Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)

Summary of Act

The Mineral and Petroleum Resources Development Act (MPRDA) makes provision for equitable access to, and sustainable development of, the nation's mineral and petroleum resources.

Applicability to Project

The MPRDA stipulates under Section 5(4) no person may prospect for or remove, mine, conduct technical co-operation operations, reconnaissance operations, explore for and produce any mineral or petroleum or commence with any work incidental thereto on any area without (a) an approved environmental management programme or approved environmental management plan, as the case may be.

2.2.3 National Environmental Management Act, 1998 (Act No. 107 of 1998)

Summary of the Act

The National Environmental Management Act (NEMA) creates the legal framework that ensures the environmental rights guaranteed in Section 24 of the Constitution are abided by.

Applicability to Project

The NEMA stipulates under Section 2(4)(a) that sustainable development requires the consideration of all relevant factors including (iii) the disturbance of landscapes and sites that constitute the nation's cultural heritage must be avoided, or where it cannot be altogether avoided, is minimised and remedied. Heritage assessments are implemented in terms of the NEMA Section 24 in order to give effect to the general objectives. Procedures

(1) The use and procurement of natural resources could potentially result in impacts on heritage resources that may exisit in the imediate vicinity

considering heritage resource management in terms of the NEMA are summarised under Section 24(4) as amended in 2008.

2.2.4 National Heritage Resources Act, 1999 (Act No. 25 of 1999)

Summary of the Act

The National Heritage Resources Act (NHRA) aims to introduce an integrated system for the management of South Africa's heritage resources. Further, the Act empowers civil society to nurture and conserve their heritage resources so that they can be passed onto future generations. The Act provides a framework for the management of heritage resources in South Africa and to protect heritage resources of national significance. In order to meet these objectives, the Act introduces an integrated system that can allow for the identification, assessment and management of heritage resources in South Africa.

Applicability to Project

The proposed activities associated with the proposed Project will include the extension and operation of an underground mine. This may result in the destruction or alteration of existing structures that may be older than 60 years.

Section 34 – Structures Older than 60 years

Section 34 of the NHRA provides for general protection of structures older than 60 years. Most importantly, Section 34(1) clearly states that no structure or part thereof may be altered or demolished without a permit issued by the relevant Provincial Resources Heritage Authority (PHRA). These permits will not be granted without a HIA being completed. A destruction permit will thus be required before any removal and/or demolition may take place, unless exempted by the PHRA according to Section 34(2) of the NHRA.

Section 35 – Archaeological and Palaeontological Resources and Meteorites

Section 35 of the NHRA provides for the general protection of archaeological and palaeontological resources, and meteorites. In the event that archaeological resources are discovered during the course of the proposed Project, Section 38(3) specifically requires that the discovery must immediately be reported to the PHRA, or local authority or museum who must notify the PHRA. Furthermore, no person may without permits issued by the SAHRA destroy, excavate, or make any alterations to archaeological or palaeontological resources encapsulated in Section 38(4).

With regards to the definition of palaeontological resources, Section 2 (xxxi) of the Act states that "'palaeontological' means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trance".

Construction and operation activities associated with the proposed Project – in the immediate receiving environment – are likely to impact on archaeological resources.

Section 36 – Burial Grounds and Graves

Section 36 of the NHRA allows for the general protection of burial grounds and graves. Should burial grounds or graves be found during the course of development, Section 36(6) stipulates that such activities must immediately cease and the discovery reported to the responsible heritage resources authority and the South African Police Service (SAPS). Furthermore, as specified in Section 38(3) no person may destroy, damage, exhume or alter any burial site without a permit issued by SAHRA.

Construction and operation activities associated with the proposed Project – in the immediate receiving environment – are likely to impact on burial grounds and graves.

Section 37 – Public Monuments and Memorials

Section 37 makes provision for the protection of all public monuments and memorials in the same manner as places which are entered in a heritage register referred to in Section 30 of the NHRA.

Construction and operation activities associated with the proposed Project – in the immediate receiving environment – are likely to impact on public monuments and memorials should they exist in the Project Area.

Section 38 – Heritage Resources Management

The provisions of this section do not apply to a development as described in Section 38 (1) if an evaluation of the impact of such development on heritage resources is required in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989), or the integrated environmental management guidelines issued by the Department of Environment Affairs and Tourism, or the Minerals Act, 1991 (Act No. 50 of 1991), or any other legislation. Section 38(8) ensures cooperative governance between all responsible authorities through ensuring that the evaluation fulfils the requirements of the relevant heritage resources authority in terms of Subsection (3), and any comments and recommendations of the relevant heritage resources authority with regard to such development have been taken into account prior to the granting of the consent.

The Listed Activities in terms of the Government Notice Regulations (GNRs) stipulated under NEMA (for which Environmental Authorisation (EA) will be required) will trigger the requirement for an HIA as contemplated in Section 38(1) above as follows:

Table 2.1 Listed Activities in Terms of the GNRs Stipulated Under NEMA

NEMA Listed Activity	NHRA Section 38 Trigger	Definition
Linear Development		
GN. R. 544-22 GN. R. 544-47 GN. R. 546-4	38(1)(a)	• Construction of a road or any linear development longer than 300 m; and • Construction of a bridge or similar structure longer than 50 m.
Non-linear Development		
GN. R. 544-13 GN. R. 544-23	38(1)(c)(i)	• Transformation of land in excess of 5 000 m² that will change the character of a site.
GN. R. 544-24 GN. R. 545-15	38(1)(c)(ii)	• Transformation of land involving three or more existing erven or divisions.
GN. R. 546-13 GN. R. 546-14	38(1)(d)	• Rezoning of land in terms of other legislation (i.e.: NEMA, etc.).
Other Triggers		
GN. R. 544-20 GN. R. 545-20	38(1)(e)	• Other triggers, e.g.: in terms of other legislation, (i.e.: NEMA, etc.).

2.3 NATIONAL GUIDELINES AND STANDARDS

2.3.1 South African Heritage Resources Agency Minimum Standards

The South African Heritage Resources Agencey (SAHRA) Minimum Standards makes provision for the compilation and integration of Archaeological Impact Assessments (AIAs) and Palaeontological Impact Assessments (PIAs) as specialist components of the broader HIA and Environmental Impact Assessments (EIAs) (SAHRA, 2006). The process of assessment for these specialist reports usually involves a Scoping Report, a Phase 1 Heritage Impact Assessment Report, a Letter of Recommendation for Exemption or Phase 2 Mitigation/Rescue, and a Phase 3 Heritage Site Management Plan.

The Phase 1 Heritage Impact Assessments, as stipulated by the SAHRA Minimum Standards, comprise of Phase 1 AIAs and/or Phase 1 PIAs. These assessments usually involve a field survey of the proposed Project and will include:

- Details of property to be developed and the type of assessment (Section 38(1) or Section 38(8);
- Location of the sites that are found;
- Short description of the characteristics of each site;

- Short assessment of the importance of each site, indicating which should be conserved and which mitigated;
- Assessment of the potential impact of the development on the site/s;
- In some cases, a shovel test, to establish the extent of the site, or collection of material might be required to identify the associations of the site (a pre-arranged permit is required); and
- Recommendations for conservation or mitigation.

When the Phase 1 report forms part of an EIA, public consultation and spatial and visual impacts of the development must be undertaken as part of the general study. If the Phase 1 forms a major component of an HIA, it will be necessary to ensure that the study complies with Section 38 of the NHRA. Phase 1 specialist reports will be assessed by the Mpumalanga Heritage Resources Authority (MPHRA). If the decision is that the sites are of low significance, they may, after recording, be destroyed to make way for development. The final decision about this should be taken by the HRA, which should give formal permission for the destruction.

In the case of AIAs and PIAs that form part of EIAs and Environmental Management Plans (EMPs), the HRA will issue comment or a Record of Decision (RoD) that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.

Where a property is either very disturbed or is very small and the archaeologist can see that it is highly unlikely that any archaeological remains will be found, a Letter of Recommendation for Exemption from a full Phase 1 HIA report may be supplied. This must be accompanied by a map and photograph indicating landscape features.

2.3.2 International Council on Monuments and Sites

The credibility of the information sources is vital in determining the importance and authenticity of heritage resources. The International Council on Monuments and Sites (ICOMOS) Nara Document on Authenticity (Nara Document on Authenticity, 1994) forms the basis of determining authenticity. Based on this document, it is accepted that understanding and determining the value attributed to heritage resources rely on certain information sources. These sources need to be assessed as credible or truthful, which requires knowledge and understanding of such information sources in relation to original and subsequent characteristics of the cultural heritage and their meaning.

The ICOMOS Charter for Places of Cultural Significance, 1999 (the Burra Charter) provides guidance for the conservation and management of places of cultural significance. ICOMOS Charters are generally published following proceedings held in and hosted by various ICOMOS member states. The Burra Charter: ICOMOS Charter for Places of Cultural Significance is thus a Charter that was adopted by ICOMOS following the 1979 ICOMOS meeting in Burra, South Australia. The Burra Charter considered the 1964 Venice Charter: International Charter of the Conservation and Restoration of Monuments and Sites and the 1978 Moscow Resolutions of the 15th General Assembly of ICOMOS. The Burra Charter also formed the foundation for much of the South Africa NHRA. It defines and describes various heritage issues in more detail that are at times only alluded to in the NHRA.

According to this Charter, the cultural significance of a heritage resource (defined as a site, area, land, landscape, building or other work, group of buildings or other works, and may include components, contents, spaces and views) and other issues affecting its future are best understood by a sequence of collecting and analysing information before making decisions. Understanding cultural significance comes first, then development of policy and finally management of the heritage resource in accordance with the policy. The policy for managing a heritage resource must therefore be based on an understanding of its cultural significance. Policy development should also include consideration of other factors affecting the future of a heritage resource such as the owner's needs, resources, external constraints and its physical condition (The Burra Charter, 1999).

2.4 KANGRA COAL POLICIES

Kangra Coal is committed to responsible environmental stewardship and sustainable business practices; Kangra Coal pledges to improve their overall environmental performance across all their business activities. Kangra Coal encourages their business partners and members of the entire Kangra group to participate in this endeavour.

In accordance with this Environmental Policy (ENV-P-001), strives for compliance with all environmental laws and commits to manage all of its activities in the environment. With regards to heritage and the environment, Kangra Coal pledges to:

- Adopt the highest environmental standards in all areas of operations meeting and exceeding all relevant legislative requiremets to which Kangra suscribes to;

- Regularly evaluating the existing and potential impact of its operations (including those relating to work undertaken by all staff) on the environment; and

- Continuosly conduct research to increase the knowledge on the environmental effects of Kangra Coal's relative activities and development or adoption of approprite processes, technologies and equipment to meet anticipated environmental needs.

3 IMPACT ASSESSMENT METHODOLOGY

The Impact Assessment methodology comprises a number of steps that collectively assess the manner in which the proposed Kusipongo Resource Expansion Project will interact with elements of the heritage resources to produce impacts to resources / receptors. The steps involved in the impact assessment stage are described in greater detail below.

3.1 HERITAGE RESOURCES MANAGEMENT (HRM)

Digby Wells has developed a HRM process aimed at expediting decisions by relevant Heritage Resources Authorities (HRAs). This process is firmly founded on the NHRA. This process is a phased approach aimed at integrating HRM with the MPRDA and NEMA processes.

Heritage resources – both cultural and natural – are finite, non-renewable and irreplaceable. They characterise community identity and cultures and are therefore intrinsic to the history and beliefs of communities. As sources of information, heritage resources have inherent potential to contribute significantly to research, education and tourism as well as allowing capacity for reconciliation, understanding and mutual respect.

Considering the innate value of heritage resources, the foundation of HRM is the acknowledgement that heritage resources have lasting worth as evidence of the origins of life, humanity and society. Every generation is therefore morally obligated to act as trustees of heritage for future generations through conservation, preservation and protection.

Accordingly, HRM must take into account rights of affected communities to be consulted and to participate. Where heritage resources are developed and presented, the dignity and respect of diverse cultural values must be ensured. In addition, heritage in its broadest sense must never be used for sectarian purpose or political gain.

3.2 IMPACT ASSESSMENT METHODOLOGY

The impact assessment stage includes several steps aimed to evaluate the way in which environmental aspects will or may interact with the cultural landscape resulting in environmental impacts on heritage resources See *Appendix B* for the Impact Assessment Methodology created by Digby Wells. Environmental aspects and impact are defined as:

- ***Environmental Aspects*** – an element of an organisation's activities, products, or services that can interact with the environment; and

- ***Environmental Impacts*** – any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects.

However, in terms of cultural heritage resources, environmental impacts should be assessed relative to the heritage value or significance of a resource. The methodology employed in the various stages of the impact assessment process is described in more detail in the sections below [1].

3.3 STATEMENT OF SIGNIFICANCE OR VALUE

Notwithstanding the fundamental value ascribed to heritage, the significance of individual heritage resources needs to be determined to allow implementation of appropriate management measures. This is achieved through assessing a heritage resource's value relative to certain prescribed criteria, encapsulated in the NHRA as well as in several international conventions. The significance of a heritage resource thus determines the magnitude of change that may result from environmental impacts. As a result, environmental impacts that are rated as low may cause severe change in a heritage resources rated as highly significant. Conversely, severe impacts may cause negligible change to an insignificant resource. Value is determined by assessing the authenticity and integrity of a heritage resource by applying the formula provided in *Table 3.1*. Value thresholds are provided in *Table 3.2.*

Table 3.1 Formula for Calculating Heritage Resource Value

Multiplied By		Authenticity					
		0	3	6	9	12	15
Integrity	0	0	0	0	0	0	0
	1	0	3	6	9	12	15
	2	0	6	12	18	24	30
	3	0	9	18	27	36	45
Value = authenticity + integrity where Authenticity = importance (average sum of attributes per dimension) + credibility							

Table 3.2 Value Thresholds

Score	Description	Rating
0	Resource of no / negligible heritage value as part of national estate	None / negligible
1-15	Resource of low heritage value: change to resource not significant	Low
16-30	Resource of medium heritage value: project mitigation must aim to reduce any impacts on	Medium

(1) This Impact Assessment Methodology, excluding the sections on Impact Significances, Residual Impacts and Cumulative Impacts which were produced by ERM (Pty) Ltd, has been produced by Digby Wells Environmental and can be found in its entirety in Appendix B.

	resource; conservation may be required.	
31-45	Resource of exceptional value and must be considered for inclusion in national estate: project mitigation must attempt to remove all impacts; consideration must be given to conservation / preservation of resource.	High

The steps involved in determining the value of a heritage resource are described in more detail below.

3.3.1 *Authenticity*

As is mentioned above, the Nara Document on Authenticity (Nara Document on Authenticity, 1994) forms the basis of determining authenticity. Based on this document, it is accepted that understanding and determining importance attributed to heritage resources rely on credible information sources [(1)]. These sources need to be assessed as credible or truthful. This requires knowledge and understanding of information sources employed in relation to original and subsequent characteristics of heritage resources, and their meaning.

Authenticity is therefore determined in terms of the importance of a resource considering available sources of information. Thresholds for authenticity are provided in *Table 3.3*.

Table 3.3 Authenticity Thresholds

Score	**Description**	**Rating**
0	None	None / negligible
1-5	Negligible to low level of authenticity evident.	Low
6-10	Authenticity merely evident: importance illustrated in credible information sources.	Medium
11-15	Authenticity of resource undisputed.	High

Importance

The importance of a heritage resource is determined on four dimensions – aesthetic, historic, scientific, and social. In turn, each dimension is measured

[(1)] **Information sources** are defined as all physical, written, oral, and figurative sources, which make it possible to know the nature, specifications, meaning, and history of the cultural heritage. Therefore, determining authenticity of a resource requires a sound knowledge of the type of heritage resource as well as the context within which it occurs – the cultural landscape. This knowledge must be gained through a detailed baseline that must aim to contextualise the resources. Information that should be considered are published, peer reviewed literature, archival research, popular publications, and any other information source that may be relevant (Nara Document on Authenticity, 1994).

against one or more descriptive attributes, defined in national legislation and in international convention: NHRA, ICOMOS Guidance on Heritage Impact Assessments for Cultural World Heritage Properties, and the Burra Charter. These attributes, or criteria, are aimed to provide a guide as to whether a resource should be included in the National Estate as defined in these documents and presented in *Table 3.4*.

Table 3.4 Summary of Dimensions and Attributes

Dimension	Attributes considered		NHRA Ref.
Aesthetic and technical	1	Importance in aesthetic characteristics	S.3(3)(e)
	2	Degree of technical / creative skill at a particular period	S.3(3)(f)
Historical importance and associations	3	Importance to community or pattern in country's history	S.3(3)(a)
	4	Site of significance relating to history of slavery	S.3(3)(i)
	5	Association with life or work of a person, group or organisation of importance in the history of the country	S.3(3)(h)
Information potential	6	Possession of uncommon, rare or endangered natural or cultural heritage aspects	S.3(3)(b)
	7	Information potential	S.3(3)(c)
	8	Importance in demonstrating principle characteristics	S.3(3)(d)
Social	9	Association to community or cultural group for social, cultural or spiritual reasons	S.3(3)(g)

Importance ratings need to be provided for each applicable attribute per dimension. Each dimension's ratings are averaged and rounded off to allow for a consistent rating irrespective of whether one or more attributes are considered. Definitions and ratings are provided in *Table 3.5*.

Table 3.5 Importance Definitions

Importance	Definition
0	None
1	Attributes considered commonplace, well or over represented; Importance generally not considered by any community
2	Attributes considered uncommon, underrepresented; Importance generally considered by some communities.
3	Attributes considered singular, unique, irreplaceable; Importance always considered by most communities.

Credibility

Credibility of information sources forms the basis in determining the importance of heritage resources. The importance rating per dimension and attribute discussed above is thus intrinsically linked to the credibility of information sources used. Credibility thresholds and definitions are provided in *Table 3.6*.

Table 3.6 Credibility Definitions

Credibility	Definition
0	Credibility of information cannot be determined: Conjecture, unverified personal opinions; biases evident.

1	Secondary and tertiary information sources such as popular media, newspapers, magazines; 'Information' websites e.g. Wikipedia, etc., and individual opinions.
2	Credible secondary sources such as factually correct textbooks and popular publications, official websites, and verifiable oral accounts.
3	Highly credible information sources such as peer reviewed publications, primary sources, and verified oral accounts.

3.3.2 Integrity

Integrity is determined by examined the physical condition of a heritage resource – as witnessed at the time of the assessment – compared to an ideal or other existing example. Integrity ought to be assessed only after the resource's authenticity has been determined, as the information source/s used should provide comparative examples against which its present condition may be measured. Thresholds and definitions for integrity are described in *Table 3.7*.

Table 3.7 Integrity Definitions

Integrity	Definition
0	Resource degraded to extent where no information potential exists; resource cannot be restored; single, isolated find, without any site context.
1	Poor condition, active decay visible; excessive restoration required; little information potential.
2	Fair to good condition; well preserved; some decay present; can be easily restored/conserved/preserved; good information potential.
3	Excellent/pristine; extremely well preserved; little to no decay present; little restoration required/restoration will greatly enhance resource; excellent information potential.

3.4 IMPACT ASSESSMENT

Assessing impacts on heritage resources is based first on the value of a resource and second, on how that value may change due to impacts. The impact assessment stage comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to heritage resources. The steps involved in the impact assessment stage are described in greater detail the section below.

Environmental management systems employ relative standard terminology that characterises impacts. This terminology has been adapted to provide a well-defined descriptive terminology for use in assessing environmental impacts on heritage resources summarised in *Table 3.8* below.

Table 3.8 *Impact Characteristic Terminology*

Characteristic	Definition	Designations
Type	Relationship of an assumed impact to a heritage resource (in terms of cause and effect).	Direct Indirect Induced
Scale of Change	The physical area (size) of a heritage resource that may change.	None Isolated parts / aspects will change Large parts / aspects will change Most or entire resource will change
Duration	The time period over which a resource will change.	Immediate, non-permanent and fully reversible Long-term, non-permanent and reversible Long-term, permanent and irreversible Immediate, permanent and irreversible
Intensity	How an impact could change the authenticity and integrity, thus importance, of a resource.	None Change in integrity without affecting authenticity Change in integrity will affect aspects of authenticity Change in integrity will affect overall authenticity
Probability	Likelihood of change occurring.	None Project-related mitigation will remove change Project-related mitigation will reduce change Project-related mitigation will not reduce change

The significance of change to heritage resources due to environmental impacts is determined as follows:

Impact significance = Value X Magnitude

Where

Magnitude = Consequence X Probability

And

Consequence = Spatial Scale + Duration + Intensity

The impact rating is applied to pre- and post-mitigation scenarios. The ideal is to remove all impacts to a heritage resource. Where post-mitigation significance is not zero, the recommended field rating (heritage) mitigation must be undertaken. The tables

Table 3.9 to *Table 3.12* below provides the various descriptions and thresholds applicable to the impact assessment ratings.

Table 3.9 Scale Thresholds, Definitions and Designation

Score	Description	Rating
0	No change	None
1	Isolated parts / aspects of heritage resource will be affected	Low
2	Large parts / aspects of heritage resource will be affected	Medium
3	Most or entire heritage resource will be affected	High

Table 3.10 Duration Thresholds, Definitions and Designation

Score	Description	Rating
0	Change will be immediate, non-permanent and fully reversible	None
1	Change will occur over the long-term, result will be non-permanent and reversible	Low
2	Change will occur over the long term and the result will be permanent and irreversible	Medium
3	Change will be immediate, permanent and irreversible	High

Table 3.11 Intensity Thresholds, Definitions and Designations

Score	Description	Rating
0	No change to integrity and authenticity	None
1	Change to integrity that will not cause any change in authenticity (importance)	Low
2	Change to integrity that will cause change to certain authentic aspects (importance) (describe and define aspects)	Medium
3	Change to integrity that will cause change to overall authenticity (importance)	High

Table 3.12 Probability Thresholds, Definitions and Designations

Score	Description	Rating
0	No change	None
1	Project-related mitigation measures will avoid change	Unlikely
2	Project-related mitigation measures will reduce change	Probable
3	Project-related mitigation measures will not avoid change	Certain

Once the impact characteristics are understood, these characteristics are used to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Scale;
- Duration;
- Intensity; and
- Probability.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the heritage resource. The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *no change* to *high*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *no change* magnitude. In the case of *positive* impacts no magnitude will be assigned. The thresholds designations and definitions for magnitude are described in *Table 3.13* overleaf.

Table 3.13 Magnitude of Change Thresholds, Designations and Definitions in Relation to Three Categories of Heritage Resources

Threshold	Magnitude	Archaeology, Palaeontology	Built Environment/Structures	Historic Landscape
0	No change	No change	No change to fabric or setting	No changes to landscape elements, parcels or components; no visual or audible changes; no changes in amenity or community factors.
1-49	Low	Very minor changes to key archaeological materials, or setting.	Slight changes to historic building elements or setting that hardly affect it.	Very minor changes to key historic landscape elements, parcels or components; virtually unchanged visual effects; very slight changes in noise or sound quality; very slight changes to use or access; resulting in very small change to historic landscape character.
50-98	Medium	Changes to key archaeological materials, such that the resource is slightly altered; slight changes to the setting.	Change to key historic building elements, such that the resource is slightly different; change to setting of an historic building, such that it is noticeably changed.	Change to few key historic landscape elements, parcels or components; slight visual changes to few key aspects of the historic landscape; limited changes in noise or sound quality; slight changes to use or access; resulting in limited changes to historic landscape character.
99-147	High	Changes to many key archaeological materials, such that the resource is clearly modified; changes to the setting that affect the character of the asset	Change to many key historic building elements, such that the resource is significantly modified; change to setting of an historic building, such that it is significantly modified.	Change to many key historic landscape elements, parcels or components; visual change to many key aspects of the historic landscape; noticeable differences in noise or sound quality; considerable changes to use or access; resulting in moderate changes to historic landscape character.
		Changes to attributes that convey outstanding national value of national estate; Most or all key archaeological materials, including those that contribute to ONV such that the resource is totally altered; comprehensive changes to setting	Change to key historic buildings that contribute to outstanding national value of national estate such that the resource is totally altered; Comprehensive changes to setting.	Change to most or all key historic landscape elements, parcels or components; extreme visual effects; gross change of noise or change to sound quality; fundamental changes to use or access; resulting in total change to historic landscape character unit and loss on outstanding national value.

After characterising the magnitude of impact, the next principal step [(1)] necessary to assign significance for a given impact is to define the sensitivity of the impacted heritage resource. There are a range of factors to be taken into account when defining the sensitivity of the heritage resource and these are discussed in *Section 3.3* above.

The sensitivity designations themselves are universally consistent, but the definitions for these designations will vary on a heritage resource basis. The sensitivity designations are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity of heritage resource have been characterised, the significance can be assigned for each impact.

Table 3.14 Impact Significances

		Value of Heritage Resource			
		None/negligible	**Low**	**Medium**	**High**
Magnitude of Impact	**No change**	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Minor	Moderate	Moderate
	Medium	Minor	Moderate	Major	Major
	High	Moderate	Major	Major	Major

The matrix applies to heritage resources and all impacts to heritage resources, as the resource- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box 3.1* provides a context for what the various impact significance ratings signify.

(1) This step of the Impact Assessment Methodology that is presented here in this HIA report has been developed by ERM (Pty) Ltd.

Box 3.1 Context of Impact Significances

An impact of ***negligible*** significance is one where a heritage resource will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations. An impact of ***minor*** significance is one where a heritage resource will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and / or the heritage resource is of low importance. In either case, the magnitude should be well within applicable standards. An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and / or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently. An impact of ***major*** significance is caused by an activity that in effect is breaking the law and / or is not best practice. This means that impacts of major significance have to be reduced to moderate or minor impacts and that the impacts have to be managed effectively and efficiently.

3.5 FIELD RATING

Field ratings, or proposed grading of heritage resources, are required by SAHRA in terms of Section 7(1) of the NHRA. Field ratings are based on the assessments of heritage resources in relation to criteria contained in Section 3(3) of the NHRA (see *Section 3.4* above). Section 7 further outlines a three-tier system for heritage resources management of the National Estate based on proposed grading:

- National: SAHRA is responsible for identification and managing of Grade I heritage resources;
- Provincial: PHRAs are responsible for identification and managing of Grade II heritage resources; and
- Local: Local authorities (local and district municipalities, metros, local government) are responsible for identification and managing of Grade III heritage resources.

Field ratings are based on (equal to) the value of heritage resources. The thresholds for field ratings are presented in *Table 3.15*.

Table 3.15 ***Field Rating Thresholds and Descriptions***

NHRA Section 7 Grading			
Score	**Grade**	**Protection**	**Recommended Heritage Mitigation**
41-45	Grade I	National	Heritage resource should be nominated as a National Site / Object, included in National Estate
36-40	Grade II	Provincial	Heritage resource should be nominated as a Provincial Site / Object, included in National Estate
31-35	Grade III A	Local	Heritage resource should be nominated as a Regional Site / Object, included in National Estate
16-30	Grade III B	Local	The heritage resource must be mitigated and partly conserved / preserved
8-15	Grade IV A	General	The heritage resource must be mitigated before destruction
1-7	Grade IV B	General	The heritage resource must me recorded before destruction
0	Grade IV C	General	No mitigation required – heritage resource has been sufficiently recorded

3.6 MITIGATION OF IMPACTS

Once the significance of a given impact has been characterised using the HRM matrix, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the heritage resource via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude). Mitigation measures can therefore fall in two categories: project-related mitigation and mitigation of sites / heritage resources:

1. ***Project-Related Mitigation*** – impacts on heritage resources may be avoided or reduced through the implementation of feasible mitigation measures related to the Project design and planning. For instance, an historical building may be preserved *in situ* by changing infrastructure footprints.

2. ***Mitigation of Heritage Resources*** – where Project-related mitigation does not reduce of remove impacts on a heritage resource, the resource itself may require mitigation. For example, any resource located in the footprint of Adit A will inevitably be destroyed, irrespective of any project-related mitigation measures as the pit cannot be moved. Depending on the value of a resource (field rating / grading) certain prescribed site mitigation measures must then be implemented. This could include:

    - ***Site Preservation*** – conservation is essentially a no-development recommendation ad may be achieved through appropriate project-related mitigation;

- ***Site Mitigation*** **–** site conservation (no-development in the particular area) or Phase 2 mitigation (Shovel Test Pits (STPs)) after which development may legally proceed in the area; and

- ***Site Destruction*** – if a particular identified resource is of little archaeological or cultural heritage significance, a recommendation of site destruction will be made by an accredited archaeologist. A site destruction recommendation essentially implies that the site may be destroyed during the course of development without the developer having to comply with any archaeological or cultural heritage requirements.

It is important to have a solid basis for recommending mitigation measures. The role of any impact assessment is to develop a consentable Project, and to help achieve business objectives in a responsible manner. Impact assessment is about identifying the aspects of a Project that need to be managed, and demonstrating how these have been appropriately dealt with. As key influencers in the decision making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure, rather it is to make balanced judgements as to what is warranted, informed by a high quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an ALARP level.

Embedded controls (i.e., physical or procedural controls that are planned as part of the Project design and are not added in response to an impact significance assignment), are considered as part of the Project (prior to entering the impact assessment stage of the impact assessment process).

3.7 RESIDUAL IMPACT ASSESSMENT

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

3.8 CUMULATIVE IMPACTS/EFFECTS

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process should predict any cumulative impacts/effects to which the proposed Project may contribute. The approach for assessing cumulative impacts and effects resulting from the proposed Project and another activity affecting the same heritage resource is based on a consideration of the approval / existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

4 *RECEIVING ENVIRONMENT*

This section will describe the receiving environment of the Study and Project Areas. The Study Area was considered to include the cultural landscape in an approximately 100 km radius of the Project Area within the borders of South Africa (*Figure 4.1* and *Figure 4.2*). The Project Area is defined as the boundaries supplied by Kangra Coal for the proposed development. The Study Area allowed inferences to be made of potential sites that could exist within the Project Area based on certain sources of information such as previously completed relevant heritage studies.

The following subsections are discussed in this section:

- Heritage Baseline from Literature:
    - Previous Impact Assessment Studies
- Paleontological Context
- Historical Context:
    - Stone Age
    - Iron Age
    - Histroic Period
    - Social Histroy
- Screening Assessment

Figure 4.1 Regional Setting of the Project Area 1:50 000

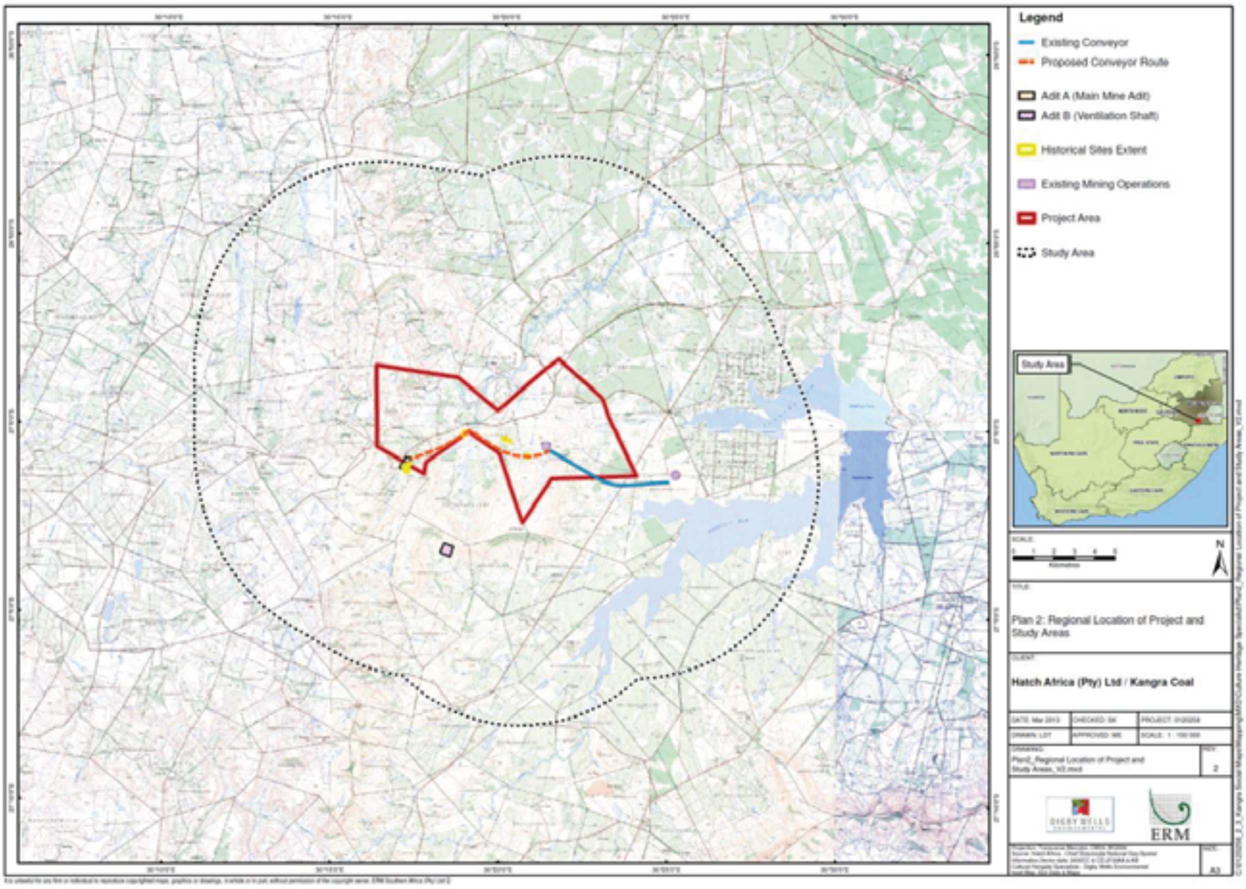
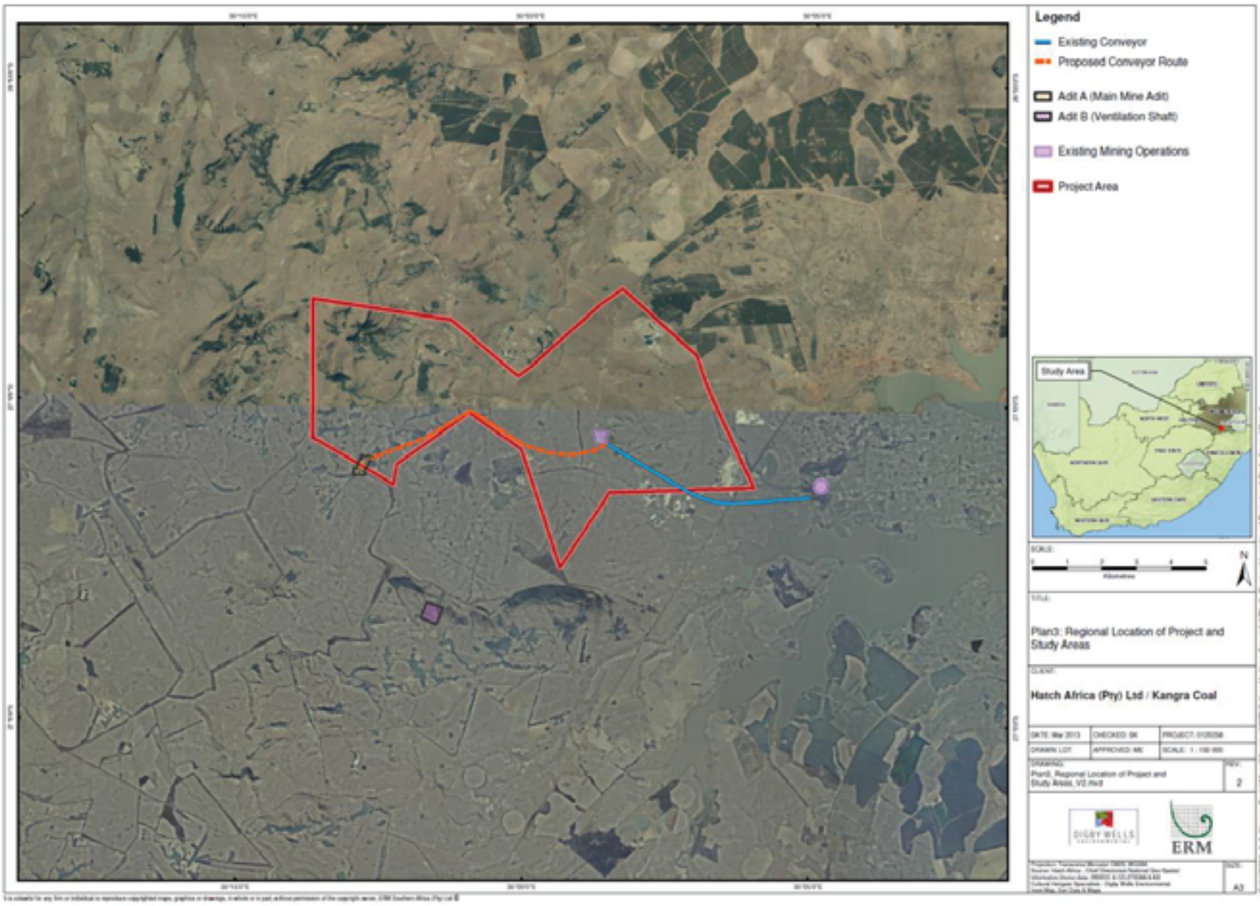


Figure 4.2 Regional Setting of the Project Area 1:10 000



4.1 GEOLOGICAL SETTING

The Study Area is underlain by the sedimentary rocks of the Madzaringwe Formation of the Ecca Group. hese Ecca Group rocks form part of the north-eastern margin of the Karoo basin which were filled by the sedimentary rocks of the Karoo Supergroup.

The Onverwacht Group which underlies the Ecca Group consists mostly of lava, tuff, schists and chert. During deposition of the sediments in the Karoo Basin, tension in the crust due to continuing loading lead to intrusion of Post-Karoo dolerite sills and dykes along fractures, fissures and faults. As a result, dykes and sills intruded the Project Area.

Table 4.1 Stratigraphy of the Project Study Area

Phanerozoic	**Palaeozoic**	**250 million years ago (mya)**	*Madzaringwe Formation*
			Ecca Formation
			KAROO SUPERGROUP

4.2 PALAEONTOLOGICAL CONTEXT (1)

Within the Mpumalanga Province, the 300 million year old rocks of the Karoo Super Group are well preserved and extensively distributed. In the far north regions of the province, the Karoo rocks comprise a thin layer covering the bedrock but further south towards Carolina and Ermelo the Karoo rocks are thick and contain massive coal seams.

The Mpumalanga coals were formed from rotting forests in vast swamps over a 100-million years period between 200 mya and 300 mya. During this time, primitive plants such as *Glossopteris* flora (*Figure 4.3*) were found in abundance throughout the entire southern hemisphere and mammal-like reptiles and later dinosaurs roamed the entire landscape of Mpumalanga.

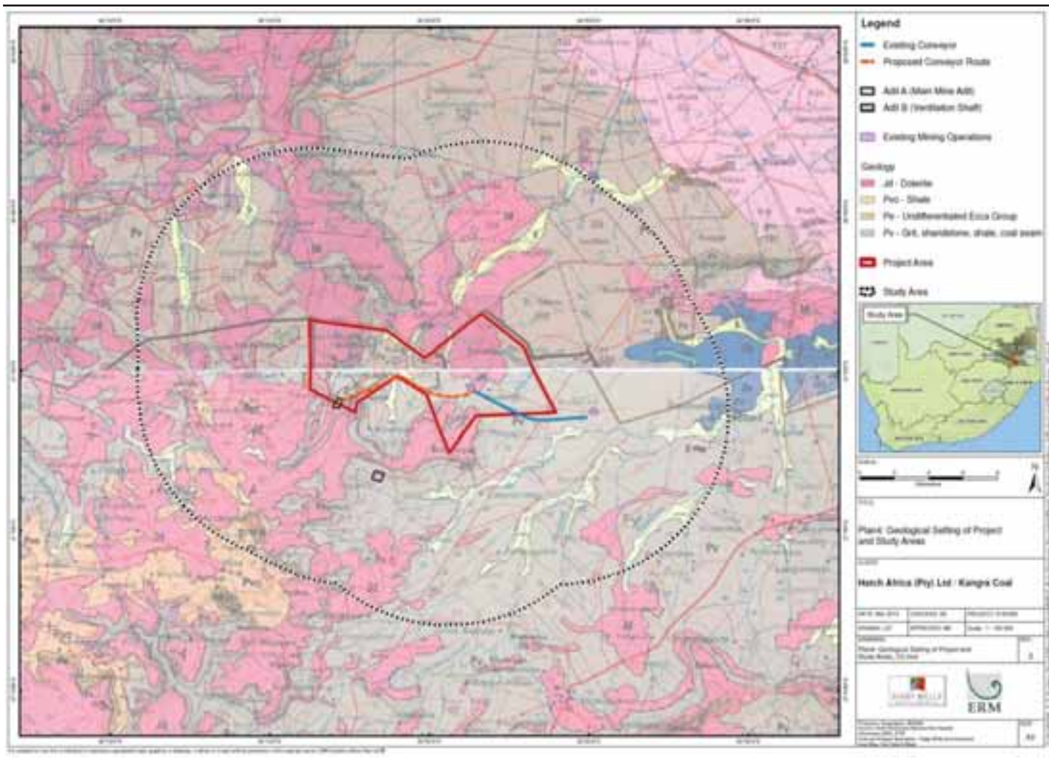
(1) ***Please Note*** – a standalone Palaeontological study was not completed; rather, the palaeontological study forms an integrated component of this HIA.

Figure 4.3 Glossopteris Leaves (Source: Maropeng Museum (Maropeng, 2013))

4.3 EXPECTED PALAEONTOLOGY

Coals are, by their nature, plant rich. Good quality coal do not preserve the anatomy of the original plant matter but the shales between the sequences do. Here it is possible to find well preserved *Glossopteris* leaves, roots and inflorenscence, lycopod and sphenophyte stems, ferns, cordaitaleans and early germnosperms. Bones of vertebrates that occurred at this time are seldom preserved with the plants. Fossil of insects, however, are often found. Fossils of plants and insecrs are found in in the shales of the Ecca Group and are commonly displayed in local and national museums.

Figure 4.4 Geological Setting



4.4 PRE-HISTORICAL AND HISTORICAL CONTEXT (1)

Please Note

This Section provides a historical context of the *broader* Study Area and its aim is to inform the study as to the potential heritage resources that could potentially be located in the Project Area.

4.4.1 Stone Age

South Africa has been inhabited by tool producing hominids for at least two million years. Much of the evidence for the presence of hominin activity is derived from stone tools. These tools are not only indicative of their presence in the landscape, but also attest to the technological developments of our genus. Varying factors, including geology, geomorphology, climate, fauna and flora have resulted in a complex record of social and technological changes through time.

An approach adopted by Lombard *et al.* (2012) is to acknowledge that archaeological assemblages are not exact replicas of one another even though they may overlap economically, chronologically and/or regionally as indicated in *Table 4.2*. The classification is based on *technocomplexes*, also known as industrial complexes, defined as assemblages that share a polythetic range (a context or a class of things having many but not all properties in common). Through time, changes in an industry may be expressed as phases, whereas regional variations (spread less widely than a technocomplex but found at several sites) may be expressed as distinct industries in a technocomplex where there is a high level of similarity in design, but not necessarily frequency, of artefact types (Lombard, et al., 2012).

Table 4.2 The South African and Lesotho Stone Age Sequence (After Lombard et al., 2012)

Period	Technocomplex	Also Known as (Including Regional Variants)
Early Stone Age >200 ka	ESA-MSA transition >200 000-600 000 years ago (ka)	(informal designation) (Fauresmith, Sangoan)
	Acheulean 300 ka-1.5 mya	
	Oldowan 1.5-2 mya	
Middle Stone Age >20 ka - <300 ka	final MSA 20-40 ka	(informal designation) MSA IV at Klasies River, MSA 4 generally
	Sibudu 45-58 ka	late MSA / post-Howieson's Poort or MSA III at Klasies and MSA 3 generally (all informal designations)
	Howieson's Poort 58-66 ka	
	Still Bay 70-77 ka	

(1) ***Please Note*** – this Section is based on a review of literature and describes the heritage setting of the area surrounding the Project Area, namely the Study Area. The prupose of this section is to provide background as to what type of heritage resources have been identified in the Study Area and thus an overview of what resources may occur on Project Site.

Period	Technocomplex	Also Known as (Including Regional Variants)
	pre-Still Bay 72-96 ka	(informal designation)
	Mossel Bay 77-105 ka	MSA II at Klasies River, MSA 2b generally (Pietersburg, Orangian)
	Klasies River 105-130 ka	MSA I at Klasies River, MSA 2a generally (Pietersburg)
	early MSA 130-300 ka	(informal designation)
Later Stone Age <40 ka	ceramic final LSA <2 ka	Ceramic post-classic Wilton, Late Holocene with pottery (Doornfontein, Swartkop)
	final LSA 0.1-4 ka	Post-classic Wilton, Holocene microlithic (Smithfield, Kabeljous, Wilton)
	Wilton 4-8 ka	Holocene microlithic
	Oakhurst 7-1 ka	Terminal Pleistocene / early Holocene non-microlithic (Albany, Lockshoek, Kuruman)
	Robberg 12-18 ka	Late Pleistocene microlithic
	early LSA 18-40 ka	(informal designation) Late Pleistocene microlithic

The ESA dates between 200 ka and 2 mya. General characteristics of the ESA include:

- Simple flakes struck from cobbles, cores and pebble tools;
- Intentionally shaped handaxes, cleavers and picks during the later stages; and
- Large blades in the final or transitional stages.

ESA surface scatters have been investigated at Waterval Drift I off the N2 near Piet Retief and approximately 25 km north east of the Project Area.

MSA sites dating from c. 30 000 to 100 000 Before Present (BP) are known by archaeologists to occur within the Study Area. The MSA dates between 20 ka and 300 ka. A key technique characteristic of the MSA is the Levallois or prepared core technique in which triangular flakes with convergent dorsal scars, often with faceted striking platforms, are produced. Discoidal systems and intentional blade production from volumetric cores also occur within the MSA. The general characteristics of the MSA include:

- Formal tools such as:
  - Unifacial and bifacial retouched points;
  - Backed artefacts; and
  - Scrapers and denticulates.
- Evidence of shafted tools;
- Occasional marine shell beads;
- Bone points;

- Engraved ochre nodules;
- Engraved ostrich eggshell (OES) fragments;
- Engraved bone fragments; and
- Grindstones.

Within the Study Area, MSA assemblages are commonly found as surface scatters of flaked stone. MSA surface scatters have been investigated at Waterval Drift I and Waterval Drift II off the N2 nears Piet Retief and approximately 25 km north east of the Project Area.

LSA and rock art sites may also occur in the Study Area [(1)] and are particularly associated with shelters in sandstone cliffs or outcrops. The LSA dates between 20 ka and 40 ka. The economy of the LSA may be associated with hunter-gatherer or herder societies. Within the LSA, there is much variability between assemblages. Stone tool assemblages are often microlithic but in some areas they are dominated by long scrapers and few backed microliths. The LSA includes a wide range of formal tools such as:

- Scrapers;
- Backed artefacts;
- Shafted stone and bone tools;
- Borers;
- Upper and lower grindstones;
- Grooved stones;
- OES beads;
- Undecorated and decorated OES fragments;
- Flask and / or flask fragments;
- Bone tools;
- Fishing equipment;
- Rock art; and
- Ceramics.

Within the Study Area, LSA surface scatters have been identified and recorded to occur at Twyfelaar, Waterval Drift II, Idalia, Rustplaas, and Oak Harbour (University of the Witwatersrand, 2010). These sites are located off the N2 near Piet Retief, approximately between 23 km and 39 km north east of the Project Area.

An important (in the context of archaeology) recent rock art site discovery, is an archaeological site complex at De Wittekrans located approximately 100 km north-east of the Project Area. The discovery was made in 2008 during an AIA and subsequently assessed by Ouzman (2009). Although the site complex is relatively far from the Project Area (approximately 100km away), its location in the landscape is sufficiently similar to the landscape in the Project Area, thus allowing inference that similar sites may exist. The

[(1)] no rock art sites were found in the proposed development area; however, previous sitings in the Study Area were recorded in literature. This is discussed in more detail later in this report.

following description as well as *Figure 4.5* to *Figure 4.7* are taken from the report (Ouzman, 2009):

The four sites located to date occur on a low sandstone outcrop less than 500m northeast of the Klein Olifants River (indicated in Figure 4.5). The largest site spatially occurs at the waterfall, while three similar sites – which include the most densely painted site – occur within 400 m to the west of the sandstone outcrop. All of the sites have associated archaeological deposit, with some stone tools and pottery visible on the surface in and around the sites. There are at least two kinds of rock art at De Wittekrans: Fine-line, brush-painted rock paintings made by hunter-gatherers ancestral to today's 'San/Bushman' (illustrated in Figure 4.6); and

Finger-painted rock paintings made by Khoekhoen herder peoples, formerly known as 'Khoi' or 'Hottentot' (illustrated in Figure 4.7).

Both these forms of rock art are significant at local, regional, and national levels. San rock art is known to be of great spiritual and symbolic significance, while Khoekhoen rock art is as yet imperfectly understood and through to relate to initiation and group identity. Furthermore, the co-occurrence of both forms of rock art at De Wittekrans are evidence of possible contact and communication between these groups – something about which little is known. De Wittekrans is thus a key site – one of the top 3 in South Africa – in terms of Khoekhoen herder art research, and must be preserved at all costs.

Figure 4.5 View of the De Wittekrans Site Complex (Source: Ouzman 2009)

Figure 4.6 An example of a 'San' Rock Painting from De Wittekrans (Source: Ouzman 2009)

Figure 4.7 An Example of a 'Khoekhoen' Rock Painting from De Wittekrans (Source: Ouzman 2009)

4.4.2 Iron Age

The Iron Age in South Africa is divided into three periods:

- Early Iron Age;
- Middle Iron Age; and
- Late Iron Age.

The Stone Age is followed by the Iron Age which continues well into the Historic Period (c. 1840 onwards). Sites including pottery, grain bin foundations, stone foundations and low kraal walls have been identified in Robertsdrift approximately 100km from the Project Area. Stonewalled sites have previously (in 2006) also been recorded within the Study Area (Van Schalkwyk, 2006).

An aerial imagery survey in a previous heritage study (Derricourt & Evers, 1973), led to the discovery of an Iron Age settlement known as Robertsdrift. The site is a Type V (1) settlement at the confluence of the Vaal and Klip rivers outside Standerton approximately 100 km west of the Project Area. Excavations were carried out in the 1970s during which ceramics with comb stamping motifs were identified (Derricourt & Evers, 1973).

Other Iron Age sites include Tafelkop and Tafelkop II on the farm Tafelkop 270 IS approximately 80 km north west of the Project Area. These Late Iron Age sites comprise Moloko ceramics and Type V stone walling.Towards the south east and approximately 100 km from the Project Area, heritage studies have documented sites known as Kupwal 14.74 on the farm Kupwal 49 HU and Kortnek on the farm Kortnek 50 HU (University of the Witwatersrand, 2010). These sites have been recorded as Iron Age smelting sites with stone walling.

Battlefields from the Mfecane era, approximately from 1815 to 1840, are located within the Study Area and 50 km south east of the Project Area. According to Huffman and van der Merwe (1993), the capital of a Swazi chief, Mandla-angangawempisi (Mandlangampisi), was situated on Kafferkraal 98 HT between 1780 and 1840 (Huffman & van der Merwe, 1993). Mandlangampisi is reputed to have fought and been victorious in two battles against Zulu warriors during the Mfecane period. One specific battle took place in or near a cave known as Mhlogamvula in the KwaMandlangampisi mountain range approximately 20 km south east of the Project Area.

4.4.3 Historic Period

The Project Area is situated in the centre of KwaYende, an area that includes Heyshope Dam. Today, the capital of KwaYende lies approximately 9 km east of the Project Area. The tribal area of KwaYende (previously KwaNgema) is the traditional settlement of Mthonga, the first-born son of Shaka Zulu's half-brother Mpande. Mthonga was a catalyst for the first European settlements. In the mid-19th century, Mthonga fled KwaZulu-Natal to escape Cetshwayo. In

[1] Type V stone walling consists of the standard core of cattle enclosures surrounding beehive houses and grain bins. Corbelled huts may be present with this type of stone walling (Maggs, 1976).

return for their assistance in finding and handing Mthonga over, Mpande granted the early Boers settlement rights in the region in 1854. Mathonga fled but was captured by the Boers in March 1861 and handed over to Cetshwayo in exchange for a land agreement (Wakkerstroom Tourism, 2012).

Historically, European settlement occurred from as early as the mid-1830s when Cape Dutch migrants, the *Voortrekkers* and precursors of what would become Afrikaner Boers, entered the region. Some of the first to settle in the region were Boers who left the former Natal (now KwaZulu-Natal) after the Boer Republic of Natalia was annexed by the British. Among these were Dirk Uys who surveyed a town he named 'Uysenburg' approximately 40 km south west of the Project Area. The town was later renamed Marthinus Wesselstroom that was in turn named Wakkerstroom. Dirk Uys is also credited as the 'father' of the Drakensberger cattle race (Uys, 1976). The first towns to be established in the region were those of Utrecht approximately 60 km south of the Project Area, Uysenburg (Wakkerstroom), and Volksrust approximately 56 km south west of the Project Area.

Remnants of these early European settlers are scattered across the region and include stonewalled foundations and old oak trees (Huffman & Steel, 1995).

The region saw military action during the First Anglo-Boer War (1880 to 1881) and the Second Anglo-Boer War (1899 to 1902). Citizens of the *Zuid-Afrikaansche Republiek* known as *Burghers* from the surrounding towns and surrounding farms of Wakkerstroom, Piet Retief, Volksrust and others, formed commandos that engaged invading British forces in several places. Important nearby battlefields include Amajuba (1881) and Lancaster Hill (1900) approximately 90 km south of the Project Area near Vryheid, KwaZulu-Natal (Coghlan, 1996). During the Second Anglo-Boer War, the British established many infamous concentration camps one of which was located at Volksrust.

In 1902, the British attempted to erect telegraph lines between Pretoria and Piet Retief while advancing eastwards to Ermelo where they planned to surround the Boer forces who had gathered there (Hippisley, 1903). The telegraph lines were put up only for the Boers to cut them down again thereby preventing the British troops from communicating with Pretoria and other columns.

Eventually, the British troops under the leadership of General French reached Piet Retief and erected telegraph lines to connect Standerton via Newcastle and Utrecht to the Pongola River at Luneburg (Hippisley, 1903). This particular line was established in 1901 and was 104 km long. Military posts were established all along the line. Another telegraph line was established and operated from 14 February 1901 to 15 March 1901. In total, four telegraph lines were constructed from Piet Retief:

- Utrecht Piet Retief line (104 km);
- Piet Retief Zandbank line (24 km)

- Piet Retief Annyspruit (32 km); and
- Piet Retief Vryheid line (13 km).

In 1901, a military office was opened in Piet Retief. To restrict the guerrilla tactics of the Boers during the latter phase of the war, an extensive defensive blockhouse system was created by the British. Of the more than 9 000 blockhouses that were constructed, more than 130 were located between Volksrust and the Swaziland border outside of Piet Retief and approximately 60 km east from the Project Area (Wakkerstroom Tourism, 2012). One particular blockhouse extended from Volksrust to Swaziland and passed Piet Retief. This blockhouse line was approximately 129 km long and had five telegraph offices with 32 telephones (Hippisley, 1903). Another blockhouse line from Wakkerstroom to Piet Retief has an Amsterdam office situated near the present day Dirkieskop approximately 16 km south of the Project Area.

The above information indicates that there was a British and Boer presence within the vicinity of the Project Area. Heritage resources pertaining to this period of history may be present within the Project Area. The sites describe above are approximately between 23 km and 100 km of the Project Area and will not be affected by the proposed Project.

4.4.4 Social History

The most recent history includes attempted forced removals of local communities during the 1980s, significantly from the Driefontein and KwaYende areas. KwaNgema is located approximately 10 km east of the Project Area. It was a 'Black freehold' settlement granted to the community in 1904. Driefontein is located approximately 4 km east of the Project Area and unlike KwaNgema it was bought by the community in 1912 (Ndaba, 1998). Due to these settlements' proximity to 'white' areas, they were declared as 'Blackspots' in 1965 and earmarked for forced relocation to KaNgwane and KwaZulu – two former Black homelands. However, only in 1981 when the Heyshope Dam was due to be constructed did relocation become certain as the dam would flood parts of both settlements. There were high levels of resistance from the communities who were adamant against the resettlement. Various churches and organisations within South Africa including the Black Sash, a women's resistance group, voiced their concern to government on the forced removal of residents in Driefontein (NASA - BAO; 2/4324;T8/7/2/2/W1/3).

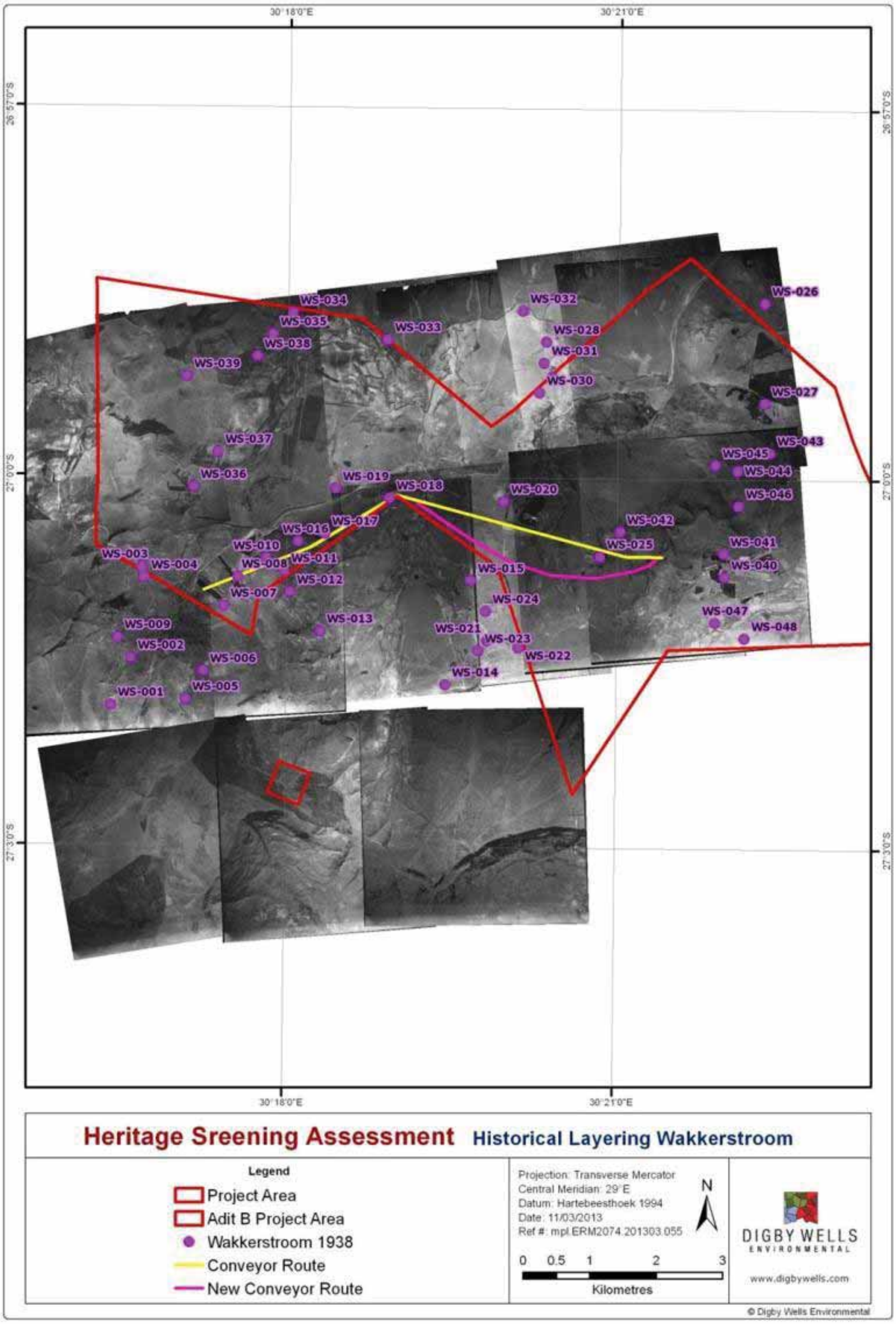
New areas were proposed for resettlement for the two groups that had been identified in the Driefontein community: the Zulu and the Swazi. The proposed resettlement site for the Swazi people was in an area near Oshoek at the Oshoek border post between South Africa and Swaziland approximately 100 km north east of the Project Area. The Swaziland government did not approve of this as they felt it may create a refugee situation (NASA – BAO; 2/4304/T8/7/2/2/W1/3). During negotiations, several community protests occurred such as one in June 1983 where a crowd of 1 000 residents chanted "*We are not going away*" (Rand Daily Mail, 1983). Some negotiations turned violent and at least one activist and community leader, Saul Mkhize, was gunned down by police during the period of resistance on 2 April 1983 (BAO; 2/4304/T8/7/2/2/W1/3). This caused uproar within the community and increased protests against the resettlement. Opposition and activism took place between 1981 and 1985. A ruling was made in favour of the two communities and wholesale removal was avoided.

A major cause of concern within the community was the rising water table which was caused by the construction of the Heyshope Dam and which resulted in water damage to many homes in close proximity to the dam. There were also concerns regarding the exhumation and the temporary reburial of such graves, causing much anger in the community. During a meeting on 10 November 1984, an individual by the name of Shadrack Mkhize states [translation] "*As tombs move, move the people. You use the dam to let [verskuif] us*" (BAO; 4/2903; T8/7/2/2/W1/3).

This shows that there was a historical notion of resistance and mistrust to relocation. That being said compensation was also awarded to families who were relocated. Only those whose properties were flooded were resettled on adjacent land and retained their property rights (Ndaba, 1998). Compensation was offered to affected property owners to reimburse them of any improvements made to their properties that would be destroyed by the construction of the dam (BAO; 2/4324; T8/7/2/2/W1/3).

A survey of historical aerial photographs showed that a number of possible structures occurred in the Project Area from 1938 to 1955 (Figure 4.8). These structures could include residential complexes, homesteads and stone walls. The numbering of the possible structures includes the town name, in this case Wakkerstroom (WS), suffixed by the structure number. The strutures located in the Main Mine Adit, Adit B and the conveyor route were verified by the HIA fieldwork. Only one possible structure identified in the aerial photograph was verified by the HIA fieldwork and this is discussed in more detail in *Section* 5.2 on *Page* 5-5.

Figure 4.8 Historical Aerial Photograph from 1938 Showing Structures Located within the Project Area



Based on the above sections, the landscape may thus be described as an agrarian landscape with a deep time depth, increasing the potential of sites existing from as early as the MSA through to rock art and the Iron Age and into the historic period.

4.5 HERITAGE BASELINE

4.5.1 Screening Assessment

A screening assessment of the Project Area was undertaken by Johan Nel (Unit Manager: Heritage Resources Management at Digby Wells) on 6 December 2012. The assessment comprised both vehicular and pedestrian surveys of the proposed conveyor route.

The screening assessment identified 15 sites and / or landscape features (*Table 4.3*). The identified sites included historical burial grounds and farmsteads, a Late Iron Age / Historical settlement, and modern settlements with associated burial grounds. Sensitive landscape features that were identified included sandstone ridges and low, boulder-strewn hills.

Sites identified during the screening assessment were named using the Digby Wells project number, followed by the map sheet number and reference to the relevant NHRA section suffixed with the site number: **ERM2074/2730AB/S.35-001**. This number was shortened to the NHRA reference number suffixed with the site number: **S.35-001**.

The NHRA reference numbers and designations are as follows:

- ***S.34*** – structures;
- ***S.35*** – archaeology, palaeontology and / or meteorites;
- ***S.36*** – burial grounds and graves; and
- ***S.37*** – public monuments and memorials.

Table 4.3 Sites Identified and Recorded during the Screening Assessment of the Proposed Conveyor Route Conducted by Digby Wells

Site ID	Coordinates	Description
ERM1990 / 2730AB / S.34-001	27⁰ 00' 18.7" S 30⁰ 20' 14.9" E	Foundations and ruins of historical homestead.
ERM1990 / 2730AB / S.36-002	27⁰ 00' 24.6" S 30⁰ 20' 13.7" E	Burial ground, probably associated with S.34-001
ERM1990 / 2730AB / S.35-003	27⁰ 00' 20.8" S 30⁰ 20' 04.0" E	Archaeological, early historical homestead and possible graves
ERM1990 / 2730AB / S.35-004	27⁰ 00' 20.9" S 30⁰ 20' 04.0" E	Archaeological, early historical homestead and possible graves
ERM1990 / 2730AB / S.36-005	27⁰ 00' 09.7" S 30⁰ 18' 52.5" E	Burial ground, at least 10 graves associated with Yende family
ERM1990 / 2730AB / S.35-006	27⁰ 00' 40.2" S	Landscape feature, sandstone

Site ID	Coordinates	Description
	30^{0} 18’ 00.6” E	outcrop with potential for rock art and palaeontology, also possible historical quarry.
ERM1990/2730AB/S.35-007	27^{0} 00’ 35.8” S 30^{0} 18’ 09.1” E	Landscape feature, sandstone outcrop with potential for rock art and palaeontology, also possible historical quarry.
ERM1990/2730AB/008	27^{0} 00’ 41.2” S 30^{0} 17’ 49.2” E	Soccer field
ERM1990/2730AB/009	27^{0} 00’ 41.6” S 30^{0} 17’ 29.4” E	Large rural homestead
ERM1990/2730AB/S.34-010	27^{0} 00’ 49.6” S 30^{0} 17’ 27.8” E	Foundations and ruins of historical homestead, two old oak trees and several large jacaranda trees present.
ERM1990/2730AB/S.35-011	27^{0} 00’ 05.0” S 30^{0} 19’ 57.5” E	Burial ground comprising at least five graves.
ERM1990/2730AB/S.36-013	27^{0} 00’ 42.7” S 30^{0} 17’ 49.0” E	Alleged Yende burial ground in black-wattle bush
ERM1990/2730AB/S.35-014	27^{0} 00’ 12.7” S 30^{0} 21’ 03.5” E	Low, boulder-strewn hill
ERM1990/2730AB/S.36-015	27^{0} 01’ 02.2” S 30^{0} 17’ 15.3” E	Large cemetery comprising more than 30 graves, associated with Masondo family.

The impacts associated with sites mentioned in *Table 4.3* above are discussed in *Section 5* of this report.

4.5.2 Previous Impact Assessment Studies

A review of relevant impact assessments that had been previously conducted in the surrounding areas was completed to ascertain what type of heritage resources have been identified within the Study Area. The following reports were consulted:

- Huffman, T. N. & van der Merwe, H. D. R., 1993. *Archaeological Survey for Savemore Colliery*, Johannesburg: Archaeological Resources Management.

- Huffman, T. N. & Steel, R., 1995. *Archaeological Survey of Balgarthan Colliery*, Johannesburg: Archaeological Resources Management.

- Anderson, G., 1998. *Archaeological Survey of the Proposed Route for the Pongola-Vergenoeg Transmission Line*, Pietermaritzburg: Institute for Cultural Resource Management.

- Van Schalkwyk, J., 2005. *Heritage Impact Assessment for the Proposed Development on the Farm Evergreen 425 IT, Piet Retief District, Mpumalanga Province*, Pretoria: National Cultural History Museum.

- Van Schalkwyk, L., 2006. *Heritage Impact Assessment for the Majuba-Umfolozi 765 KV Transmission Line in Mpumalanga and KwaZulu-Natal, South Africa*, Pietermaritzburg: eThembeni Cultural Heritage.

- Pistorius, J. C. C., 2011. *A heritage Baseline Study for Proposed Adit Positions in a Project Area near the Heyshope Dam to the West of Piet Retief in the Mpumalanga Province of South Africa*. Johannesburg: Environmental Resources Management (Southern Africa) Pty Ltd (ERM).

The archaeological survey conducted by **Huffman and van der Merwe** (1993) for the Savemore Colliery was carried out approximately 16 km south east of the Project Area. A total of six sites were identified during the survey. These included Stone Age lithics, Late Iron Age ceramics and grain bin foundations as well as foundations for a historical structure (Huffman & van der Merwe, 1993).

The archaeological survey conducted by **Huffman and Steel** (1995) for the Balgarthan Colliery was carried out approximately 4 km south of the Project Area. A total of seven Swazi homesteads, one recent dwelling and one European farmhouse were identified during the survey (Huffman & Steel, 1995).

The archaeological survey conducted by **Anderson** (1998) for the Pongola-Vergenoeg transmission line was carried out approximately 94 km south east of the Project Area. During the survey, a total of seven Iron Age stone walled sites were identified, five of which contained graves (Anderson, 1998).

A HIA conducted by **Van Schalkwyk** (2005) for a proposed development on the farm Evergreen 425 IT was carried out approximately 49 km north east of the Project Area. A scatter of iron smelting slag was identified and recorded during the survey (Van Schalkwyk, 2005).

A HIA conducted by **Van Schalkwyk** (2006) for the Majuba-Umfolozi 765 KV transmission line was carried out approximately 26 km south of the Project Area over a 160 km distance. During the study, it was found that a number of heritage resources were located within the Majuba-Umfolozi development area. These include the following sites that lie within and immediately adjacent to the Study Area:

- Ancestral graves;
- Rock painting sites that were recorded along and below the eastern uKhahlamba escarpment;
- Stone Age open air sites (1);
- Stone walled settlements dating to the Late Iron Age;
- Battlefields of:
    - Majuba (1887);
    - Hlobane (1879);
    - Holkrantz (1879);
    - Khambula (1879);

[1] Open air sites are sites that are in the open as opposed to being in a shelter or cave.

- Bloed River's Poort (1879);
- Ncome / Bloed River (1838);
- Fort Newdigate (1879); and
- Price Imperial's capture site (1879).

A heritage baseline study conducted by **Pistorius** (2011) for the construction of three proposed adits by Kangra Coal was carried out within the Project Area. During the study, five heritage resources were identified and recorded (Pistorius, 2011). These include the following sites:

Table 4.4 Sites Identified and Recorded during the Heritage Baseline Assessment by Pistorius (2011)

Site ID	Coordinates	Description
G01	27⁰ 01' 04.3" S 30⁰ 17' 24.3" E	A single, historic informal grave with stone dressing
CE01	27⁰ 03' 21.1" S 30⁰ 14' 51.1" E	A single square cattle enclosure
LIA01	27⁰ 02' 50.5" S 30⁰ 22' 38.0" E	A Late Iron Age site with stone wall enclosures
GY01	27⁰ 03' 18.4" S 30⁰ 14' 45.8" E	A historical graveyard demarcated with stone walling
SB	27⁰ 03' 39.9" S 30⁰ 19' 03.3" E	A sandstone bank that may be associated with Stone Age sites

All of the site mentioned in *Table 4.4* are located outside of the footprint of proposed Project, and will therefore not be directly impacted on.

From these reports, heritage resources such as Stone Age sites, Iron Age settlements, historical structures and battlefields, and burial grounds and graves were identified in the Study Area.

5 IMPACT ASSESSMENT AND MITIGATION

The predicted impacts to the heritage environment as a result of the proposed Project are described in this chapter. The heritage resources that will be discussed in this chapter are only those that will be impacted upon by the proposed development. These include Section 35 archaeological and historical resources and Section 36 burial grounds and graves.

The GPS track log and position of sites identified as part of this Heritage Impact Assessment are depicted in *Figure 5.1* and *Figure 5.2*.

Figure 5.1 GPS Track Log 1:50 000

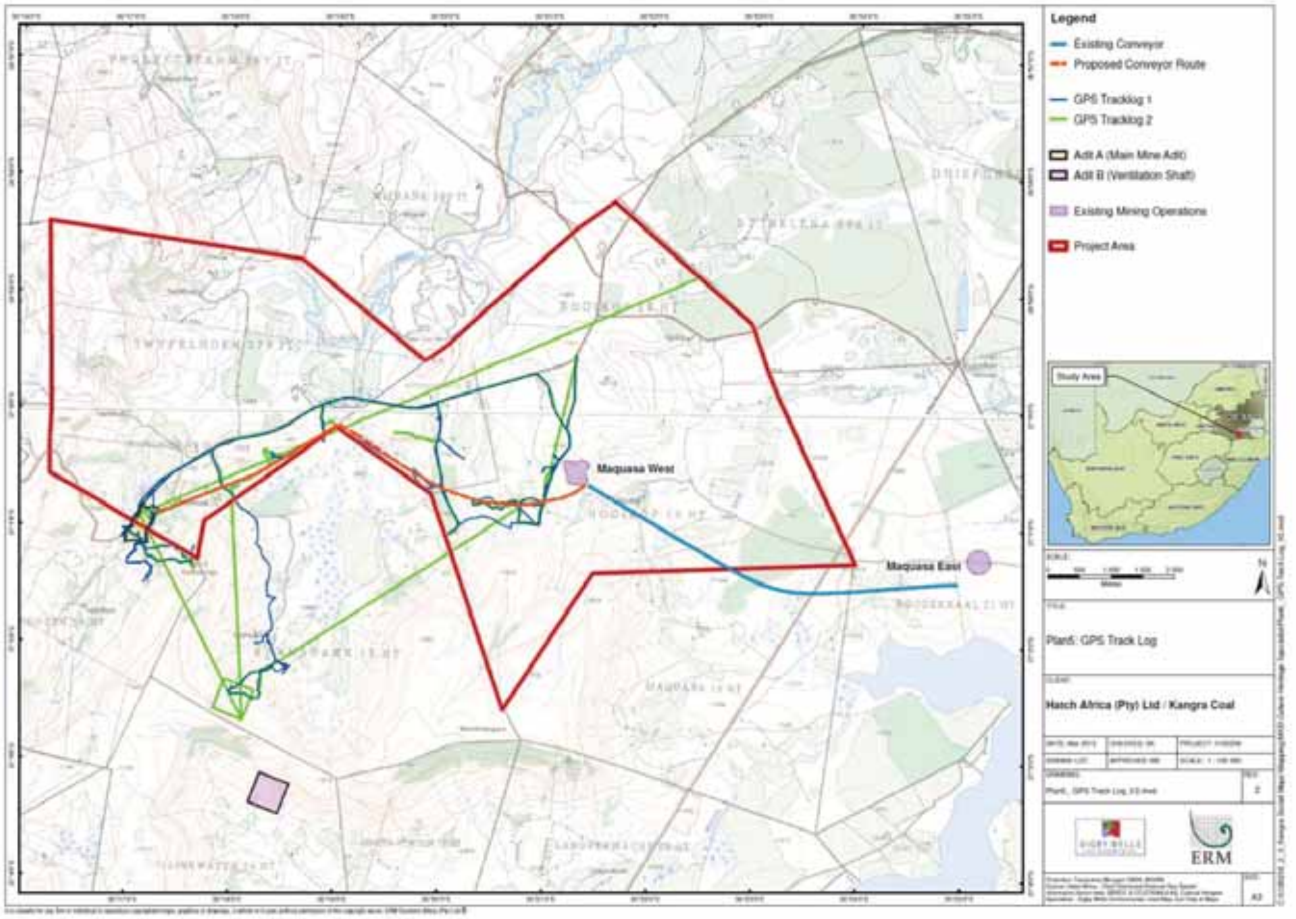
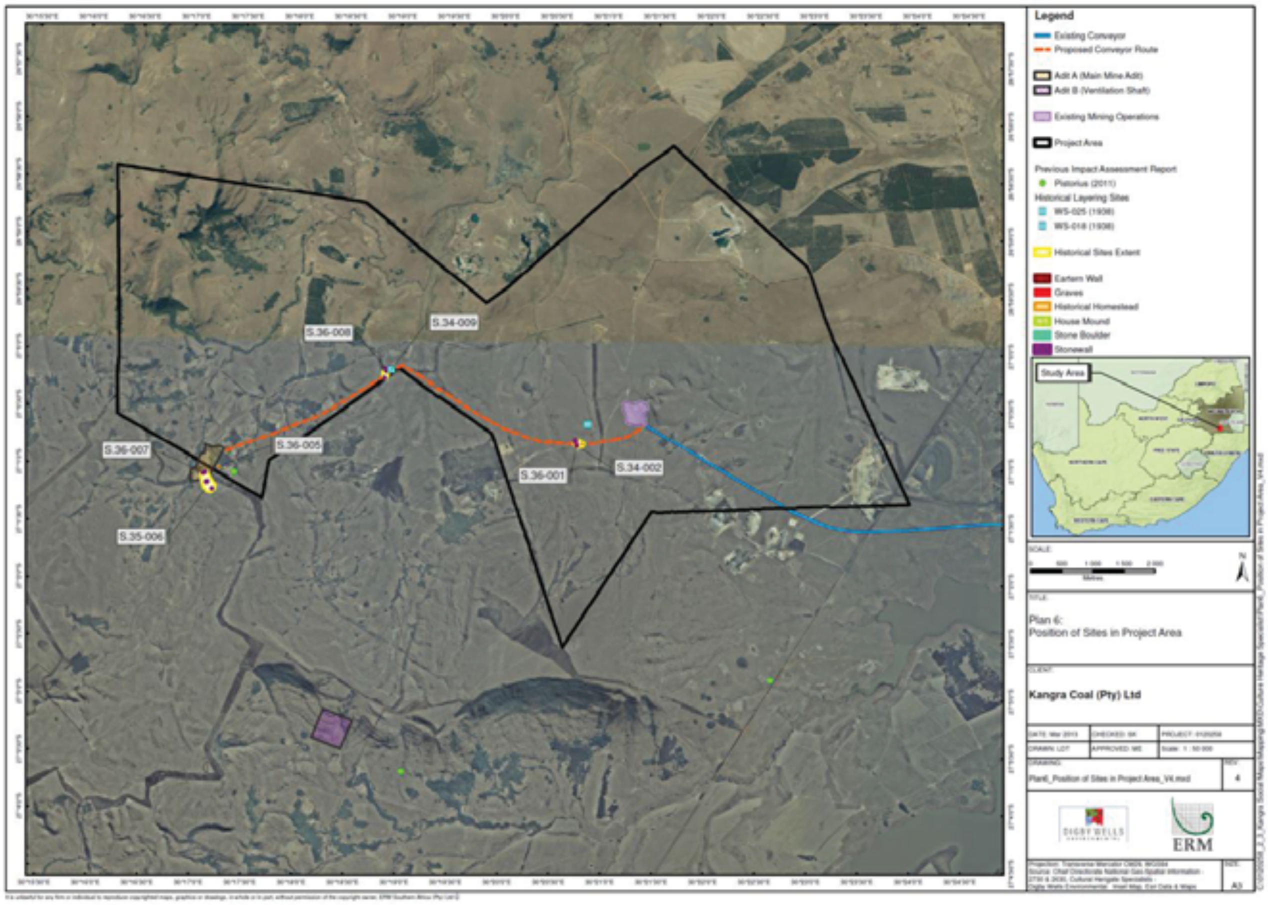


Figure 5.2 Position of Sites in Project Area 1:10 000



5.1 *IMPACTS ON THE <u>PALAEONTOLOGY</u> (1) IN THE STUDY AREA*

5.1.1 Description of the Baseline Environment

The stratigraphy of the Project Area consists of the Madzaringwe Formation of the Ecca Group. The Madzaringwe Formation consists of lenses of sandstone and shale and contains a number of coal seams. Lenses of calcareous sandstone and sandy limestone are relatively common. The rocks of the Ecca Group are of palaeontological importance and the desktop research done indicates that there may be fossils in the Study Area which could be encountered when construction and mining commences.

5.1.2 Proposed Project Activities

Construction activities relating to the Main Mine Adit and Adit B that could impact on potential fossil heritage (beneath ground surface) include earth moving activities and excavations for civil works. Machinery involved in excavation may damage or destroy fossils, or they may be hidden within the excavated material.

5.1.3 Sensitive Receptors

Fossils may be affected by Project activities discussed in *Section 5.1.2* above. The existence of subsurface fossils is unknown because no excavations have taken place in the general area. If subsurface fossils exist they could be found during site construction.

5.1.4 Impact

During the field survey, no surface fossils were identified along the proposed conveyor routes or within the Adit A and Adit B footprints. However, one must make the assumption that most fossil heritage is embedded within the rocks beneath the land surface or obscured by surface deposits such as alluvium or soil and by vegetation cover.

Fossils plants are not well preserved in coal seams due to the natural coalification process where the fossil plants undergo changes from peat to lignite to bituminous coal. According to Section 2 (xxxi) of the NHRA, these fossil fuels along with fossiliferous rocks intended for industrial use are not included in the definition of palaeontological resources.

Fossilised remains or trace fossils of animals or plants which lived in the geological past do occur in the shales associated with the coal seams. These palaeontological remains are defined as heritage resources in Section 2 (xxxi) of the NHRA but there existence beneath the surface can only be verified through monitoring excavations. **<u>In this sense, the impact of construction</u>**

(1) ***Please Note*** – a standalone Palaeontological study was not completed; rather, the palaeontological study forms an integrated component of this HIA.

activities such as excavations is positive for palaeontology, provided that efforts are made to monitor and rescue the fossils.

5.1.5 *Recommendation and Mitigation/Management Measures*

Subsurface fossils fall under the protection and management of the Chance Find Procedure. It is therefore recommended that the Chance Find and Fossil Find Procedures be implemented during the construction and mining phases of the Main Mine Adit and Adit B. Refer to *Appendix C* for the Chance Find and Fossil Find Procedures.

An appointed Environmental Control Officer (ECO) should be trained to identify palaeontological resources and should be present on site during the construction and mining phases. This monitoring may be limited to overburden dumps in which fossil material may be deposited with overburden material.

5.2 IMPACTS ON SECTION 34 SITES – STRUCTURES

Two Section 34 Sites (as defined by NHRA) were identified on the Project Site. Both sites are older than 60 years and are therefore protected in terms of Section 34 of the NHRA. These sites, which are historical stone wall structures, are described separately below:

1. **S.34-002** – the coordinates are 27⁰ 00’ 47.57” S and 30⁰ 20’ 45.88” E. The site is a multi-component, historical srtucture that corresponded to a 1938 aerial photograph in which residential structures were identified (*Figure 5.3*). See point WS-025 in Figure 5.5 on *Page 5-8*.

2. **S.34-009** – the coordinates are 27⁰ 00’ 12.62” S and 30⁰ 18’ 52.07” E. The site is a multi-component, residential structure that corresponded to a 1938 aerial photograph in which other residential structures were identified (*Figure 5.4*). See point WS-018 in *Figure 5.6* on *Page 5-10.*

The locations of these structures in the Project Area are illustrated on *Figure 5.2* on *Page 5-3*.

Figure 5.3 *Historical Structure S.34-002 Corresponding to a 1938 Historical Aerial Photograph*

Figure 5.4 *Historical Structure S.34-009 Corresponding to a 1938 Historical Aerial Photograph*

5.2.1 Description of the Baseline Environment

1. **S.34-002** is approximately 19 234 square meters in extent and is bisected by the proposed overland conveyor route (*Figure 5.5*). This heritage resource has no value in aesthetic and technical characteristics, as it is known to occur frequently within the Study Area. In addition, a survey of the historical 1938 aerial photograph indicates that sites similar to S.34-002 are a common occurrence within the Study Area. The site is in a poor condition with active decay visible. Contemporary use and / or occupation of the structure has resulted in the alteration of the structure to such an extent that it has limited information potential. The structure is located near an existing community and burial ground (S.36-001) and may have an association to the community or cultural group for social and / or spiritual reasons. Taking these characteristics into account, the structure was given **a low heritage value**.

Figure 5.5 Stonewalled Site (S.34 002) in Relation to the Overland Conveyor System indicated as the orange line in the figure

2. **S.34-009** is approximately 12 367 square meters in extent and is bisected by the proposed overland conveyor route (*Figure 5.6*). The heritage resource has no value in terms of its aesthetic and technical attributes, as structure similar to it are known to occur frequently within the Study Area. The structure is in a poor condition with active decay visible. There is no site context and as a result it has limited information to offer. The structure is located near an existing community and burial ground (S.36-005) and may have an association to the community or cultural group for cultural and/or spiritual reasons. Taking these characteristics into account, the structure was given a **low heritage value**.

Figure 5.6 Stonewalled Site (S.34 009) in Relation to the Overland Conveyor System indicated as the orange line in the figure

5.2.2 *Proposed Project Activities*

Kangra Coal proposes to transport mined coal from the proposed Main Mine Adit in the Kusipongo Resource to the existing Maquasa West Adit via the proposed new overland conveyor system. Sites S.34-002 and S.34-009 are bisected by the proposed overland conveyor system.

The activities that are associated with the establishment and operation of the overland conveyor system have the potential to impact on these historical structures through site clearance activities. In addition, site clearance and construction of the conveyor system will increase human traffic thereby increasing the risk to these site in terms of accidental or purposeful damage or destruction. The operation and maintenance of the conveyor system will also create long-term risks associated with more regular and increased human traffic, allowing access to the sites. The construction of the conveyor system may also change the landscape character and may impact on the integrity of the sites.

5.2.3 *Sensitive Receptors*

As is mentioned above, both structures are located near existing communities and burial grounds and may have an association to the community or associated cultural group for cultural and / or spiritual reasons.

Furthermore, the existence of subsurface cultural remains is unknown because no excavations have taken place in the general area. If subsurface cultural remains do exist they could be found during site construction. Subsurface cultural remains fall under the protection and management of the Chance Find Procedure outlined in *Appendix C*.

5.2.4 *Significance of Impact (Pre-mitigation)*

The impact related to the construction of the proposed conveyor system on the heritage sites will be a '**Negligible to Minor Negative Impact'** (*Table 5.1*). This significance is attributed to the fact that both heritage resources have a low heritage value.

Table 5.1 Rating of Impacts Related to Section 34 Sites (Structures) (Pre-Mitigation)

Type of Impact		
Direct or Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Scale	High	Most or the entire heritage resource could be affected by the construction of the proposed conveyor route.
Duration	Permanent	Unless avoided, the structures will be destroyed by groundworks during the construction phase of the proposed Project.

Intensity	Low	Change to integrity will cause change to overall authentic aspects of the heritage resource, as the structure will be partly or completely destroyed by the construction of the proposed overland conveyor; however, the heritage resource is of a low heritage value and therefore any change to the heritage resource as a result of the Project is not significant.
Probability	Probable	Construction activities will take place on certain portions of the heritage site.
Magnitude		
Low Magnitude		
Value of the Resource/Receptor		
Low Sensitivity		
The heritage resource is of a low heritage value and therefore any change to the heritage resource as a result of the Project is not significant; however, this said both structures are located near existing communities and burial grounds and may have an association to the community or associated cultural group for cultural and / or spiritual reasons.		
Significant Rating Before Mitigation		
Negligible to Minor Negative Impact		

5.2.5 *Recommendations and Mitigation/Management Measures*

The heritage resources are generally protected and their field rating is Grade IVB, which means that no Project-related mitigation measures were recommended for the site (see the Field Rating guide in *Section 3.5* for a description of the field ratings). The sites were significantly recorded and mapped in the HIA and they can be destroyed; however, prior to its destruction, Kangra Coal will confirm whether the communities are using the site as part of a ceremonial area and a destruction permit must initially be obtained from SAHRA.

The following management measure must be implemented during the construction phase of the proposed Project:

- The appointed Environmental Control Officer (ECO) should be trained to identify heritage resources and should be present on site when ground clearing inside the perimeter (defined by the extent of the site presented in *Section 5.2.1* above) of the heritage resource takes place. The ECO should be able to monitor any potential subsurface exposure of material culture.

5.2.6 *Residual Impact (Post-mitigation)*

There are no Project-related mitigation measures recommended for this site. However, the heritage-related mitigation measures were implemented as both heritage resources were adequately recorded and mapped and can therefore be destroyed. The above mentioned heritage-related mitigation measures will keep the level of significance for this impact to a **'Negligible Negative Impact'** (*Table 5.2*).

Table 5.2 ***Rating of Residual Impacts Related to Section 34 Sites (Structures) (Post-Mitigation)***

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Scale	High	Most or the entire heritage resource could be affected by the construction of the proposed conveyor route.
Duration	Permanent	Unless avoided, the structures will be destroyed by groundworks during the construction phase of the proposed Project.
Intensity	Low	Change to integrity will cause change to overall authentic aspects of the heritage resource, as the structure will be partly or completely destroyed by the construction of the proposed overland conveyor; however, the heritage resource is of a low heritage value and therefore any change to the heritage resource as a result of the Project is not significant.
Probability	Probable	Construction activities will take place on certain portions of the heritage site; however, the structures have been adequately recorded and mapped and this information has been stored for future reference. The site can therefore be destroyed.
Magnitude		
Low Magnitude		
Significant Rating After Mitigation		
Negligible Negative Impact		

5.3 IMPACTS ON SECTION 35 SITES - ARCHAEOLOGICAL SITES

5.3.1 IMPACTS ON THE S.35-006 Archeological Site

This site (S.35-006) is an archaeological site that is protected in terms of Section 35 of the NHRA. The coordinates for the site are S27 01 09.64 and E30 17 08.44. The site is a multi-component site that is possibly archaeological to early historical. It is a stonewalled site identified on three elevations (*Figure 5.7* to *Figure 5.10*).

The location of this structure in the Project Area is illustrated on *Figure 5.2* on *Page 5-3*.

Figure 5.7 The First Stone Wall Identified and Recorded at the Archaeological Site

Figure 5.8 The Second Stone Wall Identified and Recorded at the Archaeological Site

Figure 5.9 The Third Stone Wall Identified and Recorded at the Archaeological Site

Figure 5.10 The Fourth Stone Wall Identified and Recorded at the Archaeological Site

Description of the Baseline Environment

S.35-006 is approximately 55 807 square meters in extent and falls within the Main Mine Adit footprint (*Figure 5.11*). This heritage resource has no value in aesthetic and technical characteristics as this type of site is known to occur frequently within the Study Area. The site is in a poor condition with active decay visible. It has a limited information potential because there was no site context and no archaeological deposit (artefacts) were noted. Taking these characteristics into account, the site was given a **low heritage value**.

Figure 5.11 Stonewalled Site S.35 006 Bisected by the Main Mine Adit (Main Mine Adit illustrated as Orange Hatched Polygon)

Proposed Project Activities

Site S.35-006 falls within the footprint of the Main Mine Adit and as such will essentially be lost through earthworking activities and associated establishment of mine infrastructure.

Sensitive Receptors

The existence of subsurface cultural remains is unknown as no excavations have taken place in the general area. If subsurface cultural remains do exist, they could be found during site construction.

Significance of Impact (Pre-mitigation)

The impact from the construction of the Main Mine Adit on the heritage site will be a '**Negligible to Minor Negative Impact'** (*Table 5.3*). This significance is attributed to the fact that both heritage resources have a low heritage value and is known to occur frequently within the Study Area.

Table 5.3 Rating of Impacts Related to a Section 35 Archaelogical Site (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Scale	High	As the archaeological resource falls within the footprint of the Main Mine Adit, it will essentially be lost.
Duration	Permanent	Unless avoided, the structures will be destroyed by groundworks during the construction phase of the proposed Project.
Intensity	Low	Change to integrity will cause change to overall authentic aspects of the heritage resource, because the site will be destroyed by the construction of Adit A. However, the heritage site has no value in aesthetic and technical characteristics as this type of site is known to occur frequently within the Study Area. The site is in a poor condition with active decay visible. It has a limited information potential because there was no site context and no archaeological deposit (artefacts) were noted. As such, the site was given a low heritage value.
Probability	Probable	Should the proposed Adit A be constructed, the heritage resource will be lost.
Magnitude		
Low Magnitude		
Value of the Resource/Receptor		
Low to Negligible Sensitivity		
The heritage resource is of a low heritage value and therefore any change to the heritage resource as a result of the Project is not significant.		
Significant Rating Before Mitigation		
Negligible to Minor Negative Impact		

Recommendations and Mitigation/Management Measures

Subsurface cultural remains fall under the protection and management of the Chance Find Procedures outline in *Appendix C*.

The heritage resource is generally protected and their field rating is Grade IVB, which means that no Project-related mitigation measures were recommended for the site (see the Field Rating guide in *Section 3.5* for a description of the field ratings). The site was significantly recorded and mapped in the HIA and no further mitigation measures are required.

The following management measure must be implemented during the construction phase of the proposed Project:

- The appointed Environmental Control Officer (ECO) should be trained to identify heritage resources and should be present on site when ground clearing inside the perimeter (defined by the extent of the site) of the heritage resource takes place. The ECO should be able to monitor any potential subsurface exposure of material culture.

Residual Impact (Post-mitigation)

There are no Project-related mitigation measures recommended for this site. However, the heritage-related mitigation measures were implemented as the heritage resource was adequately recorded and mapped and can therefore be destroyed. The above mentioned heritage-related mitigation measures will keep the level of significance for this impact to a **'Negligible Negative Impact'** (*Table 5.4*).

Table 5.4 Rating of Residual Impacts to a Section 35 Archaelogical Site (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Scale	High	As the archaeological resource falls within the footprint of the Main Mine Adit, it will essentially be lost.
Duration	Permanent	Unless avoided, the structures will be destroyed by groundworks during the construction phase of the proposed Project.
Intensity	Low	Change to the integrity of the heritage resource will not cause changes to its authenticity because the heritage resource has been adequately recorded and mapped and the information stored.
Probability	Probable	Project-related mitigation measures, if required, will not avoid change and the site will be destroyed.
Magnitude		
Low Magnitude		
Significant Rating After Mitigation		
Negligible Negative Impact		

5.4 IMPACTS ON SECTION 36 SITES – <u>BURIAL GROUNDS AND GRAVES</u>

5.4.1 Impacts on the S.36-001 Burial Ground

This site is a burial ground that is protected in terms of Section 36 of the NHRA. The coordinates are S27 00 48.99 and E30 20 43.78. The site is associated with the multi-component historical site S.34-002. .

Figure 5.12 Grave Identified and Recorded in Burial Ground Site

The location of this structure in the Project Area is illustrated on *Figure 5.2* on *Page 5-3*.

Description of the Baseline Environment

S.36-001 is approximately 199 square meters in extent and comprises 11 graves. It is located 18 m south of the proposed conveyor route (*Figure 5.2*). The burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources. It is in a fair to good condition and is well preserved. There is some decay present but it can easily be restored. Based on these attributes, the burial ground was given a **medium heritage value**.

Proposed Project Activities

Activities associated with the establishment and operation of the overland conveyor system have the potential to indirectly impact on the S.36-001 heritage resource.

Although the heritage resource is situated 18 m away from the proposed conveyor route, site clearance associated with the construction of the conveyor route could destroy or cause damage to the site.

In addition, construction and operational activities associated with the proposed overland conveyor will result in increased human traffic in the Project Area, thereby increasing the risk of accidental or purposeful damage or destruction of the site. The construction of the conveyor system may change the landscape character and may impact on the integrity of site S.36-001.

Sensitive Receptors

The burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources.

Significance of Impact (Pre-mitigation)

The impact from the construction of the proposed conveyor route on the heritage site will be a '**Minor to Moderate Negative Impact'** (*Table 5.5*).

Table 5.5 Rating of Impacts Related to Burial Ground S.36 001 (<u>Pre-Mitigation</u>)

Type of Impact		
Direct or Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Scale	Medium	Large parts or aspects of the heritage resource may be indirectly affected by the construction of the proposed conveyor route.
Duration	Permanent	Change to the heritage resource will be permanent and irreversible.
Intensity	Low to Medium	Change to the integrity of the heritage resource will not cause change to its authenticity. The conveyor route could only impact on the surface features of the burial ground and not on the human remains themselves which would remain intact. However, the site is in a fair to good condition and is well preserved. There is some decay present but it can easily be restored..
Probability	Unlikely	The burial ground is not situated within the footprint of the conveyor route.
Magnitude		
Low to Medium Magnitude		
Value of the Resource/Receptor		
Medium Sensitivity		
The heritage resource is of a medium heritage value. Furthermore, the burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources.		
Significant Rating Before Mitigation		
Minor to Moderate Negative Impact		

Recommendations and Mitigation/Management Measures

The resource was given a Grade III B field rating (see the Field Rating guide in *Section 3.5* for a description of the field ratings). Based on this field rating, it is recommended that the heritage resource be conserved and potential impacts to the resource be mitigated.

The following Project-related mitigation measures and site management should be implemented to reduce the significance of the impact:

- The graves should be restored where these are dilapidated, protected and conserved in perpetuity. Access to this burial ground should be negotiated with communities in the immediate area.

- A perimeter fence should be built around the burial ground and placed two meters away from the perimeter of the graves. The perimeter fence should include an entry gate to allow visits from relatives and family friends. The mine should be responsible for the maintenance of this fence.

- Detailed Project design should ensure that there is a 20m buffer between the perimeter fence and the proposed conveyor route.

- The ECO should be present on site when the fence is erected around the burial ground.

Residual Impact (Post-mitigation)

The establishment of a fence around the perimeter of the burial ground will ensure that the heritage resource is maintained for the entire LOM. As such, the residual impact will be a "**Positive Impact**".

5.4.2 Impacts on the S.36-005 and S.36-008 Burial Grounds

A further three burial grounds were identified in the vicinity of the Project Site. As with the aforementioned burial site, these three sites are protected in terms of Section 36 of the NHRA. These sites include:

1. **S.36-008** - the coordinates are S27 00 09.70 and E30 18 52.50 (refer to image of heritage resource in *Figure 5.13*). The site is possibly associated with the historical site S.34-009, which was identified and recorded during the screening assessment and mapped during the HIA.

2. **S.36-005** – the coordinates are S27 01 02.20 and E30 17 15.30 (refer to image of heritage resource in *Figure 5.14*).

Figure 5.13 Grave Identified and Recorded in Burial Ground S.36-008

Figure 5.14 Grave Identified and Recorded at Burial Ground S.36-005

The locations of the above mentioned burial grounds in the Project Area are illustrated on *Figure 5.2* on *Page 5-3*.

Description of the Baseline Environment

1. **S.36-008** is approximately 64 square meters in extent with at least six graves. It is located 82 m north west of the proposed conveyor route (*Figure 5.2*). The burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources. It is in a fair to good condition and is well preserved. There is some decay present but it can easily be restored. Based on these attributes, the burial ground was given a **medium heritage value**.

2. **S.36-005** is approximately 668 square meters in extent with at least 31 graves. It is located 30 m east of the Main Mine Adit (*Figure 5.15*). The burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources. It is in an excellent condition and is well-preserved. There is little to no decay present and little restoration is required. Based on these attributes, the burial ground was given a **medium heritage value**

Figure 5.15 Burial Ground S.36 005 Located Approximatly 30m east of the Main Mine Adit (Main Mine Adit illustrated as Orange Hatched Polygon)

Proposed Project Activities

Although these sites are situated a distance away from sites proposed for Project infrastructure, the activities that are associated with the establishment and operation of proposed Project infrastructure have the potential to impact on these burial grounds through site clearance activities. In addition, site clearance and construction activities associated with the proposed Project will increase human traffic thereby increasing the risk to these burial grounds in terms of accidental or purposeful damage or destruction. The operational phase of the proposed Project will also create long-term risks associated with more regular and increased human traffic, allowing access to the sites. Proposed Project infrastructure may also change the landscape character and may impact on the integrity of the sites.

Sensitive Receptors

Sensitive receptors for this heritage site include those community members who visit the burial ground.

Significance of Impact (Pre-mitigation)

The impact related to the construction and operation of the proposed Project on heritage sites will be a '**Minor Negative Impact'** (*Table 5.6*).

Table 5.6 Rating of Impacts Related to S.36-005 and S.36-008 Burial Ground (Pre-Mitigation)

Type of Impact		
Direct or Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Scale	Low to Medium	Isolated parts or aspects of the heritage resource could be indirectly affected by the construction and operation of the proposed Project.
Duration	Permanent	Unless avoided, changes to the heritage resource will be indirect and may occur over the LOM.
Intensity	Medium to Low	Change to the integrity of the heritage resource will not cause change to its authenticity. Indirect impacts associated with proposed infrastructure establishment would only impact on the surface features of the burial ground and not on the human remains themselves which would remain intact.Furthermore, the burial grounds may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Their importance is also based on highly credible information sources. These burial grounds are in an poor to excellent condition and are well-preserved.
Probability	Unlikely	The burial grounds are not situated within the footprints of the infrastructure proposed.
Magnitude		
Medium to Low Magnitude		
Value of the Resource/Receptor		
Medium Sensitivity		

The heritage resources are of a medium heritage value. Project-mitigation must aim to reduce any impacts on the heritage resources as conservation is required. Furthermore, the burial grounds may have a strong association to the community or cultural group for social, cultural and spiritual reasons.
Significant Rating Before Mitigation
Minor to Moderate Negative Impact

Recommendations and Mitigation/Management Measures

The heritage resources were given a Grade III B field rating (see the Field Rating guide in *Section 3.5* for a description of the field ratings). Based on this field rating, it is recommended that the heritage resources be partly conserved and potential impacts to the resources mitigated.

The following Project-related mitigation measures and site management should be implemented in order to reduce the significance of the impact:

- The graves should be restored where these are dilapidated, protected and conserved in perpetuity. Access to this burial ground should be negotiated with communities in the immediate area.

- A perimeter fence should be built around each burial ground and placed two meters away from the perimeter of the graves. The perimeter fences should include an entry gate to allow visits from relatives and family friends. The mine should be responsible for the maintenance of these fences.

- The ECO should be present on site when these fences are been erected around the burial grounds.

Residual Impact (Post-mitigation)

The establishment of a fence around the perimeter of the burial grounds will ensure that the heritage resources are maintained for the entire LOM. As such, the residual impact will be a "**Positive Impact**".

5.4.3 *Impacts on the S.36-007 Grave*

This grave (coordinates are S27 01 04.96 and E30 17 06.91) is protected in terms of Section 36 of the NHRA (*Figure 5.16*). The site may be part of the multi-component archaeological site S.35-006 and is located within a circular stonewalled enclosure.

Figure 5.16 Single Grave Identified and Recorded in Site S.36-007

The locations of this grave in the Project Area is illustrated on *Figure 5.2* on *Page 5-3*.

Description of the Baseline Environment

S.36-007 is approximately 20 square meters in extent and is located within the Main Mine Adit footprint (*Figure 5.17*). The burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources. It is in a fair to good condition and is well preserved. There is some decay present but it can easily be restored. Based on these attributes, the burial ground was given a **medium heritage value**.

Figure 5.17 Single Grave (S.36 007) Located within the Main Mine Adit

Proposed Project Activities

Activities associated with the establishment and operation of Main Mine Adit will result in the loss of S.36-007, as development of the entire footprint of the Main Mine Adit is proposed.

Sensitive Receptors

As is previously mentioned, the burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources.

Significance of Impact (Pre-mitigation)

The impact related to the loss of the grave through construction of the Main Mine Adit will be a '**Major Negative Impact'** (*Table 5.7*).

Table 5.7 Rating of Impacts Related to S.36-007 Grave (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Scale	High	The heritage resource will be lost.
Duration	High	Change to the heritage resource will be immediate, permanent and irreversible.
Intensity	High	Change to the integrity of the heritage resource will cause change to its overall authenticity because the impact will occur on the human remains and not just on the surface.
Probability	Certain	The grave is situated within the footprint of the Main Mine Adit (Adit A) and therefore it is certain that the grave will be lost in its entirety.
Magnitude		
High Magnitude		
Value of the Resource/Receptor		
Medium Sensitivity		
The heritage resource is of a medium heritage value. Project-mitigation must aim to reduce any impacts on the heritage resource as conservation is required. Furthermore, the burial ground may have a strong association to the community or cultural group for social, cultural and spiritual reasons. Its importance is also based on highly credible information sources.		
Significant Rating Before Mitigation		
Major Negative Impact		

5.4.4 Recommendations and Mitigation/Management Measures for Site S.36-007

No project-related mitigation measures such as changes to design or mine plan wereconsidered as the grave is located within the footprint of the Main Mine Adit (Adit A) and will never be preserved. It is therefore recommended that this grave in particular be relocated.

Grave Relocation Process

The Grave Relocation Process (GRP) consists of the following three phases that must be adhered to:

1. Consultation;
2. Permit application; and
3. Exhumation.

Burial grounds and graves are protected in terms of Section 36 of the NHRA and as such cannot be relocated without a permit issued by SAHRA. The GRP is regulated through the NHRA Regulations (Government Gazette No. 21239, Notice No. 548). A summary of each of these three phases is presented in this section.

Phase 1 - Consultation

The GRP is regulated through the NHRA Regulations (Government Gazette No. 21239, Notice No. 548). Chapter XI of the NHRA Regulations regulate the procedure for consultation regarding the burial that must include the following minimum requirements:

- Archival or documentary research regarding the origin of the grave;

- The erection of a site notice for a duration of at least 60 days at the grave displaying in all official languages of the province concerned information about the proposals affecting the site with the following details included:

    - Contact details of the Applicant and/or its nominated representative; and
    - Date by which contact must be made that must be at least seven days after the end of the notification period

- Advertising in the local press;

- Results of direct consultation with local community organisations and/or members that must include:

    - Accurate records of all actions and consultation taken;
    - Contact register of all persons and organisations contacted and their response, copies must be submitted to the SAHRA BGG Unit with the application; and
    - Details of agreements reached between the Applicant and interested parties concerning the future of the grave.

Phase 2 – Permit Application

Chapter IX of the NHRA Regulations provide the legal framework for permit applications for grave relocation. Permit applications must be made to the SAHRA BGG Unit and can only be submitted after the consultation process described above. Section 34 of the NHRA Regulations stipulate the following minimum information that must be included the permit application:

- Name and address, farm number and geographical coordinates of the grave;
- The magisterial district within which the grave is located;
- The contact details of the responsible planning authority;
- Details of the proposed exhumation and relocation;
- Motivation of the proposed exhumation, including supporting documents that may include:
    - The HIA report; and
    - Consultation report presenting results of consultation described above, including copies of agreements reached between Kangra Coal and interested parties.
- Details of the cost of the exhumation;
- The contact details, qualifications and relevant experience of the archaeologist who will be responsible;
- Contact details, identity number and signed consent of the landowner on whose property the grave is situated; and
- Contact details and signature of the Applicant.

A permit for exhumation will only be issued if the exhumation is undertaken under the supervision of an archaeologist and after suitable arrangements have been made for the reinterment of the mortal remains. The Applicant will also be held liable for all costs, unless otherwise agreed on in writing between the former and the interested parties.

Due respect for the customs an beliefs of the community associated with the grave must be upheld.

Phase 3 – Exhumation

Phase three of the GRP includes exhumation, relocation and reburial. Established archaeological field and excavation methodologies must be employed during exhumations to recover all the remains, minimise the damage to the remains and record the context of the burial. In addition, a registered funeral undertaker must be appointed to transport an reinter the remains. Where applicable local municipal by-laws concerning graves must be complied with.

5.4.5 Residual Impact (Post-mitigation) to Site S.36-007

The site will be relocated so there is no residual impact on the physical site location. However, residual impacts on the descendants and/or community (receptors) may occur. Such impacts may manifest as specific social impacts that are not discussed here.

6 CUMULATIVE IMPACTS AND MITIGATION

6.1 INTRODUCTION

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This chapter considers the cumulative impacts that would result from the combination of the Maquasa Mine Expansion Project.

6.2 IDENTIFIED CUMULATIVE IMPACTS

Cumulative impacts are those impacts that act together to affect the same heritage resource.

Increased development in the greater Study Area will have a number of cumulative impacts on heritage resource. For example, tourism and mining could, over the long term, increase human activity that could change, alter or destroy heritage resources.

Other identified cumulative impacts would result from the Maquasa Mine Expansion Projects. The development of the proposed Project and the continual mining at the Savmore Colliery through Maquasa East, Maquasa West, and Maquasa West Extension, would result in cumulative impacts on heritage resources.

Cumulative impacts that could result from a combination of the proposed Project and other actual or proposed future developments in the broader Study Area include:

- **Site Clearance and the Removal of Topsoil** – could result in damage to or the destruction of heritage resources that have not previously been recorded. Heritage resources such as burial grounds and graves and archaeological and historical sites are common occurrences within the greater Study Area. These sites are often not visible and as a result, can be easily affected / lost.

- **Increased Human Activity** – allows increased access to nearby heritage resources. Furthermore, many heritage resource in the greater Study Area are informal, unmarked and may not be visible, particularly during the wet season when grass cover is dense. As such, construction workers may not see these resources, which results in increased risk of resource damage and / or loss.

- **<u>Increased Atmospheric Emissions</u>** – the continued operation of the Savmore Colliery and the establishment of the proposed Maquasa Mine Expansion Project together with the Kusipongo Resource Expansion Project may potentially result in increased atmospheric emissions (dust and particulate matter) in the greater Study Area. These emissions could result in a change to the integrity of tangible heritage resources such as rock art sites. Rock art sites can become covered with coal dust which would result in a change to the integrity and authenticity of the heritage resource.

- **<u>Vibrations and Earth Moving Activities associated with Mining</u>** – has the potential to crack / damage rock art covered surfaces, which are known to occur in the greater Study Area.

- **<u>Dewatering of Mine Workings</u>** - has the potential to exfoliate and dry-out rock art sites.

- **<u>Impacts to Paleontological Resources</u>** - no specific paleontological resources were found in the Project Area during the time of this study; however, this does not preclude the fact that paleontological resources may exist within the greater Study Area. As such, future has the potential to impact on possible paleontological resources in the area.

- **<u>Subsidence</u>** - Potential subsidence of existing and proposed underground mine workings, has the potential to result in the collapse of burial ground and graves in the Study Area.

It is recommended that prior to the establishment of future developments in the Study Area (especially green-field developments) that heritage assessments be conducted. These assessments should provide suitable mitigation / management measures that allows for effective preservation and protection of heritage resources in the Study Area that have a medium to high heritage value.

7 CONCLUSION

Kangra Coal commissioned ERM to conduct an ESIA for the proposed Kangra Coal Project in accordance with the NEMA and MPRDA. ERM has subsequently appointed Digby Wells to conduct the HIA for the proposed Project.

Based on the Scoping Report, SAHRA stipulated that a HIA report must be completed and submitted for assessment. The HIA report presented here is, according to ToR received from SAHRA, inclusive of:

- An archaeological assessment that:
  - Identifies all the archaeological resources that may be impacted by the proposed Project;
  - Assesses the significance of all impacts to resources; and
  - Makes recommendations about what mitigation may be required.
- A palaeontological study to indicate whether or not the Project Area is palaeontoloigcally sensitive: if sensitive, a full Palaeontological Report is required.

A total of seven sites were identified and recorded during the vehicle and pedestrian survey conducted during the HIA assessment on 5 to 7 May 2013.

The historical structures S.34-002 and S.34-009 are of **low heritage value**. These structures are bisected by the proposed overland conveyor route and will be impacted on. However, these heritage resources were given a Grade IV B field rating and no Project-related mitigation measures are recommended for these structures. The heritage resources were significantly recorded and mapped.

The archaeological site S.35-006 is of **low heritage value**. The site is bisected by the Main Mine Adit footprint and will essentially be lost. The resource was given a Grade IV B field rating and as a result, no Project-related mitigation measures are recommended for the site. The heritage resource was significantly recorded and mapped.

The burial ground S.36-001 is of **medium heritage value**. The site is located 18m from the proposed overland conveyor route and may be indirectly impacted on. It is therefore recommended that the perimeter of the burial ground be fenced and that detailed design of the conveyor route be such that a 20 m buffer is created between the fenced perimeter of the burial ground and the perimeter of the servitude for the proposed conveyor.

The burial grounds S.36-005 and S.36-008 are of **medium heritage value**. The sites are located between 30 and 82 meters from the proposed overland conveyor route and could be indirectly impacted on during the construction and operational phases of the proposed Project. As with burial ground S.36-001, it is recommended that the perimeter of the burial grounds be fenced.

A single grave S.36-007 is of **medium heritage value**. The site is located within the Main Mine Adit footprint and and therefore it is certain that the grave will be lost in its entirety. As such, no Project-related mitigation measures such as changes to design or mine plan were considered. It is therefore recommended that this grave be relocated in accordance with the Section 36 of the NHRA and NHRA Regulations.

During the field survey, no surface fossils were identified along the proposed conveyor routes or within the Main Mine Adit and Adit B footprints. Most fossil heritage is embedded within the rocks beneath the land surface or obscured by surface deposits such as alluvium or soil and by vegetation cover. It is therefore recommended that a palaeontologist or geologist be appointed to inspect the palaeontological sensitive sites during the construction and mining phases. This monitoring may be limited to overburden dumps in which fossil material may be deposited with overburden material.

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[Accessed 13 September 2012].

Appendix A

Curriculum Vitae of Specialists

MS SHAHZAADEE KARODIA

Archaeology Consultant
Social Science Department
Digby Wells Environmental

Education

2006: BA Anthropology & Archaeology, University of the Witwatersrand
2007: BSc Honours Palaeontology, University of the Witwatersrand
2012: Msc Archaeology, University of the Witwatersrand

Language Skills

English (read, write, speak)
Currently completing French training for beginners

Employment

2012: Archaeology consultant, Digby Wells Environmental
April 2012 – June 2012: External archaeology consultant, EcoAfrica
April 2011 – November 2011: Archaeology intern, University of Pretoria
2007 – 2008: Palaeontology collections assistant, BPI, University of the Witwatersrand
2006 – 2007: Tour guide, Sterkfontein caves

Experience

Archaeology field school at Klipriviersberg with Dr Karim Sadr, University of the Witwatersrand
Archaeology field school at Swartkrans and Maropeng with Dr Kathy Kuman, University of the Witwatersrand
Archaeology field school at Ottosdal with Dr Thembi Russell, University of the Witwatersrand
Palaeontology field school in the Karoo with Professor Bruce Rubidge, University of the Witwatersrand
Palaeontology field school at Gladysvale with Professor Lee Berger, University of the Witwatersrand
Palaeontology field school at Wonderkrater with Dr Lucinda Backwell, University of the Witwatersrand

Project Experience

Heritage Statement and Letter of Recommendation from Exemption for the Central Basin, Witwatersrand Acid Mine Drainage Project
Heritage Impact Assessment for the Witwatersrand Gold Fields Acid Mine Drainage Project (Western Basin)

Archaeological Watching Brief on Access Road for Bokoni Platinum Ltd

Heritage Statement and Notification of Intent to Develop for Eskom Transmission Division – Roodepoort Strengthening Project

Heritage Statement and Notification of Intent to Develop for the Zandbaken Coal Mine Project, Zandbaken 585 IR, Sandbaken 363 IR and Bosmans Spruit 364 IS, Standerton, Mpumalanga

Heritage Statement and Notification of Intent to Develop for Rhodium Reef Limited Platinum Operation, 2430 CA & CC, De Goedverwachting 332 KT, Boschkloof 331 KT and Belvedere 362 KT

Heritage Statement and Notification of Intent to Develop for the Thabametsi Project, 2327 CB, Vaalpensloop 313 LQ, Lephalale, Limpopo Province

Heritage Statement and Notification of Intent to Develop for the Dalyshope Project

Heritage Statement and Notification of Intent to Develop for the Harwar Colliery

Heritage Statement and Notification of Intent to Develop for the Consbrey Colliery

Heritage Statement and Notification of Intent to Develop for the Waterberg Prospecting Rights Application

Professional affiliations

Association of Southern Africa Professional Archaeologists (ASAPA)
The South African Archaeology Society (SAAS)
Society of Africanist Archaeologists (SAfA)
The Geological Survey of South Africa (GSSA)
The Palaeontological Society of Southern Africa (PSSA)
The South African Society for Amateur Palaeontologists (SASAP)

Mr Johan Nel

Unit manager: Heritage Resources Management
Social Sciences
Digby Wells Environmental

Education

2002: BA Honours - Archaeology
2001: BA Anthropology & Archaeology
1997: Matriculated Brandwag Hoërskool

Language Skills

Fluent in English and Afrikaans

Employment

2011 to present: Unit manager: Heritage Resources Management, Digby Wells Environmental
2010-2011: Archaeologist, Digby Wells Environmental
2005-2010: Manager and co-owner, Archaic Heritage Project Management
2003-2005: Freelance archaeologist
Resident archaeologist, Rock Art Mapping Project, Ndidima, Ukhahlamba-Drakensberg World Heritage Site
2002-2003: Special Assistant: Anthropology, Department of Anatomy, University of Pretoria
2001-2002: Technical Assistant: Department of Anatomy, University of Pretoria
1999-2001: Assistant: Mapungubwe Project, National Cultural History Museum & Department of Anthropology and Archaeology, UP

Experience

I have 13 years of combined experience in the field of cultural heritage resources management (HRM) including archaeological and heritage assessments, grave relocation, social consultation and mitigation of archaeological sites. I have gained experience both within urban settings and remote rural landscapes. Since 2010 I have been actively involved in environmental management that has allowed me to investigate and implement the integration of heritage resources management into environmental impact assessments (EIA). Many of the projects since have required compliance with International Finance Corporation (IFC) requirements and other World Bank standards. This exposure has allowed me to develop and implement a HRM approach that is founded on international best practice and leading international conservation bodies such as UNESCO and ICOMOS. I have worked in most South African Provinces, as wells Swaziland, the Democratic Republic of the Congo and Sierra Leone. I am fluent in English and Afrikaans, with excellent writing and research skills.

Project Experience

Phase 1 Archaeological Impact Assessments

Above Ground Storage Tanks survey, SASOL Oil (Pty) Ltd, Free State Province, South Africa

Access road establishment , AGES-SA, Tzaneen, South Africa

Boikarabelo Railway Link, Resgen South Africa, Steenbokpan, South Africa

Conversion of prospecting rights to mining rights, Georock Environmental, Musina, South Africa

Galaxy Gold Agnes Mine, Barberton, South Africa

HCI Khusela Palesa Extension, Bronkhorstspruit, South Africa

Kennedy's Vale township establishment, AGES-SA, Steelpoort, South Africa

Koidu Diamond Mine, Koidu Holdings, Koidu, Sierra Leone

Lonmin Platinum Mine water pipeline survey, AGES-SA, Lebowakgomo, South Africa

Mining right application, DERA Environmental, Hekpoort, South Africa

Mogalakwena water pipeline survey, AGES-SA, Limpopo Province, South Africa

Nzoro Hydropower Station, Environmental and Social Impact Assessment, DRC

Randgold Kibali Gold Project, Environmental and Social Impact Assessment, Kibali, Democratic Republic of the Congo

Randwater Vlakfontein-Mamelodi water pipeline survey, Archaeology Africa cc, Gauteng, South Africa

Residential and commercial development, GO Enviroscience, Schoemanskloof, South Africa

Temo Coal, Limpopo, South Africa

Transnet Freight Line survey, Eastern Cape and Northern Cape, ERM, South Africa

Van Reenen Eco-Agri Development Project, GO Enviroscience, South Africa
Platreef Platinum Mine, Ivanhoe Nickel & Platinum, Mokopane, South Africa

Mitigation of Projects

Mitigation of Iron Age archaeological sites: Kibali Gold Project, DRC

Mitigation of Iron Age metalworking site: Koidu Diamond Mine, Sierra Leone

Mitigation of Iron Age sites: Boikarabelo Coal Mine, South Africa

Exploratory test excavations of alleged mass burial site: Rustenburg, Bigen Africa Consulting Engineers, South Africa

Mitigation of Old Johannesburg Fort: Johannesburg Development Agency (JDA), South Africa

Site monitoring and watching brief: Department of Foreign Affairs Head Office, Imbumba-Aganang Design & Construction Joint Venture, South Africa

Grave Relocation

Du Preezhoek-Gautrain Construction, Bombela JV, Pretoria, South Africa
Elawini Lifestyle Estate social consultation, PGS (Pty) Ltd, Nelspruit, South Africa

Motaganeng social consultation, PGS (Pty) Ltd Burgersfort, South Africa
Randgold Kibali Mine, Relocation Action Plan, Kibali, DRC

Repatriation of Mapungubwe National Park and World Heritage Site, DEAT, South Africa

Smoky Hills Platinum Mine social consultation, PGS (Pty) Ltd Maandagshoek South Africa

Southstock Colliery, Doves Funerals, Witbank, South Africa

Tygervallei. D Georgiades East Farm (Pty) Ltd, Pretoria, South Africa

Willowbrook Ext. 22, Ruimsig Manor cc, Ruimsig, South Africa

Zondagskraal social consultation, PGS (Pty) Ltd,Ogies, South Africa

Zonkezizwe Gautrain, PGS, (Pty) Ltd, Midrand, South Africa

Other Heritage Assessments and Reviews

Heritage Scoping Report on historical landscape and buildings in Port Elizabeth: ERM South Africa

Heritage Statement and Cultural Resources Pre-assessment scoping report on Platreef Platinum Mine, Mokopane: Platreef Ltd

Heritage Statement and Scoping Report on five proposed Photo Voltaic Solar Power farms, Northern Cape and Western Cape: Orlight SA

Land claim research Badenhorst family vs Makokwe family regarding Makokskraal, Van Staden, Vorster & Nysschen Attorneys, Ventersdorp South Africa

Research report on Cultural Symbols, Ministry for Intelligence Services, Pretoria, South Africa

Research report on the location of the remains of kings Mampuru I and Nyabela, National Department of Arts and Culture, Pretoria, South Africa
Review of Archaeological Assessment: Resources Generation, Coal Mine Project in the Waterberg area, Limpopo Province

Review of CRM study and compilation of Impact Assessment report, Zod Gold Mine, Armenia

Professional affiliations

Society for Africanist Archaeologists (SAfA)

Professional Registration

Association fo Southern African Professional Archaeologists (ASAPA)
Accredited by ASAPA Cultural Resources Management section
International Association of Impact Assessors (IAIA)

Publications

Nel, J. 2001. Cycles of Initiation in Traditional South African Cultures. *South African Encyclopaedia* (MWEB).

Nel, J. 2001. *Social Consultation: Networking Human Remains and a Social Consultation Case Study*. Research poster presentations at the Bi-annual Conference (SA3) Association of Southern African Professional Archaeologists: National Museum, Cape Town.

Nel, J. 2002. *Collections policy for the WG de Haas Anatomy museum and associated Collections*. Unpublished. Department of Anatomy, School of Medicine: University of Pretoria.

Nel, J. 2004. Research and design of exhibition for Eloff Belting and Equipment CC for the Institute of Quarrying 35th Conference and Exhibition on 24 – 27 March 2004.

Nel, J. 2004. *Ritual and Symbolism in Archaeology, Does it exist?* Research paper presented at the Bi-annual Conference (SA3) Association of Southern African Professional Archaeologists: Kimberley.

Nel, J & Tiley, S. 2004. The Archaeology of Mapungubwe: a World Heritage Site in the Central Limpopo Valley, Republic of South Africa. Archaeology World Report, (1) United Kingdom p.14-22.

Nel, J. 2007. *The Railway Code: Gautrain, NZASM and Heritage.* Public lecture for the South African Archaeological Society, Transvaal Branch: Roedean School, Parktown.

Nel, J. 2009. *Un-archaeologically speaking: the use, abuse and misuse of archaeology in popular culture*. *The Digging Stick*. April 2009. 26(1): 11-13: Johannesburg: The South African Archaeological Society.

Nel, J. 2011. 'Gods, Graves and Scholars' returning Mapungubwe human remains to their resting place.' In: *Mapungubwe Remembered*. University of Pretoria commemorative publication: Johannesburg: Chris van Rensburg Publishers.

Nel, J. 2012. *HIAs for EAPs*. Paper presented at IAIA annual conference: Somerset West.

Appendix B

Impact Assessment Methodology

1 INTRODUCTION

The impact assessment stage includes several steps aimed to evaluate the way in which environmental aspects will / may interact with the cultural landscape (the environment) resulting in environmental impacts to heritage resources. Environmental aspects and impacts are defined as:

- *Environmental aspects*: an element of an organisation's activities or products or services that can inteact with the environment' (ISO 14001: 2004 – 3.6); and

- *Environmental impacts*: any change to the environment, whether adverse or beneficial, wholly or partial resulting from an organisation's environmental aspects (ISO 1400: 2004 – 3.7).

However, in terms of cultural heritage resources, environmental impacts should be assessed relative to the heritage value or significance of a resource. The methodology employed in the various stages of the impact assessment process is described in more detail below.

1.1 STATEMENT OF SIGNIFICANCE OR VALUE

Heritage resources – both cultural and natural – are finite, non-renewable and irreplaceable. They characterise community identity and cultures and are therefore are intrinsic to the history and beliefs of communities. As sources of information, heritage resources have inherent potential to contribute significantly to research, education and tourism, as well as allowing capacity for reconciliation, understanding and mutual respect.

Considering the innate value of heritage resources, the foundation of heritage resources management (HRM) is the acknowledgement that heritage resources have lasting worth as evidence of the origins of life, humanity and society. Every generation is therefore morally obligated to act as trustees of heritage for future generations through conservation, preservation and protection.

Accordingly, HRM must take into account rights of affected communities to be consulted and to participate. Where heritage resources are developed and presented the dignity and respect of diverse cultural values must be ensured. In addition, heritage in its broadest sense must never be used for sectarian purposed or political gain.

Notwithstanding the fundamental value ascribed to heritage, significance of individual resources needs to be determined to allow implementation of appropriate management measures. This is achieved through assessing a heritage resource's value relative to certain prescribed criteria, encapsulated in the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA) as well as several international conventions. The significance of a resource thus determines the magnitude of change that may result from environmental impacts. As a result, environmental impacts that are rated low may cause severe change in a heritage resources rated as highly significant. Vice versa, severe impacts may cause negligible change to an insignificant resource. Value is determined by assessing the authenticity and integrity of a resource by applying the formula provided in Table 8. Value thresholds are provided Table 9.

Table 8: Formula calculating heritage resource value

multiplied by		**Authenticity**					
		0	3	6	9	12	15
Integrity	0	0	0	0	0	0	0
	1	0	3	6	9	12	15
	2	0	6	12	18	24	30
	3	0	9	18	27	36	45

Value = authenticity + integrity
where
Authenticity = importance (average sum of attributes per dimension) + credibility

Table 9: Value thresholds

Score	Description	Rating
0	Resource of no / negligible heritage value as part of national estate	None / negligible
1-15	Resource of low value heritage value: change to resource not significant	Low
16-30	Resource of medium heritage value: project mitigation must aim to reduce any impacts on resource; conservation may be required.	Medium
31-45	Resource of exceptional value and must be considered for inclusion in national estate: project mitigation must attempt to remove all impacts; consideration must be given to conservation / preservation of resource.	High

The steps involved in determining the value of a heritage resource is described in more detail below.

1.1.1 *Authenticity*

The Nara Document on Authenticity (1993) forms the basis of determining authenticity. Based on this document, it is accepted that understanding and determining importance attributed to heritage resources rely on credible information sources[1]. These sources need to be assessed as credible or truthful. This requires knowledge and understanding of information sources employed in relation to original and subsequent characteristics of heritage resources, and their meaning.

Authenticity is therefore determined in terms of the importance of a resource considering available sources of information. Thresholds for authenticity are provided in Table 10.

[1] **Information sources** are defined as all physical, written, oral, and figurative sources, which make it possible to know the nature, specificities, meaning, and history of the cultural heritage. Therefore, determining authenticity of a resource requires a sound knowledge of the type of heritage resource as well as the context within which occurs – the cultural landscape. This knowledge must be gained through a detailed baseline that must aim to contextualise the resource. Information that should be considered are published, peer reviewed literature, archival research, popular publications, and any other information source that may be relevant (Nara Document on Authenticity, 1993)

Table 10: Authenticity thresholds

Score	Description	Rating
0	None	None / negligible
1-5	Negligible to low level of authenticity evident.	Low
6-10	Authenticity merely evident: importance illustrated in credible information sources.	Medium
11-15	Authenticity of resource undisputed.	High

Importance

The importance of a heritage resource is determined on four dimensions – aesthetic, historic, scientific, and social. In turn, each dimension is measured against one or more descriptive attributes, defined in national legislation and international convention: NHRA (1999), the United Nations Education, Scientific and Cultural Organisation (UNESCO) World Heritage Convention (1972), International Council on Monuments and Sites (ICOMOS) Guidance on Heritage Impact Assessments for Cultural World Heritage Properties and the Australian ICOMOS Charter for Places of Cultural Significance (1999) (Burra Charter). These attributes, or criteria, are aimed to provide a guide as to whether a resource should be included in the national estate as defined in these documents and presented in Table 11 below.

Table 11: Summary of dimensions and attributes

Dimension		Attributes considered	NHRA Ref.	UNESCO Ref.
Aesthetic & technical	1	Importance in aesthetic characteristics	S.3(3)(e)	Appendix 3A
	2	Degree of technical / creative skill at a particular period	S.3(3)(f)	Appendix 3A
Historical importance & associations	3	Importance to community or pattern in country's history	S.3(3)(a)	Appendix 3A
	4	Site of significance relating to history of slavery	S.3(3)(i)	Appendix 3A
	5	Association with life or work of a person, group or organisation of importance in the history of the country	S.3(3)(h)	Appendix 3A
Information potential	6	Possession of uncommon, rare or endangered natural or cultural heritage aspects	S.3(3)(b)	Appendix 3A
	7	Information potential	S.3(3)(c)	Appendix 3A
	8	Importance in demonstrating principle characteristics	S.3(3)(d)	Appendix 3A
Social	9	Association to community or cultural group for social, cultural or spiritual reasons	S.3(3)(g)	Appendix 3A

Importance ratings need to be provided for each applicable attribute per dimension. Each dimension’s ratings are averaged and rounded off to allow a consistent rating irrespective of whether one or more attributes are considered. Definitions and ratings are provided in

Table 12 below.

Table 12: Importance definitions

Importance	
0	None
1	Attributes considered commonplace, well or over represented; Importance generally not considered by any community
2	Attributes considered uncommon, underrepresented; Importance generally considered by some communities.
3	Attributes considered singular, unique, irreplaceable; Importance always considered by most communities.

Credibility

Credibility of information sources forms the basis in determining the importance of heritage resources. The importance rating per dimension and attribute discussed above is thus intrinsically linked to the credibility of information sources used. Credibility thresholds and definitions are provided in Table 13 below.

Table 13: Credibility definitions

Credibility	
0	Credibility of information cannot be determined: Conjecture, unverified personal opinions; biases evident.
1	Secondary and tertiary information sources: Popular media, newspapers, magazines; 'Information' websites e.g. Wikipedia, etc.; Individual opinions.
2	Credible secondary sources: Factually correct textbooks and popular publications, etc.; Official websites; Verifiable oral accounts.
3	Highly credible information sources: Peer-reviewed publications; Primary sources; Verified oral accounts.

1.1.2 Integrity

Integrity is determined by examining the physical condition of a heritage resource – as witnessed at the time of assessment – compared to an ideal or other existing example. Integrity ought to be assessed only after the resource's authenticity has been determined, as the information source / s used should provide comparative examples against which its present condition may be measured. Thresholds and definitions for integrity are described in Table 14 below.

Table 14: Integrity definitions

Integrity	
0	Resource degraded to extent where no information potential exists; resource cannot be restored; single, isolated find, without any site context;
1	Poor condition, active decay visible; excessive restoration required; little information potential
2	Fair to good condition; well preserved; some decay present; can be easily restored / conserved / preserved; good information potential
3	Excellent / pristine; extremely well preserved; little to no decay present; little restoration required / restoration will greatly enhance resource; excellent information potential

1.2 Impact Assessment

Assessing environmental impacts on heritage resources are based first on the value of a resource and second how that value may change due to environmental aspects. Environmental management systems employ relative standard terminology that characterises impacts. This terminology has been adapted to provide a well-defined descriptive terminology for use in assessing environmental impacts on heritage resources summarised in Table 15.

Table 15: Impact characteristic terminology

Characteristic	Description	Designation
Type	Relationship of an assumed impact to a heritage resource (in terms of cause and effect).	Direct Indirect Induced
Scale of change	The physical area (size) of a heritage resource that may change	None Isolated parts / aspects will change Large parts / aspects will change Most or entire resource will change
Duration	Time period over which resource will change	Immediate, non-permanent and fully reversible Long-term, non-permanent and reversible Long-term, permanent and irreversible Immediate, permanent and irreversible
Intensity	How an impact could change the authenticity and integrity, thus importance, of a resource	None Change in integrity without affecting authenticity Change in integrity will affect aspects of authenticity Change in integrity will affect overall authenticity
Probability	Likelihood of change occurring	None Project-related mitigation will remove change Project-related mitigation will reduce change Project-related mitigation will not reduce change

The significance of change to heritage resources due to environmental impacts is determined as follows:

Impact significance = Value x Magnitude

where

Magnitude = Consequence x Probability

and

Consequence = Spatial Scale + Duration + Intensity

The impact rating is applied to pre- and post-mitigation scenarios. The ideal is to remove all impacts to a heritage resource. Where post mitigation significance is not zero, the recommended field rating (heritage) mitigation must be undertaken. The tables below provide the various descriptions and thresholds applicable to the impact assessment ratings.

Table 16: Scale thresholds, definitions and designation

Score	Description	Rating
0	No change	None

1	Isolated parts / aspects of heritage resource will be affected	Low
2	Large parts / aspects of heritage resource will be affected	Medium
3	Most or entire heritage resource will be affected	High

Table 17: Duration thresholds, definitions and designation

Score	Description	Rating
0	Change will be immediate, non-permanent and fully reversible	None
1	Change will occur over the long term, result will be non-permanent and reversible	Low
2	Change will occur over the long term, result will be permanent and irreversible	Medium
3	Change will be immediate, permanent and irreversible	High

Table 18: Intensity thresholds, definitions and designations

Score	Description	Rating
0	No change to integrity and authenticity	None
1	Change to integrity that will not cause any change in authenticity (importance).	Low
2	Change to integrity that will cause change to certain authentic aspects (importance) (describe and define aspects).	Medium
3	Change to integrity that will cause change to overall authenticity (importance)	High

Table 19: Probability thresholds, definitions and designations

Score	Description	Rating
0	No change	None
1	Project-related mitigation measures will avoid change	Unlikely
2	Project-related mitigation measures will reduce change	Probable
3	Project-related mitigation measures will not avoid change	Certain

Table 20: Magnitude of change thresholds, designations and definitions in relation to three categories of heritage resources

Score	Designation	Archaeology, Palaeontology	Built Environment/Structures	Historic Landscape
0	**No change**	No change	No change to fabric or setting	No changes to landscape elements, parcels or components; no visual or audible changes; no changes in amenity or community factors.
1-49	**Low**	Very minor changes to key archaeological materials, or setting.	Slight changes to historic building elements or setting that hardly affect it.	Very minor changes to key historic landscape elements, parcels or components; virtually unchanged visual effects; very slight changes in noise or sound quality; very slight changes to use or access; resulting in very small change to historic landscape character.
50-98	**Medium**	Changes to key archaeological materials, such that the resource is slightly altered; slight changes to the setting.	Change to key historic building elements, such that the resource is slightly different; change to setting of an historic building, such that it is noticeably changed.	Change to few key historic landscape elements, parcels or components; slight visual changes to few key aspects of the historic landscape; limited changes in noise or sound quality; slight changes to use or access; resulting in limited changes to historic landscape character.
99-147	**High**	Changes to many key archaeological materials, such that the resource is clearly modified; changes to	Change to many key historic building elements, such that the resource is significantly modified; change to	Change to many key historic landscape elements, parcels or

Score	Designation	Archaeology, Palaeontology	Built Environment/Structures	Historic Landscape
		the setting that affect the character of the asset	setting of an historic building, such that it is significantly modified.	components; visual change to many key aspects of the historic landscape; noticeable differences in noise or sound quality; considerable changes to use or access; resulting in moderate changes to historic landscape character.
		Changes to attributes that convey outstanding national value of national estate; Most or all key archaeological materials, including those that contribute to ONV such that the resource is totally altered; comprehensive changes to setting	Change to key historic buildings that contribute to outstanding national value of national estate such that the resource is totally altered; Comprehensive changes to setting.	Change to most or all key historic landscape elements, parcels or components; extreme visual effects; gross change of noise or change to sound quality; fundamental changes to use or access; resulting in total change to historic landscape character unit and loss on outstanding national value.

1.3 FIELD RATING (SOUTH AFRICAN PROJECTS)

Field ratings, or proposed grading of heritage resources, are required by the South African Heritage Resources Agency (SAHRA) in terms of Section 7(1) of the NHRA. Field ratings are based on the assessments of heritage resources in relation to criteria contained in Section 3(3) of the NHRA (see above). Section 7 further outlines a three-tier system for heritage resources management of the national estate based on proposed grading:

- National: SAHRA is responsible for identification and managing of Grade I heritage resources;
- Provincial: Provincial Heritage Resources Authorities (PHRAs) are responsible for identification and managing of Grade II heritage resources; and

- Local: Local authoritis (municipalitys, metros, local government) are responsible for identification and managing of Grade III heritage resources.

Field ratings are based on (equal to) the value of a heritage resource. The thresholds for field ratings are present in Table 21 below.

Table 21: Field rating thresholds and descriptions

NHRA SECTION 7 GRADING			
Score	**Grade**	**Protection**	**Recommended Heritage Mitigation**
41-45	Grade I	National	Heritage resource should be nominated as a National Site / Object, included in National Estate
36-40	Grade II	Provincial	Heritage resource should be nominated as a Provincial Site / Object, included in National Estate
31-35	Grade III A	Local	Heritage resource should be nominated as a Regional Site / Object, included in National Estate
16-30	Grade III B	Local	The heritage resource must be mitigated and partly conserved / preserved
8-15	Grade IV A	General	The heritage resource must be mitigated before destruction
1-7	Grade IV B	General	The heritage resource must be recorded before destruction
0	Grade IV C	General	No mitigation required - application for destruction permit

Appendix C

Chance Find and Fossil Find Procedures

1 CHANCE FIND AND FOSSIL FIND PROCEDURES

1.1 CHANCE FINDS PROCEDURES FOR HERITAGE RESOURCES

The following procedures must be considered in the event that previously unknown heritage resources, including burial grounds or graves, are exposed or found during the life of the project (extracted and adapted from the National Heritage Resources Act, 1999 Regulations Reg No. 6820, GN: 548).

List of Acronyms

CRM	Cultural Resources Management
HIA	Heritage Impact Assessment
NHRA	National Heritage Resources Act
PHRA	Provincial Heritage Resources Authority
SAHRA	South African Heritage Resources Authority
SAPS	South African Police Service

For simplicity, the term 'heritage resource' includes burial grounds and graves, unless these are specifically addressed.

Heritage Resources: structures, archaeology, palaeontology, meteors, public monuments

1. The heritage resource must be avoided and all activities in the immediate vicinity temporarily ceased;
2. The Digby Wells Environmental (Digby Wells) project manager and/or Cultural Resources Management (CRM) Unit must be notified of the discovery;
3. Digby Wells will deploy a qualified specialist to consider the heritage resource, either via communicating with the Environmental Officer via telephone or email, or based on a site visit;
4. Appropriate measures will then be presented to Kangra Coal (Pty) Ltd;
5. Should the specialist conclude that the find is a heritage resource protected in terms of the NHRA (1999) Sections 34, 36, 37 and NHRA (1999) Regulations (Regulation 38, 39, 40), Digby Wells will notify the South African Heritage Resources Agency (SAHRA) and/or the Mpumalanga Provincial Heritage Resources Agency (MPRHA) on behalf of Kangra Coal (Pty) Ltd; and
6. SAHRA/MPHRA may require that a Heritage Impact Assessment (HIA) in terms of NHRA Section 38 must take place that may include rescue excavations, for which Digby Wells will submit costs and proposal as relevant.

Burial grounds and graves

1. In the event that human remains were accidently exposed, the Digby Wells project manager and/or the CRM Unit must immediately be notified of the discovery in order to take the required further steps:

a. The local South African Police Service (SAPS) will be notified on behalf of Kangra Coal (Pty) Ltd;

b. Digby Wells will deploy a suitably qualified specialist to inspect the exposed burial and determine in consultation with the SAPS whether:

i. The temporal context of the remains, i.e.:
- forensic,
- authentic burial grave (informal or older than 60 years, NHRA (1999) Section 36); or
- archaeological (older than 100 years, NHRA (1999) Section 38).

ii. Any additional graves may exist in the vicinity.

2. Should the specialist conclude that the find is a heritage resource protected in terms of the NHRA (1999) Section 35 and NHRA (1999) Regulations (Regulation 38, 39, 40), Digby Wells will notify SAHRA and/or MPHRA on behalf of Kangra Coal (Pty) Ltd;
3. SAHRA/MPHRA may require that an identification of interested parties, consultation and /or grave relocation take place;
4. Consultation must take place in terms of NHRA (1999) Regulations 39, 40, 42;
5. Grave relocation must take place in terms of NHRA (1999) Regulations 34

Digby Wells can facilitate and assist with all chance find procedures outlined above.

CRM Unit:	Johan Nel
	Work: 011 789 9495
	Cell: 072 288 5496

1.2 *FOSSIL FIND PROCEDURES*

List of Acronym

ECO	Environmental Control Officer

1.2.1 Introduction

In the context under consideration, it is improbable that fossil finds will require declarations of permanent “no go” zones. At most, a temporary pause in activity at a limited locale may be required. The strategy is to rescue the material as quickly as possible.

The procedures suggested below are in general terms, to be adapted as befits a context. They are described in terms of finds of fossil bones that usually occur sparsely. However, they may also serve as a guideline for other fossil material that may occur.

Bone finds can be classified as two types: isolated bone finds and bone cluster finds.

1.2.2 Isolated Bone Finds

In the process of digging excavations, isolated bones may be spotted in the hole sides or bottom, or as they appear on the spoil heap. By this is meant bones that occur singly, in different parts of the excavation. If the number of distinct bones exceeds six pieces, the finds must be treated as a bone cluster (below).

1.2.3 Response by personnel in the event of isolated bone finds

The following responses should be undertaken by personnel in the event of isolated bone finds:

- Action 1: An isolated bone exposed in an excavation or soil heap must be retrieved before it is covered by further soil from the excavation and set aside;

- Action 2: The site foreman and Environmental Control Officer (ECO) must be informed;

- The responsible field person (site foreman or ECO) must take custody of the fossil. The following information is to be recorded:

  - Position (excavation position)
  - Depth of find in hole;
  - Digitial image of hole showing vertical section (side); and
  - Digital image of fossil.

- Action 4: The fossil should be placed in a bag (e.g. a Ziploc bag), along with any detachment fragments. A label must be included with the date of the find, position information, and depth; and

- Action 5: The ECO is to inform the developer who then contacts the archaeologist and/or palaeontologist contracted to be on standby. The ECO is to describe the occurrence and provide images via email.

1.2.4 Response by Palaeontologist in the event of isolated bone finds

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established.

1.3 BONE CLUSTER FINDS

A bone cluster is a major find of bones (e.g. several bones in close proximity or bones resembling parts of a skeleton). These bones will likely be seen in broken sections of the sides of the hole and as bones appearing in the bottom of the hole and on the spoil heap.

1.4 RESPONSE BY PERSONNEL IN THE EVENT OF A BONE CLUSTER FIND

The following responses should be undertaken by personnel in the event of bone cluster finds:

- Action 1: Immediately stop excavation in the vicinity of the potential material. Mark or flag the position as well as the soil heap that may contain fossils;

- Action 2: Inform the sie foreman and the ECO; and

- Action 3: The ECO is to inform the developer who must then contact the archaeologist and / or palaeontologist contracted to be on standby. The ECO is then to describe the occurrence and provide images via email.

1.5 RESPONSE BY PALAEONTOLOGIST IN THE EVENT OF A BONE CLUSTER FIND

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established. It is likely that a Field Assessment by the palaeontologist will be carried out.

It will be probably be feasible to avoid the find and continue to the excavation farther along, or proceed to the next excavation, so that the work schedule is minimally disrupted. The response time / scheduling of the Field Assessment is to be decided in consultation with the developer / owner and the environmental consultant.

The Field Assessment could have the following outcomes:

- If a human burial, the appropriate authority is to be contacted. The find must be evaluated by a human burial specialist to decide in Rescue Excavation is feasible, or if it is a Major Find;

- If the fossils are in an archaeological context, an archaeologist must be contacted to evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find; and

- If the fossils are in a palaeontological context, the palaeontologist must evaluate the site and descide if Rescue Excavation is feasible, or of it is a Major Find.

1.6 RESCUE EXCAVATION

Rescue Excavation refers to the removal of the material from the “design” excavation. This would apply if the amount or significance of the exposed material appears to be relatively circumscribed and it is feasible to remove it without compromising contextual data. The time span for Rescue Excavation should be reasonable rapid to avoid any undue delays, e.g. one to three days and definitely less than one week.

In principle, the strategy during the mitigation is to “rescue” the fossil material as quickly as possible. The strategy to be adopted depends on the nature of the occurrence, particularly the density of the fossils. The methods of collection would depend on the preservation or fragility of the fossil and whether in loose or in lithified sediment. These could include:

- On-site selection and sieving in the case of robust material in sand; and
- Fragile material in loose sediment would be encased in blocks using Plaster-of-Paris or reinforced mortar.

If the fossil occurrence is dense and is assessed to be a “Major Find”, a carefully controlled excavation is required.

1.7 MAJOR FINDS

A Major Find is the occurrence of material that, by virtue of quantity, importance and time constraints, cannot be feasibly rescued without compromise of detailed material recovery and contextual observations.

1.7.1 Management Options for Major Finds

In consultation with the developer / owner and the environmental consultant, the following options should be considered when deciding on how to proceed in the event of a Major Find.

Option 1: Avoidance

Avoidance of the Major Find through project redesign or relocation. This ensures minimal impact to the site and is the preferred option from a heritage resource management perspective. When feasible, it can also be the least expensive option from a construction perspective.

The find site will require site protection measures, such as erecting fencing or barricades. Alternatively, the exposed finds can be stabilised and the site refilled or capped. The latter is preferred if excavation of the find will be delayed substantially or indefinitely. Appropriate protection measures should be identified on a site-specific basis and in wider consultation with the heritage and scientific communities.

This option is preferred as it will allow the later excavation of the finds with due scientific care and diligence.

Option 2: Emergency Excavation

Emergency excavation refers to the “no option” situation where avoidance is not feasible due to design, financial and time constraints. It can delay construction and emergency excavation itself will take place under tight time constraints, with the potential for irrevocable compromise of scientific quality. It could involve the removal of a large, disturbed sample by an excavator and conveying this by truck from the immediate site to a suitable place for “stockpiling”. This material could then be processed later.
Consequently, the emergency excavation is not the preferred option for a Major Find.

1.8 EXPOSURE OF FOSSIL SHELL BEDS

1.8.1 Response be personnel in the event of intersection of fossil shell beds

The following responses should be undertaken by personnel in the event of intersection with fossil shell beds:

- Action 1: The site foreman and ECO must be informed;
- Action 2: The responsible field person (site foreman or ECO) must record the following information:
  - Position (excavation position)
  - Depth of find in hole;
  - Digitial image of hole showing vertical section (side); and
  - Digital image of fossiliferous material.
- Action 3: A generous quantity of the excavated material containing the fossils should be stockpiled near the site for later examination and sampling; and
- Action 4: The ECO is to inform the develop who must then contact the archaeologist and / or palaeontogist contracted to be on standby. The ECO is to describe the occurrence and provide images via email.

1.8.2 Response by the palaeontologist in the event of fossil shell bed finds

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established. This will most likely be a site visit to document and sample the exposure in detail, before it is covered up.

1.9 EXPOSURE OF FOSSIL WOOD AND PEATS

1.9.1 Response be personnel in the event of exposure of fossil wood and peats

The following responses should be undertaken by personnel in the event of exposure of fossil wood and peats:

- Action 1: The site foreman and ECO must be informed;
- Action 2: The responsible field person (site foreman or ECO) must record the following information:
  - Position (excavation position)
  - Depth of find in hole;
  - Digitial image of hole showing vertical section (side); and
  - Digital image of fossiliferous material.

- Action 3: A generous quantity of the excavated material containing the fossils should be stockpiled near the site for later examination and sampling; and

- Action 4: The ECO is to inform the develop who must then contact the archaeologist and / or palaeontogist contracted to be on standby. The ECO is to describe the occurrence and provide images via email.

1.9.2 Response by the palaeontologist in the event of exposure of fossil wood and peats

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established. This will most likely be a site visit to document and sample the exposure in detail, before it is covered up.

Volume III Annex C.5

Noise Impact Assessment Report

Version 5.0

May 2013

Document Ref.	Prepared By	Reviewed By	Date Submitted to Kangra Coal for Review
0120258_V5.0_NIA	Morné de Jager – M2 Environmental Connections	Dieter Rodewald	May 2013

CONTENTS

LIST OF ACRONYMS

Abbreviation	Full Definition
DEA	Department of Environmental Affairs
DEDET	Department of Economic Development, Environment and Tourism
DMR	Department of Minerals and Resources
DWA	Department of Water Affairs
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act
ENIA	Environmental Noise Impact Assessments
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessment
MPRDA	Mineral and Petroleum Resources Development Act
NEMA	National Environment Management Act
NEMWA	National Environmental Management Waste Act
NIA	Noise Impact Assessment
NWA	National Water Act

1 INTRODUCTION

1.1 TERMS OF REFERENCE

Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) were appointed by Kangra Coal (Pty) Ltd. (Kangra Coal) to undertake the function of independent Environmental Assessment Practitioner (EAP) and undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Kusipongo Resource Expansion Project (the proposed Project) and compile an associated Environmental and Social Management Plan. The ESIA is been undertaken as the proposed Project requires the following environmental authorisations/licenses:

- **Mining Rights** from the Regional (Mpumalanga) Department of Minerals and Resources (DMR) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA).

- **Environmental Authorisation** from the Regional (Mpumalanga) Department of Economic Development, Environment and Tourism (DEDET) in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA).

- **Waste License** from the National Department of Environmental Affairs (DEA) in terms of the National Environmental Management Waste Act (No. 59 of 2008) (NEMWA).

- **Water Use Licenses** from the National Department of Water Affairs (DWA) in terms of the National Water Act (No. 36 of 1998) (NWA).

M2 Environmental Connections (Menco) was contracted by ERM to undertake a Noise Impact Assessment for the proposed Project. The purpose of the investigation is to determine the potential noise impact on the surrounding environment due to the establishment of the proposed Project and to develop a Noise Impact Assessment (NIA) Report (this report).

1.2 PROJECT BACKGROUND

Kangra Coal is considering expanding their coal mining operations at the Savmore Colliery, located within the Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities (which form part of the Gert Sibane District Municipality) in Mpumalanga, which is approximately 51km west-south-west from Piet Retief and 64km south east from Ermelo (refer to *Figure 1-1*). This expansion is proposed to include the Kusipongo coal resource, situated to the west of existing operations. The proposed Project will be restricted to underground mining; however, surface infrastructure to support this underground expansion will include (*Figure 1-2*):

- **A Main Mine Adit (Adit A) –** entrance to the proposed underground mine which is inclined and through which people, equipment and coal will pass. The Adit A footprint will also include the following:

  - Emergency back-up generators installed in a generator building;
  - Mechanical and electrical workshops;
  - Ventilation fans and associated ducting (4x ventilation fans);
  - A wash bay;
  - Brake test ramp for mine vehicles;
  - A single silo for the storage of mined coal;
  - Primary and secondary screening and crushing positioned on conveyors plus a recycle conveyor belt, feeder breaker and recycle chute; and
  - An access road through to the Main Mine Adit.

- **A Ventilation Shaft (Adit B) –** an adit used solely for ventilation intake. Adit B will include only a ventilation opening. Access to the underground working via this ventilation opening will be restricted by the installation of a metal grid that will prevent access by humans and animals. Adit B will require approximately 500m^2. Fresh air drawn in through this Adit will be returned directly to the main exhaust fans at Adit A.

- **An Overland Conveyor System –** this system will be approximately 8.4km in length with a servitude width of 32m, and will be used to transport coal from the underground operations at the proposed Adit A to the existing Maquasa West Adit conveyor system. This in turn will transport mined coal to the existing wash plant facilities at the Savmore Colliery.

- **A Temporary Construction Camp –** to provide accommodation for semi-skilled and skilled workers and supervisory workers during the construction phase of the proposed Project, provisionally located 6km away (towards the east) from the proposed site for the Main Mine Adit A along the extension of the D2548. This will be decommissioned at the end of the construction phase.

Figure 1-1   Project Locality

Figure 1-2   Location of Mine Site Infrastructure

1.3 STUDY OBJECTIVES

The objectives of the NIA are to:

- Understand the existing environmental context from the perspective of noise, and provide a benchmark of pre-Project conditions to help predict proposed Project-induced changes and inform the impact predictions.

- Provide an analysis of the direct and indirect impacts to the physical environment that are expected to result from the construction, operation and decommissioning phases of the proposed Kusipongo Expansion Project.

1.4 STUDY CRITERIA

SANS 10328:2008 (Edition 3) specifies the methodology to assess the noise impacts on the environment associated with projects that have the potential to impact such. The standard also stipulates the minimum requirements to be investigated for any given environmental impact assessment. These minimum requirements include:

1. The purpose of the investigation;

2. A description of the planned development or the changes that are being considered;

3. A description of the existing development including, where relevant, the topography, surface conditions and meteorological conditions during measurements;

4. The identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, operating cycles, nature of sound emission, spectral composition and directional characteristics;

5. The identified noise sources that were not taken into account and the reasons why they were not investigated;

6. The identified noise-sensitive developments (receptors) and the noise impact on them;

7. Where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;

8. An explanation, either by description or by reference, of all calculation and measuring procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations;

9. An explanation, either by description or reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question;

10. The location of measuring or calculating points in a sketch or on a map;

11. Quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;

12. Alternatives that were considered and the results of those that were investigated;

13. Conclusions that were reached; and

14. Recommendations.

1.5 REPORT STRUCTURE

Chapter	Contents
Chapter 1 - Introduction	Project terms of reference, background and study objectives
Chapter 2 – Legal Framework	Describes the legislative, policy and administrative requirements, as well as international good practise and standards/guidelines applicable to the proposed Project
Chapter 3 – Why noise concerns communities	Discussing the sound and how unwanted sound can annoy communities
Chapter 4 – Impact Assessment Methodology	Description of the criteria used to determine the magnitude, extent, duration and significance of the noise impact
Chapter 5 – Receiving Environment	Provides ambient sound levels as measured in the pre-mining environment
Chapter 6 – Impact Assessment	Description of the modelling process, assumptions and noise levels as calculated
Chapter 7 – Cumulative Impacts and Mitigation	Describing potential cumulative impacts as well as potential mitigation measures that can be considered to reduce the noise impact
Chapter 8 – Conclusion	Summarises the key findings of the ENIA Study
Chapter 9 – References	List of bibliography referred too or consulted for this project

1.6 *About the Author*

The author of this report, M. de Jager (B. Ing (Chem), UP) graduated in 1998 from the University of Pretoria. He has been interested in acoustics since school days, doing projects mainly related to loudspeaker enclosure design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. As from 2007 he has been involved with the following projects:

- Full Noise Impact Studies for a number of Wind Energy Facilities, including: Great Fish River, Cookhouse Western, Bedford, Cookhouse II, Amakhala Emoyeni, Dassiesfontein/Klipheuwel, Rheboksfontein, AB, Dorper, Suurplaat, Gouda, Riverbank, Oyster Bay, Walker Bay, De Aar, Loeriesfontein, Noupoort, Prieska, Deep River, West Coast, Happy Valley, Canyon Springs, Tsitsikamma WEF, West Coast One, Karoo, Kleinsee, INCO Swellendam, Eskom Abedene, Hidden Valley, Koningaas, Spitskop, Zen, Garob, Kangnas, Loeriesfontein, Noupoort, Prieska, Velddrift and Saldanha.

- Full Noise Impact Studies for a number of mining projects, including: Skychrome (Pty) Ltd (A Ferro-chrome mine), Mooinooi Chrome Mine (WCM), Buffelsfontein East and West (WCM), Elandsdrift (Sylvania), Jagdlust Chrome Mine (ECM), Apollo Brick (Pty) Ltd (Clay mine and brick manufacturer), Arthur Taylor Expansion project (X-Strata Coal SA), Klipfontein Colliery (Coal mine), Sephaku Limestone Mine, Sekoko Railway Siding, Verkeerdepan Expansion, Tweefontein Colliery, Lesego Platinum, Schoongezicht Coal, WPB Colliery, Landau Expansion project (Coal mine), Goedehoop Colliery, Kromkrans Colliery, Welgelegen, BEFSA, Vametco, NATREF, Frankfort Power, Strahrae Colliery, Der Brochen Platinum, Imbabala Colliery.

- A number small projects including: noise measurement programmes, ambient sound baseline reports, project reviews, noise scoping reports and noise screening investigations.

2 *LEGAL FRAMEWORK AND GOOD PRACTICE STANDARDS*

This Section details the legal requirements that are relevant to the NIA.

2.1 *NATIONAL REGULATORY FRAMEWORK*

2.1.1 *Constitution of the Republic of South Africa (No. 108 of 1996)*

Summary of Constitution

The Constitution of the Republic of South Africa is the legal source for all law, including environmental law, in South Africa. The Bill of Rights is fundamental to the Constitution of the Republic of South Africa and in Section 24 states that:

Everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Applicability to Project

The residents of the immediate and surrounding area have the basic constitutional right to a protected environment that is not unnecessarily and/or irreparably damaged by any industrial or related development.

2.1.2 *National Environmental Management Act (Act No. 107 of 1998)*

Summary of Act

The National Environmental Management Act ("NEMA") creates the legal framework that ensures the environmental rights guaranteed in Section 24 of the Constitution are abided by.

As such the fundamental principles that apply to environmental decision making are laid out, the core environmental principle being the promotion of ecological sustainable development. These principles serve as a guideline for any organ of state when exercising any function in the process of decision making under NEMA.

NEMA introduces the duty of care concept which is based on the policy of strict liability. This duty of care extends to the prevention, control and rehabilitation of significant pollution and environmental degradation. It also dictates a duty of care to address emergency incidents of pollution. A failure to perform this duty of care may lead to criminal prosecution, and may lead to the incarceration of managers or directors of companies for the conduct of the legal persons.

Applicability to Project

Any mining-related or other industrial development has the potential to impact on the receiving physical (including noise), biophysical and social environments. As such potential impacts need to be thoroughly and competently assessed prior to execution of the proposed Project.

2.1.3 Environmental Conservation Act (Act No. 73 of 1989)

Summary of Act

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism (now the "Ministry of Water and Environmental Affairs") to make environmental regulations; including regulations associated with noise (refer to *Section 0* below).

Applicability to Project

The current Noise Control Regulations was promulgated in terms of this Act. Kangra Coal will need to ensure that all activities associated with the construction, operational and decommissioning and closure phases are in compliance with the regulations.

2.1.4 National Environmental Management: Air Quality Act (Act No. 39 of 2004)

Summary of Act

Section 34 of the National Environmental Management: Air Quality Act (Act No. 39 of 2004) makes provision for:

1. The Minister to prescribe essential national noise standards –
   a. For the control of noise, either in general or by specified machinery or activities or in specified places or areas; or
   b. For determining –
      i. A definition of noise; and
      ii. The maximum levels of noise
2. When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

Applicability to Project

This section of the Act is in force, but no such standards have yet been promulgated. Draft regulations have been promulgated for adoption by Local Authorities. In addition, an atmospheric emission licence can be issued in terms of Section 22 of the Act which may contain conditions in respect of noise. This will however not be relevant to the facility as it is unlikely that the process would include a listed activity requiring an Atmospheric Emission Licence.

2.1.5 *Model Air Quality Management By-laws for Adoption and Adaption by Municipalities*

Summary of Regulation

Model Air Quality Management By-Laws for adoption and adaptation by municipalities was published by the Department of Water and Environmental Affairs in the Government Gazette of 2 July 2010 as Government Notice 579 of 2010.

The main aim of the model air quality management by-laws is to assist municipalities in the development of their air quality management by-law (which will include noise limits) within their jurisdictions. It is also the aim of the model by-law to ensure uniformity across the country when dealing with air quality management challenges. Therefore, the model by-law is developed to be generic in order to deal with most of the air quality management challenges.

- **IT IS NOT** the aim of the model by-law to have legal force and effect on municipalities when published in the Gazette; and
- **IT IS NOT** the aim of the model by-law to impose the by-law on municipalities.

Therefore, a municipality will have to follow the legal process set out in the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000) when adopting and adapting the model by-law to its local jurisdictions.

Applicability to Project

If either the Gert Sibane District Municipality or Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities adopt these regulations and develop by-laws dealing with air quality management, the proposed Kusipongo resource expansion Project will need to comply with these.

2.1.6 *Noise Control Regulation*

Summary of Regulation

In terms of Section 25 of the ECA (refer to *Section 2.1.3* above), the national noise-control regulations (GN.R154 in Government Gazette No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996, legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Western Cape and Gauteng provinces, but the Mpumalanga province has not yet adopted provincial regulations in this regard.

Applicability to Project

These regulations provide definitions of important concepts regarding noise, as well as when noise impact assessments are required.

2.2 *NATIONAL GUIDELINES AND STANDARDS*

Four South African Bureau of Standards (SABS) scientific standards are considered relevant to noise from any given mining activity. They are:

- **SANS 10103:2008.** 'The measurement and rating of environmental noise with respect to annoyance and to speech communication' – covers methods and gives guidelines to assess working and living environments with respect to acoustic comfort, excellence, and with respect to possible annoyance by noise (i.e. whether complaints can be expected). It also gives a method to predict speech communication efficiency.

- **SANS 10210:2004.** 'Calculating and predicting road traffic noise' – Noise Emissions from road traffic will be calculated using this method.

- **SANS 10328:2008.** 'Methods for environmental noise impact assessments (ENIAs)' – this document provides a guideline and sets the terms of reference on how NIAs should be conducted in South Africa.

- **SANS 10357:2004.** 'The calculation of sound propagation by the Concave method' – Noise Emissions from industrial and mining activities will be calculated using this method.

2.3 *KANGRA COAL POLICIES*

Kangra Coal is committed to responsible environmental stewardship and sustainable business practices; Kangra Coal pledges to improve their overall environmental performance across all their business activities. Kangra Coal encourages their business partners and members of the entire Kangra group to participate in this endeavour.

In accordance with this Environmental Policy (ENV-P-001), Kangra Coal strives for compliance with all environmental laws and commits to manage all of its activities in the environment. Of applicability to this study, Kangra Coal pledges to:

- Adopt the highest environmental standards in all areas of its operations, meeting and exceeding all relevant legislative requirements to which Kangra subscribes to.

- Regularly evaluating the existing and potential impact of its operations (including those relating to work undertaken by all staff) on the environment.

- Continuously improving on the overall company's environmental performance.

- Continuously conducting research to increase the knowledge on the environmental effects of Kangra Coal's relative activities and development or adoption of appropriate processes, technologies and equipment to meet anticipated environmental needs.

3 WHY NOISE CONCERNS COMMUNITIES

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping); and
- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. For example – the driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Noise also does not need to be loud to be considered "disturbing". For example – one can become irate by the soft sound of a dripping tap, or the irritating "thump" of the neighbours music at night when one is trying to sleep.

Severity of the annoyance depends on factors such as:

- Background sound levels, and the background sound levels the receptor is used to;
- The manner in which the receptor can control the noise (helplessness);
- The time, unpredictability, frequency distribution, duration, and intensity of the noise;
- The physiological state of the receptor; and
- The attitude of the receptor about the emitter (noise source).

3.1 NOISE CRITERIA OF CONCERN

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Regulations, published by the Department of Environmental Affairs (April 1998) in terms of the NEMA, SANS 10103 as well as guidelines from the World Health Organization.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- **Increase in Noise Levels:** People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than ***7 dBA*** is considered a disturbing noise. This is also the criteria promoted to define the potential on potentially sensitive receptors (refer to *Figure 3-1* below).

- **Zone Sound Levels:** Also referred to as the acceptable rating levels, which set acceptable noise levels for various areas (refer to *Table 3.1* below).

- **Absolute or Total Noise Levels:** Depending on their activities, people are generally tolerant to noise up to a certain absolute level, e.g. ***65 dBA***. Anything above this level will be considered unacceptable.

Figure 3-1 *Criteria to Assess the Significance of Impacts Stemming from Noise*

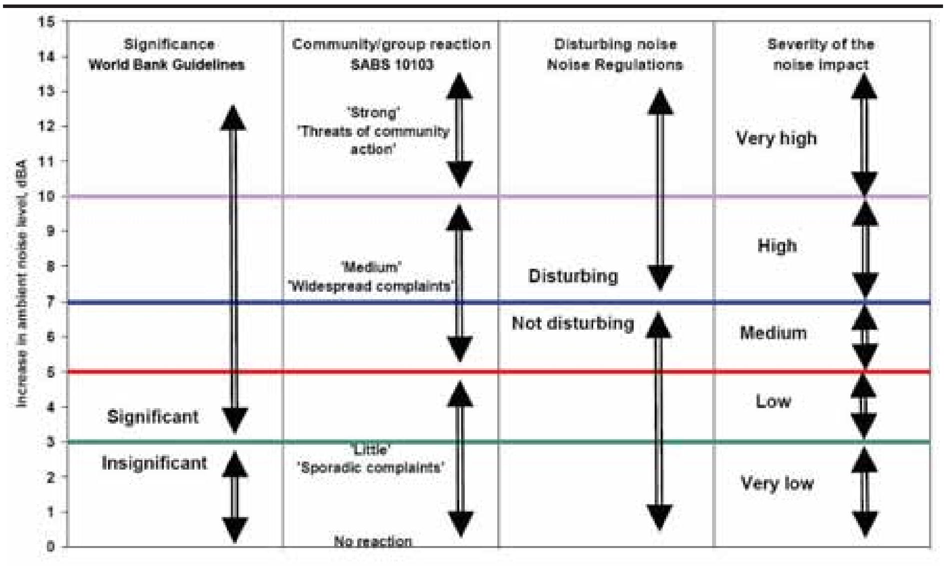


Table 3.1 *Acceptable Zone Sound Levels for Noise in Districts (SANS 10103)*

Type of District	Equivalent continuous rating level ($L_{req.T}$) for noise dBA					
	Outdoors			Indoors, with open windows		
	Day/night $L_{R,dn}{}^{a}$	Daytime $L_{Req.d}{}^{b}$	Night-time $L_{Req.n}{}^{b}$	Day/night $L_{R,dn}{}^{a}$	Daytime $L_{Req.d}{}^{b}$	Night-time $L_{Req.n}{}^{b}$
Rural districts	45	45	35	35	35	25
Suburban districts with little road traffic	50	50	40	40	40	40
Urban districts	55	55	45	45	45	35
Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
Central business districts	65	65	55	55	55	45
Industrial districts	70	70	60	60	60	50

In South Africa the document that addresses issues concerning environmental noise is SANS 10103 (*Table 3.1* above). SANS provides the maximum average background ambient sound levels, $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed. Based on onsite measurements, the ambient sound levels on and around the proposed Project Site correspond to the rating levels for a rural area. As such, the acceptable Zone Sound Levels used include:

- **Day** (06:00 to 22:00) - $L_{Req,d}$ = *45 dBA*.
- **Night** (22:00 to 06:00) - $L_{Req,n}$ = *35 dBA*.

SANS 10103 also provides a guideline for estimating community response to an increase in the general ambient sound level caused by an intruding noise. If **Δ** is the increase in noise level, the following criteria are of relevance:

- **Δ ≤ 3 dBA**: An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity, an increase of less than 3 dBA in the general ambient noise level would not be noticeable.

- **3 < Δ ≤ 5 dBA**: An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.

- **5 < Δ ≤ 15 dBA**: An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

4 IMPACT ASSESSMENT METHODOLOGY

The impact assessment stage comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors. The steps involved in the impact assessment stage are described in greater detail below.

4.1 IMPACT ASSESSMENT

The impact characteristic terminology to be used is summarised in *Table 4.1*.

Table 4.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value]

In the case of type, the designations are defined universally (i.e., the same definitions apply to all resources/receptors and associated impacts). For these universally-defined designations, the definitions are provided in *Table 4.2*.

Table 4.2 Designation Definitions

Designation	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
Extent	

Designation	Definition
Local	Defined on a resource/receptor-specific basis.
Regional	
International	
Duration	
Temporary	Defined on a resource/receptor-specific basis.
Short-term	
Long-term	
Permanent	

In the case of *extent* and *duration*, the designations themselves (shown in *Table 4.1*) are universally consistent, but the definitions for these designations will vary on a resource/receptor basis (e.g., the definition of what constitutes a "short term" duration for a noise-related impact may differ from that of a "short term" duration for a habitat-related impact). This concept is discussed further below.

In the case of *scale* and *frequency*, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of acres affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

An additional characteristic that pertains only to unplanned events (e.g., traffic accident, operational release of toxic gas, community riot, etc.) is *likelihood*. The likelihood of an unplanned event occurring is designated using a qualitative (or semi-quantitative, where appropriate data are available) scale, as described in *Table 4.3*.

Table 4.3 Definitions for Likelihood Designations

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource/receptor sensitivity/vulnerability/importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (e.g., modelling, frequency charts) where available.

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. As in the case of extent and duration, the magnitude designations themselves (i.e., negligible, small, medium, large) are universally used and across resources/receptors, but the definitions for these designations will vary on a resource/receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

In the case of this NIA, small, medium and large magnitudes have the following designations:

- **Small** – a change in ambient noise levels that is **less than 5 dBA**;
- **Medium** – a change in ambient noise levels that is between 5 and 10 dBA of the selected rating level; and

- **Large** – a change in ambient noise levels that is more than 10dBA of the selected rating.

Furthermore, sound levels (dBA) are based on a logarithmic scale and cannot be simply added or subtracted from one another. Instead the following logarithmic equation is used:

$$L_{\Sigma} = 10 \cdot \log_{10}\left(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} + \cdots + 10^{\frac{L_n}{10}}\right) \text{ dB}$$

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *negligible* magnitude. In the case of positive impacts no magnitude will be assigned.

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource/receptor is biological or cultural (for example, the marine environment or a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact.

Impact significance is designated using the matrix shown in *Table 4.4*.

Table 4.4 *Impact Significances*

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box 4.1* provides a context for what the various impact significance ratings signify.

Box 4.1 *Context of Impact Significances*

An impact of ***negligible*** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of ***minor*** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of ***major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

4.2 *MITIGATION OF IMPACTS*

Once the significance of a given impact has been characterised using the above matrix, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any impact assessment is to help our clients develop a consentable Project, and to help them achieve their business objectives in a responsible manner. Impact assessment is about identifying the aspects of a Project that need to be managed, and demonstrating how these have been appropriately dealt with and left a good quality and appropriate development. As key influencers in the decision making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an ALARP level.

Embedded controls (i.e., physical or procedural controls that are planned as part of the Project design and are not added in response to an impact significance assignment), are considered as part of the Project (prior to entering the impact assessment stage of the impact assessment process).

4.3 RESIDUAL IMPACT

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

4.4 CUMULATIVE IMPACTS/EFFECTS

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process should predict any cumulative impacts/effects to which the Project may contribute. The approach for assessing cumulative impacts and effects resulting from the Project and another activity affecting the same resource/receptor is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

5 *RECEIVING ENVIRONMENT*

This description of the baseline environment is essential in that it represents the conditions of the environment before the construction of the proposed Kusipongo Resource Expansion Project. The description of the baseline environment therefore provides a description of the current environment against which the impact of the proposed Project can be assessed and future changes monitored.

The information presented in this Section has been collected from desktop studies and supplemented with site visits to the Study Area.

5.1 *STUDY AREA*

A site locality map is presented in *Figure 1-2* on *Page 1-4*. The environmental components that may contribute or change the sound character of the Study Area are described in detail in this section.

5.1.1 *Wind Field*

Wind plays a significant role in an area where wind speeds exceed 3 m/s. The site visit highlighted that this site could experience significant winds which will increase ambient sound levels. Since no on-site meteorological data are available, hourly average meteorological data from the South African Weather Service (SAWS) station in Piet Retief for the period 2002 to 2005 was analysed. This station is located approximately 40 km east of the proposed Project Site. The prevailing winds are presented in the form of wind roses (1) in *Figure 5-1*.

(1) Wind roses comprise 16 spokes which represent the directions from which winds blew during the given period. The colours reflect the different categories of wind speeds, the grey area, for example, representing winds of 1 to 3 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. For the current wind roses, each dotted circle represents 4% and 3% frequency of occurrence. The figure given in the centre of the circle described the frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s.

Figure 5-1 Wind Roses for the Period 2002 to 2005 Recorded at Piet Retief

Source: South African Weather Service

5.1.2 *Surrounding Land-use*

The land use in the Study Area of proposed Project is mainly agriculture and rural residential.

Roads

The road proposed to access the Main Mine Adit (Adit A) will be along the existing extension of the D2548 in the direction of Amersfoort and Volksrust. The intended use will be for commercial purposes (i.e. not for the transportation of coal). During the site visit the traffic consisted of light delivery vehicles and taxis at a rate of ±20 per hour (day-time).

Other Industrial Activities

There are no industrial areas or significant noise sources in the immediate vicinity of the proposed Adit A or B. However, Kangra Coal operates the Maquasa West coal mine (± 7km to the east) as well as the Maquasa coal beneficiation plant (± 12km) to the east of the proposed Project Site (*Figure 1-2*). These facilities are too far from the proposed Adits to result in a cumulative noise impact or influence the ambient sound levels at the proposed Project Site.

5.1.3 *Ground Conditions and Vegetation*

The terrain in the Study Area is uneven and mountainous, with significant vegetation (mainly grasses) covering the surface area. There are a number of small commercial forestry plantations that are scattered throughout the Study Area; however, these plantations will not influence ground conditions in terms of sound propagation. It may influence ambient sound levels at areas in close vicinity to these plantations.

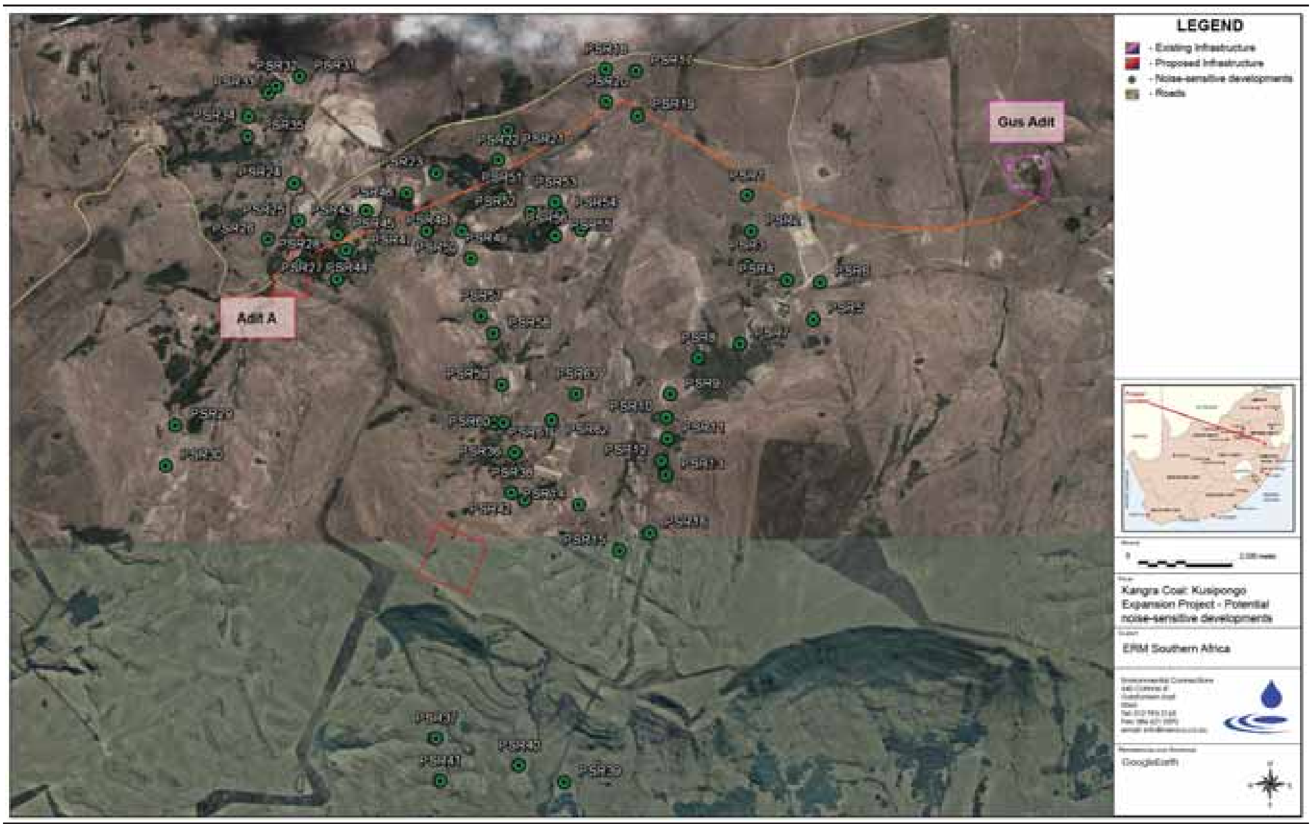
5.2 *POTENTIAL NOISE SENSITIVE RECEPTORS*

Potential noise-sensitive receptors were initially identified using GoogleEarth®; however, their presence was supported by a site visit to confirm the status of the identified dwellings on 11 and 12 November 2011 [(1)]. Potential receptors are illustrated in *Figure 5-2* overleaf.

The reason for the site visit, apart from measuring ambient sound levels, was to ensure that noise sensitive locations identified on GoogleEarth® were not derelict or abandoned dwellings; and small dwellings that could not be identified on GoogleEarth® were identified.

(1) It should be noted that residence of existing dwellings and the establishment of new dwellings may have changed/taken place from the time the site visit took place in November 2011.

Figure 5-2 Potential Noise Sensitive Receptors in the Study Area as identified by author



5.3 AMBIENT SOUND BASELINE

Day and night time noise measurements were collected on 11 November 2010. The sound measuring equipment was calibrated directly before, and directly after each measurement was taken.

The equipment defined in *Table 5.1* was used for gathering data:

Table 5.1 Equipment Used to Measure Baseline Noise Levels

Equipment	Model	Serial no	Calibration
SLM	Rion NL-32	01182945	17 June 2010
Microphone	Rion UC-53A	315479	17 June 2010
Preamplifier	Rion NH-21	28879	17 June 2010
Calibrator	Rion NC-74	34494286	13 February 2011
Wind meter	Kestrel 4000	587391	Calibrated[1]

Please Note - Microphone fitted with the WS-10 windshield.

The locations used to measure ambient (background) sound levels are presented in *Figure 5-3* overleaf and *Table 5.3*. These points are considered sufficient to determine the ambient (background) sound levels in the Study Area. The results are presented in *Table 5.2*.

[1] Factory Calibrated

Figure 5-3 Baseline Noise Measuring Locations

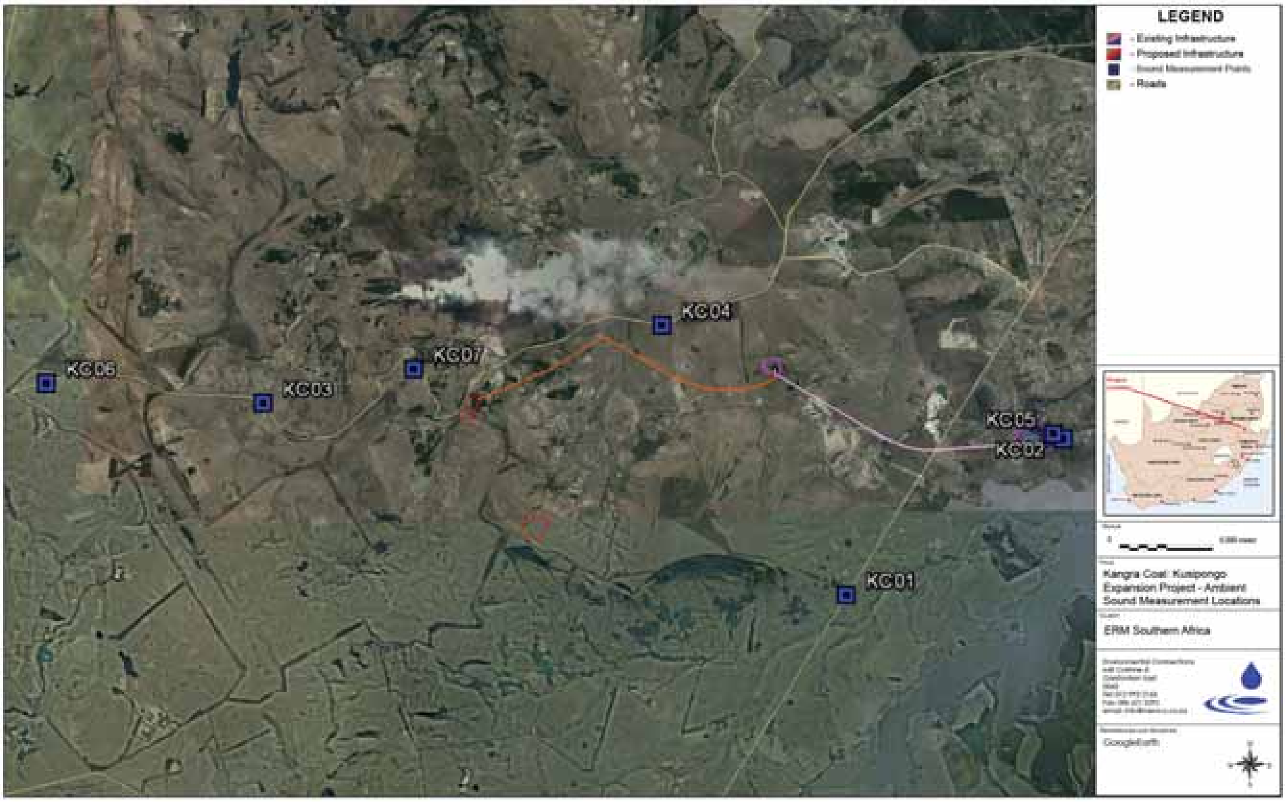


Table 5.2 Results of Baseline Noise Measurements

Point name	$LA_{eq,T}$ (dBA)	LA_{90} (dBA)	$LA_{,max}$ (dBA)	$LA_{,min}$ (dBA)
KC01 Daytime	36.9	27.7	51.0	24.9
KC01 Night-time	38.2	30.1	55.7	28.3
KC02 Daytime	55.4	53.7	66.4	51.8
KC02 Night-time	52.7	49.9	30.4	48.2
KC03 Daytime	59.9	50.5	70.0	40.1
KC03 Night-time	29.3	24.8	54.7	23.1
KC04 Night-time	26.2	23.2	43.5	21.4
KC05 Night-time	55.7	53.4	60.6	51.3
KC06 Daytime	55.4	44.4	67.9	37.6
KC07 Daytime	45.7	41.8	53.5	37.4

LAeq,T – Equivalent continuous sound pressure level with 'A' frequency weighting - The value of the sound pressure level of a continuous steady noise that, a measurement interval of time (t), has the same mean square sound pressure as the sound under consideration whose level varies with time.

LA_{90} – The percentile sound pressure level exceeded for 90% of the measurement period with 'A' frequency weighting calculated by statistical analysis.

Table 5.3 Baseline Conditions when Baseline Noise Measurements were taken

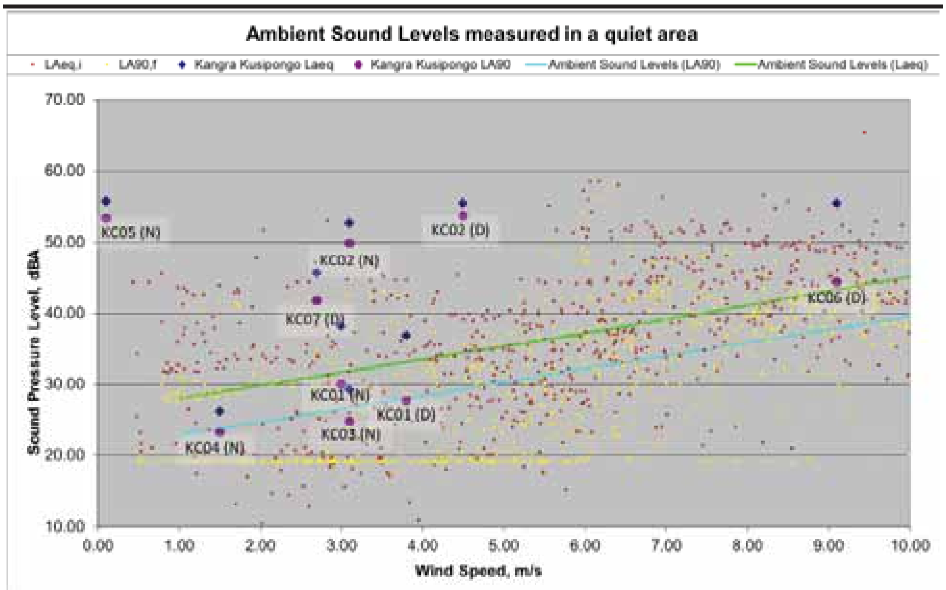
Point name	Co-ordinates	Wind speed Ave. (m/s)	Temp (°C)	Humidity (%)
KC01 Daytime	27° 3'18.94"S 30°22'21.40"E	3.8	26.5	34.1
KC01 Night-time	27° 3'18.94"S 30°22'21.40"E	3.0	20.0	67.0
KC02 Daytime	27° 1'23.52"S 30°25'20.89"E	4.5	26.6	34.1
KC02 Night-time	27° 1'23.52"S 30°25'20.89"E	3.1	16.5	87.8
KC03 Daytime	27° 0'57.23"S 30°14'18.62"E	10.1	26.4	24.4
KC03 Night-time	27° 0'57.23"S 30°14'18.62"E	3.1	15.7	87.0
KC04 Night-time	26°59'59.69"S 30°19'48.67"E	1.5	16.6	84.0
KC05 Night-time	27° 1'19.67"S 30°25'12.83"E	0.1	17.2	84.5
KC06 Daytime	27° 0'42.30"S 30°11'19.18"E	9.1	26.5	28.4
KC07 Daytime	27° 0'31.97"S 30°16'23.23"E	2.7	26.8	24.2

From the data obtained, it can be seen that the ambient daytime sound levels ranges between 27.7 and 50.5 dBA ($LA_{,90}$) and 24.9 and 40.1 dBA ($LA_{,min}$) for measurement locations away from existing mining activities (KC01; KC03; KC06 and KC07). Location KC02 is situated in close proximity to existing mining activities and has an ambient daytime sound level of 53.7 dBA ($LA_{,90}$) and 51.8 dBA ($LA_{,min}$) (*Table 5.2*). Unfortunately wind induced noises dominated the soundscape. There are no correction factors that can allow the elimination of wind induced noises.

Average ambient night-time sound levels ($LA_{,90}$) ranged between 23.2 and 30.1 dBA ($LA_{,90}$) and 21.4 and 28.3 dBA ($LA_{,min}$) away from existing mining activities (KC01; KC03 and KC04). Locations in proximity to existing mining activities ranged between 49.9 and 53.4 dBA ($LA_{,90}$) and 48.2 and 51.3 dBA ($LA_{,min}$). Being the period when a quieter environment is more desired, the night-time ambient sound character is generally of higher importance.

Figure 5-4 below illustrates night-time ambient sound level data as measured at a very quiet area with a sound character considered similar to the Study Area. Measurements closer to existing mining/industrial activities illustrate higher ambient sound levels, with the low difference between the LA_{eq} and LA_{90} for KC02 and KC05, indicating a constant noise source from existing Kangra Coal mining activities that dominated the soundscape of this given area.

Figure 5-4 ***Ambient Sound Levels for a Quiet Environment Similar in Sound Character to that of the Study Area***



6 IMPACT ASSESSMENT

The predicted impacts to the Noise Environment of the Study Area as a result of the proposed Kusipongo Resource Expansion Project are described in this Section.

6.1 IMPACTS ON THE NOISE ENVIRONMENT DURING THE CONSTRUCTION PHASE

6.1.1 Description of the Baseline Environment

Baseline sound measurements showed that the Study Area is relatively quiet during both the day and night-time periods with low ambient sound levels; however, sound levels increased in closer proximity to existing mining operations. The soundscape in the Project Site can be defined as natural; with faunal, amphibian, insect and wind-induced sounds dominating the sound character.

Because noise levels closer to receptors are generally higher (due to typical household activities generating sound, e.g. listening to the TV/Radio, conversation, cleaning, working, preparing food, etc.) a ambient sound level of *42 dBA* will be assumed at receptor locations. This sound level will be used to estimate how the introduced noises will increase the ambient sound levels.

6.1.2 Proposed Project Activities

It is assumed that construction will occur only during the daytime period and will likely include the following activities:

- Vegetation removal;
- Topsoil removal and the development of infrastructure footprints;
- Site establishment;
- Construction of access roads;
- Developments of the foundations for the conveyor belt system;
- The removal of soft (using excavator) and hard material (drill and blast to remove very hard material) during the development of the adits; and
- The establishment of infrastructure.

Equipment Likely to be used during the Construction Phase of the Proposed Project

At this stage of the Project, it is unknown as to the type of equipment that will be used for during the construction phase; however, it is assumed that equipment such as graders, bulldozers, excavators, articulated dump trucks, tip-load-buckets, long-haul delivery trucks, drilling machinery, compressors and diesel generators as well as front-end loaders will be used during the construction phase of the proposed Project.

During the construction phase, noise impacts are related to machinery noise emissions and impulsive noises (tipping of material, hammering, piling and blasting activities). Construction noise sources are generally intermittent and impacts depend on the number and types of equipment used for each activity, the duration of the various activities, the locations where the activities can take place, etc. As such, the potential noise impact has been based on a simplistic model that considers distance from the activity.

Maximum noises generated ($LA_{, max}$) during the construction phase can be audible over a large distance; however, these activities and associated noise emissions are generally of very a short duration. If maximum noise levels exceed 65 dBA at a receptor, or if it is clearly audible with a significant number of instances where the noise level exceeds the prevailing ambient sound level with more than 15 dB, the noise will increase annoyance levels and may ultimately result in noise complaints. Potential maximum noise levels generated by various construction equipment, as well as the potential extent of these sounds, are presented in *Appendix A* (*Table 9.1*). Maximum noise events are currently not regulated.

Average or equivalent sound levels (LA_{eq}) is another factor that impacts on the ambient sound levels, and is typically the constant sound level that any given receptor experiences. Typical sound power levels associated with various activities that may be found at a construction site are also presented *Appendix A* (*Table 9.2*). Equivalent noise levels are regulated by the National Noise Control Regulations. For a rural area as found at this location the SANS 10103:2008 rating level would be 45 dBA.

For the purpose of this NIA the SANS 10103:2008 daytime rating level of 45 dBA will therefore be used.

Using *Table 9.1* and *Table 9.2* in *Appendix A*, it is possible to see that operating a large machine such as a CAT 700 Load Haul Dumper within 1 000m from a receptor during the day would raise the ambient sound levels to a level above the SANS 10103:2008 rating level at the receptor during the period the machine is operational. The closer the activity is to any given receptor, the higher the risk of a noise complaint being registered.

Other noises associated with the construction phase would relate to increased traffic leading to and from the construction area. For the purpose of this NIA, it was assumed that traffic would comprise of 20 vehicles [(1)] (10 heavy and 10 light delivery vehicles) travelling at 60km/h. The assessment however indicated that LA_{eq} levels would be less than 45 dBA within a distance of 50m from the road. As such, noise from construction traffic is considered a low concern.

[1] Worst-case scenario

6.1.3 *Sensitive Receptors*

For the purpose of model simulation for this NIA, a number of Hitachi EX1200 Excavators [(1)] were assumed at locations where construction activities were likely to take place, including along the route of the proposed conveyor belt. The projected noise level was calculated in terms of $LA_{eq,1hr}$ level (the equivalent noise level that the receptor will experience over an hour with the machine operating at full load), with the calculated potential noise levels presented in *Table 6.1*.

Table 6.1 ***Potential Daytime Noise Levels and Magnitude of the Construction Noise Impact***

Receptor	Co-ordinates (Lat/Lon Deg. Min. Sec WGS84)	Projected Day Noise Level	Change from Ambient sound level (taken as 42 dBA)	Distance from closest (potential) activity (m)	Magnitude
PSR01	27 0'37.76"S, 30 19'42.99"E	59.0	14.1	168	High
PSR02	27 0'48.80"S, 30 19'44.38"E	46.6	3.9	452	Low
PSR03	27 0'59.27"S, 30 19'43.00"E	39.8	1.1	747	Low
PSR04	27 1'3.84"S, 30 19'56.82"E	39.2	1.0	767	Low
PSR05	27 1'15.64"S, 30 20'5.92"E	34.6	0.4	988	Low
PSR06	27 1'4.34"S, 30 20'8.13"E	40.0	1.2	636	Low
PSR07	27 1'23.17"S, 30 19'40.74"E	32.0	0.2	1462	Low
PSR08	27 1'27.46"S, 30 19'26.47"E	31.0	0.2	1727	Low
PSR09	27 1'38.68"S, 30 19'16.92"E	29.9	0.1	2156	Low
PSR10	27 1'45.83"S, 30 19'15.55"E	29.5	0.1	2156	Low
PSR11	27 1'52.22"S, 30 19'15.97"E	29.1	0.1	2061	Low
PSR12	27 1'59.02"S, 30 19'13.91"E	29.1	0.1	1914	Low
PSR13	27 2'3.35"S, 30 19'15.48"E	28.8	0.1	1901	Low
PSR14	27 2'12.66"S, 30 18'45.60"E	34.8	0.4	1030	Low
PSR15	27 2'26.46"S, 30 18'59.63"E	31.5	0.2	1339	Low
PSR16	27 2'21.02"S, 30 19'10.05"E	29.4	0.1	1632	Low
PSR17	26 59'59.93"S, 30 19'4.73"E	52.2	8.0	307	Medium
PSR18	26 59'59.39"S, 30 18'54.36"E	51.6	7.4	325	Medium
PSR19	27 0'13.48"S, 30 19'5.33"E	72.0	27.0	45	High
PSR20	27 0'9.33"S, 30 18'54.56"E	69.4	24.5	60	High
PSR21	27 0'17.97"S, 30 18'20.83"E	51.0	6.9	319	Medium
PSR22	27 0'27.08"S, 30 18'17.54"E	63.0	18.1	129	High
PSR23	27 0'31.17"S, 30 17'56.38"E	52.7	8.4	265	Medium
PSR24	27 0'34.47"S, 30 17'7.59"E	46.2	3.7	660	Low
PSR25	27 0'46.01"S, 30 17'9.17"E	55.7	11.0	305	High
PSR26	27 0'51.77"S, 30 16'58.62"E	54.6	10.1	321	High
PSR27	27 1'3.88"S, 30 17'22.40"E	57.1	12.4	290	High
PSR28	27 0'59.33"S, 30 17'9.18"E	72.1	27.2	103	High
PSR29	27 1'48.63"S, 30 16'27.07"E	32.6	0.2	1709	Low
PSR30	27 2'1.08"S, 30 16'23.85"E	30.2	0.1	2070	Low
PSR31	27 0'1.93"S, 30 17'9.31"E	35.0	0.4	1594	Low
PSR32	27 0'4.83"S, 30 17'1.39"E	35.1	0.4	1586	Low
PSR33	27 0'7.07"S, 30 16'58.72"E	35.5	0.5	1532	Low
PSR34	27 0'13.99"S, 30 16'51.89"E	36.5	0.6	1378	Low
PSR35	27 0'20.15"S, 30 16'51.58"E	38.1	0.8	1205	Low
PSR36	27 1'56.63"S, 30 18'23.53"E	36.9	0.6	951	Low
PSR37	27 3'24.09"S, 30 17'56.94"E	28.4	0.1	1746	Low
PSR38	27 2'9.01"S, 30 18'22.52"E	42.4	1.9	596	Low
PSR39	27 3'37.33"S, 30 18'40.91"E	25.3	0.0	2356	Low

[1] The excavator was used as the noise source as it produces a louder equivalent noise than most other equipment

PSR40	27 3'32.28"S, 30 18'25.34"E	26.6	0.1	2061	Low
PSR41	27 3'37.08"S, 30 17'58.37"E	26.1	0.1	2140	Low
PSR42	27 2'11.20"S, 30 18'27.16"E	41.3	1.5	623	Low
PSR43	27 0'42.91"S, 30 17'32.34"E	58.0	13.2	184	High
PSR44	27 0'54.90"S, 30 17'25.50"E	65.2	20.2	89	High
PSR45	27 0'50.28"S, 30 17'22.60"E	67.1	22.1	74	High
PSR46	27 0'37.47"S, 30 17'46.23"E	57.1	12.4	193	High
PSR47	27 0'49.08"S, 30 17'53.15"E	55.9	11.2	214	High
PSR48	27 0'49.04"S, 30 18'5.17"E	50.4	6.5	336	Medium
PSR49	27 0'54.58"S, 30 18'1.29"E	47.3	4.3	477	Low
PSR50	27 0'57.45"S, 30 18'8.24"E	44.1	2.6	608	Low
PSR51	27 0'38.64"S, 30 18'18.97"E	58.2	13.4	197	High
PSR52	27 0'43.20"S, 30 18'28.65"E	48.2	4.9	455	Low
PSR53	27 0'39.98"S, 30 18'37.19"E	46.2	3.6	498	Low
PSR54	27 0'43.48"S, 30 18'38.86"E	43.9	2.5	612	Low
PSR55	27 0'50.42"S, 30 18'37.27"E	41.7	1.7	775	Low
PSR56	27 0'48.48"S, 30 18'46.12"E	40.2	1.2	856	Low
PSR57	27 1'14.99"S, 30 18'11.79"E	38.2	0.8	1151	Low
PSR58	27 1'20.19"S, 30 18'16.12"E	36.7	0.6	1340	Low
PSR59	27 1'35.99"S, 30 18'19.05"E	34.7	0.4	1514	Low
PSR60	27 1'47.48"S, 30 18'19.77"E	35.3	0.4	1191	Low
PSR61	27 1'47.67"S, 30 18'16.34"E	35.7	0.5	1150	Low
PSR62	27 1'46.75"S, 30 18'36.21"E	33.4	0.3	1378	Low
PSR63	27 1'38.78"S, 30 18'44.6"E	32.3	0.2	1708	Low

6.1.4 *Significance of Impact (Pre-mitigation)*

Based on the analysis provided above, it is the opinion that noise related impacts from construction activities associated with the proposed Project will be a "**Major Negative Impact**" (pre-mitigation) for potential noise sensitive receptors identified as having a high magnitude in *Table 6.1* (refer to *Table 6.2* below).

Table 6.2 Rating of Impacts Related to Noise Emissions during the Construction Phase of the Proposed Project (Pre-mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact would be limited to the local area up to approximately 1km from source.
Duration	Short-term	Activities will take place during the day-time hours and will continue for 18 to 21 months.
Scale	Large	Construction activities are likely to influence the baseline ambient sound levels over an area of more than 1km from source. The magnitude of the noise levels is likely to be in excess of 55 dBA for receptors living in a distance of 300m from where construction activities will take place.
Frequency	Daily	The activities generating noise are anticipated to take place daily during daylight hours.
Likelihood	Definite	Because of the very low ambient sound levels in the Project Area, it is definite that the receptors will be aware of the increased noise levels. The proximity of existing receptors means that noise levels during construction will be in excess of 55 dBA for a number of communities.
Magnitude		
Large Magnitude		
Construction activities without mitigation will result in noise levels up to 72 dBA at the closest receptors (refer *Table 6.1*)		

Sensitivity/Vulnerability/Importance of the Resource/Receptor
High Sensitivity
Local communities affected would comprise of a number of individuals ranging from babies, teens, adults and the elderly. It has been proven that very young children and the elderly are generally more susceptible to increased noises, especially if these noises contain an impulsive component, frequently associated with construction activities (such as hammer blows).
Significant Rating Before Mitigation
Major Negative Impact

6.1.5 Recommendations and Mitigation/Management Measures

It is recommended that Kangra Coal consider the following mitigation/management measures so as to reduce the significance of the impact:

- When working within a distance of 500m [1] of potential noise-sensitive receptors, the number of simultaneous noise emitting activities must be minimised, thus reducing the impacts associated with cumulative noise emissions [2].

- Ensure a good working relationship between mine management and all potentially noise-sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them. Information that should be provided to potentially sensitive receptor(s) includes:

  - Proposed working dates, the duration that Kangra Coal will be working in the area and working times;
  - The reason why the activity is taking place;
  - The construction methods that will be used; and
  - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.

- When simultaneous noise emitting activities are to take place close to potential noise-sensitive receptors, co-ordinate the working time with periods when the receptors are not at home. An example would be to work within the 8 am to 2 pm time-slot, as:

  - Potential noise-sensitive receptors are most likely to be at school or work; and
  - Normal daily household activities (cleaning, listening to TV/Radio, etc.) will generate other noises that would most likely mask

[1] Studies have shown that noise measurements taken from construction activities indicated that noise levels are generally less than 50 dBA at distances in excess of 500m from where activities are been undertaken. Also refer to *Annex A*.

[2] Noise levels cumulatively increase as the number of noise sources increases. A conceptual machine may emit 50 dBA at 100m, but the addition of the same machine will increase the noise emissions with 3 dBA (to 53 dBA – logarithmic addition). The more equipment operating simultaneously the higher the resulting sound pressure levels (acoustic energy) and the higher the noise level.

construction noises, thus minimizing the effects of cumulative noise impacts.

- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures.

Potential Resettlement

In those areas where model predictions indicate a change from ambient sound levels (taken as 42 dBA) and construction of the proposed Project exceeds levels in excess of 55dBA (indicated in Red in *Table 6.1* above), the monitoring effort should be focused at these locations to confirm such model predictions.

Where measured exceedances of the applicable standard persist and are demonstrably due to construction activities associated with the establishment of the proposed Project (i.e. not because of regionally increased baseline), the mitigation efforts described above to reduce any such levels at these locations should be well maintained, in some cases the frequency of such mitigation measures increased, and the mitigation programmes frequently audited to ensure their effective and continued implementation.

If *avoidance* of Major significant impacts is not feasible using these measures during the Construction phase, consideration will be given to the option of resettling the affected community/structures. This will be explored in consultation with the affected communities and will be planned and implemented in accordance with the Resettlement Action Plan (RAP) to be developed by Kangra Coal.

6.1.6 *Residual Impact (Post Mitigation)*

With suitable mitigation/management this impact is likely to decrease resulting in a residual assessment of the impact to a "**Minor Negative Impact**" (refer to *Table 6.3* below).

Table 6.3 Rating of Impacts Related to Noise Emissions during the Construction Phase (Post-mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact would be limited to the local area up to approximately 1km from source.
Duration	Short-term	Activities will take place during the day-time hours and will continue for 18 to 21 months.
Scale	Minor to medium	Construction activities are likely to influence the baseline ambient sound levels over an area of more than 1km from source; however, with implementation of the above mitigation measures the the magnitude of the noise impact would likely decrease to levels close to the SANS 10103 rating level for a rural district (45 dBA).
Frequency	Daily	The activities generating noise are anticipated to take place daily during daylight hours.
Likelihood	Possible	Because of the very low ambient sound levels in the Project Area, it is definite that the receptors will be aware of the increased noise levels; however, with implementation of the above resettlement recommendations, the magnitude of the noise impact would

		likely be close to the SANS 10103 rating level for a rural district (45 dBA). As such, the likelihood of complaints from communities in the Project Area should be low.
Magnitude		
Small Magnitude		
Construction activities with mitigation will result in noise levels close to the SANS 10103 daytime rating level for a rural area.		
Significant Rating After Mitigation		
Minor Negative Impact		

6.2 *IMPACTS ON THE NOISE ENVIRONMENT DURING THE OPERATIONAL PHASE*

6.2.1 *Description of the Baseline Environment*

Baseline sound measurements showed that the Study Area is relatively quiet during both the day and night-time periods with low ambient sound levels; however, sound levels increase in closer proximity to existing mining operations. The soundscape in the Project Site can be defined as natural; with faunal, amphibian, insect and wind-induced sounds dominating the sound character.

Because noise levels closer to receptors are generally higher (due to typical household activities generating sound, e.g. listening to the TV/Radio, conversation, cleaning, working, preparing food, etc.) an ambient sound level of *42 dBA* will be assumed at receptor locations. This sound level will be used to estimate how the introduced noises will increase the ambient sound levels.

6.2.2 *Proposed Project Activities*

The operational phase of the proposed Project comprises a considerable number of processes, activities and equipment that generate noise. The proposed Project will operate 24 hours a day, 7 days a week.

Operational activities that can produce noise at the Main Mine Adit (Adit A) and associated coal transport system will include:

- General activities at the workshop area;
- General activities at the vehicle ramp;
- Operation of the ventilation fans (4x ventilation fans);
- Primary and secondary crushing and screening of mined coal;
- Material transfer into and out of storage silos;
- Coal tipping; and
- Operation of the overland conveyor system.

As with the construction phase, maximum noises can be audible over a large distance but the character of noise changes during the operational phase to a noise with a broadband character that is less impulsive. Maximum noise events are currently not regulated.

Equivalent sound levels are regulated in terms of the National Noise Control Regulations. For a rural area as found at this location the SANS 10103:2008 **daytime rating level would be 45 dBA and 35 dBA for the night-time period**. This environmental NIA will only investigate the night-time period as this is the time-period where a quieter environment is more important for receptors [(1)].

The sound power levels at source for noise emitting equipment listed in *Table 6.4* was used in modelling noise levels and its extent during the operational phase. The layout as modelled is presented in *Figure 6-1*.

Table 6.4 Sound Power Levels of Equipment as used in Modelling for Operational Impacts

Equipment	Sound Power Level (dBA)
Coal silo (Material Transfer)	103.2
Coal crushing	114.5
Coal Screen	105.1
Conveyor Belt	81.0
Conveyor Transfer points	99.4
General noise	108.8
Ventilation Fan	110.1

As with the construction phase it was assumed that 10 heavy and 10 light vehicles will be using the access road to and from Adit A per hour during the night-time hours.

[1] Day-time noise levels would be similar to the night-time noise levels, but, because of the 10 dB lower rating level, night-time would represent the worse-case scenario. By addressing the potential night-time noise noise impacts the applicant would also directly address daytime noise impact.

Figure 6-1 Location of Noise Generating Activities during the Operational Phase (as modelled)

6.2.3 *Sensitive Receptors*

For the purpose of the model simulation for noise related impacts during the operational phase of the proposed Project and for this NIA, the placement of noise generating activities during the operational phase were assumed at locations presented in *Figure 6-1*. The project noise levels associated with this configuration of noise generating activities and the magnitude of the perceived noise impact is presented in *Table 6.5* and *Figure 6-2*.

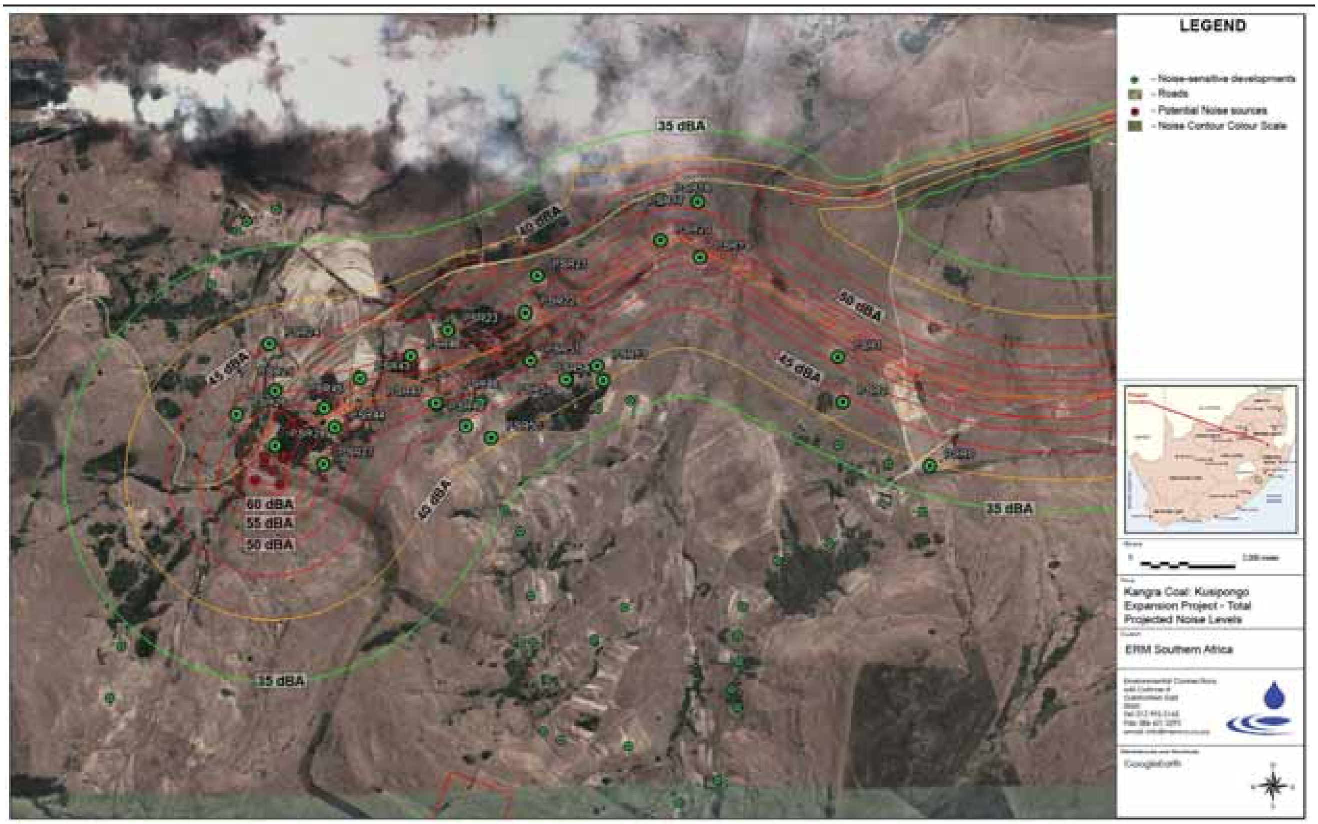
The projected noise level is calculated in terms of the logarithmic change from night-time rating levels for a rural district (35 dBA).

Table 6.5 Potential Logarithmic Change in Baseline Night-time Noise Levels and Magnitude of the Operational Noise Impact

Receptor	Co-ordinates (Lat/Lon Deg. Min. Sec WGS84)	Projected Night-time Noise Level	Change from Night-time Rating Level for a Rural District (35 dBA)	Distance from Closest (Potential) Operational Activity (m)	Magnitude
PSR01	27 0'48.80"S, 30 19'44.38"E	52.5	17.5	168	High
PSR02	27 0'59.27"S, 30 19'43.00"E	43.8	9.3	452	Medium
PSR03	27 1'3.84"S, 30 19'56.82"E	37.2	4.3	747	Low
PSR04	27 1'15.64"S, 30 20'5.92"E	37.8	4.6	767	Low
PSR05	27 1'4.34"S, 30 20'8.13"E	32.5	1.9	988	Low
PSR06	27 1'23.17"S, 30 19'40.74"E	39.5	5.8	636	Medium
PSR07	27 1'27.46"S, 30 19'26.47"E	27.5	0.7	1462	Low
PSR08	27 1'38.68"S, 30 19'16.92"E	26.5	0.6	1727	Low
PSR09	27 1'45.83"S, 30 19'15.55"E	25.3	0.4	2156	Low
PSR10	27 1'52.22"S, 30 19'15.97"E	24.8	0.4	2156	Low
PSR11	27 1'59.02"S, 30 19'13.91"E	24.3	0.4	2061	Low
PSR12	27 2'3.35"S, 30 19'15.48"E	23.9	0.3	1914	Low
PSR13	27 2'12.66"S, 30 18'45.60"E	23.6	0.3	1901	Low
PSR14	27 2'26.46"S, 30 18'59.63"E	24.9	0.4	1030	Low
PSR15	27 2'21.02"S, 30 19'10.05"E	23.2	0.3	1339	Low
PSR16	26 59'59.93"S, 30 19'4.73"E	23.0	0.3	1632	Low
PSR17	26 59'59.39"S, 30 18'54.36"E	47.4	12.7	307	High
PSR18	27 0'13.48"S, 30 19'5.33"E	47.4	12.6	325	High
PSR19	27 0'9.33"S, 30 18'54.56"E	61.8	26.8	45	High
PSR20	27 0'17.97"S, 30 18'20.83"E	59.8	24.8	60	High
PSR21	27 0'27.08"S, 30 18'17.54"E	46.8	12.1	319	High
PSR22	27 0'31.17"S, 30 17'56.38"E	54.4	19.4	129	High
PSR23	27 0'34.47"S, 30 17'7.59"E	48.5	13.7	265	High
PSR24	27 0'46.01"S, 30 17'9.17"E	44.2	9.7	660	Medium
PSR25	27 0'51.77"S, 30 16'58.62"E	53.3	18.4	305	High
PSR26	27 1'3.88"S, 30 17'22.40"E	51.4	16.5	321	High
PSR27	27 0'59.33"S, 30 17'9.18"E	54.5	19.6	290	High
PSR28	27 1'48.63"S, 30 16'27.07"E	64.1	29.1	103	High
PSR29	27 2'1.08"S, 30 16'23.85"E	33.7	2.4	1709	Low
PSR30	27 0'1.93"S, 30 17'9.31"E	31.1	1.5	2070	Low
PSR31	27 0'4.83"S, 30 17'1.39"E	32.8	2.0	1594	Low
PSR32	27 0'7.07"S, 30 16'58.72"E	33.1	2.2	1586	Low
PSR33	27 0'13.99"S, 30 16'51.89"E	33.5	2.3	1532	Low

PSR34	27 0'20.15"S, 30 16'51.58"E	34.8	2.9	1378	Low
PSR35	27 1'56.63"S, 30 18'23.53"E	36.4	3.8	1205	Low
PSR36	27 3'24.09"S, 30 17'56.94"E	28.3	0.8	951	Low
PSR37	27 2'9.01"S, 30 18'22.52"E	22.1	0.2	1746	Low
PSR38	27 3'37.33"S, 30 18'40.91"E	27.1	0.7	596	Low
PSR39	27 3'32.28"S, 30 18'25.34"E	21.1	0.2	2356	Low
PSR40	27 3'37.08"S, 30 17'58.37"E	21.5	0.2	2061	Low
PSR41	27 2'11.20"S, 30 18'27.16"E	21.6	0.2	2140	Low
PSR42	27 0'42.91"S, 30 17'32.34"E	26.5	0.6	623	Low
PSR43	27 0'54.90"S, 30 17'25.50"E	52.1	17.2	184	High
PSR44	27 0'50.28"S, 30 17'22.60"E	58.4	23.4	89	High
PSR45	27 0'37.47"S, 30 17'46.23"E	59.7	24.7	74	High
PSR46	27 0'49.08"S, 30 17'53.15"E	51.2	16.3	193	High
PSR47	27 0'49.04"S, 30 18'5.17"E	50.8	15.9	214	High
PSR48	27 0'54.58"S, 30 18'1.29"E	46.7	12.0	336	High
PSR49	27 0'57.45"S, 30 18'8.24"E	44.1	9.6	477	Medium
PSR50	27 0'38.64"S, 30 18'18.97"E	41.1	7.0	608	Medium
PSR51	27 0'43.20"S, 30 18'28.65"E	51.4	16.5	197	High
PSR52	27 0'39.98"S, 30 18'37.19"E	43.6	9.1	455	Medium
PSR53	27 0'43.48"S, 30 18'38.86"E	42.7	8.4	498	Medium
PSR54	27 0'50.42"S, 30 18'37.27"E	40.4	6.5	612	Medium
PSR55	27 0'48.48"S, 30 18'46.12"E	37.5	4.5	775	Low
PSR56	27 1'14.99"S, 30 18'11.79"E	36.5	3.8	856	Low
PSR57	27 1'20.19"S, 30 18'16.12"E	34.9	2.9	1151	Low
PSR58	27 1'35.99"S, 30 18'19.05"E	33.4	2.3	1340	Low
PSR59	27 1'47.48"S, 30 18'19.77"E	31.2	1.5	1514	Low
PSR60	27 1'47.67"S, 30 18'16.34"E	29.7	1.1	1191	Low
PSR61	27 1'46.75"S, 30 18'36.21"E	30.2	1.2	1150	Low
PSR62	27 1'38.78"S, 30 18'44.6"E	27.9	0.8	1378	Low
PSR63		27.7	0.7	1708	Low

Figure 6-2 Total Projected Noise Levels during the Operational Phase of the Proposed Project – Contours of Constant Sound Levels



6.2.4 *Significance of Impact (<u>Pre-mitigation</u>)*

Based on the analysis provided above, it is the opinion that the noise related impacts from operational activities associated with the proposed Project will be a "**Major Negative Impact**" (pre-mitigation) for potential noise sensitive receptors identified as having a high magnitude (*Table 6.5*) or that are located in the Red Zone (refer to *Figure 6-2* above). Refer to Table 6.6 below.

Table 6.6 Rating of Impacts Related to Noise Emissions during the Operational Phase of the Proposed Project (<u>Pre-mitigation</u>)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact would be limited to the local area up to approximately 2km from source.
Duration	Long-term	Activities will take place both during day- and night-time hours and will continue for the duration of the operational phase of the proposed Project (10 to 20 years).
Scale	Large	Operational activities are likely to influence the baseline ambient sound levels over an area in excess of 1 000ha. The magnitude of the noise levels are likely to increase baseline noise levels to 5 dBA or higher than the SANS 10103 night-time rating level of 35 dBA for receptors living in a distance of 630m from the proposed overland conveyor system and approximately 900m from the area proposed for the Main Mine Adit (Adit A). Noise-sensitive receptors in the confines of these distances will likely lay complaints relating to noise.
Frequency	Constant	The activities generating noise are anticipated to take place continuously (24 hours per day, 7 days a week).
Likelihood	Definite	Because of the very low ambient sound levels in the Project Area, it is definite that the receptors will be aware of the increased noise levels. The proximity of existing receptors means that baseline noise levels during operational phase will increase by 5 dBA for a number of communities in the Study Area.
Magnitude		
Large Magnitude		
Operational activities without mitigation will result in noise levels exceeding the SANS 10103 night-time rating level (for a rural area) for a number of rural communities in the Project Area.		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Local communities affected would comprise of a number of individuals ranging from babies, teens, adults and the elderly. It has been proven that very young children and the elderly are generally more susceptible to increased noises.		
Significant Rating Before Mitigation		
Major Negative Impact		

6.2.5 *Recommendations and Mitigation/Management Measures*

It is recommended that Kangra Coal adopt the following mitigation/management measures so as to reduce the significance of the impact:

- Ensure a good working relationship between mine management and all potential noise-sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them.

- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. This is critical for the conveyor belt system.

- The introduction of a noise component in the Environmental Awareness education (Training and Induction courses) for employees and contractors. This is especially important for the drivers of vehicles that will operate vehicles at night.

Potential Resettlement

In those areas where model predictions indicate an increase in baseline noise levels to 5 dBA or higher than the SANS 10103 night-time rating level of 35 dBA (as provided in *Table 6.5*), monitoring effort should be focused at these locations to confirm such model predictions.

Where measured exceedances of the applicable standard persists and are demonstrably due to operational activities associated with the proposed Project (i.e. not because of regionally increased baseline), the mitigation efforts described above to reduce any such levels at these locations should be well maintained, in some cases the frequency of such mitigation measures increased, and the mitigation programmes frequently audited to ensure their effective and continued implementation.

If *avoidance* of Major significant impacts is not feasible using these measures, consideration will be given to the option of resettling the affected community/structures. This will be explored in consultation with the affected communities and will be planned and implemented in accordance with the Resettlement Action Plan (RAP) to be developed by Kangra Coal.

6.2.6 *Residual Impact (Post Mitigation)*

With suitable mitigation/management this impact is likely to decrease resulting in a residual assessment of the impact to a "**Minor Negative Impact**" (refer to *Table 6.7* overleaf).

Table 6.7 Rating of Impacts Related to Noise Emissions during the Construction Phase (Post-mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact would be limited to the local area up to approximately 2km from source.
Duration	Short-term	Activities will take place both during day- and night-time hours and will continue for the duration of the operational phase of the proposed Project (10 to 20 years).
Scale	Minor	Operational activities are likely to influence the baseline ambient sound levels over an area of more than 2km from source; however, with the implementation of the above mentioned mitigation measures will result in noise levels close to the SANS 10103 night-time rating level for a rural district
Frequency	Daily	The activities generating noise are anticipated to take place continuously (24 hours per day, 7 days a week).
Likelihood	Possible	Because of the proximity of the receptors to the activities as well as the very low ambient sound levels in the area, it is definite that the receptors will be aware of the increased noise levels. The implementation of the above mentioned mitigation measures will result in noise levels close to the SANS 10103 night-time rating level for a rural district and the likelihood of complaints should be low.
Magnitude		
Small Magnitude		
Operational activities with mitigation will result in noise levels close to the SANS 10103 night-time rating level for a rural area.		
Significant Rating After Mitigation		
Minor Negative Impact		

6.3 IMPACTS ON THE NOISE ENVIRONMENT DURING THE DECOMMISSIONING PHASE

6.3.1 Description of the Baseline Environment

Baseline sound measurements showed that the Study Area is relatively quiet during both the day and night-time periods with low ambient sound levels; however, sound levels increased in closer proximity to existing mining operations. The soundscape in the Project Site can be defined as natural; with faunal, amphibian, insect and wind-induced sounds dominating the sound character.

Because noise levels closer to receptors are generally higher (due to typical household activities generating sound, e.g. listening to the TV/Radio, conversation, cleaning, working, preparing food, etc.) a ambient sound level of *42 dBA* will be assumed at receptor locations. This sound level will be used to estimate how the introduced noises will increase the ambient sound levels.

It must be noted however, that after a number of years of coal mining the sound character in the area is expected to be different.

6.3.2 *Proposed Project Activities*

During the decommissioning phase of the proposed Project, noise impacts will be related to the dismantling and removal of infrastructure as well as the rehabilitation (earthworks and re-vegetation) of previously disturbed areas. With regard to noise emissions, decommissioning works are less intensive than construction, although involving similar equipment, but usually not requiring heavy earthworks.

6.3.3 *Sensitive Receptors*

Communities within a distance of 500m from where decommissioning activities will take place will be the most affected; however, affected communities would have being resettled during the construction and operational phase of the proposed Project.

6.3.4 *Significance of Impact (Pre-mitigation)*

As is mentioned above, decommissioning works are less intensive than that of construction; as such, activities associated with decommissioning would have similar or lesser impacts to those predicted for construction (refer to *Section 6.1*). However, should affected communities have already been resettled in the construction and operational phases of the proposed Project; the impact will be a "**Negligible Negative Impact**" pre-mitigation.

6.3.5 *Recommendations and Mitigation/Management Measures*

The assessment concluded that there will be no significant impacts on people from noise during the decommissioning phase should affected communities have already been resettled in the construction and operational phases of the proposed Project, and additional mitigation measures other than good construction work methods and practice (set out in *Section 6.1.5*) are not required.

6.3.6 *Residual Impact (Post Mitigation)*

As additional mitigation measures (other than good decommissioning work methods) are not required, the impact will remain as a "**Negligible Negative Impact**".

6.4 *NOISE MONITORING RECOMMENDATIONS*

Considering the proximity of noise-sensitive receptors to the proposed Project Site, an acoustic consultant will be appointed to design a noise measurement programme for all phases of the proposed Project. The noise measurement programme will allow for quarterly noise measurements to be taken in 10-minute bins over a period of at least 24 hours.

Noise monitoring locations are based on noise model predictions for the proposed Project, and more specifically, where predictions indicate the following:

- **<u>Construction Phase</u>** - change from ambient sound levels (taken as 42 dBA) as a result of the proposed Project that are in excess of 55dBA.

- **<u>Operational Phase</u>** – increase in baseline noise levels to 5dBA or higher than the SANS 10103 night-time rating level of 35 dBA (as the operation will be 24hours per day).

As such, noise measurements will be taken at the following location during the following phases of the proposed Project (refer to *Table 6.8*).

Table 6.8 Noise Measurement Locations for Construction and Operational Phases

Receptor	Coordinates		Monitoring Required	
	Latitude	Longitude	Construction Phase	Operational Phase
PSR01	27^0 0' 37.76" S	30^0 19' 42.99" E	X	X
PSR17	26^0 59' 59.39" S	30^0 18' 54.36" E		X
PSR18	27^0 0' 13.48" S	30^0 19' 5.33" E		X
PSR19	27^0 0' 9.33" S,	30^0 18' 54.56" E	X	X
PSR20	27^0 0' 17.97" S	30^0 18' 20.83" E	X	X
PSR21	27^0 0' 27.08" S	30^0 18' 17.54" E		X
PSR22	27^0 0' 31.17" S	30^0 17' 56.38" E	X	X
PSR23	27^0 0' 34.47" S	30^0 17' 7.59" E		X
PSR25	27^0 0' 51.77" S	30^0 16' 58.62" E	X	X
PSR26	27^0 1' 3.88" S,	30^0 17' 22.40" E	X	X
PSR27	27^0 0' 59.33" S	30^0 17' 9.18" E	X	X
PSR28	27^0 1' 48.63" S	30^0 16' 27.07" E	X	X
PSR43	27^0 0' 54.90" S	30^0 17' 25.50" E	X	X
PSR44	27^0 0' 50.28" S	30^0 17' 22.60" E	X	X
PSR45	27^0 0' 37.47" S	30^0 17' 46.23" E	X	X
PSR46	27^0 0' 49.08" S	30^0 17' 53.15" E	X	X
PSR47	27^0 0' 49.04" S	30^0 18' 5.17" E	X	X
PSR48	27^0 0' 54.58" S	30^0 18' 1.29" E		X
PSR51	27^0 0' 43.20" S	30^0 18' 28.65" E	X	X

Measurements will be collected as construction commences through the operational phase of the proposed Project, and carried out in accordance with SANS 10103:2008 (or any future updates) using instruments as defined in the National Noise Control Regulations (or any future promulgated laws).

Should (for any given reason) during the construction and operational phases of the proposed Project, it be realised that the applicable standards (day time for the construction phase and or night time for the operational phase) be exceeded, and that these exceedances are demonstrably due to activities associated with the establishment/operation/decommissioning of the proposed Project (i.e. not because of regionally increased baseline), the mitigation efforts described above to reduce any such levels at these locations will be well maintained, in some cases the frequency of such mitigation measures increased, and the mitigation programmes frequently audited to ensure their effective and continued implementation.

If avoidance of Major significant impacts is not feasible using these measures consideration will be given to the option of resettling the affected community/structures. This will be explored in consultation with the affected communities and will be planned and implemented in accordance with the

Resettlement Action Plan (RAP) to be developed by Kangra Coal at a later stage of the proposed Project.

7 *CUMULATIVE IMPACTS AND MITIGATION*

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This Section considers the cumulative impacts that would result from the combination of the proposed Kangra Coal Expansion Project and other actual or proposed future developments in the broader Study Area.

7.1 *IDENTIFIED CUMULATIVE NOISE IMPACTS*

Noise emissions associated with the proposed Project will cumulatively add to the noise levels from existing mining operations as well as any future operations proposed in the Study Area. However, these cumulative noise increases will generally be negligible unless the proposed activities falls within the same zone of influence identified in this NIA (refer to noise contours in *Figure 6-2* – area of influence would be any area within the noise contours).

8 CONCLUSION

The NIA made use of a predictive model to identify issues of concern. The NIA indicated that the proposed Project would have a noise impact of high significance on a number of noise-sensitive receptors during all phases of the proposed Project; however, should communities be resettled within a distance of 630m from the proposed overland conveyor system and approximately 900m from the area proposed for Adit A, the residual impact will be reduced to a Minor Negative Impact.

Furthermore, this NIA recommends that an acoustic consultant should be appointed to design a noise measurement programme for all phases of the proposed Project. The noise measurement programme should allow for quarterly noise measurements to be taken in 10-minute bins over a period of at least 24 hours. Feedback regarding noise measurements should be presented to all stakeholders and other interested and affected parties in the area.

This report should also be made available to all potentially noise-sensitive receptors in the area, or the contents explained to them to ensure that they understand all the potential noise risks that the proposed Project may have on them and their families.

9 *REFERENCES*

Heggies, 2004: *Conveyor Noise Specification and Control.* Proceedings of Acoustics 2004

Norton, M.P. and Karczub, D.G. (2003): *Fundamentals of Noise and Vibration Analysis for Engineers*, Second Edition

SANS 10103:2008. '*The measurement and rating of environmental noise with respect to annoyance and to speech communication*'.

SANS 10210:2004. '*Calculating and predicting road traffic noise*'.

SANS 10357:2004. '*The calculation of sound propagation by the Concave method*'.

SANS 10328:2008. '*Methods for environmental noise impact assessments*'.

Appendix A

Noise Levels Generated by Construction Equipment

Table 9.1 Potential Maximum Noise Levels Generated by Construction Equipment

Equipment Description[1]	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential **maximum** noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Backhoe	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Chain Saw	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Compactor (ground)	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Crane	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dozer	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Grader	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6

[1] Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Equipment Description[1]	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential **maximum** noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Jackhammer	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Mounted Impact Hammer	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6
Paver	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Pumps	111.7	86.7	80.7	74.6	66.7	60.7	57.1	54.6	51.1	46.7	43.2	40.7	34.6
Rivit Buster/Chipping Gun	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Rock Drill	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Roller	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sand Blasting (single nozzle)	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Scraper	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sheers (on backhoe)	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Slurry Plant	112.7	87.7	81.7	75.6	67.7	61.7	58.1	55.6	52.1	47.7	44.2	41.7	35.6
Slurry Trenching Machine	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Soil Mix Drill Rig	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Tractor	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Vacuum Excavator	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vacuum Street Sweeper	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Ventilation Fan	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibrating Hopper	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibratory Concrete Mixer	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Vibratory Pile Driver	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Warning Horn	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Welder/Torch	107.7	82.7	76.7	70.6	62.7	56.7	53.1	50.6	47.1	42.7	39.2	36.7	30.6

Table 9.2 Potential Equivalent Noise Levels Generated by Various Equipment

Equipment Description[1]	Sound Power Level, L_W (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)										
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Bulldozer CAT D10	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D11	113.3	88.4	82.3	76.3	68.4	62.3	58.8	56.3	52.8	48.4	44.8	42.3	36.3
Bulldozer CAT D9	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D6	108.2	83.3	77.3	71.2	63.3	57.3	53.7	51.2	47.7	43.3	39.8	37.3	31.2
Bulldozer CAT D5	107.4	82.4	76.4	70.4	62.4	56.4	52.9	50.4	46.9	42.4	38.9	36.4	30.4
Bulldozer Komatsu 375	114.0	89.0	83.0	77.0	69.0	63.0	59.5	57.0	53.4	49.0	45.5	43.0	37.0
Bulldozer Komatsu 65	109.5	84.5	78.5	72.4	64.5	58.5	54.9	52.4	48.9	44.5	41.0	38.5	32.4
Diesel Generator (Large - mobile)	106.1	81.2	75.1	69.1	61.2	55.1	51.6	49.1	45.6	41.2	37.6	35.1	29.1
Dumper/Haul truck - CAT 700	115.9	91.0	85.0	78.9	71.0	65.0	61.4	58.9	55.4	51.0	47.5	45.0	38.9
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.2	57.7	55.2	51.7	47.2	43.7	41.2	35.2
Dumper/Haul truck - Bell 25 ton (B25D)	108.4	83.5	77.5	71.4	63.5	57.5	53.9	51.4	47.9	43.5	40.0	37.5	31.4
Excavator - Cat 416D	103.9	78.9	72.9	66.8	58.9	52.9	49.3	46.8	43.3	38.9	35.4	32.9	26.8
Excavator - Hitachi EX1200	113.1	88.1	82.1	76.1	68.1	62.1	58.6	56.1	52.6	48.1	44.6	42.1	36.1
Excavator - Hitachi 870 (80 t)	108.1	83.1	77.1	71.1	63.1	57.1	53.6	51.1	47.5	43.1	39.6	37.1	31.1
Excavator - Hitachi 270 (30 t)	104.5	79.6	73.5	67.5	59.6	53.5	50.0	47.5	44.0	39.6	36.0	33.5	27.5
FEL - CAT 950G	102.1	77.2	71.2	65.1	57.2	51.2	47.6	45.1	41.6	37.2	33.7	31.2	25.1
FEL - Komatsu WA380	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7

[1] Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Equipment Description[1]	Sound Power Level, L_W (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
General noise	108.8	83.8	77.8	71.8	63.8	57.8	54.2	51.8	48.2	43.8	40.3	37.8	31.8
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.9	54.4	51.9	48.4	43.9	40.4	37.9	31.9
Grader	110.9	85.9	79.9	73.9	65.9	59.9	56.4	53.9	50.3	45.9	42.4	39.9	33.9
JBL TLB	108.8	83.8	77.8	71.8	63.8	57.8	54.3	51.8	48.3	43.8	40.3	37.8	31.8
Road Transport Reversing/Idling	108.2	83.3	77.2	71.2	63.3	57.2	53.7	51.2	47.7	43.3	39.7	37.2	31.2
Road Truck average	109.6	84.7	78.7	72.6	64.7	58.7	55.1	52.6	49.1	44.7	41.1	38.7	32.6
Vibrating roller	106.3	81.3	75.3	69.3	61.3	55.3	51.8	49.3	45.8	41.3	37.8	35.3	29.3
Water Dozer, CAT	113.8	88.8	82.8	76.8	68.8	62.8	59.3	56.8	53.3	48.8	45.3	42.8	36.8

Appendix B

Curriculum Vitae of Specialists

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Morné de Jager

Personal Data

Identity Number	711221 5062 080
Date of Birth	21 December 1971
Sex	Male
Marital Status	Married, three children
Driver's license	Code 08
Nationality	South African
Home Language	Afrikaans (speak, read and write)
Other Languages	English (speak, read and write)
Higher Educational Qualifications	B.Ing (Chemical Engineering) [Pretoria University]
Previous Employment	Wates Meiring and Barnard Department of Water Affairs and Forestry
Current Employment	M2 Environmental Connections

Educational Qualifications

Secondary Education

Last schools attended	Technical High Klerksdorp North-West (1985-1989)
Highest Standard	Matriculated with first class pass
Subjects passed	Afrikaans, English, Science, Mathematics, Technical Drawings, Technical Electric
Prizes and awards	Best Mathematics student for Standard 9, Mathematics Olympiad Award - Standard 9
Leadership roles	School prefect
Extramural activities	Cross-country Running

Tertiary Education

University attended	Pretoria University, Gauteng
Degree Obtained	B. Ing. (Chemical Engineering)
Date Obtained	1997
Extramural activities	Social Squash, jogging, Cycling

Previous Employment

Name of Firm	Wates, Meiring and Barnard; seconded to Department of Water Affairs and Forestry
Type of firm	Consulting Engineering
Post held	Contract: Line function - Water Resource Management
Main Job functions	Water Management on a Catchment basis. Water Management Reports, Environmental Impact Assessments & Environmental Management Reports evaluation and approval/recommendations. Recommendations/approvals of Industry/Mining Environmental Policies. Enforcing water management practices as regulated by relevant Acts. Issuance of permits dealing with all water quality issues, as well as relevant Sections of the Environmental Conservation Act. Any complaints/issues dealing with water resources management/pollution in area of responsibility. Auditing and monitoring for compliance to relevant Acts. Close interaction and liaison with all Interested and Affected Parties as well as Non Government Organizations
Area of Responsibility	Triangle formed by: Northern Gauteng, Phalaborwa Complex, Upper Olifants Catchment
Period	March 1998 – May 2000

Short Resumé

Morné started his career in the mining industry as a bursar Learner Official (JCI, Randfontein), working in the mining industry, doing various mining related courses (Rock Mechanics, Surveying, Sampling, Safety and Health (Ventilation, noise, illumination etc) and Metallurgy. He did work in both underground (Coal, Gold and Platinum) as well as opencast (Coal). He changed courses from Mining Engineering to Chemical Engineering after his second year of his studies at the University of Pretoria.

After graduation he worked as a Water Pollution Control Officer at the Department of Water Affairs and Forestry for two years (first year seconded from Wates, Meiring and Barnard), where duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents (such as EMPR’s, Water Licence Applications and EIA’s), as well as the compilation of Technical Documents.

Since leaving the Department of Water Affairs, Morné has been in private consulting for the last 10 years, managing various projects for the mining and industrial sector, private developers, business, other environmental consulting firms as well as the Department of Water Affairs. During that period he has been involved in various projects, either as specialist, consultant, trainer or project manager, successfully completing these projects within budget and timeframe.

He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker design. Interest in the matter brought him into the field of Environmental Noise

Measurement, Prediction and Control. He has been doing work in this field for the past 5 years, and was involved with the following projects in the last few years:

Project Experience – Larger projects (last 5 years)

Noise monitoring reports	Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Tweefontein (Xstrata), Sephaku Delmas (AGES)
Small Noise Impact Assessments	*Hacra Project (Prescali), Saldanha WEF (Terramanzi), TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Hopefield WEF (Umoya), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (Noman Shaikh), Boskop Road (MTO), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma (Cennergi), Amakhala Emoyeni (Windlab), Spreeukloof (Savannah), Spinning Head (Savannah), Kangra Coal (ERM)*

Golder Associates: BECSA - Middelburg	*Regional Noise Monitoring Programme and Environmental Noise Impact Assessment for their coal operations near Emalahleni*
Geovicon Environmental: Kromkrans Colliery	*Environmental Noise Impact Assessments for the Kromkrans Colliery Project*
JMA: SASOL Borrow Pits Project	*Environmental Noise Impact Assessment for the proposed SASOL Borrow Pits*
AGES: Lesego Platinum Project	*Environmental Noise Impact Assessment for the proposed Lesego Platinum Mine in Limpopo*
Savannah Environmental: Zen WEF	*Environmental Noise Impact Assessment for the proposed* Zen *Wind Energy Facility*
Savannah Environmental: Goereesoe WEF	*Environmental Noise Impact Assessment for the proposed* Goereesoe *Wind Energy Facility*
Savannah Environmental: Springfontein WEF	*Environmental Noise Impact Assessment for the proposed Springfontein Wind Energy Facility*
Cleanstream: Tweefontein Colliery TOP amendment	*Update of Environmental Noise Impact due to amendments to mining programme*
AGES: Outshoorn Airport	*Long-term Noise Monitoring and Environmental Noise Impact Assessment to determine the impact of overflying planes*
JMA: Evraz Vametco Mine and Plant	*Environmental Noise Impact Assessment: Process changes at Evraz Vametco, Brits*
Windlab Developments: Amakhala Emoyeni WEF	*Long-term noise monitoring to define the ambient sound levels: Amakhala Emoyeni Wind Energy Facility*
RES: Oyster Bay WEF	*Long-term noise monitoring to define the ambient sound levels: Oyster Bay Wind Energy Facility*
Cennergi (Pty) Ltd: Tsitsikamma WEF	*Long-term noise monitoring to define the ambient sound levels: Tsitsikamma Wind Energy Facility*
Xstrata Coal South Africa: Colliery	*Development of a Regional Noise Monitoring Programme for their coal operations near Emalahleni*
Geovicon Environmental: Goedehoop Colliery	*Environmental Noise Impact Assessments for the Goedehoop Mine Shaft and Conveyor Belt, North Discard Dump Extension as well as the South Reclamation Plant (4 different studies)*
Savannah Environmental: Juwi Renewable Energy – Garob WEF	*Environmental Noise Impact Assessment for the proposed Garob Wind Energy Facility*
Savannah Environmental: ESKOM Kleinzee WEF	*Environmental Noise Impact Assessment for the proposed Kleinzee Wind Energy Facility*
Savannah Environmental: WWK Development (Pty) Ltd – Project Blue WEF	*Environmental Noise Impact Assessment for the proposed Project Blue Wind Energy Facility*
Aurecon SA: iNCa Renewables – Gouda WEF	*Environmental Noise Impact Assessment for the proposed Gouda Wind Energy Facility*
Aurecon SA: Mainstream Renewable Energy (Pty) Ltd	*Environmental Noise Impact Assessment for the proposed Kangnas Wind Energy Facility*
Savannah Environmental: RES	*Environmental Noise Impact Assessment for the proposed Walker Bay Wind Energy Facility*
Savannah Environmental: RES	*Environmental Noise Impact Assessment for the proposed Oyster Bay Wind Energy Facility*
Urbansmart Planning Studio	*Noise Impact Assessment for the proposed K220 road extension*
Urbansmart Planning Studio	*Noise Annoyance Assessment: Christian Life Church*
J9 Environment: Der Brochen Platinum Project	*Environmental Noise Impact Assessment for the proposed Der Brochen Platinum Project*
Savannah Environmental: ACED	*Environmental Noise Impact Assessment for the proposed Hidden Valley Wind Energy Facilities*
SiVEST SA: ESKOM	*Noise Impact Assessment for the Oil Fuels Storage Tank at Grootvlei Power Station*
SiVEST SA: Mainstream WEFs	*Noise Impact Assessment for the proposed Wind Energy Facility*

	near Loeriesfontein
SiVEST SA: Mainstream WEFs	*Noise Impact Assessment for the proposed Wind Energy Facility near Noupoort*
SiVEST SA: Mainstream WEFs	*Noise Impact Assessment for the proposed Wind Energy Facility near Prieska*
Thornhill and Lakeside Residential Estate	*Noise Annoyance Assessment due to the Operation of the Gautrain*
Aurecon SA: Mulilo WEFs	*Noise Impact Assessment for the proposed Plateau East Wind Energy Facilities*
Aurecon SA: International Project Development Power (Pty) Ltd	*Noise Impact Assessment for the proposed Saldanha Wind Energy Facility*
Aurecon SA: International Project Development Power (Pty) Ltd	*Noise Impact Assessment for the proposed Veldrift Wind Energy Facility*
Alpine Aviation	*Noise Impact Assessment for the proposed Helipad in Sandton*
AGES: Delft Sand	*Noise Annoyance Investigation for Delft Sand*
AGES: Brandbach Sand	*Noise Impact Assessment for the proposed Cullinan Sand*
AGES: Sekoko Mining Lephalale Coal Siding	*Noise Impact Assessment for the proposed Sekoko Coal Siding*
Clean Stream: Xstrata Coal South Africa	*Noise Impact Assessment for the proposed Verkeerdepan Extension*
Upington Solar Thermal Facility – Abengoa Solar South Africa	*Noise Impact Assessment for Scoping purposes for the establishment of the Upington Solar Thermal Facility*
Samancor Chrome: Eastern Chrome Mines	*Noise Impact Assessment for the proposed Jagdlust Mine*
WPB Coal	*Noise Impact Assessment for the proposed WPB Coal Mine*
AGES: Sephaku Cement: Dwaalboom	*Noise Impact Assessment for the proposed Dwaalboom Limestone Mine*
Clean Stream: Landau Expansion – AngloCoal	*Noise Impact Assessment for the proposed Landau Expansion Project*
Savannah Environmental: Renewable Energy Systems	*Noise Impact Assessment for the proposed Oyster Bay Wind Energy Facility*
Savannah Environmental: Exxaro Resources Limited	*Noise Impact Assessment for the proposed Tsitsikamma Wind Energy Facility*
Xstrata Coal South Africa: Verkeerdepan Extension	*Noise Impact Assessment for the proposed Verkeerdepan Extension mine*
Savannah Environmental: Project Ilanga - Ilangalethu Solar Power (Pty) Ltd	*Noise Impact Assessment for Scoping for the Project Ilanga Solar Thermal Power Plant near Upington, Northern Cape*
Savannah Environmental: Rainmaker Energy Projects – AB Wind Energy Facility	*Noise Impact Assessment for the AB Wind Energy Facility near Indwe*
ASEC: Otjikoto Gold – AurexGold	*Environmental Noise Impact Assessment for the proposed Otjikoto Gold Mine near Otavi*
Savannah Environmental: West Coast Wind Energy Facility - Exxaro Resources Limited	*Noise Impact Assessment for the West Coast Wind Energy Facility near Namakwa Sands*
Savannah Environmental: Rainmaker Energy Projects – Dorper Wind Energy Facility	*Noise Impact Assessment for the Dorper Wind Energy Facility near Molteno*
Savannah Environmental: Gouda Wind Energy Facility - VentuSA Energy	*Noise Impact Assessment for the Gouda Wind Energy Facility near Gouda*
Savannah Environmental: Pofadder Solar Thermal Facility – Abengoa Solar South Africa	*Noise Impact Assessment for Scoping purposes for the establishment of the Pofadder Solar Thermal Facility*
Cleanstream: Noise Impact Assessment – Tweefontein Colliery	*Noise Impact Modelling for new proposed expansion of coal mine. Including mitigation measures.*
Klipfontein Colliery – Hoyoyhoyo Mining	*Noise Impact Assessment for EIA for the establishment of the Klipfontein Colliery*
Imbabala Colliery – Alpha Coal	*Noise Impact Assessment for EIA for the update of the EMPR of Imbabala Colliery*
Jones and Wagner: ATCOM East Expansion - X-Strata Coal	*Noise impact assessment for the proposed expansion at ATCOM*
Savannah Environmental: Amakhala Emoyeni Wind Energy Facility Windlab Developments	*Noise Impact Assessment for the Amakhala Wind Energy Facility near Bedford*
Savannah Environmental: Klipheuwel / Boontjiekraal Wind Energy Facility - BioTherm Energy	*Noise Impact Assessment for the Klipheuwel / Boontjiekraal Energy Facility near Caledon*
Department of Water Affairs: North-west – Integrated Monitoring	*Catchment Assessment, Gap Analysis, Design and Implementation of Integrated Chemical Water Monitoring Programme*
Savannah Environmental: Cookhouse WEF - ACED	*Noise Impact Assessment for the proposed Wind Energy Facility (200 WTGs) near Cookhouse in the Eastern Cape*
Savannah Environmental: Cookhouse II WEF - ACED	*Noise Impact Assessment for the proposed Cookhouse II Wind Energy Facility near Cookhouse in the Eastern Cape*
Department of Water Affairs: North-west – Compliance and Enforcement	*Development of a Monitoring Report Framework, compilation of concept Integrated Water Use Licence*
Canyon Springs Investments 71 (Pty) Ltd	*Noise Impact Assessment for the proposed Canyon Springs Wind Energy Facility*
Savannah Environmental: Rheboksfontein Wind Energy Facility – Moyeng Energy	*Noise Impact Assessment for the Rheboksfontein Wind Energy Facility near Darling (Scoping and EIA)*
Savannah Environmental: West Coast One Wind Energy Facility – Moyeng Energy	*Noise Impact Assessment for the West Coast One Wind Energy Facility near Vredenburg (Scoping and EIA)*
Savannah Environmental: Suurplaat Wind Energy Facility – Moyeng Energy	*Noise Impact Assessment for the Suurplaat Wind Energy Facility near Sutherland (Scoping and EIA)*
Savannah Environmental: ACED – Noise Impact Assessment	*Scoping: Noise Impact Assessment for the proposed Wind Energy Facility (100 WTGs) near Middelburg in the Eastern Cape*
Savannah Environmental: Uyekraal Wind Energy	*Noise impact assessment for scoping for the proposed Uyekraal*

Facility - Creative-Renewable-Energy-Solutions (Pty) Ltd	*wind energy facility near the town of Vredenburg, Western Cape*
Savannah Environmental: Karoo Renewable Energy Facility - South African Renewable Green Energy (Pty) Ltd	*Noise impact assessment for scoping purposes for the proposed Karoo Renewable Energy Facility near Victoria West, Western and Northern Cape Provinces*
ERM: Kangra Coal – Environmental Management Resources (Pty) Ltd	*Noise Impact Assessment for the proposed Kangra Coal Colliery near Piet Retief*
Savannah Environmental: Ruukki South Africa	*Noise Impact Assessment for Scoping: Proposed Ruukki Coal Fired Power Station near Ogies*

Volume III Annex C.6

Socio-economic Impact Assessment Report

Version 5.0

May 2013

Document Ref.	Prepared By	Reviewed By	Date Submitted to Kangra Coal for Review
0120258_V5.0_SIA	Andy Spitz	Dieter Rodewald, Mike Everett	May 2013

CONTENTS

LIST OF ANNEXURES

GLOSSARY OF TERMS

Abbreviation/ Terminology	**Full Definition**
CLO	Community Liaison Officer
Contralesa	Congress of Traditional Leaders of South Africa
CPA	Communal Property Association
CPAs	Communal Property Associations
DoCGTA	Department of Cooperative Governance and Traditional Affairs
CSR	Corporate Social Responsibility
ESIA	Environmental and Social Impact Assessment
GSDM	Gert Sibande District Municipality
IDP	Integrated Development Plan
LM	Local Municipality
MEGDP	Mpumalanga Economic Growth and Development Path
MLM	Mkhondo Local Municipality
MLM IDP	Mkhondo Local Municipality Integrated Development Plan
MTSF	Medium Term Strategic Framework
NDP	National Development Plan 2030
PKSLM	Dr. Pixley KaIsaka Seme Local Municipality
PKSLM IDP	Dr. Pixley KaIsaka Seme Local Municipality Integrated Development Plan
RDP	Reconstruction and Development Plan
SACSIS	South African Civil Society Information Service
SANRAL	South African National Roads Agency Limited
SDP	Spatial Development Plan
SEMP	Social and Environmental Management Plan
SIA	Social Impact Assessment
SLP	Social and Labour Plan
Study Area	The broader area, defined during Scoping, in which Project activities are planned to take place.
Zone 1	The homesteads and social structures within 1km of mine adits or infrastructure and within 500m of conveyor belt infrastructure and/or directly above underground mining activities
Zone 2	Homesteads and social structures outside of Zone 1 but within 2kms/1km of Adits A and B and the conveyor system respectively.
Zone 3	Driefontein residential area and Project stakeholders.
Zones of Influence	Zones of Influence that make up the broader Study Area are categorized by the extent to which a community/individual is likely to be impacted by the Project, and the extent to which a community/individual is likely to influence the Project. The Zones are divided into Zones 1, 2 and 3.

1 INTRODUCTION

1.1 TERMS OF REFERENCE

Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) were appointed by Kangra Coal (Pty) Ltd. (Kangra Coal) to undertake the function of independent Environmental Assessment Practitioner (EAP) and undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Kusipongo Resource Expansion Project (the proposed Project) and compile an associated Environmental and Social Management Plan (SEMP). The ESIA is been undertaken as the proposed Project requires the following environmental authorisations / licenses:

- **Mining Rights** from the Regional (Mpumalanga) Department of Minerals and Resources (DMR) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA).

- **Environmental Authorisation** from the Regional (Mpumalanga) Department of Economic Development, Environment and Tourism (DEDET) in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA).

- **Waste License** from the National Department of Environmental Affairs (DEA) in terms of the National Environmental Management Waste Act (No. 59 of 2008) (NEMWA).

- **Water Use Licenses** from the National Department of Water Affairs (DWA) in terms of the National Water Act (No. 36 of 1998) (NWA).

Ms Andy Spitz was contracted by ERM to undertake an assessment of the social environment for the proposed Project. The purpose of the investigation is to assess the receiving social environment for the Study Area associated with the proposed Project and to develop a Social Impact Assessment (SIA) Report (this report).

1.2 SIA TEAM

The SIA has been undertaken by a team lead by Andy Spitz. Background to the key team members is presented below:

1.2.1 Ms Andy Spitz

Andy Spitz graduated Dramatic Arts (Hons) in 1988 and received a Fullbright Scholarship thereafter. In 1995 she was awarded a Masters of Philosophy in Environmental and Geographical Sciences *cum laude*. Andy has worked as a social scientist on projects across Africa, parts of the Middle East, Europe and Asia Pacific for the past 17 years. She is a Senior Social Consultant undertaking socio-economic impact assessments, livelihood analyses, stakeholder engagement, management plan development, risk assessments and managing social teams. She works in an integrated manner with biophysical scientists to ensure accessibility of the full extent of the environmental / social context is included into stakeholder interaction, impact assessments and decision-making.

1.2.2 *Dr Graeme Rodgers*

Graeme Rodgers is an anthropologist who has worked in the field of social consulting, research and project management over the past 15 years. His focus is on research-based consulting services that assist a broad range of organizations to respond more effectively to challenges associated with population displacement and migration. Recent project experience includes: the improvement of humanitarian responses to refugees in urban areas (Cameroon, Pakistan and Indonesia); the protection of indigenous peoples from displacement related to mining; the management of project-induced in-migration related to new mining developments; baseline studies for the recognition and protection of displaced, vulnerable and marginalized groups in post-conflict areas impacted by new mining developments; and mechanisms to identify and protect the interests of recently-returned refugees to areas that are potentially affected by mining. Graeme has worked on behalf of international organizations, non-government organizations and private companies seeking to manage the complex risks of displacement posed by planned or current operations.

1.3 REPORT STRUCTURE

The report is structured as presented below:

Table 1.1 Report Structure

Chapter	Focus
1: Introduction	Establishes the Terms of Reference for the SIA and defines the approach taken to fulfil these terms. The section presents the study area for work undertaken based on the proposed Project's zones of influence.
2: Institutional Context	Summarises structures of governance and administration interacting with the Project.
3: Land Tenure and Use	Establishes the context of land access and legislation relevant to the proposed Project's requirement for land and impact on current land owners and users.
4: Development Context	Presents key development planning frameworks applicable at the national to municipal Project environment and that motivates current day planning relevant to the Project.
5: National, Provincial and District Socio-economic Setting	Presents key socio-economic aspects relevant to the broader Project environment.
6: National and Provincial Utilities, Infrastructure and Services	Highlighting existing strengths and hurdles in the broader Project environment.
7: Local Socio-economic and Cultural Setting in the Zone of Influence	Presents the key socio-economic and cultural setting which will host the Project and on which the Project will have most direct influence.

Chapter	Focus
8: Impact Assessment Methodology	Sets out the methodology followed in the assessment of social impacts.
9: Impact Assessment and Mitigation	Presents the most significant social impacts and highlights associated mitigation measures.
10: Cumulative Impacts and Mitigation	Briefly identifies potential cumulative impacts and associated mitigation measures.
11: Conclusion	Concludes the report
12: References	Provides all references used in this report

1.4 PROJECT BACKGROUND

Kangra Coal is considering expanding their coal mining operations at the Savmore Colliery, located within the Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities (which form part of the Gert Sibande District Municipality) in Mpumalanga, which is approximately 51km west-south-west from Piet Retief and 64km south east from Ermelo (refer to **Error! Reference source not found.**). This expansion is proposed to include the Kusipongo coal resource, situated to the west of existing operations. The proposed Project will be restricted to underground mining; however, surface infrastructure to support this underground expansion will include (*Figure 1.1* and *Figure 1.2*):

- **A Main Mine Adit (Adit A)** – entrance to the proposed underground mine which is inclined and through which people, equipment and coal will pass. The Adit A footprint will also include offices, workshops, stores, change house, silos, etc.

- **A Ventilation Shaft (Adit B)** – an adit used solely for ventilation intake. Adit B will include only a ventilation opening. Access to the underground working via this ventilation opening will be restricted by the installation of a metal grid that will prevent access by humans and animals. Adit B will require approximately 500m^2. Fresh air drawn in through this Adit will be returned directly to the main exhaust fans at Adit A.

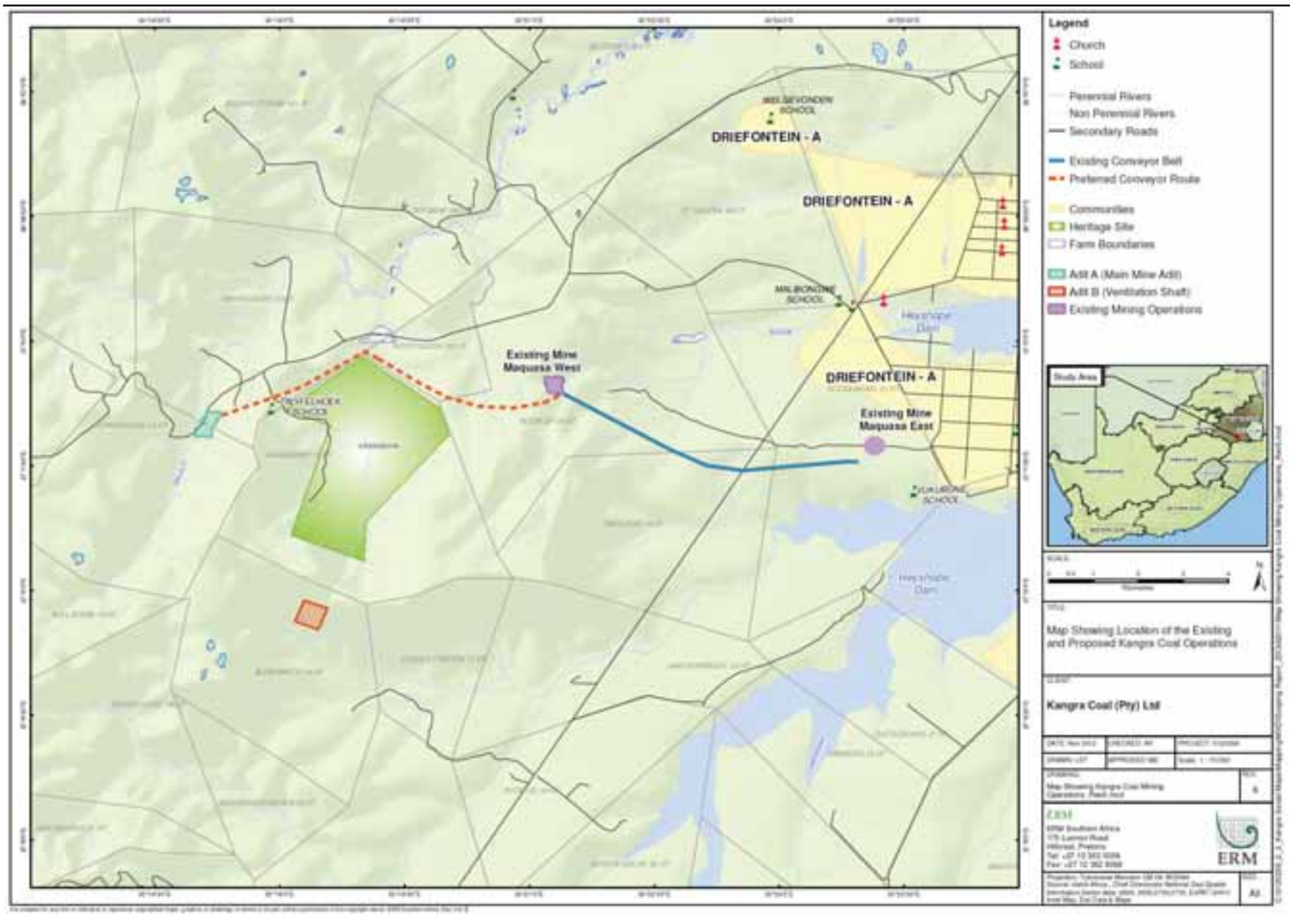
- **An Overland Conveyor System** – this system will be approximately 8.4km in length with a servitude width of 32m, and will be used to transport coal from the underground operations at the proposed Adit A to the existing Maquasa West Adit conveyor system. This in turn will transport mined coal to the existing wash plant facilities at the Savmore Colliery.

- **A Temporary Construction Camp** – to provide accommodation for semi-skilled and skilled workers and supervisory workers during the construction phase of the proposed Project, provisionally located 6km away (towards the east) from the proposed site for the Main Mine Adit A along the extension of the D2548. This will be decommissioned at the end of the construction phase.

Figure 1.1 Project Locality: Province, District and Municipality

Please Note – Pixley Ka Isaka Seme is synomonous with Dr. Pixley Kalsaka Seme

Figure 1.2   Location of Mine Site Infrastructure



1.5 STUDY PURPOSE AND OBJECTIVES

As is mentioned above, the purpose of this Report is to describe the socio-economic environment within the proposed Project area. The relationship between the Project and the different social components of this environment is two-way, with the Project impacting ON its hosts while simultaneously being impacted BY the structure and functioning of that host environment. Assessing this relationship through the Impact Assessment chapter (*Chapter* 9) depends on establishing a sound baseline understanding – which is therefore the primary focus of the Social Baseline description (*Chapter* 7). It is also important to establish this baseline data so that future changes in the Study Area (with or without the Project) can be tracked in relation to South Africa's evolving society.

The SIA and associated baseline study will be undertaken according to "good practice" using the Performance Standards of the International Finance Corporation (IFC) on Environmental and Social Sustainability (2012).

An SIA is mainly concerned with the management of socio-economic change, and thus provides both planners and decision-makers with essential information to enhance benefits and simultaneously reduce the social costs of a project. In particular, the objectives of this SIA study are:

- To determine the socio-economic Zones of Influence of the Project;
- To categorise the diverse affected groups and individuals within these zones and prioritise them according to likely levels of impact from proposed Project activities;
- Based on prioritization, to gather information from these stakeholders to establish a baseline description of the affected socio-economic environment in which the Project is proposed to take place;
- To outline the higher level socio-economic environment of the proposed Project at national, provincial, district and municipal levels;
- To overlay proposed Project activities onto the socio-economic baseline environment and identify impacts related to social, economic and community health themes.
- To assess the significance of the impacts and develop mitigation measures to avoid impacts where they are unacceptable, optimise opportunities and to manage and reduce residual impacts.

The latter two points will be addressed in the Impact Assessment section of this Report (*Chapter* 9).

1.6 THE PROJECT LOCATION

The Project is located within the Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities which fall within the greater Gert Sibande District Municipality, in the Mpumalanga Province of South Africa. These two Local Municipalities are further divided into Wards. Of relevance to this Project are Wards 2 and 3 of the Mkhondo Local Municipality (MLM) and Wards 5 and 10 of Dr. Pixley Kalsaka Seme Local Municipality (PKSLM) (***Error! Reference source not found.*** and *Figure 1.3*).

1.6.1 The Study Area and Zones of Influence

The geographical focus of the socio-economic Study Area was defined during Scoping, based on the location of the Project [1] and description of the Project components (*Section 1.2* of this Chapter) and is highlighted in Figure 1.4 by a yellow and green outline.

Further, the SIA has defined three Zones of Influence that make up the broader Study Area – two zones are inside the original Study Area while Zone 3 refers to Driefontein. The zones are categorized by the extent to which a community / individual is likely to be affected by the Project, and the extent to which a community / individual is likely to influence the Project through attitudes, concerns, and support for / opposition to the Project. Two zones within this area (Zone 1 and 2), where the influences of Project activities will be more directly experienced, constitute the main focus of this SIA. Zone 1 of Influence includes homesteads that are anticipated to be directly affected while Zone 2 homesteads have a greater physical buffer between them and project infrastructure and influences (air, noise, vibrations etc.). Zone Three and the broader municipal, district and provincial boundaries give context to the socio-economic environment. The Zones are explained in *Table 1.2* overleaf.

[1] When commenting on issues likely to arise from the Project, the reader should note that all comments are based on the premise of "if the Project is approved" or "if the Project goes ahead". This decision is to be made by the developer based on the financial feasibility of the Project and by the South African government based on the ESIA.

Table 1.2 Defining the Zones of Influence

Zone	Description
Zone 1 (Directly Affected Parties)	• Residents of homesteads and settlements within the Project footprint and up to a 1km distance from Adit A and the Ventilation Adit (Adit B) fence lines. • Residents of homesteads and settlements within the conveyor footprint and up to a 500m distance from the fenced overland conveyor system and associated service road / infrastructure corridor. • Residents of homesteads and settlements directly above the underground mine footprint. • Land users (grazing and farming) within this designated area (1km and 500m). • Land owners – Mr Greyling and Kangra Coal. • Community Property Associations (CPAs) and individual residents who own land on which infrastructure will be established and whose surface area is above ground where mining / blasting activities will occur (eKaluka and Thuthukani CPAs). • Land claimants for Twyfelhoek 379 and Donkerhoek 14.
Zone 2 (Inconvenienced parties)	• Homesteads and settlements potentially affected by nuisance factors (noise, vibrations, dust etc.) beyond the 1km / 500m Zone 1 but within 2kms / 1km of Adits A and B and the conveyor system respectively.
Zone 3 (Interested parties and Authorities)	• Driefontein residents who impact upon the Project's license to operate as a result of legacy issues resulting from current Kangra Coal operations in the area. (Individuals who attended public meetings). • Authorities and traditional structures for the affected wards and municipalities.

Figure 1.3 Contextual Map: Municipal Wards relevant to the Study Area

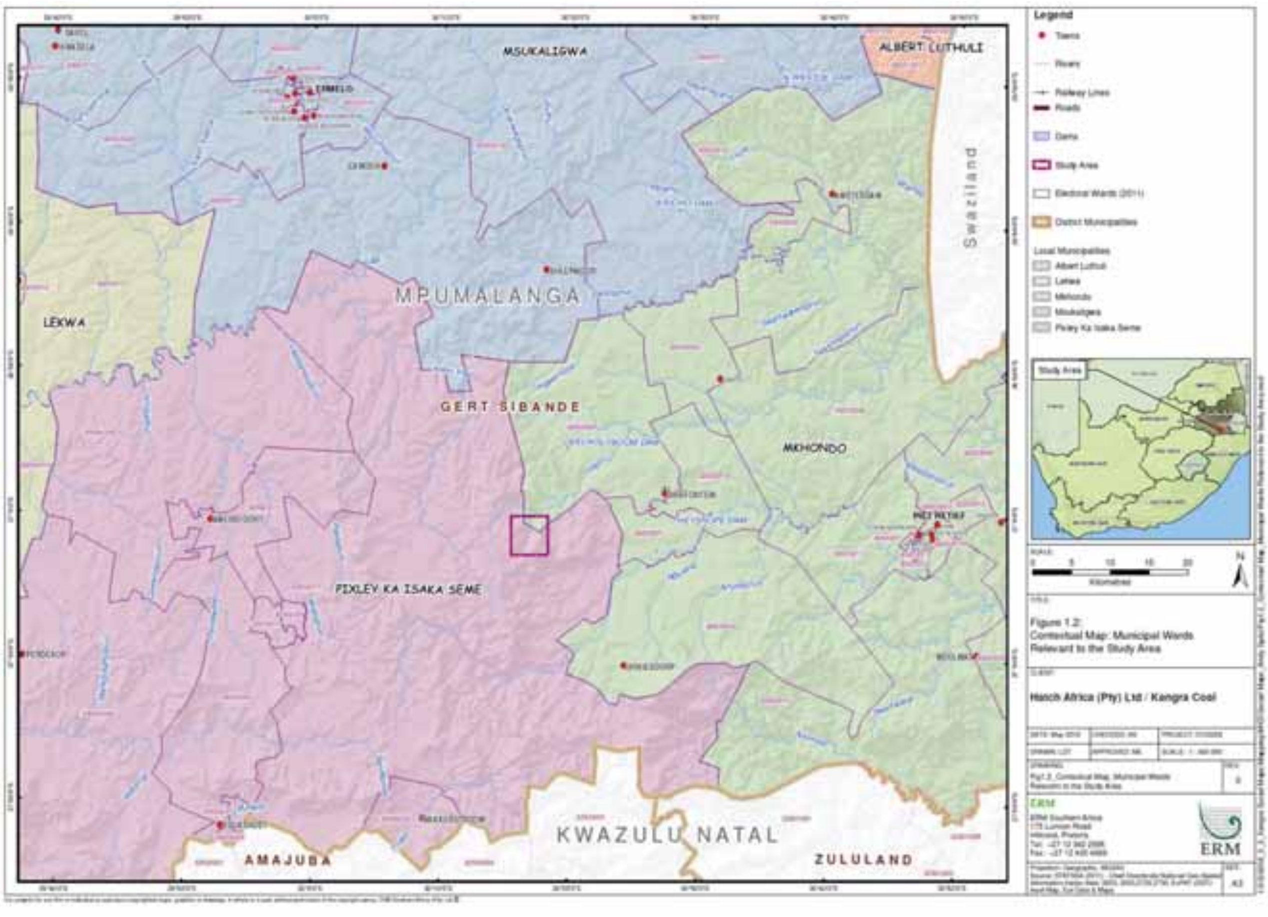
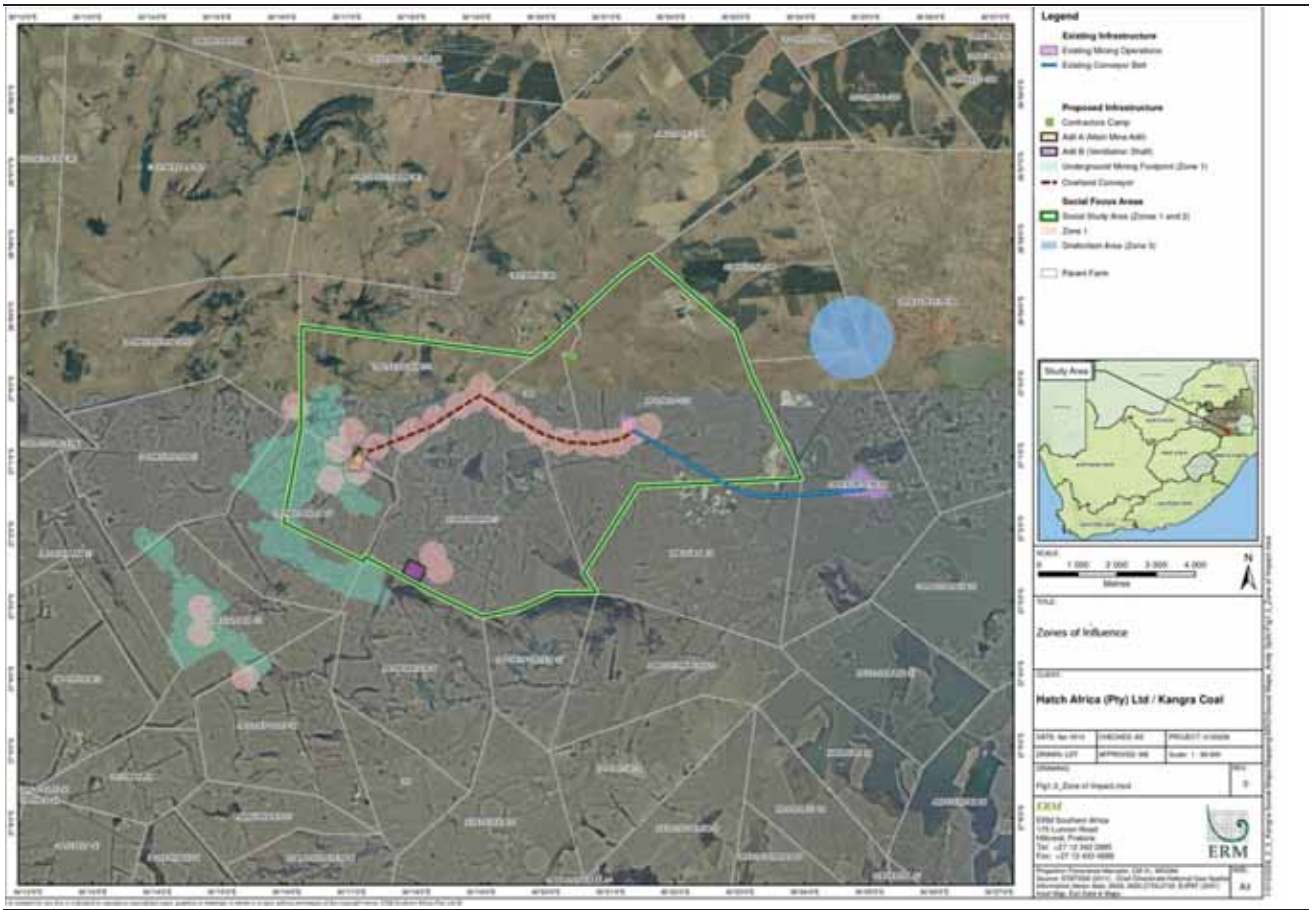


Figure 1.4 Zones of Influence



The Project is anticipated to impact particularly on owners, residents and communities on the farms Twyfelhoek, Kransbank, Donkerhoek, Rooikop and Nooitgezien.

1.7 METHODOLOGY

Baseline data for this report has been gathered using primary and secondary information.

1.7.1 Secondary Data

A review of available information on demographics, local socio-economic and political history, land-use and tenure as well as the development policy environment relevant to the Study Area was undertaken and are referenced in the *References Section* at the end of this report.

Previous stakeholder engagement activities as well as existing documents for current Kangra Coal activities in the area have also been used in gaining an understanding of the baseline environment and of the developer.

1.7.2 Primary Data

Primary field data for the social baseline description was collected using both qualitative and survey based methods. A team of four researchers and three local translators, fluent in the relevant Study Area languages, worked in the field over a four-day period.

Using aerial images, a visual homestead count was undertaken for the social Study Area. Approximately 112 homesteads or large structures were identified and numbered. These were then divided into their Zone of Influence with 42 homesteads identified in Zone 1 and the remaining 70 homesteads in Zone 2. Using these Zones, a survey of 45 homesteads(1) in the vicinity of the Project Area generated basic systematic biographical and homestead socio-economic data, and highlighted attitudes to the proposed Project and Kangra Coal's existing operations in general. Of this total number of homesteads in Zones 1 and 2, approximately 78% of Zone 1 homesteads were interviewed and 17% of Zone 2 (33 and 12 homesteads respectively).

The survey data should be regarded as non-random as it reflects the purposeful selection of homesteads that were located in close proximity to proposed Project activities and includes only those homesteads where a representative was willing and able to talk to enumerators over the research period. Survey results may not therefore necessarily be representative of the broader social Study Area. Despite these limitations the survey provides the

[1] The term "homestead/s" and "household/s" are used interchangeably.

most empirically detailed and reliable profile of the affected communities to date.

Survey data was collected through a standardized questionnaire (*Appendix A).* Given the time constraints on data collection, the questionnaire focused on the rapid and accurate collection of basic biographical and socio-economic characteristics as well as selected community attitudes to the Project and Kangra Coal's current operations in general. Survey data was analysed to highlight relationships between selected variables, to assist in predicting both the scope and scale of socio-economic impacts associated with the proposed Project.

Wherever possible and appropriate, additional qualitative data was collected from survey respondents, using semi-structured techniques. Researchers conducted qualitative enquiries with reference to a set of guidelines that were provided in advance (*Appendix B*). Researchers were, however, also encouraged to collect additional narrative-based data that appeared to be relevant, but which was not included in the guidelines. Beyond extended interviews with survey respondents, additional in-depth interviews were conducted with key informants. These included residents as well as non-residents of the Study Area: Acting Chief Yende; The eKaluka Communal Property Association (CPA) Committee and Ward Counsellors of wards 1, 2 and 18 of Driefontein. Where representatives had not been present during fieldwork, telephone interviews were held to fill information gaps. These included conversations with the Thuthukani and eKaluka CPA chairpersons as well as a representative of Birdlife Africa. Mr CJ Greyling, a private owner in Zone 1, was also interviewed telephonically and the standardized questionnaire and qualitative information was gathered from him.

1.8 ASSUMPTIONS AND LIMITATIONS

The following **assumptions** underlie this study:

- All relevant Project design information has been provided and no significant changes have been/will be made without appropriate additional studies being undertaken;

- The proposed Project will be undertaken within the legal framework of the country – including the recognition of the voluntary nature of resettlement and people's entitlement to choose not to resettle or to negotiate their resettlement conditions;

- Recommendations made in this report will be fully implemented as part of the legally binding ESIA and associated SEMP. In the absence of such commitment the value of the impact assessment is significantly undermined.

- Where information hasn't been available this report errs on the side of caution to avoid unanticipated impacts on people and their property and over-stated potential benefits.

- Detailed information about underground blasting and vibrations was not available and therefore the area of impact is cautiously estimated to extend 500m around any underground blasting activities. This is based on Kangra Coal's current safety protocols which require adjacent mines to be warned of blasting activities within 500m of their activities.

- The entire overland conveyor system will be fenced preventing random access across it. Culverts will be constructed to enable passage of people and animals at regular intervals.

The following **limitations** frame this study:

- The baseline data collection and impact assessment have been undertaken within a short timeframe limiting the level of detail of social and particularly livelihood data.

- Detailed information regarding the Project's local content, anticipated employment figures and related local spending on salaries and services, are not available at this stage and have therefore not been included in the impact assessment process of this report.

- No permission was granted during the fieldwork to access Donkerhoek farm therefore interviews were done off-site and information about homesteads is not verified.

2 INSTITUTIONAL CONTEXT

This section of the report briefly presents aspects of South Africa's institutional structures that are relevant to the Project. The levels of government outlined will have varying jurisdiction over the proposed Project. Therefore an understanding and interaction between the parties will be necessary throughout the Project's lifecycle.

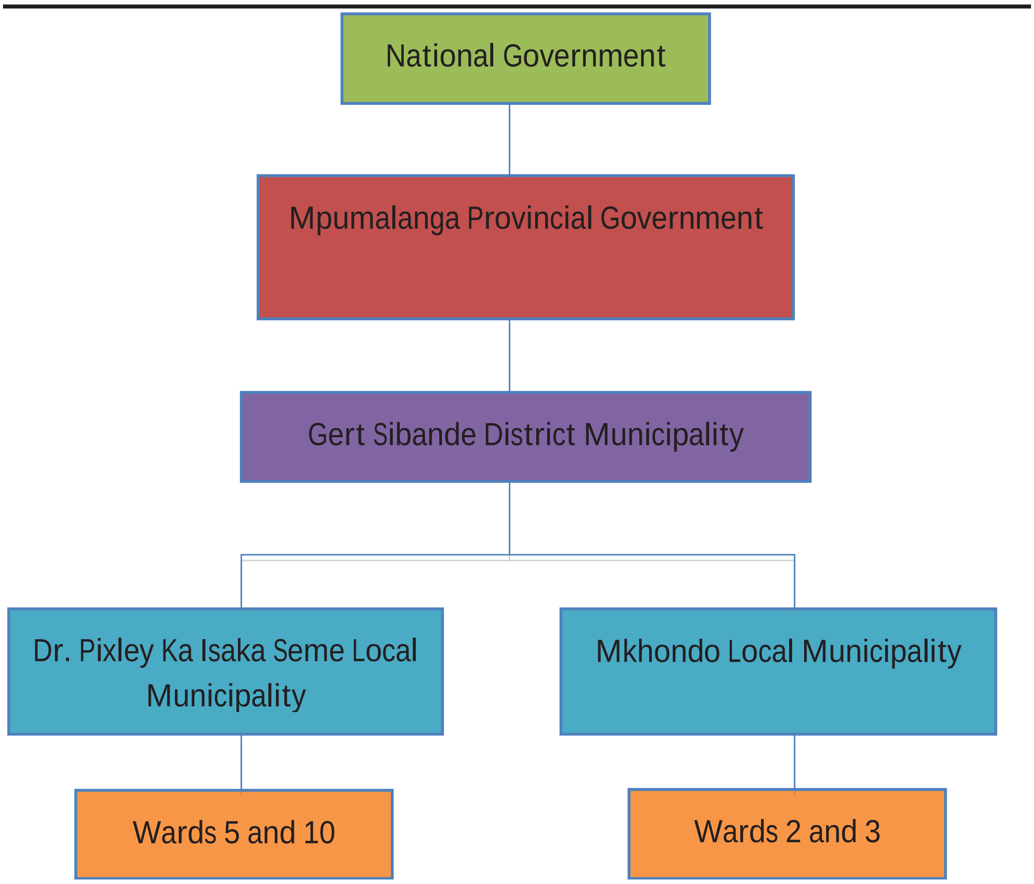
2.1 FORMAL AND TRADITIONAL ADMINISTRATIVE STRUCTURES

2.1.1 Formal Administration

South Africa is a constitutional democracy that is made up of three government structures: national, provincial and local government, each obtaining powers from the Constitution. It is a sovereign, democratic state and is divided into nine provinces that each has a provincial legislature. The provincial government, and in the case of this proposed Project, the Mpumalanga Provincial Government, is responsible for providing a strategic vision and framework for the province, as well as ensuring cooperation between municipalities and ensuring each municipality performs their respective functions. The district and local municipalities are each responsible for the provision of services and infrastructure within their municipal boundaries (see *Figure 1.1* and *Figure 1.2*). This is facilitated through the development and implementation of Integrated Development Plans (IDPs), Spatial Development Frameworks (SDF) and Local Economic Development (LED) Plans, among others.

As mentioned above, wards 2 and 3 of the Mkhondo and 5 and 10 of Dr. Pixley KaIsaka Seme Local Municipalities, which fall within the greater Gert Sibande District Municipality, in the Mpumalanga Province, provide the geo-political context of the proposed Project.

Figure 2.1 Formal Administrative Structure - National to Ward Level



At the national level, there are a number of ministries within whose domain the Project would fall including Mineral Resources; Water Affairs; Energy; Agriculture, Forestry and Fisheries; Social Development; Rural Development and Land Affairs. However, impacts relating to the Project would be monitored and managed at the Provincial level in relevant departments and through local government, which includes district and local municipalities and wards. Key amongst these Provincial departments are listed below in *Table 2.1* together with their mission or mandate.

Table 2.1 Provincial Departments Relevant to the Project

Mpumalanga Department	Mission/Mandate
Agriculture Rural Development and Land Administration	• Comprehensive development strategy linked to land and agrarian reform and food security. • Speeding up growth and transforming the economy to create decent work and sustainable livelihoods. • Strengthening the skills and human resource base. • Sustainable resource management and use. • Building a developmental state including improvement of public services and strengthening democratic institutions.
Economic Development, Environment and Tourism	• Mandated to steer provincial economic growth activities and ensure the preservation of the environment. • Speed up economic growth and transform the economy to create decent work and sustainable livelihood for the people of Mpumalanga.

Mpumalanga Department	Mission/Mandate
Health	Mandated to provide and promote integrated quality health and social services in partnership with all stakeholders to ensure healthy lifestyles and reduce poverty in all communities in Mpumalanga. Services include: 1. Social Grants 2. Social welfare Services 3. Development Implementation 4. Health Programmes 5. HIV and AIDS Programmes 6. Maternal, Child and Women's Support 7. Mental Health Programmes 8. Rehabilitation Programmes
Human Settlement	Rural Housing Programmes including • Rural Subsidy: Informal Land Rights • Farm Worker Assistance
Education	Committed to render quality education and training, through good governance, effective teaching and maximum utilization of resources for socio-economic enhancement of all citizens.
Co-operative Governance and Traditional Affairs	Tasked to facilitate and co-ordinate Intergovernmental Structures and Development Agencies for Sustainable Integrated Service Delivery through participation and Traditional system of governance
Department of Social Development	Intent on enabling the poor, vulnerable and excluded within South African society to secure better lives for themselves.
Public Works, Roads and Administration	Acts as the custodian of public infrastructure including transport and other functions such as coordinating the provincial Expanded Public Works Programme.

The above mentioned Departments operate in clusters to achieve goals set in the Province's development and service delivery strategies. Relevant clusters include:

- **The Economic Cluster** (Finance, Agriculture, Rural Development and Land Administration, Public Works and Economic Development, Environment and Tourism); and

- **The Social Services Cluster** (Education, Health and Social Development, Human Settlement and Sports, Culture and Recreation).

District and local councils (which include the wards) are independent and have legislative authority over their areas. Their primary responsibility is district-wide planning and capacity building. The wards or local councils share municipal authority with the district under which they fall.

While governance within urban environments is clear, rural areas, where the most significant changes related to this proposed Project will occur, were largely ignored in the post-apartheid transitional structures (Galvin. M, 1999). Where local government is the interface between urban citizens and the state, in rural areas this interface is extremely weak (SACSIS, 2009). Resistance to Bantustan policies had weakened traditional authorities that had been entrenched under apartheid and that had generally reinforced undemocratic governance during the 1980s and early 1990s. However, these authorities remained in place post 1994 when the Government affirmed their existence through the establishment of the Congress of Traditional Leaders of South Africa (Contralesa). At the same time, the formation of Transitional Rural Councils maintained the control and power of the minority white rural population in local government. Together, these conditions ensured that the *status quo* in rural areas continued unchanged (Greenberg. S, 2009).

2.1.2 *Traditional Authorities*

The continuing significance of the role of traditional leadership within South African society is currently under discussion. This has been particularly so since the scrapping of Apartheid-era legislation, the Black Authorities Act (1951), which employed divide and rule tactics to undermine traditional power structures (SACSIS, 2010). Many laws enacted to replace this Act however continue to perpetuate some of the instituted "traditions", marginalising women and rural communities where about one third of South Africa's population still lives (SACSIS, 2010).

Against this backdrop it is worth noting that the chieftaincy structure still operates in the Study Area, albeit not strongly, and of relevance to the Project are Chiefs Yende, Mthetwa and Tshabalala.

Acting Chief Yende is seen as the main Traditional authority for the Project Study Area and Zones of Influence. His chieftaincy, Mahlapahlapa Kwa Yende Traditional Council, includes Project affected farms of Maquasa, Donkerhoek, Twyfelhoek, Rooikop, Nooitgezien as well as Driefontein.

In Mpumalanga traditional leaders' responsibilities specifically include:

- Referring all Chieftainship disputes to the Commission on Traditional Leadership Disputes and Claims; and

- Handling all conflict and disputes between Traditional Leaders and the Community. (http://www.mphtl.gov.za/)

The role of traditional leadership in capacity building and rural development is extremely limited.

Figure 2.2 ***Traditional Leadership Structure***

As depicted in *Figure 2.2* above, the Department of Cooperative Governance and Traditional Affairs (DoCGTA) is responsible for overseeing the traditional leadership of South Africa's indigenous communities at a national level. It is also responsible for managing the relationship between the national government, the provincial governments and municipalities in regards to traditional leadership. The Mpumalanga Provincial House of Traditional Leaders draws its mandate from the DoCGTA; the mission is to "represent the aspirations of traditional communities by promoting co-operative governance" (http://www.mphtl.gov.za/). The Gert Sibande District House of Traditional Leaders falls below the provincial level and is made up of the following traditional leaders as of 2013 (http://www.mphtl.gov.za/):

Table 2.2 ***Gert Sibande District Traditional Leaders***

Traditional Leaders	
Inkhosi KJ Malaza	Chairperson
Inkhosi LF Nkosi	Deputy Chairperson
Inkhosi TP Nkosi	Member
Inkhosi SM Hlatshwayo	Member
Inkhosi AJ Tshabalala	Member
Inkhosi SM Mnisi	Member
Inkhosi ME Nkosi	Member
Inkhosi TM Nkosi	Member

3 LAND TENURE AND USE

3.1 HISTORICAL CONTEXT

This section of the report highlights issues of land tenure and access, which are central to the proposed Project, as it requires access to approximately 48.4ha[1] of land currently under private and Communal Property Association ownership. Gaining access to this land for the proposed Project, and the repercussions for affected landowners and users, will have socio-economic implications and an appropriate understanding of tenure and access issues is therefore significant.

"For South Africans, land is as precious a commodity as water, and an issue as emotional and as deeply rooted as cultural expression. Perhaps more than any one thing, the ownership of land symbolises our freedom" (Blom, N. 2007).

3.1.1 The 1913 Land Act

"Awaking on Friday morning, June 20, 1913, the South African Native found himself, not actually a slave, but a pariah in the land of his birth"(Plaatjie, S.T. 1916).

Briefly, the promulgation, in 1913, of the Native Land Act set out to facilitate the formal establishment of African reserves. 7% of South Africa's land area was set-aside for this purpose and it was from these reserves that the growing urban areas, the mines and urban employers drew migrant labour. In addition to addressing the labour needs of the mines, the Act also set out to eliminate independent rent-paying black tenants and cash croppers residing on white-owned land. To achieve this, black residence on white land was restricted to labour tenancy[2] or wage labour. In addition, blacks were prohibited from land ownership outside of the reserves. (http://www.sahistory.org.za/control-1910-1948)

"Land in the reserves (later termed homelands) was almost entirely held under the system of so-called communal tenure, controlled by the tribal chiefs and village headmen. These 'traditional' leaders were promoted by the apartheid regime as the principal form of local government in the reserves, and played an important part in the operation of the homeland system." (Lahiff, E. 1997)

[1] This calculation is based on the Project Description footprint requirement calculations.

[2] This relationship regulates the right of a "tenant" to live on a farm dependant upon at least one family member providing labour to that farm.

3.2 LAND REFORM AND REDRESS POST-APARTHEID

Based on the significance of land in both the national and personal arenas of South Africa, the relevant legal structures or tools used to redress discriminatory land legislation, ensure security of tenure, and to establish communal access and title to land are presented below:

3.2.1 Land Reform (Labour Tenants) ACT, 1996 No. 3

Key points of relevance to this Project are:

- Enactment of this Act was intended to provide security of tenure for labour tenants[1] and those persons occupying or using land as a result of their association with labour tenants; and to provide for the acquisition of land and rights to land by labour tenants;
- The Act recognised that the institution of labour tenancy in South Africa (still dominant in 1996) was the result of racially discriminatory laws and practices which led to the undermining of human rights and denial of access to land;
- It intended to ensure adequate protection of labour tenants (as people disadvantaged by unfair discrimination) in order to promote their full and equal enjoyment of human rights and freedoms; and
- It established measures to assist labour tenants to obtain security of tenure and ownership of land and thereby prevent further prejudice against them.

3.2.2 Extension of Security of Tenure Act, 1997

Key points of relevance to this Project are:

- This Act was intended to provide for measures with State assistance to facilitate long-term security of land tenure (including purchase of land);
- It was intended to regulate the conditions of residence on certain land;
- The Act was to prevent unfair eviction, by farm owners, of labour tenants from heir homes and avoid the hardships and social conflict that could arise in such situations;
- The Act should promote the achievement of long-term security of tenure for occupiers of land, where possible through the joint efforts of occupiers, landowners and government bodies while giving due recognition to rights, duties and interests of the landowner.

[1] A 'labour tenant' is a person who is residing, or has a right to reside, on a farm, or has a right to use cropping or grazing land on a farm in return for labour, or is a child or grandchild of such a person.

3.2.3 Communal Properties Associations Act, 1996

A key piece of legislation that shapes land ownership in the Study Area and in the Zones of Influence in particular is the Communal Properties Association Act (CPA Act).

The CPA Act of 1996 was developed to address the need for communities to form Communal Property Associations (CPAs) in order to acquire, hold and manage property. The Act also outlines that CPAs must be non-discriminatory, equitable, democratic and accountable to members so that members are protected against abuse of power by other members. (CPA Act, 1996). Central to the Act, and working in harmony with the Land Reform and the Extension of Security of Tenure Acts, described above, is the creation of a tool through which communities could reinforce the security of their land tenure (CPA Act, 1996, P.1).

A community application to become a CPA can be considered if the group qualifies based on several factors including:

- The main objective is the holding of property in common;
- A community constitution has been developed;
- Meetings to form the CPA were attended by a substantial number of the members of the community and the draft constitution was supported by the majority of the community present at meetings;
- The constitution reflects the view of the majority of the members of the association; and
- The constitution was adopted through a fair and inclusive process.

Key points that need to be addressed in a CPA constitution are:

- Description of land to be owned by the CPA;
- The appropriate qualification of members and their names;
- The purpose for which property is to be used;
- The allocation of the property;
- Regulation of members ability to sell their rights and, if so, to whom; and
- Description of what is to happen to a member's property upon death.

Once registered and approved, a CPA has the authority to sue and be sued, and acquire rights and dispose of immovable property. They also become liable for immovable property, real rights by mortgage, servitude or lease. By law, a CPA must continue despite changes in leadership, or exit of members from the association. Any decision to dissolve the CPA, change the constitution, or to dispose of or acquire property requires an "inclusive" decision making process and majority agreement. It is illegal for any one person to grant or purport to grant community property rights of a CPA.

4 DEVELOPMENT CONTEXT

This section presents a brief summary of the country's development environment and highlights the need for social and economic development. It sets the backdrop for a brief overview of some current policies, where they come from and how they are shaping the socio-economic and development planning that is affecting the broader Province and District in which the proposed Project would take place.

According to the CIA Factbook 2012[1] South Africa is a middle-income, emerging market; abundant in natural resources; has well-developed financial, legal, communications, energy, and transport sectors; is the 18th largest stock exchange in the world; and has modern infrastructure supporting a relatively efficient distribution of goods to major urban centres throughout the region. A combination of macro-economic stability and a global commodities boom facilitated strong growth from 2004 to 2007. This began to slow in the second half of 2007 resulting from a national electricity crisis followed by the global financial crisis and its impact on commodity prices and demand. GDP fell nearly 2% in 2009 into negative growth territory but recovered slightly in 2010 and has averaged approximately 3% over the past 13 quarters to end 2012. Unemployment is high at more than 25% of the economically active population.

Difficulty with power supply is one of the ongoing constraining factors in development in South Africa. Eskom, the State power supplier, has encountered problems with aging infrastructure and with meeting electricity demand, which resulted in rolling blackouts ("load-shedding") in 2007 and 2008 to residents and businesses in the major cities. In February 2013 Eskom was granted permission from the National Energy Regulator of South Africa to increase the cost of electricity by eight percent per year for the next five years – this was fifty percent lower than the power utility's sixteen percent per annum request. It follows a number of years of even higher increases that have not helped to stabilise the electricity challenges in the country.

Other significant economic problems continue from the pre-1994 period - especially poverty, lack of economic empowerment among the disadvantaged groups, and skills shortages. South Africa's current economic policy focuses on controlling inflation, however, significant budget deficits even those reported in the 2013 budget, continue to undermine its ability to deal with many prevalent economic problems. Poverty and unemployment, particularly in rural areas, play a significant role in the livelihood activities and perceptions amongst residents in the Study Area.

[1] CIA World Factbook - https://www.cia.gov/library/publications/the-world-factbook/geos/sf.html

4.1 NATIONAL, PROVINCIAL AND DISTRICT LEVEL DEVELOPMENT POLICY CONTEXT

Against the backdrop of socio-economic challenges, the following table highlights a selection of national to local level policies seen to be most pertinent to the development agenda in the broader Study Area and to the Zones of Influence in particular. It's valuable to keep this in mind as it also provides insight into potential areas of partnership between the Project proponent and provincial and local government when planning Project mitigation and optimisation measures.

Table 4.1 Development Policy Context

Policy	Key Aspects/Objectives
National Level Policy	

National Development Plan 2030 (2012) (NDP)	• The NDP, adopted by the ANC National Conference in Mangaung (2012) "envisages an economy that serves the needs of all South Africans – rich and poor, black and white, skilled and unskilled, those with capital and those without, urban and rural, women and men."
	• The Vision is that, in 2030, the economy should be close to full employment; people will be equipped with the skills they need; ownership of production will be less concentrated and more diverse (where black people and women own a significant share of productive assets); and the economy will be able to grow rapidly, providing the resources to pay for investment in human and physical capital.
	• Subsequently, the NDP proposes to create 11 million jobs by 2030 by:
	  • Realising an environment for sustainable employment and inclusive economic growth.
	  • Promoting employment in labour-absorbing industries.
	  • Raising exports and competitiveness.
	  • Strengthening government's capacity to give leadership to economic development.
	  • Mobilising all sectors of society around a national vision.

New Growth Path (2009)(likely to be superseded by the NDP 2030 but still in place)	• Presents growth objectives nationally and per province.
	• Mpumalanga Province (and Gert Sibande District Municipality) having to proportionally contribute towards the achievement of increased employment in, amongst others "Jobs Drivers" in the main economic sectors:
	  • 300 000 in Agriculture smallholder schemes
	  • 145 000 jobs in agro processing by 2030
	  • 140 000 additional jobs in Mining by 2020, and
	  • 200 000 jobs by 2030, not counting the downstream and side stream effects.
	  • 350 000 jobs as per the Industrial Policy Action Plan 2 targets in manufacturing by 2020
	  • 250 000 jobs in Business and Tourism by 2020

Government Outcomes (adopted in 2010)	• One of the 12 Outcomes of public service delivery priorities highlighted in the New Growth Path and relevant to this Project is **Outcome 7: Vibrant, Equitable And Sustainable Rural Communities And Food Security**, to be achieved through:
	  • Sustainable agrarian reform and improved access to markets for small farmers.
	  • Improved access to affordable and diverse food.
	  • Improved rural services and access to information to support livelihoods.
	  • Improved rural employment opportunities.
	• Enable institutional environment for sustainable and inclusive growth.

Medium Term	• Seeks to identify the major strategic choices needed to deal with

Policy	Key Aspects/Objectives
Strategic Framework (MTSF) (2009)	poverty and underdevelopment. Key objectives include: • Reduction of poverty and underemployment. • Provision of skills required by the economy. • Ensuring that South Africans can fully exercise their constitutional rights and enjoy the full dignity of freedom. • Achievement of a better national health profile and reduction in preventable deaths. • Reduce serious and priority crimes. • Position SA strategically as an effective force in global relations.
National Spatial Development Perspective (NSDP) (initiated in 1999)	• Argues that government's social objectives will be best achieved through infrastructure investment in economically sustainable areas with proven development potential. Therefore, **areas displaying little or no potential for growth should only be provided with the constitutionally mandated minimum levels of services**, and the focus of government spending should rather be on the people, i.e. social development spending. Government spending on fixed investment, beyond the constitutional obligation to provide basic services to all citizens (such as water, electricity as well as health and educational facilities), would therefore be focused on localities of economic growth and / or economic potential in order to attract private-sector investment, stimulate sustainable economic activities and / or create long-term employment opportunities[1]. • Aims to not only provide a strategic assessment of the spatial distribution and socio-economic characteristics of the South African population, but to gain a shared understanding of the distribution of economic activities and potential across the South African landscape – based on this the NSDP sets out a number of guidelines for infrastructure development in South Africa.
Provincial Level Policy	

Mpumalanga Economic Growth and Development Path (MEGDP) (2011)	The primary objective of the MEGDP is to foster economic growth that creates jobs, and reduce poverty and inequality in the Province. Main economic sectors (all of which occur in the Gert Sibande District) identified as key to spur economic growth and employment creation and of relevance to this Project include:
	• Agriculture and forestry through:
	  • skills development;
	  • support for small-scale farmers and agri-business;
	  • fast-tracking the settlement of outstanding land claims;
	  • optimal utilization of restituted and distributed land;
	  • increased acquisition of agricultural land for the previously disadvantaged; and
	  • revisiting of current legislation to create balanced development in areas of competition between mining and farming.
	• Mining and energy through:
	  • Upgrading and maintenance of coal haulage network;
	  • Increased levels of higher skilled graduates;
	  • Expanding the water network and increase reliance on water transfer schemes;
	  • Increase South Africa's load and improve alternate energy supply;
	  • Establishment of a mining supplier park to enhance enterprise development in the province ;
	  • Resolve land claims to release land for development. Comprehensive support to small-scale mining enterprises to exploit opportunities presented by corporate social; and
	  • Investment initiatives, retreatment of sub-economic deposits

[1] It's worth noting that the Local Municipalities of Mkhondo and Pixley Ka Seme are defined within the NSDP classification as areas of Combined Poverty and Economic Activity with high levels of poverty concentration situating them within the environment identified for sustainable economic development while being in need of significant social development spending.

Policy	Key Aspects/Objectives
	and dumps, and dimension stones. • Tourism and cultural industries through: • Broadening and diversifying the primarily nature-based tourism product offerings of Mpumalanga into other segments of the market and subsequently grow the economy that create jobs through: o sustained investment in all aspects of the industry – new products, destination marketing, human capital development in the service industry; o investing in economic infrastructure, e.g. airport, International Conference Centre, sports Academy, roads for tourism routes, etc. o Comprehensive support to SMMEs to exploit opportunities in the tourism and cultural industries.
District Level Policy	
Gert Sibande District Municipality Integrated Development Plan (IDP) (2012/13 - 2016/17)	• Ensuring a better life for all through: • Municipal infrastructure development; • Economic and tourism promotion; • Functioning ward committee system; • Community and stakeholder participation; • Efficient systems and administration; and • Human development.
Gert Sibande District Municipality Spatial Development Framework (SDF) (2009)	• Aims to deal with the spatial restructuring in an integrated manner, and to comply with the Municipal Systems Act (2000). • Local authorities embarked on a process of formulating Spatial Development Frameworks (SDFs) for their areas of jurisdiction as part of their Integrated Development Plans (IDPs). This included: • assessing existing levels of development in the municipality including identification of communities which do not have access to basic municipal services; • developing priorities and objectives including local economic development aims and internal transformation needs; • establishing development strategies aligned with national or provincial sectoral plans and planning requirements binding on the municipality in terms of legislation; • establishing a spatial development framework which must include the provision of basic guidelines for a land use management system for the municipality. • The SDF should promote sustainable development i.e. find a balance between the natural, social and Economic environment. This definition is also in line with the Local Agenda 21 Principles. • The general principle endorsed by this Bill is that spatial planning, land use management and land development must promote and enhance • Equality; • Efficiency; • Integration; • Sustainability; and • Fair and good governance.

When designing the proposed Project and planning for impact mitigation and maximization of opportunities, Kangra Coal would benefit from engaging with the agencies implementing these national, provincial and district development policies – particularly when defining focus areas in the Social and Labour Plan (SLP) and when identifying non-core activities, like corporate social responsibility (CSR) projects that could partner with broader provincial and district programmes to ensure sustainability beyond the life of the Project.

The following chapter provides an overview of the National, Provincial and District environment. The selection of this information is based on adding value to an understanding of the context in which the Project and its proposed activities in the Study Area will take place.

A summary of key socio-economic indicators is provided in *Table 5.1* below. Unless stipulated, the data come from the CIA World Factbook, 2012.

Table 5.1 South Africa Socio-Economic Indicators

Social/ Demographic	
Population estimate	48,810,427 (July 2012 est.)
Age Structure	0-14 years: 28.4% (male 6,955,602 / female 6,914,246) 15-64 years: 65.7% (male 16,172,553 / female 15,902,889) 65 years and over: 5.9% (male 1,151,510 / female 1,713,627) (2012 est.)
Median age	25.3 years
Population growth rate	-0.412% (2012 est.)
Urban / Rural population (2010)	
Rate of Urbanization	1.2% annual rate of change (2010-15 est.)
Birth rate:	19.32 births / 1,000 population (2012 est.)
Death rate:	17.23 deaths / 1,000 population (July 2012 est.)
Infant mortality rate	42.67 deaths / 1,000 live births
Life expectancy at birth	49.41 years (2012 est.)
Total fertility rate:	2.28 children born / woman (2012 est.)
HIV / AIDS – adult prevalence rate	17.8% (2009 est.)
HIV / AIDS – people living with HIV / AIDS	5.6 million (2009 est.)
HIV / AIDS – deaths:	310,000 (2009 est.)
Functional literacy (1): (2011 estimate) (Stats SA Census 2011)	19.1% (overall)
Primary School net enrolment ratio (Unicef SA Stats)	90 (2007-2009)
Economic	
GDP - Purchasing Power Parity (PPP) (2)	$578.6 billion (2012 est.)
GDP – real growth rate	2.6% (2012 est.)
GDP – per capita PPP (3)	$11,300 (2012 est.)
GDP – composition by sector	Agriculture: 2.4% Industry: 32.1% Services: 64.9% (2012 est.)
Unemployment Rate	24.4% (2012 est.)
Investment - gross fixed	19.5% of GDP (2012 est.)

Source: CIA World Factbook, South Africa; 2012

(1) Literacy: age 15 and over can read and write.
(2) Purchasing Power Parity: An economic theory that estimates the amount of adjustment needed on the exchange rate between countries in order for the exchange to be equivalent to each currency's purchasing power (Investopedia.com as accessed 31 May 2012 at http: / / www.investopedia.com / term)
(3) The value of all final goods and services produced within a country in a given year divided by the average (or mid-year) population for the same year.

5.1 DEMOGRAPHICS

5.1.1 National Level

According to the preliminary results of the Census 2011, South Africa's population increased from 40.5 million in 1996 to 51.7 million in 2011. KwaZulu-Natal and Gauteng have the majority of the county's population. There was a noticeable increase in the population in Gauteng from 18.8 percent in 1996 to 23.7 percent in 2011. Kwa-Zulu Natal's population remained almost constant (21,1% in 1996 to 19,8% in 2011). Amongst all the provinces, Northern Cape had the lowest population share (2,5% in 1996 and 2,2% in 2011) and Eastern Cape had a population decline from 15,1% 1996 to 12,7% in 2011. Mpumalanga's population makes up 7,8% of the country and it grew by about 52 000 people from 3,3 million in 2001 to just over 4 million in 2011 (Census 2011). The Province's growth rate between 1996 and 2011 is reported as 20% compared to the 15,5% average provincial growth rate for the period. This suggests an in-migration to the province that is significantly higher than for other provinces (Census 2011). The majority of this migration is into urban areas like Mbombela.

The overall sex ratio[1] was highest in GP and NW of over 100 in 2011. North West Province had a sex ratio of 98 in 1996 that increased to 103 in 2011. Mpumalanga's sex ratio was 91 in 2001 and increased to 97 in 2011 showing an increase in the number of men to women in the province over the past 10 years. Limpopo and Eastern Cape had sex ratios lower than 90 across the years. Evidence from 1996 and 2001 Censuses showed that the two provinces (Limpopo and Eastern Cape) were the most affected by outmigration of men in terms of inter-provincial migration (Census 2011).

5.1.2 Provincial Level

The Province of Mpumalanga is situated in the north eastern part of South Africa, bordering Mozambique and Swaziland to the east and Gauteng to the west. The Province is approximately 79 490m^2, the second smallest in South Africa, with the fourth largest economy (www.mpumalanga co.za). The town of Mbombela is the capital as well as the administrative and business hub of the area. The primary economic activity in the Mpumalanga is mining, followed by manufacturing and services. Tourism is also a significant contributor to the provincial economy.

Mpumalanga has within its jurisdiction three District municipalities, these being, Gert Sibande (pertinent to this study), Nkangala and Ehlazeni.

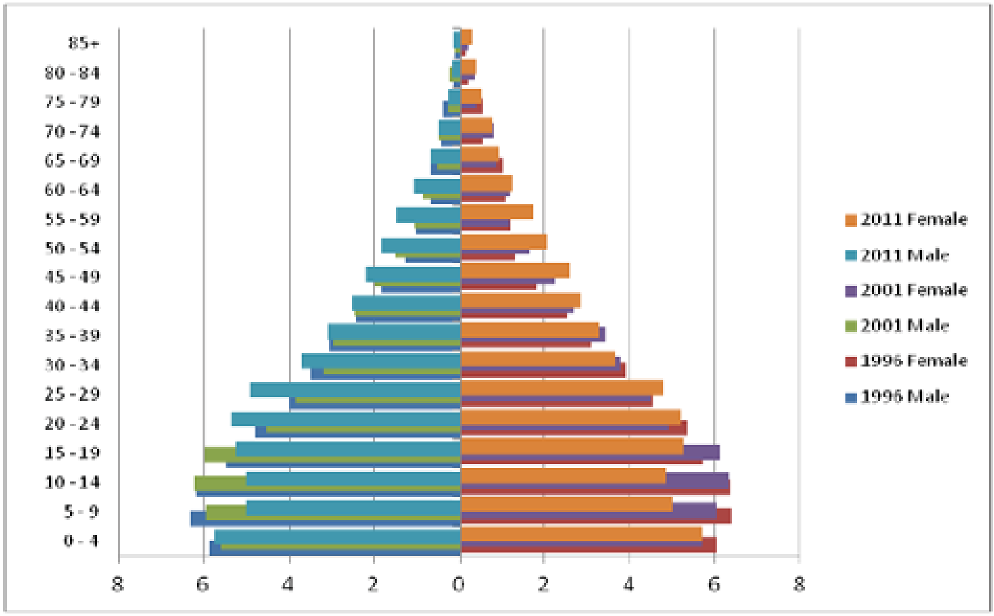
According to the 2011 Census, Mpumalanga had an estimated population of just over four million people, with a growth rate of 1.83 between 2001 to 2011

(1) Sex Ratio: Is the number of males for every 100 females. If it is above 100, it shows the predominance of males over females. When the number is lower than 100, the reverse is true. (Census 2011)

(Census, 2011). The number of homesteads within the Province is recorded at 1 075 488 for 2011 which is an increase from 785 424 in 2001.

Figure 5.1 shows the age and sex pyramid for Mpumalanga. In general, it indicates that the population is still young as the majority of the population is aged below 35 years.

Figure 5.1 Mpumalanga Population by age and gender - 1996, 2001, 2011



Source: Census 2011 – Mpumalanga Report

It's interesting to note the significant decline, for both males and females in the 5-19 age cohorts, between 2001 and 2011. This is the age range for most school-going children. Almost every other age cohort grew over the 10 years.

5.1.3 District Level

Of the three District municipalities mentioned above the Gert Sibande District Municipality is of relevance to this study. It consists of seven constituent Local Municipalities (GSDM IDP 2012-2013), including:

- Mkhondo Local Municipality;
- Dr. Pixley Kalsaka Seme Local Municipality;
- Govan Mbeki Local Municipality;
- Albert Luthuli Local Municipality;
- Msukaligwa Local Municipality;
- Lekwa Local Municipality; and
- Dipaleseng Local Municipality.

The Gert Sibande District Municipality (GSDM)

Spatially, GSDM is the largest of the three Districts in Mpumalanga Province covering 40 percent of the Province's land mass. The municipality comprises both Political (the Council, Mayor, etc.) and Administrative (Municipal Manager, Finance, Infrastructure Services, etc.) components.

The main responsibilities of the District Municipality are to maximize social development, thus leading to economic growth, both locally and on a broader scale (IDP 2012-2013). Apart from delivering basic services such as water, electricity and education, a new found role is to lead, manage and plan for development within its respective jurisdiction (GSDM IDP 2012-2013).

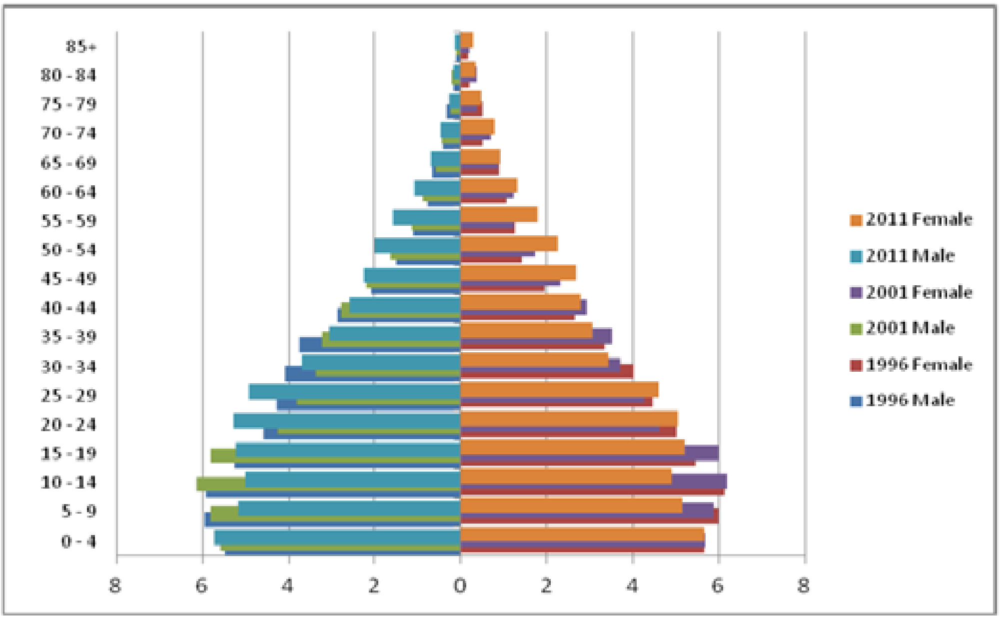
The GSDM has the smallest population size in the province numbering about 1 043 194 in 2011 (Census 2011). The total number of homesteads is 273 490 with an average homestead size of 3.8 (Census 2011). It also had the smallest population growth rate between 2001 and 2011 at 1.48 percent. This is lower than both the provincial and national growth rates (IDP 2010-2011). Within the same growth period, Mkhondo Local Municipality (LM) was the fastest growing LM at 1.84 percent, while Pixley KaIsaka Seme LM only grew at a rate of 0.30 percent (Census 2011). Both of these LMs are relevant to the Project as the broader Study Area straddles both.

The age and gender structure of the population, illustrated by the pyramid in *Figure 5.2* helps to anticipate population change and dynamics and to understand current needs. This would include planning for education for the younger cohorts, health care, particularly for vulnerable groups such as children and the elderly, skills training requirements and employment opportunities for the economically active population and planning for social security services such as child grants and pensions.

Figure 5.2 shows that in 2011, youth between 0-34 years constituted the largest share at 69.8 percent of the district population. Consistent with Provincial figures, the cohort between 5 and 19 dropped in size for both males and females. The age cohort 0 to 4 years represents the most populous age group with 127 297 at approximately 11.9 percent of the district while those aged 60 years and above accounted for 6.8 percent of the population. Although this group tapers off as would be expected, it is also apparent that the population in each of the older cohorts has grown marginally over the past 10 years (Census 2011). Additionally, women make up the majority of the population with a sex ratio[1] of 97 (Census 2011).

(1) Sex Ratio: Expressed as males / females in a population.

Figure 5.2 Gert Sibande District Population by Age and Gender



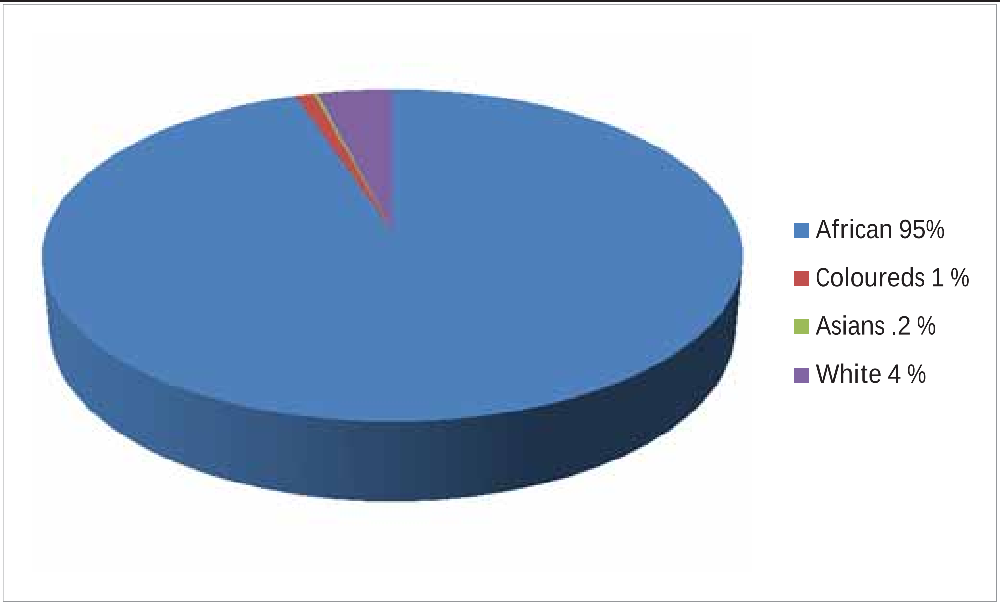
Source: Census 2011 – Mpumalanga Report

The 2011 Census revealed that the majority of the population in the District was black at a total population of 923 976, followed by whites at 94 279, coloureds at 10 767, and Indians / Asians at 11 002 in 2011 (Census 2011).

Throughout the Gert Sibande District more than half the population (57 percent) reside in urban areas with 53.6 percent of the entire black population living in urban areas. Twelve percent of the white population resides in non-urban areas, along with 17 percent of coloureds and 4.5 percent of Asians (GSDM IDP 2010-2011).

Figure 5.3 depicts racial demographics in Mkhondo LM.

Figure 5.3 Mkhondo Racial Demographics



Source: MLM IDP 2012-2013

5.1.4 Local Level

Mkhondo Local Municipality (MLM)

The Mkhondo Local Municipality (MLM) is located in the GSDM and is one of seven local municipalities whose boundaries are shown in *Figure 1.3* of this report. The municipality covers approximately 5000km^2 and is divided into 15 wards (MLM IDP 2010-2011).

The main towns in the municipality are Piet Retief, eThandakukhanya, Amsterdam and kwaThandeka, all being urban nodes (MLM IDP 2010-2011). The total population of MLM is approximately 171 591, with 81 986 males and 89 605 females (sex ratio of 92) (Census 2011). Between 1996 and 2011, the total population nearly doubled from 98 967 to 171 591 people (Census 2011). There are approximately 37 433 homesteads at an average homestead size of 4.6 (Census 2011).

Table 5.2 shows population by age cohort in MLM. (Census 2011).

Table 5.2 Mkhondo Local Municipality Population by Age Category

	0-4 years	5-9 years	10-14 years	15-24 years	25-64 years	65 and older
Population	21,657	21,069	20, 139	37,296	64,157	7,273
Percent	12.6	12.3	11.7	21.7	37.4	4.2

Source: Census 2011 – Mpumalanga Report

Zulu is the most widely spoken language in MLM with 88.2 percent of the population speaking it as their mother tongue. Roughly 4 percent of the population speaks Afrikaans, 2 percent speak English, 2 percent speak Swazi and 4 percent speak other languages (Census 2011).

Dr. Pixley KaIsaka Seme Local Municipality (PKSLM)

As the second relevant ward to the Study Area, PKSLM has 83 007 people in the municipality, which is a small decline from 80 736 in 2001; 39 360 are male and 43 647 are female – a sex ration of 90 (Census 2011). The population has been growing at an average 0.3 percent between 2001-2011, which is substantially less than the District rate of 1.48, the Provincial rate of 1.83 and an even more drastic decline in comparison to its own 2.8 percent growth rate between 1996 - 2001 (Census 2011).

According to the 2011 Census, approximately 91 percent of the population is black, 0.6 percent is coloured, 1.1 percent is Indian or Asian, 7 percent is white, and 0.3 percent is Other (Census 2011).

Table 5.3 below presents the population by age cohort (Census 2011).

Table 5.3 Dr. Pixley KaIsaka Seme LM Population by Age Category

	0-4 years	**5-9 years**	**10-14 years**	**15-24 years**	**25-64 years**	**65 and older**
Population	10,188	9,474	9,358	17,097	32,168	4,722
Percent	12.3	11.4	11.3	20.6	38.8	5.7

Source: Census 2011 – Mpumalanga Report

The most widely spoken language in PKSLM is Zulu with 88.2 percent of the population speaking it as their mother tongue. Almost 7 percent of the population speak Afrikaans, 2 percent speak English, 2 percent speak Sotho and 6.5 percent speak other languages (Census 2011).

5.1.5 Ward Level

Of relevance to this Project are Wards 2 and 3 of the MLM and Wards 5 and 10 of the PKSLM.

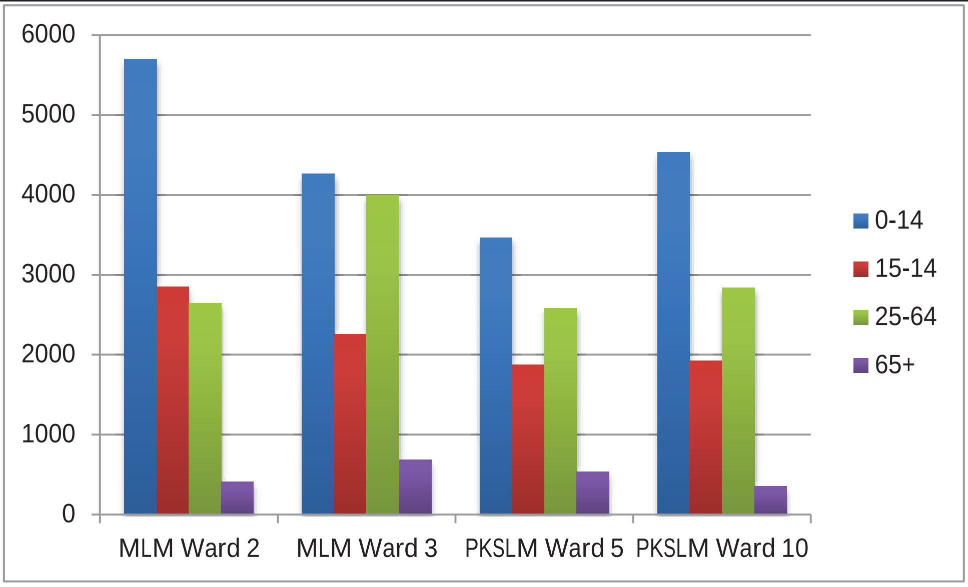
In 2001[1], the total population across the four relevant wards was 40 897 people of which 32% resided in Ward 2 of Mkhondo, 23% in Ward 3, 21% and 24% in Ward 5 and 10 of PKSLM respectively. All four Wards had an average percentage male / female population of 47: 53.

Age group representation at Ward level is shown in *Figure 5.4*. Collectively (across all Wards), a greater percentage of the population (44%) are in the 0-14 age cohort, with 21% in the 15-24 group, 30% in the 25-64 group and 5% in the

[1] No 2011 data is currently accessible at this Ward level.

over 65 age group. Of the population, 51% fell within the potentially economically active population, i.e. between 15-64 years.

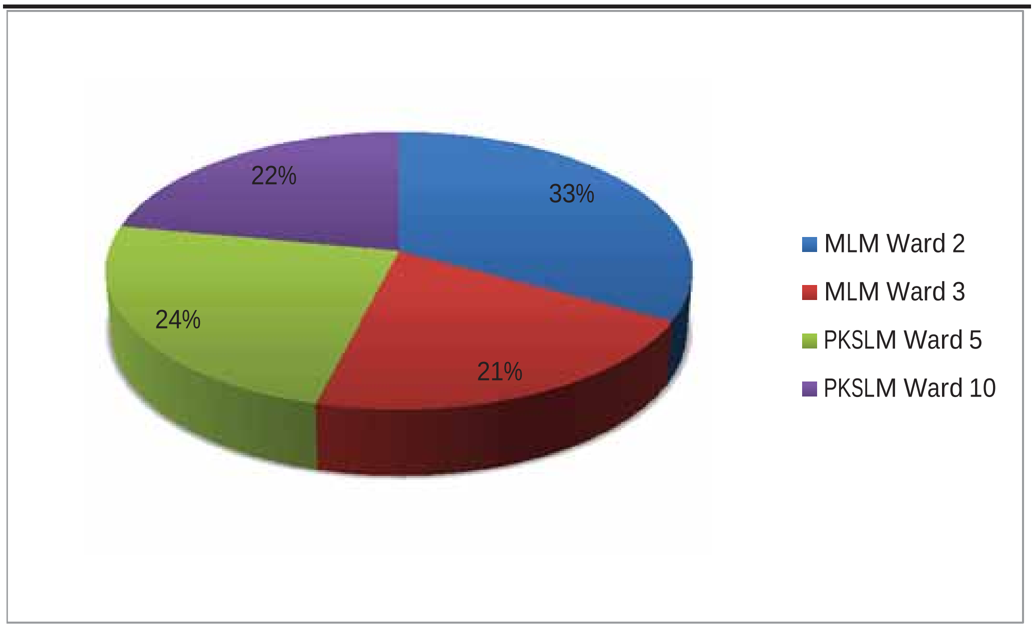
Figure 5.4 Age Group Presentation at Ward Level



Source: South Africa Population Census. 2001. Statistics South Africa. Government Printer

The total number of homesteads recorded across all four Wards was 7709. The number of homesteads per Ward (as a percentage) is reflected in *Figure 5.5* below. Given the populations in each of the four wards, it can be roughly assumed that homesteads across all four Wards average four to six members per homestead unit.

Figure 5.5 Total number of Homesteads



Source: South Africa Population Census. 2001. Statistics South Africa. Government Printer.

5.2 *MIGRATION PATTERNS*

Population has slightly increased on provincial, district and local levels in the Study Area according to 2001 and 2011 Census data (*Table 5.4*). Little secondary information exists that addresses the specific triggers of these changes. There is a perception that throughout the district in-migration occurs from sending communities in KwaZulu-Natal, Mozambique, and Zimbabwe and that these migrants work on farms; mines and in forestry in PKSLM and MLM respectively (Yende, 2013). The population of the PKSLM has been growing at an average 0.3 percent between 2001-2011, which is substantially less than the District rate of 1.48, the Provincial rate of 1.83 and an even more drastic decline from the population growth rate of 2.8 the Municipality experienced between 1996 - 2001. (Census 2011). This substantial difference may point to population out-migration but also coincides with provincial statistics related to areas affected by HIV/Aids. The GSDM Spatial Development Framework (2009) states: "Most notable is the decrease in the population numbers of the Mkhondo (-36,450), Pixley ka Seme (-14,800) and Lekwa (-12,100) local municipalities… between 2001 and 2007. Interestingly, those LMs having experienced the most notable decrease in population numbers since 2001 coincides with the areas indicated to be worst affected by the HIV/Aids virus... According to the Mpumalanga Provincial Integrated Spatial Framework, the impact of HIV/Aids between 2001 and 2011 will be the highest in the rural areas around Amsterdam, Iswepe, and Piet Retief" (GSDM Spatial Development Framework, 2009).

Table 5.4 Population Growth 1996 -2011

	1996	2001	2011	Population Growth Rate (2001 - 2011)
Mpumalanga Province	3 123 870	3 365 554	4,039,939	1.83
Gert Sibande DM	797 400	900 007	1 043 194	1.48
Dr. Pixley LM	70 178	80,737	83,235	.30
Makhondo LM	100 388	143 077	171,982	1.84

Source: 2011 Census –Mpumalanga Report

According to 2011 Census data, the majority of in-migration to MLM and PSLM is from other areas of Mpumalanga at 94.8 percent (*Table 5.5*). Although the perceptions expressed by residents of the Study Area emphasise major in-migration from neighbouring countries this is contradicted by the official figures which suggest the only 0 .8 percent of all migrants to both local municipalities come from outside of South Africa from the Southern Africa Development Community (SADC)[1] and of those 1,381 live in MLM and 330 live in PSLM (Census 2011).

1 Angola, Botswana, Democratic Republic of the Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Swaziland, Tanzania, Zambia, and Zimbabwe.

Table 5.5 In-migration to MLM and PSLM

Sending Province/Country	Mkhondo	Pixley	Total	Percent of Migrants
Kwazulu-Natal	3,010	1,373	4,383	1.7%
Gauteng	1,119	976	2,095	0.8%
Outside South Africa	1,571	516	2,087	0.8%
Mpumalanga	163,236	78,687	241,922	94.8%

Source: 2011 Census – Mpumalanga Report

5.3 EDUCATION

5.3.1 National Education Statistics

According to the South African School's Act of 1996 schooling is compulsory for children aged seven to 15 years old (Census 2011). Across South Africa, there has been a decline in the amount of the adult population (age 20 and older), who have had no schooling. According to the Census 2011, in 2011 only 8.6 percent of the population had no schooling compared to 17.9 percent in 2001. Additionally, there has been a steady upward trend in the amount of matriculating adults from 16.3 percent in 1996 to 28.9 percent in 2011 (Census 2011).

5.3.2 Local Education Statistics

National statistics also coincide with local data. In 2001 nearly 22,806 people aged 20 years and older had no schooling in MLM; this figure dropped substantially to 15,914 in 2011, a 30 percent decline. (Census 2011). Additionally, the amount of matriculating students more than doubled from 8,674 in 2001 to 22,600 in 2011. (Census 2011). Figures for PSLM are similar to MLM. In 2001, nearly 14,000 adults had no education and by 2011 this figure dropped to 8,590, an almost 40 percent decrease. (Census 2011). Likewise, the amount of matriculating students increased from 4,938 in 2001 to 11,153 in 2011. Although there have been significant improvements, still nearly 70 percent of the adult population in MLM and 68 percent of the population in PSLM have less than a high school education.

5.4 HEALTH

5.4.1 Life Expectancy

Total life expectancy in South Africa is 49.41 years of age as of 2011; males have a slightly longer life expectancy at 50.34 compared to females at 48.45 (Census 2011). The age group between 20 to 40 years old has the highest percentage of deaths per year at 26 percent of the population. This is related to the HIV/AIDS epidemic.

5.4.2 HIV/Aids

South Africa has six million people living with HIV and one of the world's highest HIV / Aids infection rates. (Aljazeera 2013). According to the country's health minister in 2013, reported by Aljazeera, as many as 28 percent of South Africa's schoolgirls are HIV positive compared to approximately four percent of school age boys. It is suggested that this is likely due to older men exploiting young girls in exchange of sex for money and gifts. (Aljazeera 2013). Despite the epidemic, HIV / Aids related deaths are declining as the country has the largest anti-retroviral programme in the world, serving 1.7 million. (Aljazeera 2013).

HIV and AIDS at the Local Level

The demographics structure of communities is determined by numerous factors including employment opportunities, educational opportunities as well as health issues. HIV and Aids in South Africa has been a key health concern over the past number of years with the country having amongst the highest infection rates globally. Amongst those most at risk are people within the PKSLM is the 16-35 age cohort and the table above would suggest that this is a high proportion of the local population. A turn around in infection rates and prevalence growth would be positive for this group in particular.

Table 5.6 indicates a decline in HIV prevalence growth rate in the PKSLM, which may be the result of focussed awareness campaigns locally and nationally. A continued decline could reduce the vulnerability of the PKSLM and MLM populations.

Table 5.6 HIV/AIDS Prevalence in the PKSLM (1996-2010)

	1996	2000	2006	2010
Population	70342	80378	90149	95377
Homesteads	14628	18037	22113	24255
HIV prevalence	3850	8295	9447	8982
AIDS Prevalence	58	281	739	962
HIV prevalence growth (5)	-	14%	-2%	-1%
HIV Prevalence (%)	5.5%	10.3%	10.5%	13.1%

Source: HIS Global Insight Regional eXplorer

5.4.3 Healthcare

Across South Africa there are largely two types of health care. Free health care, primary, is offered by the state and is under-resourced, while more vastly specialized health care is offered mostly in the private sector.

Primary health care is funded by the government and private health care is generally a part of medical schemes offered to middle and upper-income earners. Approximately 40 percent of all government expenditure goes to primary health care; however, the sector is under pressure to support nearly 80 percent of the population. (South Africa Info, 2011). According to the

National Treasury's Fiscal Review for 2011, the GDP spent on health was as follows:

- R120.8-billion (48.5 percent) in the private sector, which covers 16.2 percent of the population;

- R122.4-billion (49.2 percent) in the public sector, which is made up of 84 percent of the population; and

- R5.3-billion (2.3 percent) is donor and NGO spent. (National Treasury 2011).

Pressure on public sector health care is multiplied by HIV/AIDS and a shortage of medical professionals who mostly work in the private sector. (South Africa Info 2011).

5.5 TOURISM

In 2010 Mpumalanga attracted 1,135 million foreign tourists, compared to 1,035 million in 2009. This represents a 9,6% increase. While continuing to value these foreign tourists the emphasis in the Province is shifting to local tourism (Mpumalanga Policy and Budget Speech 2011/12).

Throughout Mpumalanga there is a focus to promote tourism as a key sector that drives the economy. This is also true of the GSDM where eco-tourism is important. "The (eco-tourism) sector is not yet fully developed and should maximise the potential of the wild frontier, grass and wetlands, and cosmos country regions…". (GSDM IDP, 2012, P. 50). Likewise, the two local municipalities in the Study Area also focus on promoting eco-tourism.

The PKSLM IDP recognizes that the N11 is used as a freight transportation route but plans to promote it as a potential corridor for boosting tourism, specifically eco-tourism (PKSLM IDP, 2012). "Tourism in the Wakkerstroom area is largely based on ornithological eco-tourism and outdoor nature based activities and has the potential to become a major destination for domestic as well as foreign tourists. This is due to the uniqueness of the area in terms of varied habitats …and the large variety and abundance of bird species associated with those habitats. The Wakkerstroom Wetland Reserve is the main centre for bird watching in South Africa." (PKSLM IDP, 2012, P. 79). Additionally, the PKSLM IDP suggests the importance of the district authorities to build a strong tourism industry establishing a large grassland and wetlands reserve, promoting a wealth of historical buildings in the area, and ensuring there are enough accommodation establishments in the district. (PKSLM IDP, 2012).

Tourism development and preservation is also highlighted in the MLM IDP. There are several South Africa Heritage Sites and nature reserves in MLM including:

- The Athole Nature Reserve;

- Entombe Battlefield;
- Rooikraal;
- Confidence;
- Kalkoenvlakte;
- Heyshope Dam;
- Witbad Nature Reserve;
- Morgenstond Nature Reserve;
- Amsterdam Conservancy; and
- Enkangala Grassland Biosphere Reserve. (MLM IDP, 2012)

These tourism sites are a critical aspect of the economy in Piet Retief, which benefits from weekend and transit travel to the aforementioned tourist "hot-spots" that are linked by the N2. This road runs through Mkhondo and connects northern KZN and the Mpumalanga/Limpopo Lowveld areas to one another.

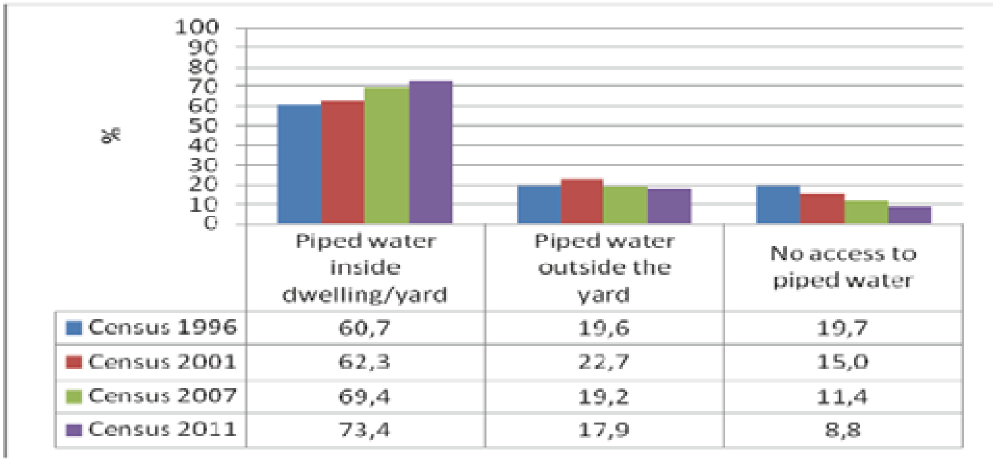
Responsible development to protect the environment and ensure easy and safe travel via main routes in Mpumalanga is therefore highly important when it comes to tourism on a regional and local level.

6 NATIONAL AND PROVINCIAL UTILITIES, INFRASTRUCTURE AND SERVICES

6.1 WATER

Nationally, access to piped water in the homestead gradually increased from 61 percent in 1996 to approximately 73 in 2011 (*Figure 6.1*). Nearly 18 percent of homesteads had access to piped water outside the yard in 2011 while the proportion of homesteads without any access to piped water decreased from 20 percent in 1996 to 9 percent in 2011. Statistics for Mpumalanga resemble those of the national figures, where 72 percent have piped water inside the homestead, 16 percent have access to piped water outside the yard, and 13 percent have no access to piped water (*Figure 6.2*). This suggests a focused effort to provide water service delivery across the country and is echoed in the Project's Study Area.

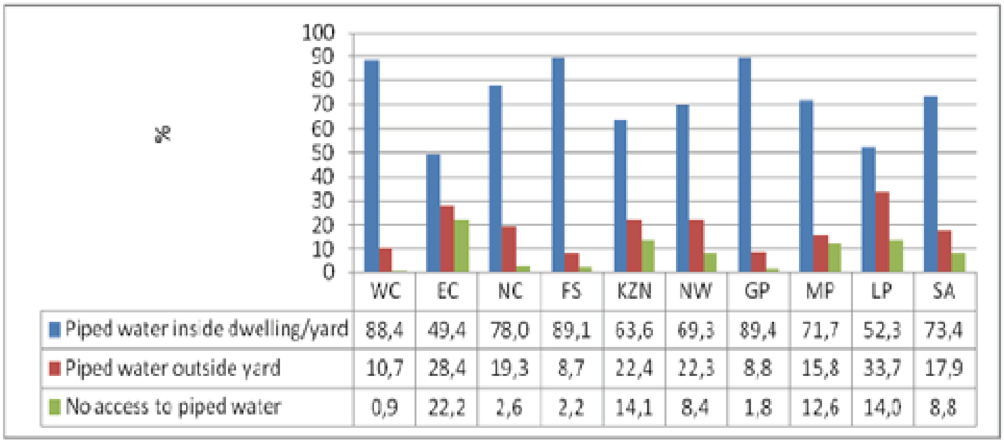
Figure 6.1 Proportion of SA Homesteads with Access to Piped Water



	Piped water inside dwelling/yard	Piped water outside the yard	No access to piped water
Census 1996	60,7	19,6	19,7
Census 2001	62,3	22,7	15,0
Census 2007	69,4	19,2	11,4
Census 2011	73,4	17,9	8,8

Source: Census 2011

Figure 6.2 Percentage of SA Homesteads with Access to Piped Water by Province



	WC	EC	NC	FS	KZN	NW	GP	MP	LP	SA
Piped water inside dwelling/yard	88,4	49,4	78,0	89,1	63,6	69,3	89,4	71,7	52,3	73,4
Piped water outside yard	10,7	28,4	19,3	8,7	22,4	22,3	8,8	15,8	33,7	17,9
No access to piped water	0,9	22,2	2,6	2,2	14,1	8,4	1,8	12,6	14,0	8,8

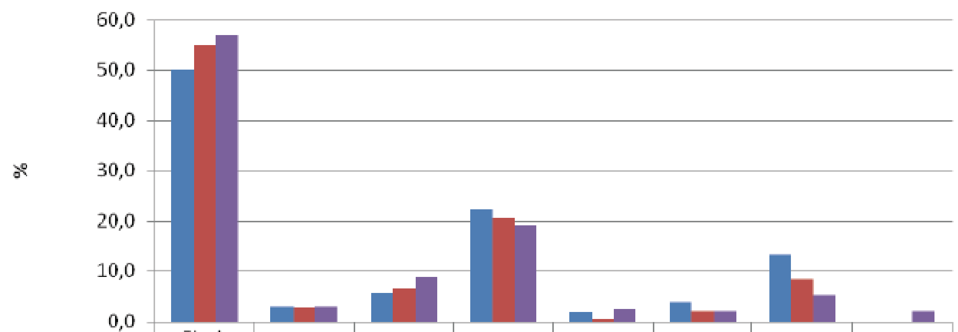
Source: Census 2011

6.2 SANITATION

Figure 6.3 presents the nationwide access to sewerage facilities. (Census 2011).

Common to the rural areas, homesteads with a ventilated pit toilet increased to 8.8 percent in 2011 from 5.6 percent in 2001. Access to a pit toilet without ventilation declined from 22.3 percent to 19.3 percent in the same period. Use of chemical toilets increased from 1.9 percent in 2001 to 2.5 percent 2011. (Census 2011).

Figure 6.3 Type of Toilet Facility by Homestead



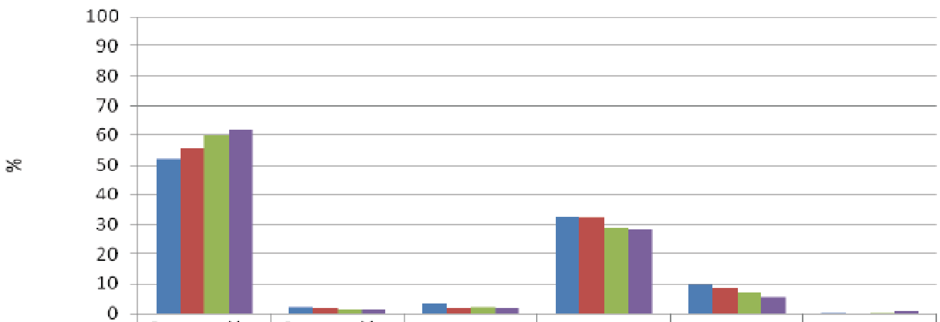
	Flush toilet (connected to sewerage system)	Flush toilet (with septic tank)	Pit toilet with ventilation (VIP)	Pit toilet without ventilation	Chemical toilet	Bucket toilet system	None	Other
Census 2001	50,0	3,0	5,6	22,3	1,9	3,9	13,3	
CS 2007	55,0	2,8	6,6	20,7	0,4	2,2	8,3	
Census 2011	57,0	3,1	8,8	19,3	2,5	2,1	5,2	2,1

Source: Census 2011

6.3 WASTE DISPOSAL

In general, South Africa has seen an improvement in refuse disposal since 1996, where the overall proportion of homesteads without refuse disposal declined significantly from 9.7 percent to 5.4 percent in 2011 (*Figure 6.4*). Moreover, the percentage of homesteads that have refuse disposal service where the refuse is removed by local authority weekly has increased from 52.1 percent in 1996 to 62.1 percent in 2011. The percentage of homesteads depending on a communal refuse dump decreased to 1.9 percent in 2011 from 2.2 percent 2007. Likewise, there was a small decline of those using a domestic refuse dump in 2007 (28.8 percent) to 28.2 percent in 2011.

Figure 6.4 Percentage of Homesteads with Refuge Disposal



	Removed by local authority at least weekly	Removed by local authority less often	Communal refuse dump	Own refuse dump	No rubbish disposal	Other
Cesus 1996	52,1	2,2	3,2	32,6	9,7	0,2
Cesus 2001	55,4	1,8	1,8	32,5	8,5	0,0
CS 2007	59,9	1,7	2,2	28,8	7,1	0,3
Cesus 2011	62,1	1,5	1,9	28,2	5,4	0,9

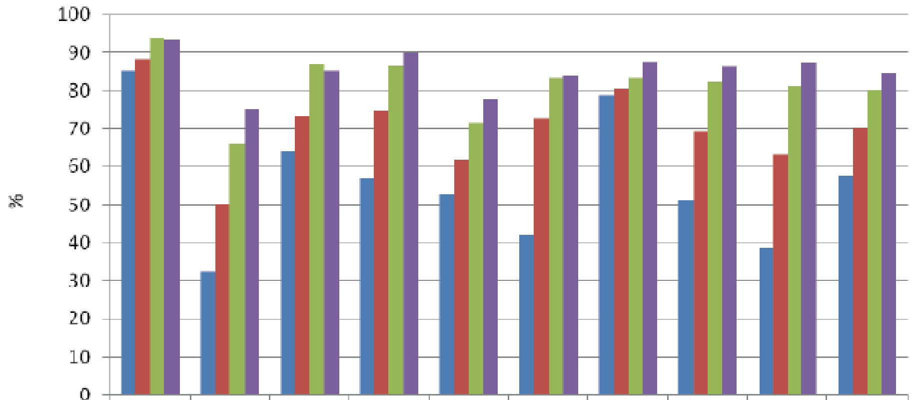
Source: Census 2011

6.4 ENERGY/FUEL SOURCES

Electricity is the most widely used form of energy across South Africa and the percentage of homesteads that use it has increase sharply from 58.2 percent in 1996 to 84.7 percent in 2011. This increase has been largely due to electrification of rural areas, although because of spiralling electricity costs many rural homesteads combine wood and other sources of fuel to reduce their electricity consumption (as will be seen in the Study Area data). (Census, 2011).

Statistics from Mpumalanga Province coincide with national figures as 86.4 percent utilized electricity for lighting in 2011 (*Figure 6.5*). *Figure 6.6* presents a comparison between the province and the Gert Sibande District Municipality. It suggests that while GSDM's use of electricity is consistently lower than provincial figures the difference in electricity use for lighting has narrowed significantly over the past 10 years.

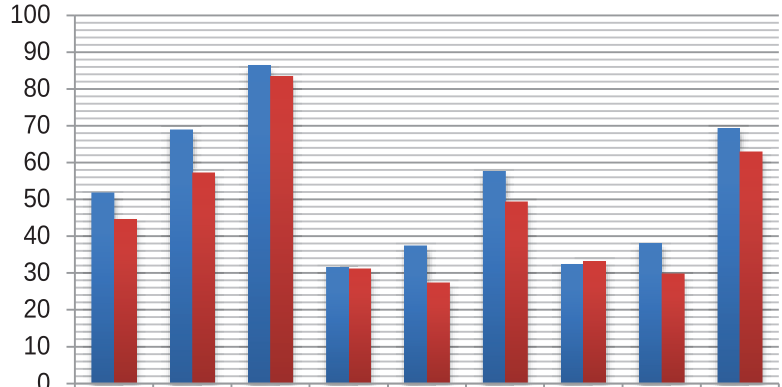
Figure 6.5 ***Percentage of Homesteads by Province Using Electricity for Lighting***



	WC	EC	NC	FS	KZN	NW	GP	MP	LP	SA
Census 1996	85,2	32,4	64,2	57,2	52,7	42,4	78,7	51,3	38,7	57,6
Census 2001	88,1	50,2	73,3	74,8	61,6	72,7	80,5	69,1	63,2	70,2
CS 2007	93,9	65,9	86,8	86,6	71,5	83,0	83,2	82,2	81,2	80,1
Census 2011	93,4	75,0	85,4	89,9	77,9	84,0	87,4	86,4	87,3	84,7

Source: Census 2011

Figure 6.6 ***Percentage of Homesteads Using Electricity for Lights, Cooking and Heating for the Province and GSDM***



	Lighting			Cooking			Heating		
	1996	2001	2011	1996	2001	2011	1996	2001	2011
Mpumalanga	51.8	68.9	86.4	31.6	37.4	57.6	32.4	38.1	69.3
Gert Sibande	44.6	57.3	83.4	31.2	27.3	49.4	33.2	29.8	62.9

Source: Census 2011

6.5 TRANSPORT AND ROAD INFRASTRUCTURE

According to the South African National Roads Agency Limited (SANREL) there is a network of 16 170 km of roads in the country. SANRAL is tasked with managing, improving and maintaining the national roads network. This network of roads, culverts and bridges is identified for its strategic importance, with due consideration of the economic development of historically under-serviced communities particularly in rural and peri-urban areas.

Mpumalanga Department of Public Works, Roads and Transport is the custodian of public infrastructure including transport and other related functions such as the coordination of the provincial Expanded Public Works Programme (EPWP) and Scholar Transport. There are 12 229 km of paved and gravel roads under its jurisdiction.

Table 6.1 Road Network Summary per Province

Network Summary Per Province

Strategic and Primary Network					Remaining Provincial Network		
Province	SANRAL Current	Remaining Strategic Network	Primary Network	Total	Surfaced	Gravel	Total
EC	2,433	227	2,366	5,026	3,285	26,340	29,625
FS	1,592	479	2,460	4,531	3,385	21,325	24,710
GP	617	249	840	1,706	2,360	1,895	4,255
KZN	1,422	804	1,405	3,631	4,540	14,437	18,977
LP	1,922	158	963	3,043	5,518	15,396	20,914
MP	2,300	59	1,552	3,911	3,341	8,887	12,229
NC	3,114	12	1,219	4,345	1,308	23,205	24,513
NW	1,303	320	1,253	2,876	3,978	14,961	18,939
WC	1,467	599	1,748	3,814	3,759	10,194	13,953
Totals	16,170	2,907	13,806	32,883	31,474	136,640	168,114

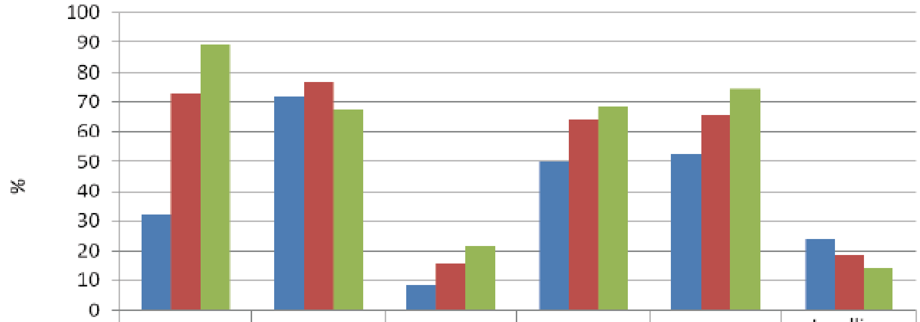
Note: The remaining strategic network and primary network are mostly being managed by the provincial authorities.

Source: SANRAL Strategic Plan 2012

6.6 TELECOMMUNICATIONS

Figure 6.7 overleaf, the proportion of homesteads owning cell phones increased from 31.9 percent in 2001 to 88.9 percent in 2011 while the proportion using landline/telephone has declined to 14.5 percent in 2011. Although 64.8 percent of the population has no access to the internet the proportion of homesteads owning computers increased from 8.5 percent to 21.1 percent between 2001 and 2011 (Census 2011). An increase in the prevalence of these material items points to an increased income in households as well as an increased emphasis on the importance of connectivity at large for social reasons as well as economic opportunities and livelihoods.

Figure 6.7 Percentage of Homesteads Using Various Homestead Goods



	Cellphone	Radio	Computer	Fridge	Television	Landline telephone
Census 2001	31,9	72,1	8,5	49,9	52,6	23,9
CS 2007	72,7	76,5	15,6	63,9	65,5	18,5
Census 2011	88,9	67,5	21,4	68,4	74,5	14,5

Source: Census 2011

7 THE LOCAL SOCIO-ECONOMIC SETTING

The Study Area and Zones of Influence related to the proposed Project have been defined in *Section 1.6.1* above. Given that impacts from the Project are likely to be most directly felt within these areas this chapter of the Social Baseline Report describes the existing socio-economic environment and local perceptions.

As mentioned above, a visual homestead count was undertaken for the social Study Area, which identified approximately 112 homesteads or large structures. These were then divided into their Zone of Influence with 42 homesteads in Zone 1 and the remaining 70 homesteads in Zone 2. 45 interviews were carried out with homestead residents, which constitute approximately 40% of the total number of homesteads in the Study Area. Of this total number, approximately 78% of homesteads in Zone 1 were interviewed and 17% in Zone 2.

Homesteads were surveyed across 5 farms. These are listed in *Table 7.1* below:

Table 7.1 Number of Homesteads per Farm

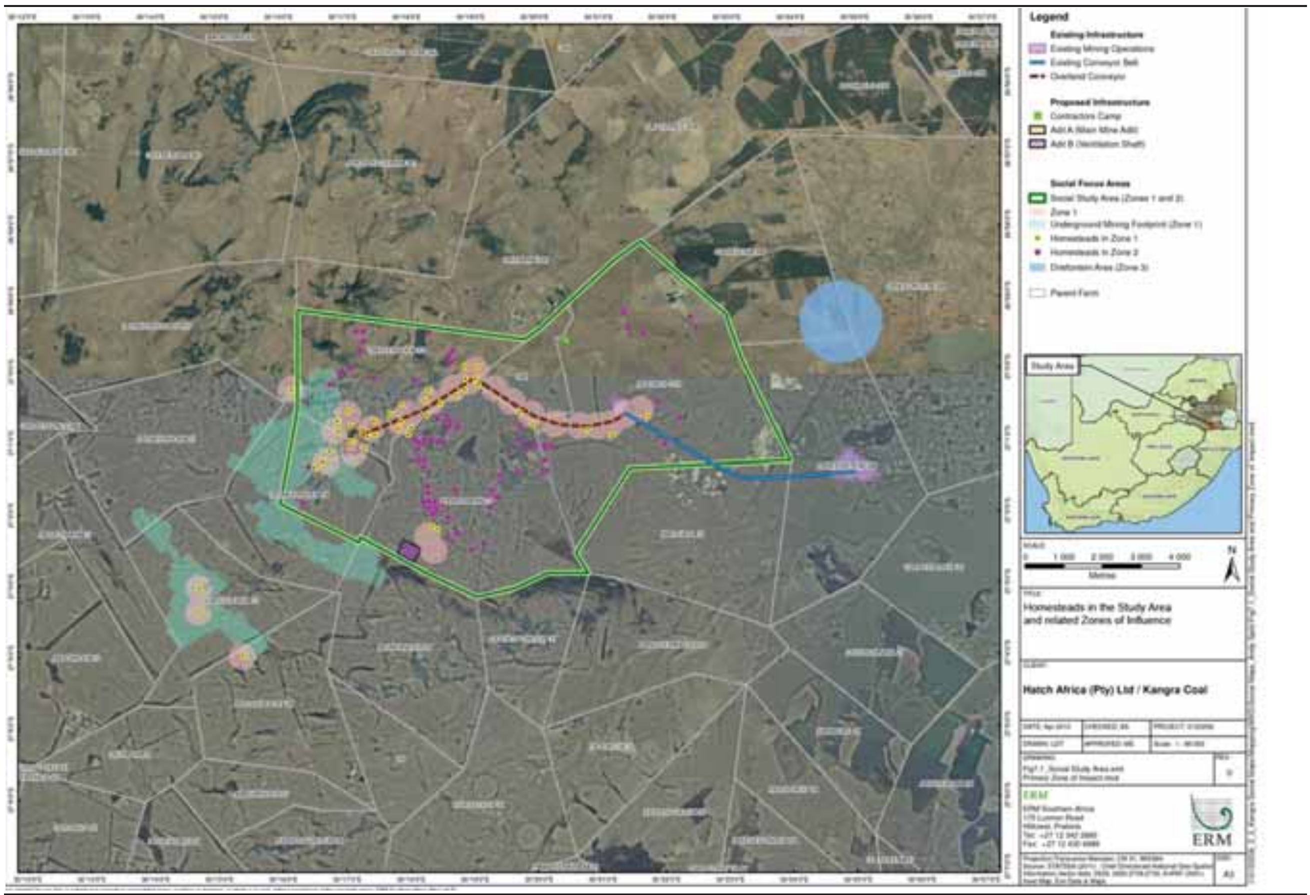
Farm Name	N= [1]
Donkerhoek 14-HT	5 [2]
Kransbank 15-HT	18
Twyfelhoek 379-IT	16
Rooikop 18-HT	5
Nooitgezien 381-IT	1
TOTAL	**45**

Findings are presented below.

[1] N= homesteads responding to survey questions.

[2] The research team was unable to contact the farm owner in time to obtain permission to conduct interviews on this farm. All interviews with residents from Donkerhoek were therefore conducted off-site.

Figure 7.1 Homesteads in the Study Area and related Zones of Influence



7.1 GOVERNANCE

As described in *Section 2.1* on formal and traditional authorities, the broader Study Area would fall under the District and Local Municipalities with their relevant wards. However, given that the Zones of Influence in the Study Area are rural and outside of the wards administration they would fall primarily under traditional authorities. In the case of Zone 1 and 2 communities the relevant authority would be the Mahlapahlapa KwaYende Traditional Council. It should be noted that the role of the traditional authority is not particularly strong in the Study Area.

Large sections of the Study Area fall under Community Property Associations (discussed below) and therefore governance and decision-making would be made through the CPA and its committees. The CPA committee (or chairperson) would approach the ward councillors to assist in pursuing development objectives defined by the CPA on a case-by-case basis (e.g provision of electricity to the farms, or road maintenance as needed etc.).

7.2 LOCAL LAND USE, RIGHTS AND ENTITLEMENTS

7.2.1 History of Land Access and Tenure

Historically the land in the Study Area was owned by private landowners and worked by farm labourers (labour tenants). Many labourers lived on the farms for generations and according to field interviews, were required to work for the farmer in return for permission to remain on the land. The 1913 Land Act (see *Section 3.1.1* of this report) would have dispossessed many of farmers land and there are currently two land claims in the area. These claims are for Donkerhoek 14HT and Twyfelhok 379 IT (see *Appendix C*). The Donkerhoek claim has been gazetted as of July 2012, and the Twyfelhoek claim was categorised as in "research".

Land ownership, access and tenure in the Study Area are significantly different today to how they were prior to 1997/8. At that time the farms were owned exclusively by white farmers and black labour tenants generally worked on the farms in exchange for living there and a small payment in cash or kind. As discussed in *Section* 3 above, this had been the case across the country for the past almost 85 years since the 1913 Land Act, and the Study Area was no exception. Since 1997/8 this situation has changed as is represented by current land ownership, access and title in the area.

Aside from the land claims, land in the Zones of Influence (Zone 1 and 2) is currently divided into two categories:

- **Privately owned land**:

  - Donkerhoek – various portions purchased from 1998 to 2004 under the names of Corneels Greyling and Ukuchuma Farming Trust Pty Ltd respectively.
  - Rooikop and Nooitgezien – purchased by Kangra Coal from Kangra Group in 2003. The original farm purchases by Kangra Group took place in 1998.

- **Communally owned land**:

  - Twyfelhoek – various portions purchased in 1997 and 2001 in the names of Yende Farmers Trust and Thuthukani Communal Property Association respectively.
  - Kransbank – purchased in the name of eKaluka Communal Property Association from Arthur Greyling De Villiers in 2000.

See *Appendix D* for title deeds to all these farms in Zones 1 and 2 of Influence.

7.2.2 *Privately Owned Land*

Donkerhoek Farm is owned by Mr CJF Greyling. The farm is used for commercial farming of various crops, including maize, and of livestock, including cattle and sheep. Mr Greyling lives on a different farm, Mooibank, where his family has been resident and owners for several generations (over 100 years).

A small number of people, outside of the farm owner's immediate family, are resident in five homesteads on the Donkerhoek property. Most of them have all been living on the land since before Mr Greyling bought portions of the farm in 1998 and 2004. Four out of five interview respondents have been living there for over 20 years.

Kangra Coal owns Rooikop and Nooitgezien farms and the land is largely used for its sub-surface mineral value (coal mining) and for the establishment of related mining infrastructure on the surface. There are a small number of homesteads on the land and although most of these were not visited (1), and therefore their detailed history is not known, some relatively new homesteads on Rooikop and Nooitgezien, are the results of Kangra mining-related resettlements. Of the homesteads on these two farms, an interview respondent commented that "*there is no change from the original white owners*" and that access to land and grazing is still controlled.

The land access and use entitlements of these residents are not known.

[1] Most homesteads on Kangra land fall outside of Zones 1 and 2.

There is a noticeable contrast between the way residents living on privately owned lands describe their lives and those settled as CPA members on their own land. This is discussed in more detail further in this report.

7.2.3 *Community Property Association Land*

Interview respondents describing the settlement of residents on Twyfelhoek and Kransbank farms explained the following:

As motivated in *Section 3.2.3* above, the Department of Land Affairs acquired the farms of Twyfelhoek and Kransbank from their private owners or from state-owned land as part of a land redistribution and security of tenure programme in the late 1990s, following democracy in South Africa.

In the case of these two farms, two CPAs were constituted Thuthukani (for Twyfelhoek Farm) and eKaluka [1] (for Kransbank Farm) and space and membership was allocated to a number of people who registered with the Department. For Twyfelhoek, the Department approached the farm owner and bought the land while for Kransbank, residents in the area became aware of the farmer's desire to sell and they set up their own loose association of people who requested the Department to purchase the farm on their behalf. In both cases, registration as a member of the CPA comprised residents predominantly from Driefontein and people who had previously been labour tenants on white owned farms in the area.

The CPA refers to all registered members and is managed through a committee of elected representatives under a chairperson. The role of the committee is to ensure that beneficiaries "*get what is due to them*" (eKaluka committee meeting, 19 February 2013) – be it from government development projects like electrification or water services, or from third-party developments that take place on their land.

The CPA lands are allocated to homesteads and for grazing and agriculture. Residents are able to farm crops around their homesteads and cattle are free to graze anywhere on the farms. There is no legal restriction on the number of livestock an individual may own, although the carrying capacity of the land would determine these limits.

Membership of the CPA does not entitle people to sell their land. It may be passed down through generations in a family and settled by extended family members. However, the sale or other extraordinary use of the CPA property would need to be agreed to through a participatory process and majority consent according to the constitution of the CPA.

[1] This report uses the name EKaluka CPA as this is the name used on title deeds. However, members of the CPA refer to it as KanIuka. The names can therefore be used interchangeably.

7.2.4 *Homestead Location and Farms*

The differentiations between farm locations and related ownership status may represent a significant variable in the assessment of social impacts related to the proposed Project. The specific histories of farms have shaped the social characteristics, material conditions and attitudes of the homesteads and communities that live on them. In this case, Twyfelhoek and Kransbank, are former "white-owned farms" that were purchased by the South African state in order to enable previously disadvantaged communities to access land and have security of tenure (as discussed in *Sections 3.2.1, 3.2.2* and *3.2.3* above).

Donkerhoek is a privately owned farm. Apart from the farm owner (who does not live on the farm) the majority of affected homesteads are labour tenants with strong historical and economic ties to the farm. Rooikop and Nooitgezien are farms owned by Kangra Coal and include a small number of surveyed homesteads that were resettled by Kangra within the last five years.

Key Points related to Land:

- The history of access to land makes it a sensitive issue in the area.
- On CPA land an individual is not in a position to negotiate in isolation and decisions on land access and use are made communally.
- The land ownership status of Study Area homesteads is likely to play a significant role in how individuals and families respond to the proposed Project and any changes in land access and use.

7.3 HOMESTEAD PROFILE AND POPULATION CHARACTERISTICS

7.3.1 *Population and Age Profile*

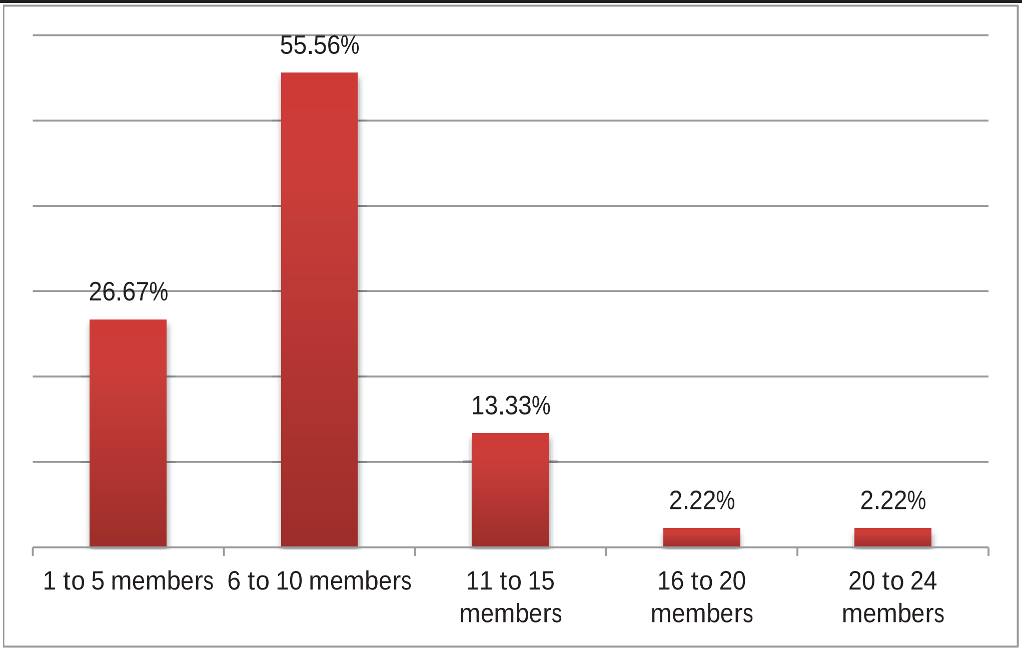
Based on the 45 interviews undertaken (33 in Zone 1 and 12 in Zone 2), and where respondents were asked about the number of residents in a homestead and the number of children within that figure, the sample represents a population of approximately 350 people, 148 of whom are reportedly children of school-going age between 6 and 18 (42% of the sample).

Respondents interviewed were not necessarily the homestead heads but were people available and willing to participate in the survey. Some homestead heads were reported to be away, either in search of work or working on neighbouring farms or as migrants further away from home.

7.3.2 *Homestead Size*

The average homestead size was 7.8 persons per homestead (including absent school-going children and migrants). This is slightly higher than the 5 to 6 person average for the District. Homesteads ranged in size from single person to 24 members. The spread of homesteads, with regard to homestead size, is reflected in *Figure 7.2* below:

Figure 7.2 Homestead Size



More than half the homesteads were comprised of between 6 and 10 members whilst more than a quarter were comprised of between 1 and 5 members. This suggests that whilst there is a broad range in size, the majority—more than 80%—were comprised of 10 members or fewer. Many of these homesteads were nuclear families with relatively high numbers of dependents, in relation to economically active members. Only two of the 45 homesteads interviewed had single occupants and in both cases these were older men – one between 51 to 70 and one over 70 years of age. Understanding this general makeup of the homestead will contribute to future planning if the resettlement of homesteads is necessary as a result of the proposed Project

The recent establishment of a boarding school (Ezakheni Combined Boarding School) that is explicitly intended to cater for children from rural areas, from pre-primary to Grade 12, meant that there were relatively few children of school going age present in the surveyed homesteads [(1)]. Migrant workers were also included as *de jure* members of the homestead. The significant numbers of absent school children and migrant workers suggests that Project impacts may not be limited to Zone 1 and 2 of Influence and may also affect persons further afield.

[1] This initiative was part of a pilot project for the Comprehensive Rural Development Programme (CRDP) of the Minister of Rural Development, Mpumulanga Province. The establishment of this school coincided with the closure of six existing schools in the area. See http://agritv.co.za/articles/ezakheni-combined-boarding-school/

Key Points related to Population:

- Average homestead size is 7.8 people.
- Approximately 42% of residents are aged between 6 and 18 years suggesting a youthful population in the area.
- Based on the small number of respondents over 50 years old, the population is predominantly within the economically active age group.

7.4 SETTLEMENT PATTERNS

The area under discussion is a rural area with predominantly scattered homesteads. In some parts of the CPA farms, homesteads are clustered more closely together. Fences and gates demarcate most homesteads (clustered and scattered) and land along the main road is fenced.

Many of the homesteads have their own small fields for subsistence farming activities, adjacent to the houses. Twyfelhoek has a significant portion of land allocated to a co-operative agriculture project while most of both CPA's farmland is available for livestock grazing (*Figure 7.3*).

Figure 7.3 Settlement Patterns

Scattered Homesteads **A Small Subsistence Field**

Aerial view of scattered homesteads and associated fields (Google Earth)

7.4.1 Residential Period

Respondents were asked how long their families had lived at the current location of their homestead. The results are reflected in Table 7.2 below.

Table 7.2 Period of Residence

Residential History	n=	%
Less than 5 years	10	22.73%
Between 5 and 10 years	7	15.91%
Between 11 and 15 years	7	15.91%
Between 16 and 20 years	5	11.36%
More than 20 years	15	34.09%
TOTAL	**44**	**100.00%**

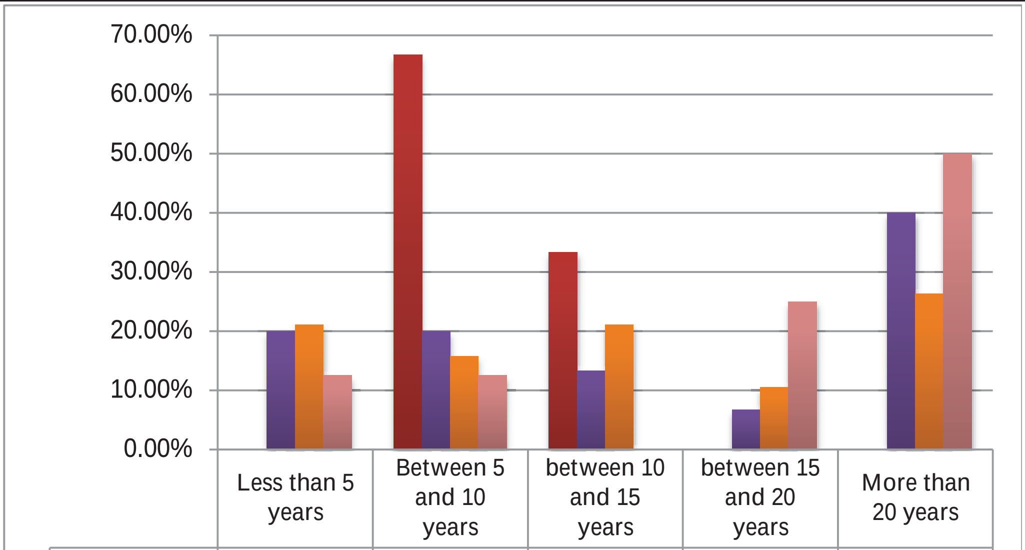
As summarized above, more than a third of residents had been living on their current sites for over 20 years and almost a quarter had lived on their present sites for less than 5 years. The affected population therefore includes a high proportion of relatively recent arrivals and long-term residents. Project-related impacts on these respective categories may be experienced differently and will require responses and mitigation measures that are sensitive to these differences. For example, a family resident in an area for a long period of time may feel strongly historically connected to the land and have great difficulties moving from it. However, relative newcomers with a history of a labour tenancy may also have strong views on their new-found land-ownership status and be less willing to negotiate alternative arrangements.

With regard to residential periods in relation to farm location, the data suggests that the majority of homesteads living on Donkerhoek (4 out of 5) and Rooikop (3 out of 5) have been resident for more than 20 years. In contrast, Twyfelhoek and Kransbank are less geographically stable populations and show greater levels of mobility within the last 20 years. This is explained largely by the fact that these two farms were purchased as part of the land reform programme discussed above. Most homesteads settling on these farms in the last 5 to 15 years reported doing so as a direct result of the establishment of the two CPAs on what is now communally-owned land. A number of these respondents chose to move from Driefontein to more rural settings. However, it should still be noted that the largest respondent group for Twyfelhoek (7 out of 15) have been resident for over 20 years. This highlights the mix on CPA land of newcomers and long-standing residents.

It's also worth noting that of the 10 homesteads resident on their land for less than 5 years three (33%) are the result of resettlement on Rooikop and Nooitgezien because of Kangra Coal mining activities elsewhere. In the case of Nooitgezien, the resettlement took place as recently as December 2012 because of mine-related blasting activities adjacent to the original homestead.

The relationship between residential period and homestead size is summarized in *Figure 7.4* below. It shows that homesteads that have been settled for longer periods tend to be larger than homesteads that have settled relatively recently. There is a notably high percentage of 1 to 2 person homesteads that settled between 5 and 10 years previously. This pattern of increasing homestead size relative to settlement period suggests a likely increase in population in the area in the future. This would be focused particularly on the CPA-owned farms as families become more established on their own land. In addition, land allocated to the eKaluka CPA anticipates 80 homesteads at its final size. Currently there are 50 homesteads registered. Thus significant population growth can be expected on this farm (approximately 37%). Although the detailed information is not available for Thuthukani, it is probable that similar homestead growth could be anticipated.

Figure 7.4 Residential Period and Homestead Size



	Less than 5 years	Between 5 and 10 years	between 10 and 15 years	between 15 and 20 years	More than 20 years
1-2 persons	0.00%	66.67%	33.33%	0.00%	0.00%
3-6 persons	20.00%	20.00%	13.33%	6.67%	40.00%
7-10 persons	21.05%	15.79%	21.05%	10.53%	26.32%
11 persons +	12.50%	12.50%	0.00%	25.00%	50.00%

7.4.2 *Housing Infrastructure*

Homesteads generally comprised a number of small structures built in close proximity to each other. These structures were generally built of either mud brick or wattle and daub often with thatched roofing, or more robust cement brick structures with corrugated iron roofing (*Figure 7.5*). Cement brick structures were generally either four-roomed or two-roomed structures and were mainly either "RDP" houses (provided by the South African government as part of the post-1994 Reconstruction and Development Plan) or built by Kangra Coal for selected homesteads. More than half of all homesteads surveyed (54.6%) included at least one cement brick structure within the homestead [1].

Most RDP and Kangra Coal built houses were reportedly built in 2012. The issue of how and why this housing was allocated has created some confusion amongst surveyed homesteads. The basis on which Kangra Coal housing is built was represented by some respondents to be random and unclear. Some suggested that the two bedroom houses were built as part of an agreement allowing Kangra Coal access to the area for previous mining exploration activities, and to some degree as recompense for inconvenience caused and damage to roads. However, not everyone in the community received these houses. Some respondents thought that it was the elderly and more vulnerable that were given houses while the opposite opinion was also expressed – that those who were more vocal or powerful received cement brick housing.

[1] The survey did not distinguish between houses built by Kangra and "RDP houses".

Although the survey team did not have access to homesteads on Donkerhoek farm, all respondents from this farm described their homesteads to be of mud-brick or wattle and daub. This group constitutes 25% of homesteads that have no RDP or Kangra cement brick structures. Respondents reported that "government" had offered to build RDP houses for the residents but that the farm-owner had turned down the offer, stating that he would build the necessary housing on his land. Respondents reported that no such housing has since been provided. Ward Councillors confirmed this during a social study team meeting (*pers comm.* February 2013). One survey respondent explained the different materials used by individuals in building their homesteads saying "*You wouldn't build with brick if the land was owned by a white farmer - as you could be fired at any time*". This suggests that people building homesteads using brick and cement feel a sense of permanence on their land.

Figure 7.5 Housing Examples in the Zones 1 and 2 of Influence

A mix of mud-brick and thatch structures together with cement and brick

A wattle and daub structure

7.4.3 Community Concerns Related to Housing, Residential Period and Potential Resettlement

Out of all homestead respondents that raised the issue of potential resettlement, only four were in favour of resettling and all four gave the same reasons – existing crime/theft in the area and the vulnerability of being relatively isolated from other houses. One respondent said she would feel safer if resettled closer to other homesteads. It is interesting to note that these four homesteads were also the only respondents who reported that Kangra had already informed them that they would be moved.

Most CPA residents raised concerns about the possibility of having to move and questioned onto what kind of land and under whose ownership this could happen. Three respondents, all on Kangra Coal-owned land, had been previously resettled – two homesteads moved about four years ago, with their graves, and one was resettled 2 months prior to this SIA study. All expressed dissatisfaction with unfulfilled promises of assistance and the quality of housing and compensation provided. Two emphasised that they had had easy access to water in their original homesteads, which was no longer the case. The respondent from the most recently resettled homestead said: "*I miss the old house. It had a big garden. I grew tomatoes, spinach, carrots and mielies. This was to live off. Kangra Coal promised to build a fence and supply new seeds but did not, so I cannot start a new garden*."

Donkerhoek residents' commenting on the potential of resettlement emphasised a concern of the unknown – "*We aren't sure because we don't know what we'll find in the next place. We don't know what's there*", one woman stated. In addition, residents asked if they would be able to choose where they wanted to go or would be instructed and moved. All residents have been living in their homesteads for more than 15 years, and four out of five homesteads for more than 20 years. "*We had no owner when he (Mr Greyling) found us here*" said one resident, highlighting her family's presence pre-dating the farm owner's.

The possibility of resettlement and its related impacts will be addressed in the Impact Assessment (*Section* 9).

Key Points related to Settlement:

- People live in a rural as opposed to urban / township setting by choice.
- People's relationship and attachment to their land is likely to differ depending on residential period and family tenure history. This attachment will affect attitudes towards changes in land use and land ownership.
- 45% of surveyed homesteads have been resident in their homesteads for more than 15 years.
- 33% of homesteads resident for less than 5 years were moved to their land in previous Kangra Coal resettlement activities. This creates increased sensitivity to relocating again in the future.
- There is a pattern suggesting that the number of residents per homestead increases in relation to increased residential period. This suggests that the population is likely to grow given that approximately 38% of homesteads have been resident for 10 years and less.
- Relatively few respondents raised the possibility of resettlement. Of those who did, only the 4 that Kangra had informed would be resettled were in favour of the idea.

7.5 LIVELIHOOD PRACTICES

Homestead livelihood strategies in the Study Area can be understood as an on-going process of negotiation between demands for the homestead to engage in cash-generating activities, and demands to engage in food-producing activities, while maintaining the social relationships that also contribute to sustainable livelihoods. A range of factors ultimately determines homestead activities and priorities in relation to these two general types of demands.

7.5.1 Livelihoods and Incomes

In a context where employment levels are low and prospects for obtaining employment are limited, homesteads are usually dependent on multiple sources of income and financial support. For survey participants these include the following:

- Cash remittances from homestead members that migrate to urban centres for employment;
- A range of social grants, including pensions, childcare grants and disability grants;
- Subsistence-level agricultural production and gardening that contributes directly to food security for the homestead;
- Limited livestock farming for food or for cash when necessary; and
- Limited access to local employment opportunities (as miners, cattle herders, domestic workers, farm workers etc.).

Whilst Kangra Coal is recognized as a significant employer within the area, only 20% [(1)] of respondents had at least one member of their homestead employed by Kangra Coal or one of its contractors at the time of the survey. A summary of the main sources of homestead income is presented in *Table 7.3* below.

Table 7.3 Main Sources of Homestead Income

Main Sources of Income	n=	%
Income from business	1	2.22%
Pensions	16	35.56%
Remittance from migrants	7	15.56%
Salary from employment	5	11.11%
Small-scale farming	2	4.44%
Welfare grants (child, disability etc.)	14	31.11%
TOTAL	**45**	**100.00%**

The data summarized above shows that more than two-thirds of homesteads rely on government grants as their most important source of homestead income. This suggests that homestead employment opportunities are limited and levels of agricultural production are relatively low. Reliance on

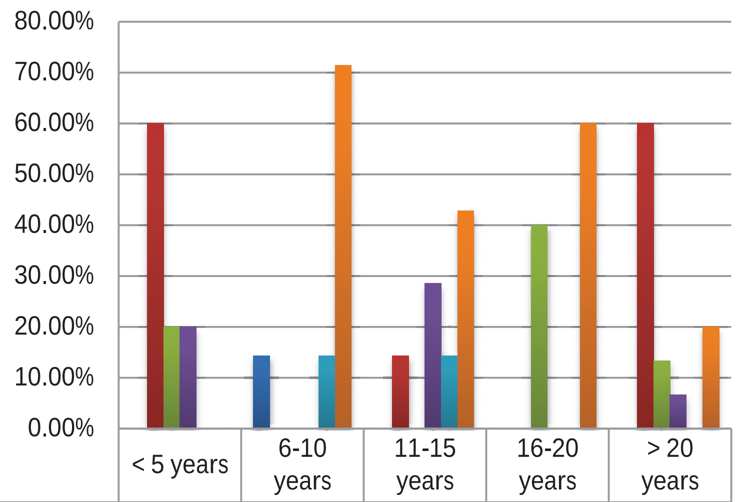
[1] 9 of 45 homesteads surveyed.

remittances from migrant workers was also relatively low. Dependence on grants points to some income stability while the pensioner is alive and while children fall into the eligible age group. However, the fact that entire families can be predominantly dependent on these grants set up an instability in the medium to long term, if alternative income sources cannot be secured.

With regard to residential period, recently arrived homesteads and well-established homesteads (> 20 years residence) tended to rely more on pensions than other categories whereas homesteads in between these categories relied more on welfare grants. Homesteads that arrived between 16 and 20 years previously, (i.e. before the establishment of CPA farms) rely particularly strongly on migrant remittances. Homesteads that arrived between 11 and 15 years previously reflected the highest reliance on local employment (*Figure 7.6*). These patterns suggest that period of residence shapes access to opportunities and income sources.

An understanding of these dynamics highlights some of the potential strengths and vulnerabilities of different homesteads. The data suggests that it takes time for a family to set down roots and feel sufficiently located in a place to actively seek out livelihood activities. Thus, families who may be resettled could display this vulnerability. Once established, some family members are more able to find employment, even against the backdrop of high local to national unemployment figures.

Figure 7.6 Main Source of Homestead Income and Residential Period



	< 5 years	6-10 years	11-15 years	16-20 years	> 20 years
Business	0.00%	14.29%	0.00%	0.00%	0.00%
Pensions	60.00%	0.00%	14.29%	0.00%	60.00%
Migrant Remittances	20.00%	0.00%	0.00%	40.00%	13.33%
Salary	20.00%	0.00%	28.57%	0.00%	6.67%
Small-scale farming	0.00%	14.29%	14.29%	0.00%	0.00%
Welfare Grants	0.00%	71.43%	42.86%	60.00%	20.00%

It is clear from the analysis of homestead income above that local employment plays a moderate role amongst those surveyed (11.11%), behind pensions

(35.56%), welfare grants (31.11%) and migrant remittances (15.56%). This was verbalised in many interviews when respondents highlighted the lack of local job opportunities in mining, forestry and farming. People expressed anger at the perceived employment of outsiders (from KwaZulu-Natal; Lesotho; Mozambique and Zimbabwe in particular) at the expense of local residents.

Several respondents referred to family members who were forced to seek work in other parts of Mpumalanga and, commonly, in Gauteng. Of those with migrant family members, many were said to be working outside of the Province. This is not surprising given that unemployment in the Province and District is 31.6% and 29.7% respectively. And more specifically, the relevant local municipalities to the Zones of Influence, Mkhondo and Pixley Kalsaka Seme Local Municipalities have an unemployment rate of 35.9% and 36.1% respectively - more than 4% above the Provincial rate and 10% above the national rate (Stats SA, Census 2011).

7.5.2 *Subsistence and Small-Scale Agriculture*

Most homesteads have small fields in proximity to the houses. Respondents reported growing maize, cabbages, potatoes, spinach and other less common vegetables (*Figure 7.7*). Growing vegetables is made easier given that the majority of homesteads have access to water in their yards.

One man, living along the main road, who described his occupation as a small-scale farmer, plants maize, spinach and potatoes to sell, rather than for subsistence. Another respondent said that her mother sold home-grown crops at the local pension market, which takes place monthly.

Most respondents said that their home-grown vegetables met the majority of their staple food needs and that when the crops are finished they would then buy maize-meal and other vegetables from shops in Driefontein, Amsterdam and Volksrust. Winter was highlighted as the time of least food security with the situation improving towards the end of August.

Maize is reportedly sown in October / November at the beginning of the rainy season and should be ready for harvesting by the end of February / March. One respondent said that a 60kg bag of maize can last almost a month and said he harvested six to eight such bags per season. At least two other respondents from CPA farms reported that the maize they grew typically satisfied approximately half of the homestead’s annual demand for this staple.

A number of Twyfelhoek residents participate in a community agriculture project intended to improve farming production on Twyfelhoek and increase surplus produce for sale. According to one resident, the project is run with a neighbouring farmer, Mr Ferreira, who provides the tools and tractor. Produce is shared between the farmer and participants who work on the project in return for ground maize-meal while surplus produce is sold and profits deposited into a bank account and used for purchases that are intended to contribute to community development (e.g. a tractor).

Figure 7.7 Subsistence Agricultural Activities

7.5.3 Livestock and Domestic Animals

A number of respondents in Twyfelhoek and Kransbank highlighted new farming and agricultural activities in the Zone 1 of Influence, (none older than two years) as potential future sources of homestead income.

Several residents producing chickens at home and selling within the community (*Figure 7.8*) have undertaken this venture to replace the failure of a co-operative chicken-farming project established by Kangra Coal, which was damaged in a storm. One resident suggested that the proposed mine in the area could increase the market for chickens farmed on Kransbank.

A number of respondents had geese in their homesteads, which were used for food if necessary.

Figure 7.8 Subsistence and Small-scale Production and Livestock Farming

Only a small number of respondents spoke about livestock farming. For most, cows, goats and chickens are used for domestic purposes for milk, eggs and meat when necessary. Many CPA residents in the area have animals and expressed satisfaction that the number of cattle they could rear was no longer determined by a white farm-owner. In the past, if they were resident on someone else's land, they were allowed to keep a maximum of three cows and grazing areas were strictly limited. The farm-owner taxed any additional cattle, which is still reportedly the case on non-CPA land in the Study Area. Of the five respondents who spoke of owning cattle, herd sizes ranged from 17 to 25. These respondents also pointed out that seven breeding bulls had been introduced through government to increase cattle farming in the area. The bulls are communally owned and are allowed to graze freely in the area, hopefully impregnating the cows.

No respondents said that they owned any sheep.

There are a number of goats in the area, which are mainly used for domestic purposes and for traditional celebrations. A few people own horses, which are used for transport, and most homesteads have dogs as pets, for security and occasionally for hunting wild pigs in the mountains (*Figure 7.9*).

Figure 7.9 Common Local Animals

Key Points related to Livelihood:

- People rely on a mix of income sources with social grants dominating.
- Main sources of income reported were: pensions (35.56%), welfare grants (31.11%) and migrant remittances (15.56%), local employment (11.11%). There is insufficient agricultural and livestock activity to make it the main source of income for any respondents.
- Employment opportunities are limited and unemployment is high
- Subsistence agriculture meets the majority of fresh produce needs of those surveyed. Buying fresh produce only happens when local produce is used up.
- There are new agricultural and livestock projects being undertaken in the Zones of Influence suggesting the intention of increasing local productivity and income generation rather than merely subsistence activities (particularly on CPA land). Some of these activities are taking place within Zone 1 of the Zones of Influence.

7.6 HEALTH

7.6.1 Access to Health Services

The nearest primary healthcare clinics are both in Driefontein, which is approximately 15km away from the farthest homesteads in the Zones of Influence, following the main road. According to Acting Chief Yende, there are no doctors at the clinic, which is staffed by nurses. There is also no ambulance. Piet Retief would be the closest hospital (43km from Driefontein) and a return taxi journey would cost a patient R60. There is a dentist working in Driefontein on Tuesdays.

A mobile clinic is supposed to service the farm areas monthly but budget constraints have seen this service becoming erratic over the past months and reports from residents in Zone 1 and 2 are that the clinic had not visited in the month prior to this survey.

According to some respondents, there are no traditional healers practicing in the area. Some people mentioned using natural medicinal remedies found in the less disturbed parts of the Study Area.

A number of residents raised the issue of improved access to medical care. One Twyfelhoek resident described that his new-born infant had died "*…because we couldn't get to that clinic*", while another woman said "*If the mine opens they must bring a clinic closer to us*". Access to medical care is recognised as a development need amongst those in the Zones of Influence.

7.6.2 Local Health Status

The homestead survey made a limited enquiry into chronic health concerns for adults and children. The results did not reveal any widespread public health concerns or environmentally-related diseases. The survey did highlight that there had been a recent outbreak of Chicken Pox in the area, probably circulating in the boarding school.

Overall respondents reflected limited recurring health complaints across the age groups and most respondents had to think carefully to identify health problems. This should however not be construed as indicating that the community has no health issues; rather it may highlight a lack of awareness of health issues or a lack of access to health services.

Health concerns expressed by Acting Chief Yende included the spread of HIV, potential increase in teenage pregnancies and the presence of domestic violence, particularly near to Driefontein and directly associated with salary payments and alcohol abuse. One survey respondent reported a child on chronic ARV medicines who had tuberculosis. This was the only mention of HIV during the surveys. Against the backdrop of the GSDM Strategic Development Framework report (2009) which highlighted the MLM and PKSLM as municipalities with high HIV infection rates, this suggests either that prevalence in the Study Area is low or, more likely, that the subject is still a taboo locally.

Key Points related to Health:

- Provision of health services in Driefontein is basic and mobile services to the Study Area were reportedly increasingly erratic.
- Respondents showed limited concerns over public health problems.
- HIV-related issues were raised twice during the fieldwork suggesting low prevalence or continued taboos around the issue.

7.7 EDUCATION

7.7.1 Access to Education

Enrolment in school for children of school-going age was 91.2% (135 of 148 children surveyed). This is remarkably high and largely a consequence of the recent opening of the Ezakheni Combined Boarding School, close to Driefontein. As discussed above, this school was developed in order to improve access to quality schooling for children living on farms and remote locations. There are no school fees and boarding is also free. Local "farm schools" in the Zones of Influence have mainly closed and children from pre-primary level up to Grade 12 are accommodated at the new boarding school. There are reportedly 1 402 learners in the school meaning that children from the Zones of Influence survey sample constitute just fewer than 10% of the student body.

On the face of it, the establishment of this school in 2012 and the 91.2% attendance is an important success story, particularly when school attendance in the Province and District are 74.8% and 73.6% respectively. Comparative enrolment statistics for Mkhondo and Pixley Kalsaka Seme Local Municipalities are not available however of the 132 143 municipal residents over the age of 20, surveyed in the 2011 national census, only 37 753 had completed Grade 12 (28.5%). It is not possible to predict how many of the currently enrolled Zone of Influence area children will complete their schooling but the numbers are encouraging.

Parents expressed a number of concerns about the boarding school system even though most of their children are enrolled there. Concerns included, amongst others:

- "*Pre-primary children are too young to be away from home during te*rm";
- "*The school is like a jail*";
- "*Parents are not allowed to visit children during the term*" and "*the boarding master does not allow children to go home outside of holiday times*";
- Personal items are stolen at the school;
- "*There is inappropriate sexual behaviour between learners*";
- "*The teachers are not sufficiently caring of the children*".

This is the first year of operation for the school and it will be important to address these perceptions to increase the likelihood of children completing their Standard 10 certificates.

One set of parents responding to the survey reported taking their children out of the school and registering them in Driefontein. The children are six and 14 years old and are living in a rented house in the town. The 14 year old is taking responsibility for the six year old and the father visits on weekends when he has money. Occasionally he is able to bring the children home during term-time. Given the age of the children this seems like a difficult decision to have come to and highlights the significance placed on education by these parents.

Some parents who feel their children are too young to go to boarding school have sent them to the local crèche, which was established in the old Twyfelhoek Primary School facilities. There are currently about 28 children at the crèche, run by a teacher and her assistant.

Key Points related to Education:

- 91.2% of children from surveyed homesteads are enrolled at school. This is almost 20% higher than the district and provincial figure.
- Based on 2011 Census data, only approximately 28.5% of residents in the two relevant municipalities have completed grade 12. This would highlight likely low levels of literacy in the Study Area. This could impact on people's employability for a range of job opportunities in the proposed Project and more broadly.

7.8 ENERGY

7.8.1 Electricity and Cooking Fuel

Eskom provides electricity to some homesteads in the Study Area (*Figure 7.11*). Local ward councillors explained that if a large enough demand for electricity is demonstrated Eskom will agree to establish the necessary infrastructure. The local municipality carries the installation costs per homestead and then charges the user to recoup its costs. Ward councillors reported assisting in negotiations with land owners/farmers to supply electricity to their farm workers. However councillors said that this is still problematic, as majority of farm-owners do not allow their farm workers to have electricity and running water in their homesteads (*pers comm.* Ward Councillors meeting, 20 February 2013).

The provision of electricity infrastructure to some parts of Zones 1 and 2 is relatively recent (2011/12), covers large parts of Twyfelhoek and only goes up to a point within the Kransbank farm. All serviced homesteads work on pre-paid meters. Mobile phones were generally charged through the pre-paid electricity system, and occasionally using the government-supplied solar panel (*Figure 7.10*).

Figure 7.10 Government Provided Solar Panel for Charging Mobile Phones and Batteries

The vast majority of the homesteads surveyed (88.89%) relied on wood (*Figure 7.11)* as their primary fuel for cooking and even though a number of homesteads had access to pre-paid electricity this was very conservatively used with the main reliance on wood. Only four homesteads (8.89%) used pre-paid electricity as their main source of energy for cooking and only one homestead relied mainly on coal. All of the four homesteads that relied on pre-paid electricity were located on either Twyfelhoek (3) or Kransbank (1).

Homesteads on the Donkerhoek farm all use wood exclusively as the farm-owner has reportedly not permitted the provision of electricity by government in their homesteads.

A small number of government-provided solar panels were seen in homesteads surveyed. In these cases solar power was used mainly for charging of batteries, cell phones and running of televisions and occasionally a light.

Wood is also used for heating in winter. Respondents reported collecting wood from nearby forests. One person said he collected wood to sell to other community members.

Figure 7.11 Energy Sources in the Zones 1 and 2 of Influence

Newly installed pre-paid electricity infrastructure **Firewood cut from nearby wooded area**

Key Points related to Energy:

- While electricity infrastructure has been installed in many Zone 1 and 2 homesteads, almost 89% of survey respondents rely predominantly on wood for cooking and heating.
- Wood is collected from wooded areas in and around the Zones of Influence.
- Electricity is managed on a pre-paid basis.
- Government has provided a small number of solar panels to homesteads, mainly those beyond the reach of electricity infrastructure.

7.9 WATER

In almost every formal and informal interaction with people in the Zones of Influence and broader Study Area, the importance of already having access to "good quality" drinking water was emphasised and concerns about future Project-related water contamination were raised. Interestingly, the proposed Project is named after the natural spring, Kusipongo, found on the Kransbank farm. The springs, streams and rivers in the Study Area are an important source of water for local communities for drinking, cultivation and livestock watering. One Kransbank respondent commented, "*Where Kangra Coal proposes their Project is where the drinking water comes from*".

7.9.1 *Water Supply*

The broad Study Area in general and the Zones of Influence in particular have been the focus of a range of government-led development interventions in the post-apartheid period. Recently, this has included development and upgrading of water supply infrastructure to homesteads directly. While the survey captured this data as house connections, in order to describe the fact that water was transported directly to people's homestead, the sources of this water include springs, streams and rivers. *Table 7.4* overleaf summarizes where sampled homesteads obtained their water.

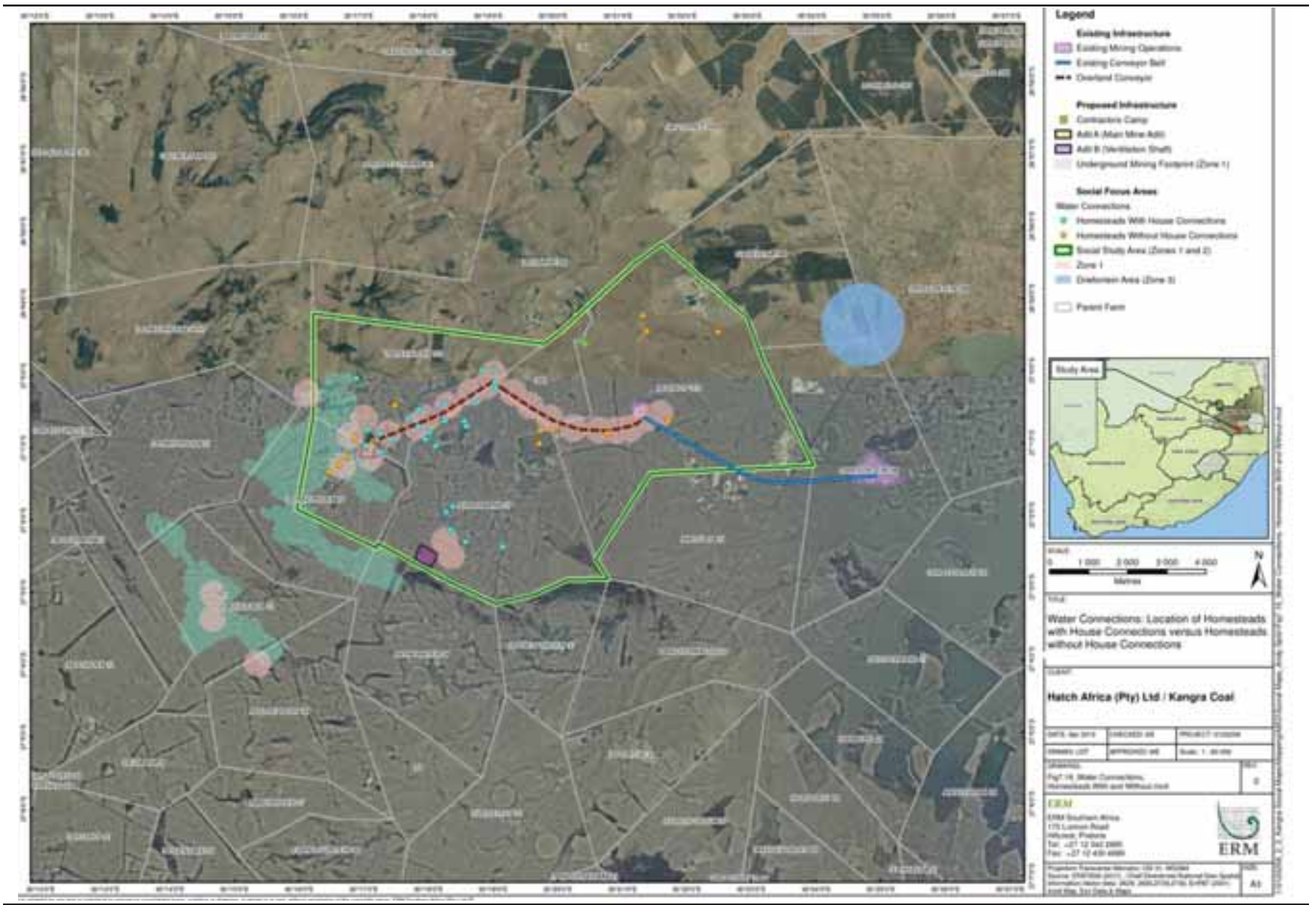
Table 7.4 Sources of Homestead Drinking Water

Water Source	n=	%
Borehole or well	1	2.22%
House connection	30	66.67%
Neighbour	1	2.22%
Spring	1	2.22%
River	12	26.67%
TOTAL	**45**	**100.00%**

It is significant that two thirds of homesteads surveyed had "house connections" within their homes. In many cases, these connections were recent developments and were only installed within the year prior to the survey. At least 18 of the homestead connections were confirmed to be fed from local springs while at least eight connections were piped from nearby rivers or streams. One of the homesteads resettled by Kangra Coal on Rooikop farm reported having had access to water at their previous homestead but now had to collect water from the river. "*Commitments from Kangra Coal to give our homestead water access haven't been fulfilled*", the interviewee stated. Homesteads on Donkerhoek all describe accessing water in the same way. There is no infrastructure provided by the farmer, and residents, who live very close together, reported creating small diversions in the stream to direct water to their homesteads.

Compared to many rural communities in South Africa, a relatively high percentage of respondents to the survey had water piped into their homesteads—65.91% on average. The spread of house connections over surveyed homesteads is reflected in *Figure 7.12* below.

Figure 7.12 Location of Homesteads with House Connection versus No House Connection



Homesteads with connections (shown in blue) appear to be located predominantly on the western part of the Study Area, particularly around Adit A and the western portion of the proposed overland conveyor system– generally within 1 km of the Main Mine Adit or 500m of the route of the proposed overland conveyor. Homesteads located in the valley on the eastern slopes of the Kusipongo Hill identified a specific spring close to the proposed Adit A site as the source of the drinking water that is piped to their homesteads. Homesteads with house connections appear to be clustered on CPA farms around the Kusipongo outcrop.

Most respondents felt that the water quality to their homesteads was "*good*" while a small number of people collecting water directly from river sources described the quality as "compromised" because cattle and other animals also drink from those sources. As one respondent commented, "*…but there's no choice in this case and the family is usually fine*."

The specialist Water Study undertaken in the broad Study Area, and particularly in the Zones of Influence, confirms that ground and surface water quality are generally within the prescribed screening levels identified for ground and water, although microbiological contaminants were not sampled. (Groundwater Study completed for the Proposed Kusipongo Resource Mining Expansion Project by ERM, 2013). According to the Report, the only groundwater identified to show signs of impact by acid rock drainage, with low pH and elevated sulphate and metal concentrations, was sampled adjacent to current Maquasa West operations (Groundwater Study completed for the Proposed Kusipongo Resource Mining Expansion Project by ERM, 2013).

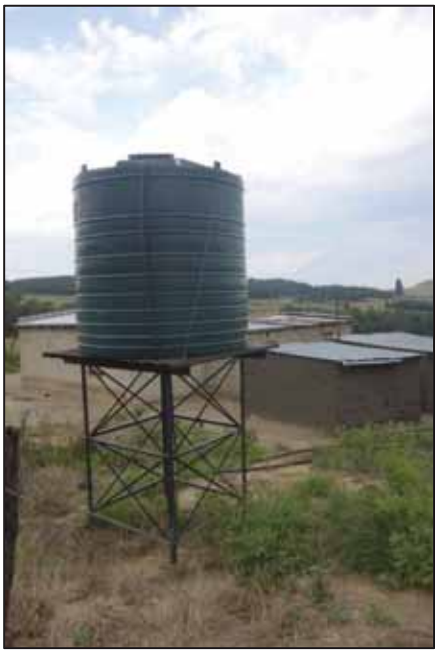
eKaluka CPA committee members were extremely concerned about the effects that mining has already had on water in the area. They suggested that water in the entire area was connected and that homesteads closer to current underground operations have experienced a drop in the water level resulting in some Kangra-installed boreholes drying up.

Key Points related to Water:

- Water quality and availability are presented as important issues for most survey respondents.
- The specialist Groundwater Study of this Project supports respondents' perceptions about potable water quality.
- CPA members emphasised the impact on reduced water availability in boreholes near current Kangra Coal mining operations.
- Government has recently installed pipes bringing water to the majority of homesteads within the yards – house connections. Within the surveyed homesteads over 66% have house connections.
- Many homesteads with this new infrastructure fall within Zones 1 and 2 of the Project's influence.

Figure 7.13 Local Water Sources

Isipongo Spring



PVC pipes transporting water to homestead tanks and taps (2 above and below left)

A local river running past Donkerhoek Farm

7.10 GRAVES

Burying the dead is an emotive and symbolic experience for many people. Choosing to use a cemetery or an historical family burial ground or to bury near the family's homestead are all options. Many families and communities hold traditional ceremonies at ancestral graves at least annually. One respondent cried when talking of the graves near her home saying she was "*remembering the people who died*" and another woman, after reporting on the number of graves in her homestead added: "…*and maybe tomorrow there will be more*."

7.10.1 *Location of Graves*

More than two thirds (68.18%) [1] of respondents declared that they knew of graves that were located either within or in close proximity to the homestead. In most instances, these were the graves of deceased relatives of long-term residents that were buried in accordance with traditional customs. Those homesteads that did not reflect any awareness of graves located in the vicinity of their homesteads were generally either recent arrivals or chose to bury their dead in cemeteries in more urbanized centres like Driefontein.

As expected, larger homesteads were more likely to be associated with nearby graves, as were homesteads that had been established over a longer period. This data is summarized in *Table 7.5, Figure 7.14* and *Table 7.6* below.

Table 7.5 Presence of Nearby Graves and Homestead Size

	Presence of Graves	
Homestead Size	**No Graves**	**Nearby Graves**
1 to 2 Persons	3	0
3 to 6 persons	5	10
7 to 10 Persons	4	14
11+ persons	2	6
TOTAL	**14**	**30**

[1] 30 of 44 homesteads surveyed.

Figure 7.14 Presence of Nearby Graves and Homestead Size

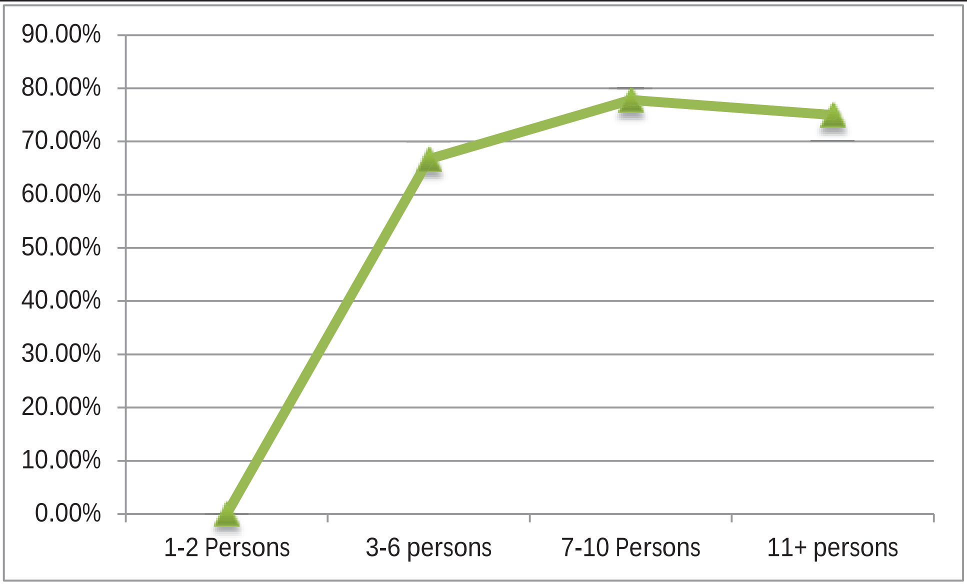
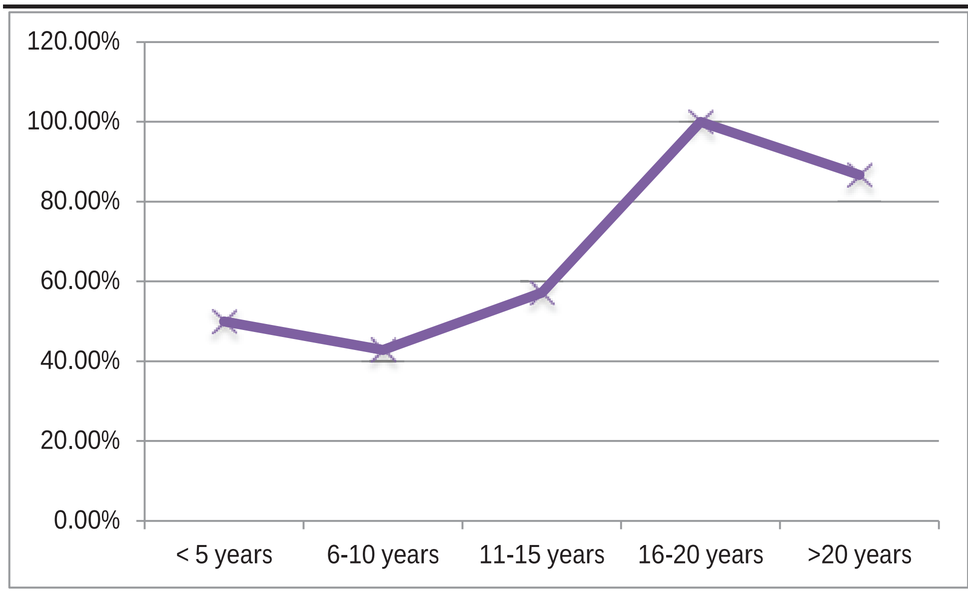


Table 7.6 Presence of Nearby Graves and Residential Period

	Presence of Graves		
Residential Period	**No**	**Yes**	**TOTAL**
Less than 5 years	5	5	10
Between 5 and 10 years	4	3	7
Between 10 and 15 years	3	4	7
Between 15 and 20 years	0	5	5
More than 20 years	2	13	15
TOTAL	**14**	**30**	**44**

Figure 7.15 Presence of Nearby Graves and Residential Period



With regard to farm locations (*Table 7.7*), Nooitgezien, Kransbank and Twyfelhoek reflected a notably lower incidence of graves associated with homesteads, compared to homesteads on Rooikop and Donkerhoek. Reasons for this may relate to the relatively recent arrival of many homesteads on Nooitgezien, Kransbank and Twyfelhoek.

Respondents from two of the Rooikop resettled homesteads reported that they had been resettled with their graves but that no other compensation for relocating the graves had been provided.

Table 7.7 Presence of Nearby Graves and Farm Location

	Presence of Graves			
Farm	**No**	**Yes**	**TOTAL**	**%**
Donkerhoek 14-HT	0	5	5	100.00%
Kransbank 15-HT	8	10	18	55.56%
Nooitgezien 381-HT	1	0	1	0%
Rooikop 18-HT	1	4	5	80.00%
Twyfelhoek 379-IT	4	11	15	73.33%
TOTAL	**14**	**30**	**44**	**68.18%**

7.11 TELECOMMUNICATION

Much of the Study Area is covered by mobile phone networks and many homesteads rely on this technology as their primary means of communications. 93.33% [1] of homesteads surveyed possessed at least one functioning mobile phone at the time of the survey. Only three homesteads, all headed by older males, did not possess cell phones [2]. All three were reliant on pensions as their primary source of income and were either living as single person homesteads (2) or two-person homesteads (1).

Reception in the area was reported to be erratic with certain spots known to have better reception.

7.12 ROADS AND TRANSPORT

A main gravel road runs in an east-west direction connecting the Study Area and homesteads in the Zones of Influence to Driefontein. Smaller sand roads branch off and snake their way to the more remotely settled homesteads. There are occasional car-tracks through the veld that reach more distant homesteads. Footpaths cross the area suggesting that most access to homesteads is by foot (*Figure 7.16*).

The main road is gravel and is of relatively poor condition in the dry season, creating significant wear and tear on vehicles using the road regularly. In the wet season parts of the road are reportedly impassable without four-wheel

[1] 42 out of 45 respondents

[2] 1 respondent was between 50 and 70 and 2 respondents were older than 71 years of age.

drive or in a truck. During the dry season, traffic along this road would generate dust. This is the primary route proposed for vehicles carrying construction material over the 18 month construction phase and dust generation would likely be high (Air Quality Impact Assessment for the Proposed Kusipongo Resource Expansion Project).

Smaller roads within Zone 1 of Influence are also small sand roads. These are in poor condition with potholes and erosion in numerous places. Local residents expressed opinions that Kangra Coal vehicles created and/or exacerbated much of this damage while not undertaking any maintenance or repair.

Survey respondents reported using taxis to get to Driefontein or to larger towns such as Piet Retief, Amersfoort and Amsterdam for shopping. Taxis pass through the area from Daggaskraal, but are not regular in the area. Transport is also reported to be expensive so people only travel when it is necessary.

Figure 7.16 Road Infrastructure in the Study Area

Main road through Study Area

Internal road to old school building

Internal Road to Homestead

7.13 *WASTE MANAGEMENT AND SANITATION*

There is no refuse collection in the Study Area and people dispose of waste informally in dumpsites near their homesteads.

Most of the homesteads have long drop toilets on their property, and the majority appear to be ventilated.

7.14 *TOURISM*

Wetlands around in the broader Study Area are recognised for their national and international tourist appeal, related predominantly to birding in Wakkerstroom (37km south west of the Study Area). According to a representative of Bird Life Africa, the entire Wakkerstroom economy is dependent on tourism. Based on secondary research, tourism is one aspect of the Provincial and District IDPs highlighted for potential job creation and economic development. However there are no tourism activities and no one is employed in tourism-related jobs in the Study Area and the Zones of Influence. While environmental changes in the Study Area may impact on existing and potential tourism activities, local communities are not involved in tourism in any way. One social field-worker, who has a diploma in tourism and hospitality, cannot find employment in the district.

Tourism and recreational activities take place at the Heyshope Dam (including water sports and largemouth bass fishing) and these are close to current open cast and underground Kangra Coal activities.

7.15 *COMMUNITY IDENTITY, LIFESTYLE AND SENSE OF EMPLACEMENT* [1]

Understanding how people identify themselves and their community as well as the relationships within and between communities will assist in anticipating strengths and vulnerabilities to changes in the social environment. The economic activities, settlement practices and major concerns and priorities across the surveyed population suggest a relatively homogenous group of residents – particularly within each of the different farm locations. This should, however, not be simplistically interpreted to mean that identity and cleavages do not set groups apart or negate the need to address each in individual ways.

Expression of Identity

The way people have accessed land (or have not accessed it) and related security of tenure, are fundamental components of identity amongst respondents.

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[1] Emplacement refers to the "construction and negotiation of home and belonging as it takes place in daily life" (Hammond, L. 2000)

For residents who are members of the eKaluka and Twyfelhoek CPAs, the importance of ownership was strongly expressed. These expressions were often in contrast to the limitations on black ownership of land and other capital resources under Apartheid. Examples provided by respondents included:

- The ability to own as many cattle as people want;
- The freedom for cattle to graze anywhere on the farm;
- Owning a home and not having to work for a farmer to be allowed to live somewhere;
- Making choices as a community for the community – through the CPA and committee;
- Living in cement-brick structures that demonstrate a sense of permanence;
- An entitlement to reject unwanted development on the farms; and
- An entitlement to reap the benefits of land-use on the farms.

In contrast, Donkerhoek residents all emphasised the on-going restrictions of living on a "white farmer's land". These included:

- The limit on cattle ownership to three and the taxing of any additional animals;
- Restrictions on grazing areas;
- The frustration of the farm-owner's power to control other people's lives;
- The refusal by farmers to allow government provision of RDP housing and water and electrification to homesteads;
- The need for someone from the family to work on the farm in order to be allowed to remain;
- The "tenants'" lack of power in relation to the owner and to decision-making about the farm that may affect the "tenants'" life and security.

For these labour tenants, most of who have lived on the farm for more than 20 years, powerlessness is an important component of how they identify themselves. One respondent said "*Will benefits go to the farmer or to the community?*" and another asked, "*What are the benefits from the mine? They must not go to the white farmer*."

Respondents from Rooikop and Nooitgezien, Kangra Coal-owned farms, presented themselves more passively. One woman said, "We don't grow anything. We don't have cattle. We can't afford to farm." Another man, settled on Rooikop for over twenty years, reported that Kangra Coal had mentioned that the homestead might be relocated. While the respondent from a homestead resettled about four years ago is still waiting for the "promised electricity". Another man, resettled onto the farm, said his family was not ploughing any more because Kangra had said they would help the family after resettlement.

There are no records of resettlement agreements made between Kangra Coal and affected families so it is not possible to verify or refute these claims.

Community Representation

Absence of clear leadership and strong problem-solving structures and the recognition of weak local government in rural areas (*Section 2.1.2* above) mean that the sense of community, particularly on CPA farms has evolved only over the past 5 to 15 years. Most of these respondents did not know each other prior to joining the CPA. They were not from a coherent community and had no specific family ties besides within their own homestead. The absence of clear leadership is also an important factor to understand when approaching communities and individuals in future phases of the proposed Project, as it makes identifying and dealing with a recognised leader difficult.

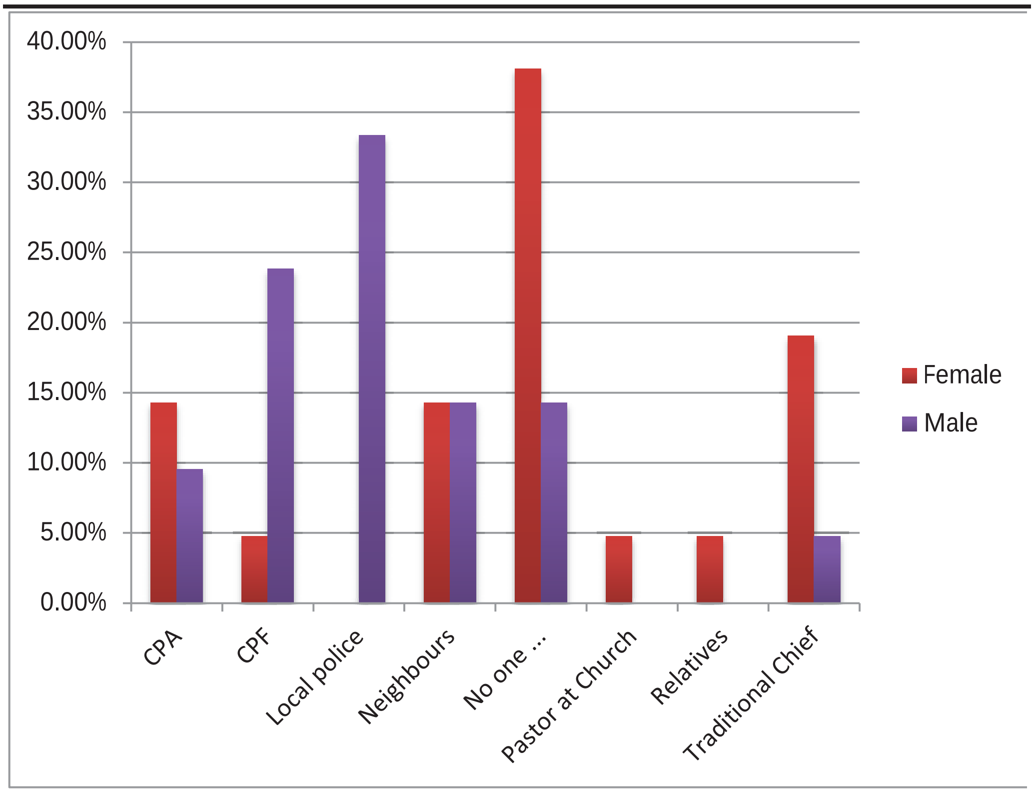
In order to assess the significance and relevance of the various authorities and representative institutions within the Zones of Influence, respondents were asked to identify the person or institution that they would appeal to for assistance in times of need or crisis. The results are summarized in *Table 7.8* below:

Table 7.8 Recognition of Community Authority

Recognised Authority	n=	%
CPF	6	13.33%
Local civic structures	5	11.11%
Local police	7	15.56%
Local tribal authority	5	11.11%
Nearby relatives	1	2.22%
Neighbours	6	13.33%
No answer	3	6.67%
No one	11	24.44%
Pastor at Church	1	2.22%
Grand Total	**45**	100.00%

The highest percentage of respondents (24.44%) indicated that they appealed to "no one". This may confirm that community-based authorities and leaderships institutions are relatively weak and ineffective, overall. A closer analysis suggests that this finding was driven largely by female respondents, with the majority of male respondents emphasizing either the local police of the Community Policing Forum (CPF). This suggests that women may be more isolated or marginalized from formal community representative structures than men (*Figure 7.17* below). It is also interesting to note that women looked to a traditional leader for authority more than men did. Traditional structures have a strong gender bias towards men, and the fact that female respondents nevertheless turn to these authorities suggests a fairly entrenched view of gender roles within the Zones of Influence. This was occasionally reinforced when women asked about potential job opportunities for "young men" rather than the youth or the unemployed in general.

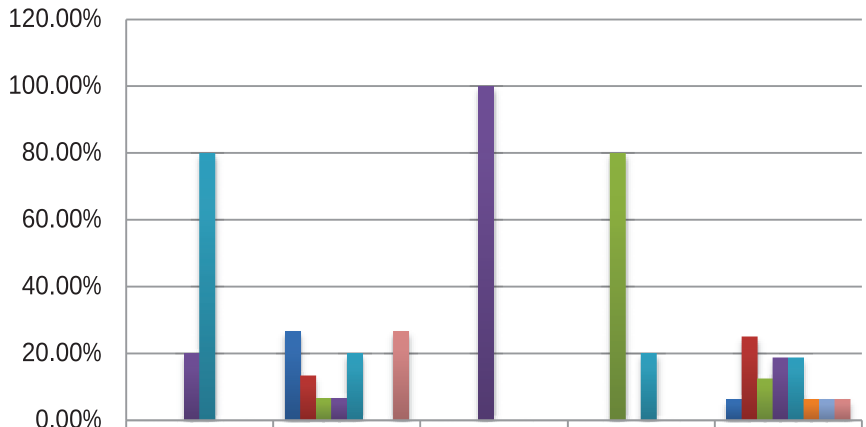
Figure 7.17 Recognised Community Authority and Gender of Respondent



A relatively high proportion of residents on Donkerhoek indicated that they would appeal to "no one" for assistance in times of trouble, as indicated below. This suggests that homesteads on privately-owned farms may be more isolated than those in formal community structures and feel more helpless than respondents from land under communal tenure. The relatively high percentage of residents on Rooikop that said they would appeal to the police for assistance is probably due to the close proximity of Rooikop to Driefontein.

In a telephone interview with Mr Greyling he highlighted that he would turn to family in times of need, as the government structures were not trustworthy.

Figure 7.18 Recognised Community Authority and Farm Locations



	Donkerhoek 14-HT	Kransbank 15-HT	Nooitgezein 381-HT	Rooikop 18-HT	Twyfelhoek 379-IT
CPA	0.00%	26.67%	0.00%	0.00%	6.25%
CPF	0.00%	13.33%	0.00%	0.00%	25.00%
Local police	0.00%	6.67%	0.00%	80.00%	12.50%
Neighbours	20.00%	6.67%	100.00%	0.00%	18.75%
No one ...	80.00%	20.00%	0.00%	20.00%	18.75%
Pastor at Church	0.00%	0.00%	0.00%	0.00%	6.25%
Relatives	0.00%	0.00%	0.00%	0.00%	6.25%
Traditional Chief	0.00%	26.67%	0.00%	0.00%	6.25%

7.15.2 Sense of Place and Emplacement

Several respondents highlighted the generally peaceful and tranquil nature of where they lived. Soil fertility for subsistence farming was valued, as was the dryness of the specific location of individual homesteads. This should be seen in context of the wetland nature of some parts of the Zones of Influence as well as areas where people might previously have lived. A key aspect of the sense of emplacement for CPA respondents was land ownership and its symbol of freedom – freedom from a farmer; to have multiple head of cattle; to make decisions over their land.

Irrespective of the nature of farms ownership, various respondents emphasised the value of their neighbours and relationships between homesteads as part of what they like about living where they do. Several respondents said that they would approach a neighbour when in need (generally for basic food stuff or small financial assistance) and that wherever possible this help was given and reciprocated. Another respondent highlighted the absence of conflict between homesteads, suggesting that relative distance from one homestead to the other reduced the potential for conflict saying, "*My chickens are not going to go to someone else's yard*".
Respondents spoke of visiting residents on nearby farms and aerial images show footpaths crossing the farms. These relationships are important and

buffer some of the more vulnerable residents from isolation. Even though local residents were not part of a distinct community in the past (as mentioned regarding the establishment of the CPAs) they express themselves as a community now and their social interactions reinforce this perception.

7.16 COMMUNITY PERCEPTIONS AND EXPECTATIONS OF KANGRA COAL

Project stakeholder meetings were held in several places around the Study Area and all three Zones of Influence, including Driefontein. People's perceptions and experiences of Kangra Coal as expressed in those meetings are documented in the SEMP Public Participation Engagement Plan and associated Comments and Response Report.

Within the Zones of Influence, community attitudes towards Kangra Coal and perceptions of current activities may provide important insight into how the affected communities may respond to social impacts associated with the Project. As mentioned earlier in this report, people's perceptions and experiences were remarkably consistent and the overall view of the company was negative.

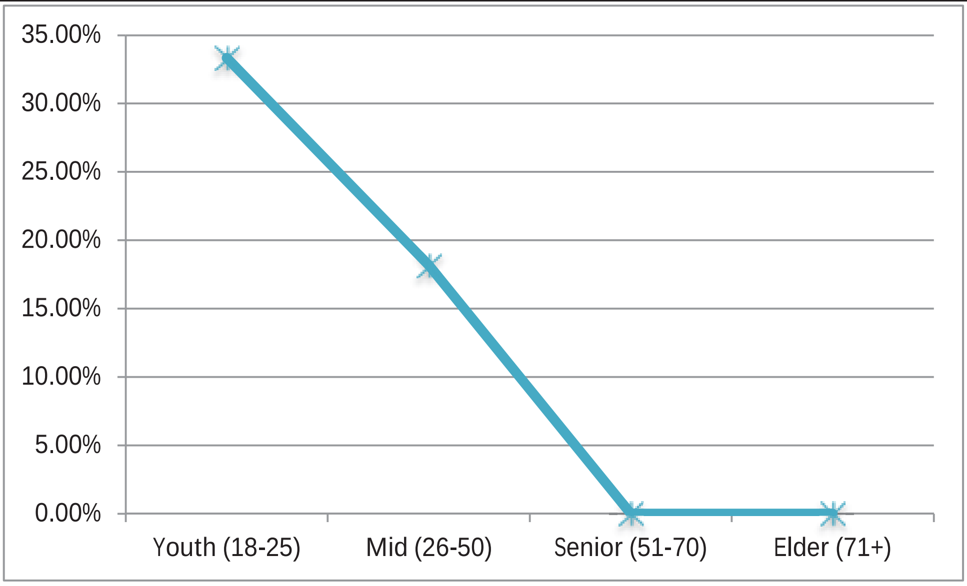
7.16.1 Perceptions of Community Benefits from Kangra Coal to Date

When asked if Kangra Coal's current operations had led to benefits or improvements for the community in general, the majority of respondents (77.78%) [(1)] said "no". Only 11.11% felt that operations brought benefits to the community whereas the remaining 11.11% declared that they were not sure. With regard to gender a slightly higher percentage of female respondents suggested that Kangra Coal's activities had led to community benefits, compared to male respondents (13.04% to 9.09% respectively).

With regard to age, the data suggests unambiguously that younger respondents were more convinced that the company's activities led to broader community benefits than older respondents (*Figure 7.19*). This may suggest a great willingness amongst younger residents to engage with the proposed Project in the anticipation of future benefits.

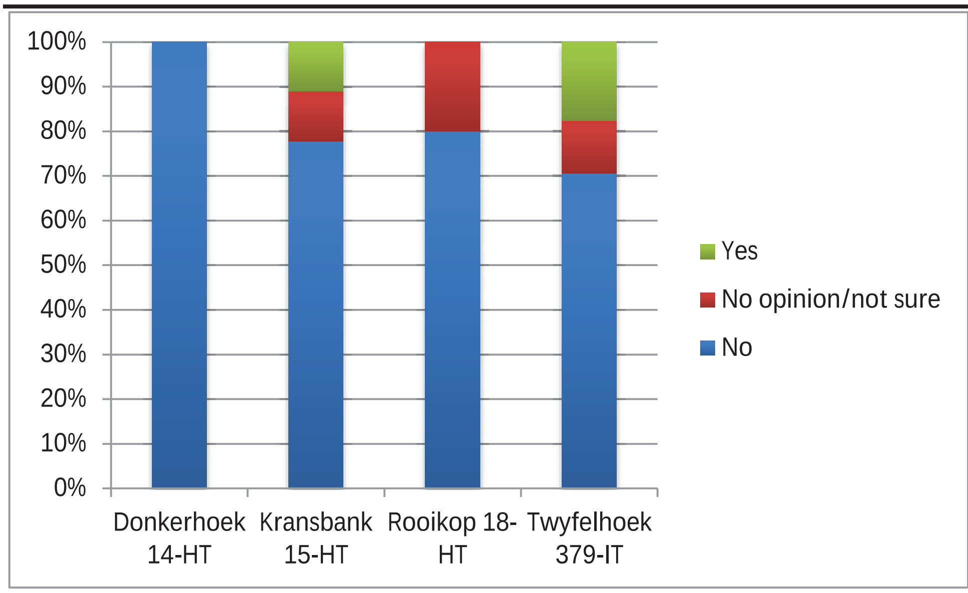
[1] 35 of 45 homesteads surveyed.

Figure 7.19 ***Perceptions of Community Benefit of Kangra Coal's Current Operations and Age Category of Respondent***



The farm on which the homestead is located also appeared to play a significant role in shaping impressions of Kangra Coal's impact on the local community. The only positive perceptions could be found on Twyfelhoek and Kransbank, which are both managed by CPAs. Donkerhoek, Rooikop and Nooitgezien reflected more negative impressions of Kangra Coals current performance (*Figure 7.20*). The fact that some respondents on CPA land did identify benefits could again suggest the potential for constructive interaction between those residents and Kangra Coal in the future.

Figure 7.20 ***Perception of Community Benefit of Kangra Operations by Farm Location***



Negative perceptions were commonly related to unfulfilled expectations – whether about resettlement agreements or non-payment to CPAs for activities taking place on communally owned farms.

Four out of 33 Zone 1 homesteads reported that they had been informed they would be resettled for the Project. All of these homesteads have high expectation of benefits from resettlement commenting on accessing better housing and improved services. An older female respondent said, "*It's no problem if the mine comes here as long as there are some benefits*." Another woman said, "*If they're here they'll have to move us and look after us*."

7.16.2 Perceptions of Impacts from Kangra Coal to Date

Respondents were asked to assess whether they or their families had been impacted by Kangra Coal's operations to date and assess the overall nature of that impact. Impacts experienced could include prior resettlement; disruptions from exploration activities; unmet expectations; damage to roads from company vehicles; acquisition of homestead structure; employment; improvement in living conditions etc. The result of this enquiry is summarized in *Table 7.9* below.

Table 7.9 Community Experience of Impact of Kangra Operations

Kangra Coal's Impact	n=	%
Positive	2	4.44%
No effect	18	40.00%
No answer	1	2.22%
Negative	24	53.33%
TOTAL	**45**	**100.00%**

Whereas a sizeable percentage of the respondents felt that Kangra Coal's operations had no impact on them directly (40.00%), the majority felt that current operations had impacted on their lives in negative ways. Less than 5% of respondents felt that operations had a positive effect on their lives. There did not appear to be significant variations in this trend with regard to the gender of the respondent.

7.16.3 Community Expectations over Kangra Coal's Kusipongo Resource Expansion Project

81.82% of respondents surveyed knew about the proposed Kusipongo Expansion Project. Respondents were asked to identify expectations of benefits as well as concerns related to the proposed Project. When isolating and identifying their main expected benefits regarding the proposed Project the overall results showed the following (refer to *Table 7.10*).

Table 7.10 Community Perceptions of Potential Benefits of the Project

Potential Benefits	n=	%
Fulfilled promises	1	2.70%
Improved Infrastructure	5	13.51%
Increased local employment opportunities	8	21.62%
Increased opportunities for business	1	2.70%
More land for grazing	1	2.70%
No expected benefits	21	56.76%
TOTAL	**37**	**100.00%**

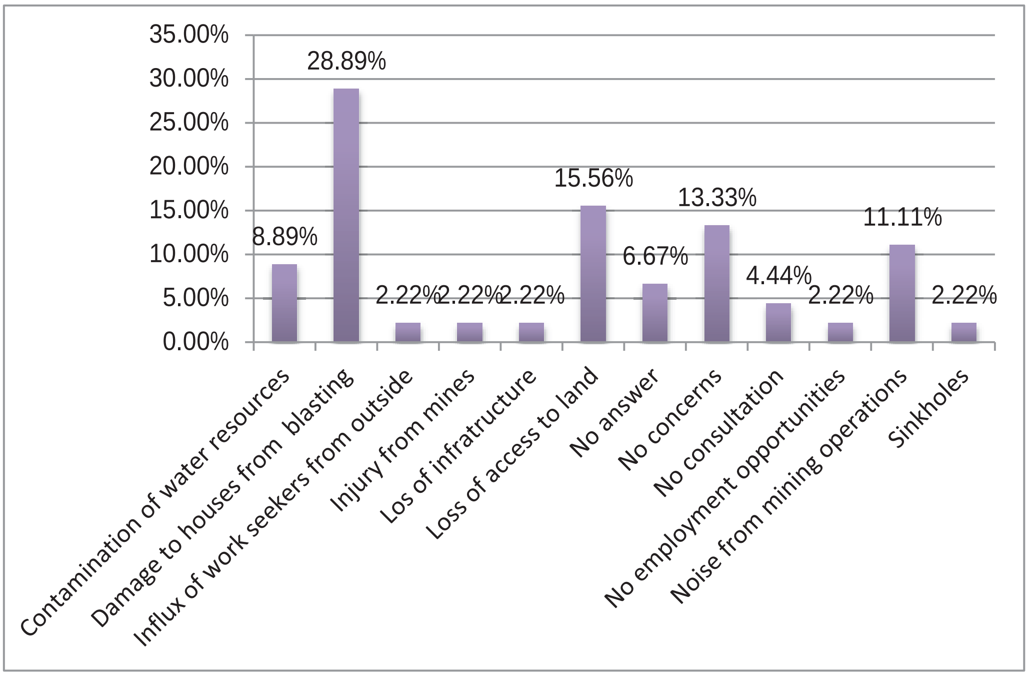
As indicated above, the majority of respondents (56.76%) did not expect any benefits associated with the proposed Project. For those who commented on potential local employment opportunities, 75% were from the 26 to 50 year old age category suggesting that it is this economically active group who have the highest expectations.

In addition to highlighting the benefits, respondents were also asked to identify concerns that the proposed Project may trigger for the community. A summary of responses is presented in *Table 7.11* and *Figure 7.21* below.

Table 7.11 Main Community Concerns over the Proposed Project Impacts

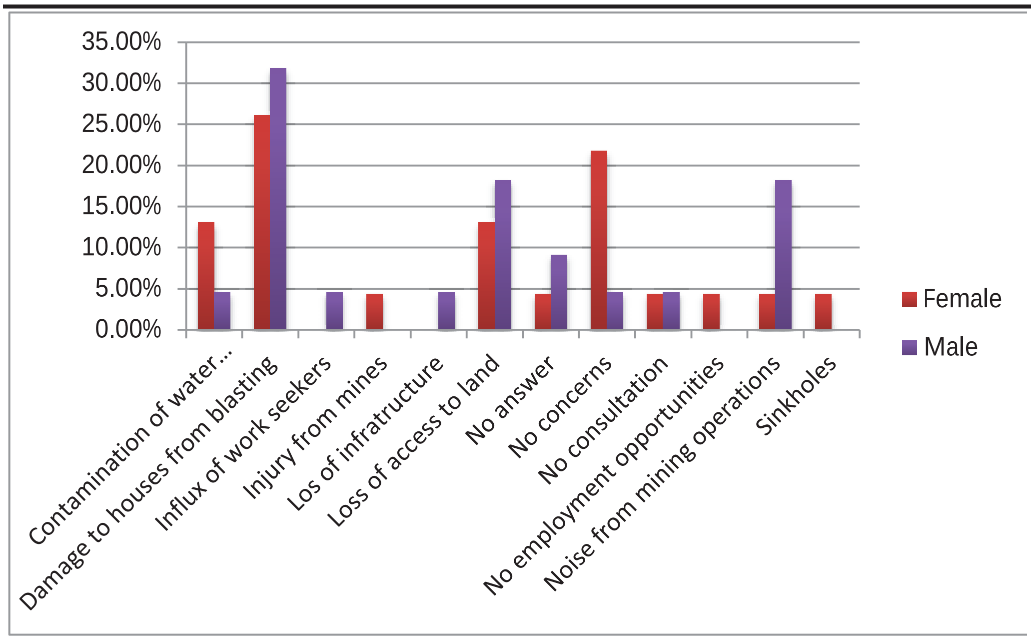
Main Concerns	n=	%
Contamination of water resources	4	9.52%
Damage to houses from underground blasting	13	30.95%
Influx of work seekers from outside	1	2.38%
Injury from mines	1	2.38%
Los of infrastructure	1	2.38%
Loss of access to land	7	16.67%
No concerns	6	14.29%
No consultation	2	4.76%
No employment opportunities	1	2.38%
Noise from mining operations	5	11.90%
Sinkholes	1	2.38%
TOTAL	**42**	**100.00%**

Figure 7.21 ***Main Communities Concerns over Proposed Project Impacts***



Expressions of concern over the proposed Project varied considerably between male and female respondents. A relatively higher percentage of female respondents reflected "no concerns" regarding the Project compared to male respondents (women: men ratio of 21.74%: 4.55%). Male respondents reflected a high level of concern over blasting associated with Project activities. The relative absence of expressions of concern from women may reflect culturally based gendered norms and several women mentioned that they did not know anything about mining and were therefore reluctant to express an opinion on how it may affect them, their land or environment (*Figure 7.22*).

Figure 7.22 ***Community Concerns over the Project and Gender of Respondent***



For both men and women the concern over damage to homesteads from blasting was highest, followed by loss of access to land. Women then identified risks of water contamination as their third highest concern while men highlighted noise. Several women commented that the blasting was not only noisy but also frightening, particularly for the children and that this fear was from both the noise and vibrations, which one woman said made her fear for an "earthquake".

Examining concerns by farm location, it's interesting to note that Donkerhoek respondents represented 40% of the overall "no concern" responses and Kransbank represented 50% of overall concerns for damage from blasting. This finding may suggest that Donkerhoek residents feel that they have less to lose and in contrast, Kransbank residents, many of who have new brick and cement structures feel vulnerable to damage to property that they own.

The one respondent who highlighted potential injury from mining was from Nooitgezien and had recently been resettled because of risks to the family from fly-rock (1).

A range of comments made during the interviews summarise various respondents' expectations and concerns:

- There should be local jobs – particularly for those affected by the Project;

- Kangra should provide training to ensure locals are qualified to apply and once trained people should get opportunities for work;

- Kangra should provide coal to local communities as they are taking the coal from community land;

- Communities should be partners in the Project, sharing the profits – because the mining would affect these farms;

- People already experience the noise and vibrations from blasting in current operations. If this is much closer the impact will be much more severe;

- People are fearful of the explosions, creating sense of potential earthquakes, which may damage houses but also may be dangerous to children and adults alike;

- Mining operations will use up all the water in the area and there won't be enough for local residents' use; and

- Mining will pollute the water and Kangra will leave the area and residents will remain with problems for future generations.

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[1] Fly-rock is the uncontrolled debris from controlled explosions.

Key Points related to Perceptions and Expectations of Kangra Coal:

- There is overall a consistently negative perception of Kangra Coal. This is based on reported experiences and on unmet expectations. Many of these dissatisfactions will need to be addressed before residents would be willing to allow the proposed Project into their area.
- Slight variations within these perceptions amongst interest groups suggest that younger people might be more open to engaging with Kangra Coal than older residents.
- Expectations for employment are high, particularly amongst the economically active respondents.
- People want to see benefits for their communities although they are sceptical about the fulfilment of these wishes.
- Major concerns over proposed Project impacts include damage to buildings; noise and vibrations from blasting; and the loss and pollution of available water in the Zones of Influence.

8 IMPACT ASSESSMENT METHODOLOGY

The previous chapters of this report have laid out the socio-economic environment in the proposed Project's Zones of Influence and Chapter 9 will identify and assess the significance of Project-related impacts on this environment. This chapter therefore describes the impact assessment methodology that has been used in Chapter 9.

The impact assessment stage comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources / receptors. The steps involved in the impact assessment stage are described in greater detail below.

8.1 IMPACT ASSESSMENT

The impact characteristic terminology to be used is summarised in *Table 8.1*.

Table 8.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value]

In the case of type, the designations are defined universally (i.e., the same definitions apply to all resources / receptors and associated impacts). For these universally-defined designations, the definitions are provided in *Table 8.2*.

Table 8.2 Designation Definitions

Designation	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource / receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
Extent	
Local	Defined on a resource / receptor-specific basis.
Regional	
International	
Duration	
Temporary	Defined on a resource / receptor-specific basis.
Short-term	
Long-term	
Permanent	

In the case of *extent* and *duration*, the designations themselves (shown in *Table 8.1*) are universally consistent, but the definitions for these designations will vary on a resource / receptor basis (e.g., the definition of what constitutes a "short term" duration for a noise-related impact may differ from that of a "short term" duration for a habitat-related impact). This concept is discussed further below.

In the case of *scale* and *frequency*, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of acres affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

An additional characteristic that pertains only to unplanned events (e.g., traffic accident, operational release of toxic gas, community riot, etc.) is *likelihood*. The likelihood of an unplanned event occurring is designated using a qualitative (or semi-quantitative, where appropriate data are available) scale, as described in *Table 8.3*.

Table 8.3 Definitions for Likelihood Designations

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and / or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource / receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource / receptor sensitivity / vulnerability / importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (e.g., modelling, frequency charts) where available.

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource / receptor in question) to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource / receptor. As in the case of extent and duration, the magnitude designations themselves (i.e., negligible, small, medium, large) are universally used and across resources / receptors, but the definitions for these designations will vary on a resource / receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *negligible* magnitude. In the case of positive impacts no magnitude will be assigned.

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity / vulnerability / importance of the impacted resource / receptor. There are a range of factors to be taken into account when defining the sensitivity / vulnerability / importance of the resource / receptor, which may be physical, biological, cultural or human. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource / receptor is biological or cultural (for example, the marine environment or a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Other factors may also be considered when characterising sensitivity / vulnerability / importance, such as legal protection, government policy, stakeholder views and economic value.

As in the case of magnitude, the sensitivity / vulnerability / importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource / receptor basis. The universal sensitivity / vulnerability / importance designations are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact.

Impact significance is designated using the matrix shown in *Table 8.4*.

Table 8.4 Impact Significances

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box 8.1* provides a context for what the various impact significance ratings signify.

Box 8.1 ***Context of Impact Significances***

An impact of ***negligible*** significance is one where a resource / receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of ***minor*** significance is one where a resource / receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and / or the resource / receptor is of low sensitivity / vulnerability / importance. In either case, the magnitude should be well within applicable standards.

An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and / or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of ***major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued / sensitive resource / receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

8.2 MITIGATION OF IMPACTS

Once the significance of a given impact has been characterised using the above matrix, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource / receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any impact assessment is to help our clients develop a consentable Project, and to help them achieve their business objectives in a responsible manner. Impact assessment is about identifying the aspects of a Project that need to be managed, and demonstrating how these have been appropriately dealt with and left a good quality and appropriate development. As key influencers in the decision making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an ALARP level.

Embedded controls (i.e., physical or procedural controls that are planned as part of the Project design and are not added in response to an impact significance assignment), are considered as part of the Project (prior to entering the impact assessment stage of the impact assessment process).

8.3 *RESIDUAL IMPACT*

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

8.4 *CUMULATIVE IMPACTS/EFFECTS*

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process should predict any cumulative impacts / effects to which the Project may contribute. The approach for assessing cumulative impacts and effects resulting from the Project and another activity affecting the same resource / receptor is based on a consideration of the approval / existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

9 IMPACT ASSESSMENT AND MITIGATION

9.1 INTRODUCTION

The focus of this Section of the SIA is on the anticipated impacts that the proposed Project will have on the socio-economic environment described above and on ways in which these impacts can be prevented and mitigated where negative or maximised where opportunities exist.

Presenting impacts through templates that standardize both biophysical and social environments has inherent difficulties. In a number of the ESIA components (e.g. air and noise, water, fauna and flora etc.) the cause and effect relationship between a project activity and its consequence is clear and even quantifiable, thus making the identification of impacts, required mitigation measures and the allocation of responsibilities for mitigation concrete. Unfortunately this is not the case for the social environment. The reason for this is that people may respond to activities in unpredictable, complex and often intangible ways. In addition, an activity may trigger both positive and negative impacts; however, the process of assessment requires an overall rating of significance for each activity / impact. Therefore, this SIA presents a discussion of anticipated impacts, discussing both positive and negative consequences, where the two co-exist. In assigning a significance rating though, the SIA weighs up the different aspects and presents one overall rating. It is therefore emphasized that to fully understand the rating it is necessary to fully understand the argument presented.

In presenting the socio-economic impacts anticipated to arise as a result of the proposed Project this Section draws on participatory fieldwork with affected communities as well as outcomes associated with stakeholder engagement activities, documented in the ESIA's Stakeholder Engagement Plan and associated Comments and Response Report. In addition, information and specialists' understandings accumulated during other similar work in South Africa and worldwide, have contributed to this impact assessment.

Impacts that require resettlement, compensation and livelihood restoration planning are presented in this assessment but due to the significance of the issue a separate specialised study (to develop a Resettlement Action Plan) will be undertaken under the auspices of Shanduka Coal post the SIA process. This plan will fully address the scale of this impact, individual homesteads affected, community land affected and will detail the approach to be taken in addressing resettlement, compensation and restoration measures.

The impacts on physical resources such as air, noise, soils, surface and groundwater as well as impacts on biological resources such fauna and flora are assessed within the respective specialist reports associated with the ESIA assessment for the proposed Project. The assessment of the socio-economic impacts presented below takes the results of these assessments on physical and biological receptors into account. Their effects on the socio-economic environment and their social implications are included in the SIA and are cross-referenced where relevant.

The predicted significant impacts to the socio-economic environment as a result of the proposed Kusipongo Resource Expansion Project are described below. For ease of review they have been divided into the following themes:

- Physical and Economic Displacement;
- Socio-Economic Environment and Livelihoods;
- Socio-cultural Identity and Relationships;
- Natural Resources;
- Community Health and Safety;
- Social Infrastructure and Governance; and
- Legacy.

9.2 PHYSICAL AND ECONOMIC DISPLACEMENT

9.2.1 Homesteads and their Residents will be displaced as a Result of the Proposed Project Footprint as well as Potential Air and Noise Impacts related to Proposed Project Activities

Description of the Baseline Environment

The footprint of the proposed Project extends over a number of farms with different types of land ownership and security of tenure arrangements for the residents. Homesteads in the Zone 1 of Influence include a variety of residential buildings, outbuildings, livestock structures and small-scale agricultural fields.

Of the 42 homesteads identified within Zone 1, 33 [1] were surveyed and the results presented below.

Table 9.1 Period of Residence by Farm Location for Homesteads in the Zone 1

Farm	>5 yrs	5 to 10 yrs	10 to 15 yrs	15 to 20 yrs	20+ yrs	No Answer	Total Homesteads
Kransbank	2	4	4		1		11
Twyfelhoek		2	1	4	6	1	14
Donkerhoek				1	4		5
Nooitgezien	1						1
Rooikop					2		2

[1] 33 homesteads out of 42 identified within Zone 1 of Project impacts (78% sample).

Figure 9.1 ***Period of Residence for All Respondents (as %)***

All of these homesteads participate in a variety of livelihood activities to ensure their survival. As discussed in *Chapter 9* livelihoods depend on a balance of social grant and pension incomes, migrant remittances and salaries, as well as subsistence agriculture and livestock farming which reduce people's dependence on a purely cash economy. Most survey respondents reported the centrality of home-grown foods over those bought for cash.

Proposed Project Activities

The proposed Project will construct mining infrastructure at two nodes – Adit A, for entry into the mine and Adit B as a ventilation shaft. There will also be a linear development of 8.4km for the overland conveyor transporting coal from Adit A to Maquasa West where it will tie into the existing overland conveyor and be transported to the existing beneficiation plant and Maquasa East. There will also be a temporary contractors camp built to house approximately 250 non-local employees for the duration of construction (18 to 24 months). This will be situated within Kangra Coal's Rooikop farm and is more than 1km away from any other homesteads. Approximate footprint requirements for these Project activities is shown in *Table 9.2* below.

Table 9.2 ***Approximate Footprint Requirements for Project Infrastructure***

Infrastructure	Footprint Requirement (m^2)	Footprint Requirement (Ha)
Adit A	184 709 (m^2)	18.5ha
Adit B (Ventilation)	500 (m^2)	0.05ha
Conveyor Belt	268 800(m^2)	27.0ha
Contractors Camp (temp)	30 000(m^2)	3ha
TOTAL	**484 009 (m^2)**	**48.4 ha**

Following completion of the construction phase the proposed mine will become operational for an anticipated 10 to 20 years. Activities associated with the operational phase of the proposed Project will include 24hr underground mining, associated underground blasting (during daytime), day-to-day surface activities at Adits A and B and 24hr operation of the overland conveyor transporting coal to Kangra Coal's existing materials handling facilities. These activities will generate noise and increases air emissions.

At closure, portions of the land will be rehabilitated.

The above activities will result in this land being lost to homesteads either from the direct loss of land for infrastructure development and operation, or as a result of health and safety, noise and air quality impacts on homesteads in proximity to these activities [1].

Sensitive Receptors– People and their Homesteads

As highlighted above, there are approximately 42 homesteads within Zone 1 of the Zones of Influence and the proposed Project activities will potentially impact on these homesteads directly affecting families living on the land.

Numbers of potentially impacted homesteads are shown in relation to their farms and tenure status are presented in *Table 9.3*.

Table 9.3 Potentially Affected Homesteads in Relation to Farm Location

Farm	No.	Ownership
Kransbank	9	Communal – eKaluka CPA
Twyfelhoek	20	Communal – Thuthukani CPA
Donkerhoek	5	Private – CJ Greyling
Nooitgezien	3	Private – Kangra Coal
Rooikop	3	Private – Kangra Coal
Other [2]	2	Private

Please Note:

The number of affected homesteads may differ from what is presented above, based on the outcomes of noise and air quality monitoring. Current modelling results for noise and air quality have indicated potential homesteads for resettlement. Actual monitoring data will validate the predicted requirements for resettlement.

These potentially impacted homesteads have different connections to their land, based on their tenure status and duration of living there, amongst other

[1] The Noise Impact Assessment has identified the need to relocate homesteads within 630m of the conveyor based on noise impacts. This increases the number of impacted households beyond those assessed in the Socio-economic Study but based on the Noise specialist's report 630m should be used as the defining impact distance for the conveyor. Exact numbers of homesteads within this range will be confirmed during the Resettlement Process

[2] Roodepoort 38_ht and Beelzebub 13-HT. These farms are not included directly in the study as operations will all be sub-surface.

attachments. But for all, residential infrastructure and the entitlement to live where they do are important factors for individual and family wellbeing and sustainability.

Kransbank and Twyfelhoek are communally owned farms managed as a community by the CPAs and through the representative committees. As a whole the CPA owns the land but individual members are not entitled to sell or negotiate their stake in the land. Furthermore, the community decides on how the land is used and by who if outside parties wish to undertake developments or commercial activities on CPA land. Thus impacted homestead owners are not, on their own, in a position to negotiate issues of relocation or compensation for loss of homesteads resulting from activities described above. This creates some vulnerability for individuals. Furthermore, the nature of CPA members' attachment to their land, physically and symbolically, must be fully acknowledged and understood. People have become part of a community and feel entitlement to ownership – perhaps for the first time in their lives. Undermining this would have additional significant negative impacts.

For residents of Donkerhoek, most of who have lived there for over 20 years but have no formal title to their homesteads, vulnerability is high. Furthermore, 4 out of 5 homesteads are within Zone 1 and the remaining single homestead is a further 200 meters away from proposed infrastructure.

Many residents on Kangra Coal land have lived on the farms before Kangra Coal's purchase in the late 1990s. The Land Reform (Labour Tenants) Act of 1996 and Extension of Security of Tenure Act (1997) provides protection and some rights to both this and the Donkerhoek group. However, the more complex legal rights are sometimes disregarded during project implementation. For example, one Nooitgezien resident in the Zone 1 was resettled by the company as recently as December 2012 and is now, once again, at risk of losing her homestead.

People's attachment to their land, given the particularly exploitative land tenure history in South Africa, should not be underestimated based on an absence of a title deed. A private farm-owner or land-owner, as applies to Donkerhoek and Kangra Coal, is not entitled to make a decision that impacts the security of tenure of other families and individuals in his land. The active involvement of these homestead owners in discussions and negotiations about loss of land is part of Kangra Coal's legal obligations.

It is important to further recognise specific vulnerabilities of various individuals or groups within the affected homesteads. The baseline description has highlighted some of the vulnerabilities related to duration of residence; main source of income; family size; land tenure; access to resources and decision-making. Some general examples include:

- Elderly people (and some disabled) for whom losing their home would be extremely traumatic.

- People who rely on their relationships with neighbours as a source of support (emotional and material) could become isolated.

- Families with a long history in the homestead may have ancestral graves in or nearby that will be affected (just under 33% of homesteads surveyed in the Zones) could find this upheaval unsettling – emotionally and traditionally (see the Heritage Impact Assessment Report associated with the ESIA for the proposed Kusipongo Resource Expansion Mining Project).

- Families relying on multiple livelihood strategies that lose access to their fields (almost 100% of homesteads surveyed) will be put at increased risk.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the magnitude of this impact is considered to be large and the impact of **"Major Negative"** significance for all directly affected homesteads and residents, pre-mitigation (*Table 9.4*).

Table 9.4 Rating of Impacts Homesteads and their Residents will be displaced as a Result of the proposed Project Footprint as well as Potential Air and Noise Impacts related to Proposed Project Activities (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to the Zone 1 area of influence.
Duration	Permanent	10 to 20 year life of mine plus land disturbance beyond closure.
Scale	48.4 Ha (approximately 42 Homesteads)	Settlement within the Zone 1 of Influence is either not possible or too disrupted because of footprint requirements and infrastructure or for health, safety and nuisance factors for residents.
Frequency	Continuous	Will be a constant impact from the construction phase through to post closure of the mine. Even if land is returned to its original state in 10 to 20 years' time it would be unreasonable to anticipate moving people temporarily from the affected areas until mine closure.
Likelihood	Definite	If the proposed Project goes ahead this impact will be inevitable.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The complexity of land issues in South Africa's history together with the security and insecurity of land tenure arrangements in the Zones of Influence, and the real and symbolic significance of land, establishes a social environment of high vulnerability and sensitivity for those affected. Additionally, poor prior examples of Kangra Coal resettlement activities highlight post-resettlement vulnerabilities for those affected.		
Significant Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

A full Resettlement process will be followed but the following approach and mitigation measures will be used to reduce the significance of the impact:

- Kangra Coal recognises that negotiated prior and informed consent from all landowners and affected stakeholders is required prior to the placement of surface infrastructure on private and communally owned land.

- Land-owners (private and communal) will be informed about what is proposed on their land. Give equal recognition to the interests of private and communal ownership when negotiating access to the land. All affected labour tenants living on private land will be included in these negotiations.

- A comprehensive Resettlement negotiation process will take the following into account:

    - The Air Quality and Noise Specialists have identified impacts (refer to *Sections 10.6* and *10.7* in *Chapter* 10) that will potentially result in the need for resettlement of certain homesteads. The Resettlement negotiation process will take these specialist findings into account, verified through further monitoring of noise and air quality impacts.
    - The CPA rights and the complexity of decision-making within the structure will be recognised by Kangra Coal.

- The entire process will be formally documented.

- Where resettlement in Kransbank and Twyfelhoek is required, people will (as far as possible) be relocated to new sites within their CPA farm to reduce community disruption. Kangra Coal is aware that people have chosen particular homestead locations because of natural conditions, and will ensure that these are maintained or improved, including ease of access to roads and transport.

- If relocation within the CPA land is not feasible, Kangra Coal will ensure that people have the same land tenure status in their re-established locations.

- A Community Benefit Agreement will be negotiated with CPAs as part of the Resettlement Process.

- Where resettlement in Donkerhoek, Rooikop and Nooitgezien is required, Kangra Coal will ensure that homesteads that do not have title deeds (this applies to both Donkerhoek and Kangra Coal owned land) are given security of tenure and entitlements at least equal to their current tenure arrangements – preferably better. The Land Reform Act and Extension of Security of Tenure Act will be used to inform these negotiations. Kangra

Coal further realises that it is important to ensure that people living as labour tenants prior to the implementation of the land acts mentioned above (1996/7) are not further discriminated against by becoming "new" residents on land that is again privately owned.

- Kangra Coal will ensure that land identified for resettlement will not be used for any future mining activities. Further resettlement of communities that have recently been resettled compounds the socio-economic disruptions and threats that they face and increases the risks of violation of basic human rights.

- Kangra Coal will use impartial legal advisors for reputable legal advice and representation (e.g. Legal Resource Centre) for all affected communities and homesteads. The legal representation will consider the needs of the residents, particularly when security of tenure is being undermined by resettlement.

- Although the majority of survey respondents rely predominantly on social grants and pensions the Resettlement process will fully understand the different components of each affected household's livelihood strategies and ensure that this is replaced, and ideally improved, by the resettlement.

- In considering how resettlement of some homesteads will affect others, the Resettlement process will develop a full understanding of relationships and social and cultural connections between homesteads. Such an understanding will inform decisions on resettling individual homesteads or entire communities to mitigate the impact. A key example is that out of five homesteads on Donkerhoek only three or four may be affected. However the cluster of families is a community and has lived together for almost two decades. Moving some but not all homesteads may increase the social and economic isolation of those left behind, with potentially serious consequences. This consideration applies to the entire resettlement approach. Resettlement that is well done will not trigger negative impacts of its own.

Residual Impact (<u>Post-mitigation</u>)

Resettlement of directly affected homesteads to places within their original CPA or to places of greater security of tenure if they are currently on privately owned land would compensate people for their loss of access to homesteads and remove people from the dangers associated with planned mining activities. Furthermore, if a fully participatory process is undertaken and homestead owners and landowners are satisfied with commitments AND implementation of resettlement agreements the physical and emotional upheaval of losing homesteads and land may be reduced.

Implementation of the mitigation measures above should, overall, reduce the scale of the impact to medium reducing the significance of the impact to a **'Moderate Negative Impact'** (*Table 9.5*).

Table 9.5 ***Rating of Residual Impacts on Homesteads and their Residents will be displaced as a Result of the proposed Project Footprint as well as Potential Air and Noise Impacts related to Proposed Project Activities (Post-Mitigation)***

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to the Zone 1 area of influence.
Duration	Medium-term	Full implementation of a participatory Resettlement process should produce an outcome where affected homesteads will be able to settle and re-establish their livelihoods within a limited timeframe (3 to 5 years).
Scale	48.4 Ha (approximately 42 Homesteads)	Settlement within the Zone 1 of Influence is either not possible or too disrupted because of footprint requirements and infrastructure or for health, safety and air quality and noise for residents.
Frequency	Once-off	If affected homesteads are properly resettled and compensated, then the impact on homesteads should cease after the initial event.
Likelihood	Definite	The impact will definitely occur if the proposed Project takes place.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The sensitivity of affected homestead residents will be high based on the discussions in pre-mitigation. However, if the Resettlement process is participatory and respectful, people may feel less vulnerable and more empowered to make decisions and take some control over events that will shape their lives. If this happens their vulnerability, post-mitigation, should be reduced.		
Significant Rating After Mitigation		
Moderate Negative Impact		

9.2.2 *Loss of Access to Land for Agriculture (approximately 25 Homesteads) and Grazing as a Result of the proposed Project Footprint and Associated Infrastructure*

Description of the Baseline Environment

Agriculture

Zone 1 of Influence is a rural farming environment with homesteads and associated adjacent small-scale fields and open areas for livestock grazing. There are a number of groundwater points for livestock drinking across the Zone. There is also land on Twyfelhoek that is under cultivation as part of an agricultural development programme, in which a number of community members are involved.

As described in the Baseline section of the report, people living in Zone 1 of Influence rely on multiple livelihood activities of which a significant component is subsistence food production. Most families interviewed highlighted that their fields produced at least half of their seasonal maize-meal requirements and that only after this produce was used up did the family need to buy maize-meal at a shop. Several families grew a variety of other food crops on this subsistence scale. Produce included tomatoes, spinach, potatoes, cabbage etc. Only two survey respondents [1] reported growing nothing – either because they did not have the means to buy seed or because they were waiting to be helped by Kangra Coal as part of their resettlement assistance / compensation.

Livestock

Under apartheid laws all residents living on white owned farms in the Study Area were restricted to three head of cattle that could graze only in small, designated areas. This is no longer the case on CPA land although it is still applicable on Donkerhoek and Kangra Coal-owned land. Kransbank and Twyfelhoek members are entitled to own as many head of cattle and other livestock as is possible within the land's carrying capacity and animals are free to roam and graze throughout the farm. Numbers of livestock have increased and a breeding programme has been initiated through the introduction of seven bulls to the farms. Government provided the bulls about two years ago and herd numbers are reportedly beginning to increase. People's freedom to own unrestricted numbers of livestock and the farms' carrying capacity for these animals serves both a practical purpose within homestead livelihood strategies (meat when necessary or animals to sell) as well as a symbolic function highlighting people's freedom and autonomy on CPA land.

Proposed Project Activities

The activities associated with footprint requirements described in *Section 9.2.1* above, 48.4 ha apply equally to the loss of land for agriculture and grazing within the footprint of the proposed infrastructure. The agricultural fields of approximately 25 homesteads will be directly impacted while grazing land for additional families will also be directly impacted. Furthermore, the conveyor infrastructure, running for 8.4km, will practically divide the land with a fenced barrier running through it. This will restrict free movement by cattle across the area and therefore limit where they can graze and find water. The layout of the CPA farms into areas of loosely clustered homesteads and large tracts of land available for grazing suggests land use planning for unrestrained access for livestock across the farms. It also allows herds to find their own grazing areas without a herder.

The above activities will result in the agricultural land being lost to homesteads (as a component of the direct impact on homesteads discussed above) as well as the loss of agricultural and grazing land within the proposed Project footprint and Zone 1 of Influence and the loss of free access to grazing across the farms.

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[1] About 4% of the survey sample

Sensitive Receptors

As highlighted above there would be approximately 25 homesteads directly impacted by proposed Project activities that would lose access to their fields. These homesteads are all strongly dependent upon subsistence agricultural as a component of their survival. Loss of these fields would force people to rely more on a cash income with which to purchase previously home-grown food. Over 66% of respondents rely predominantly on state grants and pensions (R280 per child or R 1 200 for pensions per month) and would be left extremely vulnerable if they were forced to draw more heavily on these incomes to supplement their food security.

The loss of livestock or a forced reduction in numbers due to curtailed access to grazing would impact on people's ability to choose to use the animals for food or income when necessary.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the impact from the loss of access to land for agriculture and grazing is assessed to be a **"Major Negative Impact"**, pre-mitigation (Table 9.6).

Table 9.6 Rating of Impacts Related to Loss of Access to Land for Agriculture (for approximately 25 Homesteads) and Grazing as a Result of the proposed Project Footprint and Associated Infrastructure (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to site of disturbance (within 1km from Adits A and B and 500m from the conveyor, and temporary contractors' camp footprint). Also affecting movement across the CPA farms and Rooikop and Nooitgezien.
Duration	Long Term	The impact will be triggered during construction and will continue through operations (10 to 20 year life of mine). Disturbed land will be rehabilitated at closure.
Scale	48.4 Ha directly (approximately 25 Homesteads) and all CPA residents who own livestock	Subsistence fields for approximately 25 homesteads and livestock farming and grazing is either not possible or too disrupted because of footprint requirements and infrastructure. The presence of the conveyor further disrupts the entire 8.4km corridor, splitting the land on either side. This increases the number of directly affected individuals to all those who graze cattle in the area.
Frequency	Continuous	Will be a constant impact from Construction for the life of the proposed Project. Even if land is returned to its original state post the operational period it would be unrealistic to anticipate moving people temporarily from the affected areas until mine closure.
Likelihood	Definite	This impact is inevitable if the proposed Project goes ahead.
Magnitude		
Large Magnitude		

Sensitivity/Vulnerability/Importance of the Resource/Receptor
High Sensitivity
Affected homesteads and the additional individuals whose livestock will be impacted rely heavily on a mix of livelihood activities for their survival. The disruption or undermining of one component of a livelihood strategy heightens the vulnerability for affected residents, their food security and survival.
Significant Rating Before Mitigation
Major Negative Impact

Recommendations and Mitigation/Management Measures

The following mitigation measures should be implemented to reduce the significance of the impact:

- All Resettlement mitigation measures presented in *Section 9.2.1* above will apply. This includes gaining access to privately and communally owned land and to negotiating resettlement agreements for those who lose fields and grazing and whose subsistence is therefore undermined.

- Similarly, mitigation highlighted above for communal and private landowners who lose agricultural and grazing land, will apply to this impact. Negotiations should be undertaken through the Resettlement process to determine fair compensation for the loss of current and future land use.

- Access points must be identified and culverts constructed to enable safe and convenient movement across the conveyor for people and animals. The placement of such underpasses/crossings must be regular enough so as to limit the inconvenience and detour length for affected parties. Aerial images, together with community participation, will determine the maximum distance between any two culverts.

The above impact recommends resettling people within their current CPA farms to reduce social disruptions. However, the appropriateness of this recommendation will need to be addressed from the perspective of grazing and the remaining carrying capacity of the land. In the event that no satisfactory mitigation measures can be determined, and where local residents' livelihoods continue to be at risk, Kangra Coal, in discussion with affected CPAs, should purchase alternative land, of the same size, quality and productivity as the current CPA farms to ensure people's continued survival. This land will be registered as per the current CPA tenure arrangements. The land will need to be sterilized to ensure no future mining activities threaten to unsettle affected communities. In such a situation it may also be beneficial to discuss resettling affected homesteads from privately owned land onto the new CPA land as part of those communities.

Residual Impact (Post-mitigation)

If well implemented, the mitigation measures above would reduce the magnitude of the impact to medium reducing the significance of the impact to a '**Moderate Negative**' (Table 9.7).

Table 9.7 Rating of Residual Impacts Related to Loss of Access to Land for Agriculture (for approximately 25 Homesteads) and Grazing as a Result of the proposed Project Footprint and Associated Infrastructure (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to site of disturbance (1km round Adits A and B and 500m from the conveyor, and temporary contractors' camp footprint).
Duration	Permanent	The impact will be triggered during construction and will continue through operations (10 to20 year life of mine). Disturbed land will be rehabilitated at closure.
Scale	48.4 Ha (approximately 25 Homesteads) and livestock owners in the Zones of Influence	Subsistence fields for approximately 25 homesteads and livestock farming and grazing is either not possible or too disrupted because of footprint requirements and infrastructure. The presence of the conveyor further disrupts the entire 8.4km corridor, splitting the land on either side. This increases the number of directly affected individuals to all those who graze cattle in the area. Depending on the extent and success of the mitigation measures, replacement land will be sourced or people will be resettled in areas that will enable the same levels of subsistence agriculture and provide the same access to cattle grazing as is currently available.
Frequency	Once-off or Intermittent	The impact will be constant impact from Construction for the life of the proposed Project. Even if land is returned to its original state in 10 to 20 years' time it would be unrealistic to anticipate moving people temporarily from the affected areas until mine closure. Resettled homesteads would be able to re-establish their agricultural fields and livestock will have sufficient access to grazing. The threat to people's livelihood security would be diminished. If people are resettled within the CPA land, access to grazing will continue to be limited but mitigation measures will facilitate alternative ways for livestock to access remaining grazing lands.
Likelihood	Definite	This impact is inevitable if the proposed Project goes ahead.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The sensitivity of affected homestead residents will be high based on the discussions in pre-mitigation. However, if the Resettlement process is participatory and respectful, people may feel less vulnerable and more empowered to make decisions and take some control over events that will shape their lives. If this happens their vulnerability, post-mitigation, should be reduced. Additionally, if loss of access to grazing land is limited, and alternate access points to remaining land established, people's vulnerability to this impact will again be reduced.		
Significant Rating After Mitigation		
Moderate Negative Impact		

9.3 *SOCIO-ECONOMIC ENVIRONMENT AND LIVELIHOODS*

The impacts of the proposed Project on the socio-economic environment and livelihoods in the Zones of Influence and the broader Study Area are anticipated to be limited as the proposed Kusipongo Resource Expansion Project is expected to replace existing Kangra Coal underground mining already present in the Study Area. Therefore, large-scale new activities and concomitant impacts are unlikely. What should be borne in mind is that approximately 745 people currently employed by Kangra Coal, are likely to lose their jobs if the proposed Project does not go ahead.

9.3.1 *Creation of 450 Construction Jobs and the Retention of 745 Existing Mining Jobs*

Description of the Baseline Environment

Over 30% of the population in the PKSLM and MLM are within the potentially economically active age range. However, there is high unemployment in the Study Area as well as in the Zones of Influence. Figures for the local municipalities are on average 30% and the social survey undertaken for this study reported a 64% unemployment rate.

Proposed Project Activities

The proposed Project is anticipated to create 450 jobs during construction (which is expected to be 18 to 24 months in duration). Of these, Kangra Coal expects that 250 people will be semi-skilled and skilled positions and will be sourced from outside of the Study Area. The company anticipates local employment opportunities for this phase to number approximately 200 depending on local skills levels.

During operations the proposed Project will employ 745 people. However these employees will be drawn directly from the existing Kangra Coal operations that are planned to cease at the same time as Kusipongo operations would begin. Thus no new employment will be created during the operations phase by the proposed Project.

If the proposed Project does not go ahead none of the job opportunities will be created and the 745 current positions will not be retained.

Sensitive Receptors

Levels of education in the Study Area as well as more broadly in the two affected local municipalities are relatively low. The 2011 National Census reports that in these local municipalities only about 28% of people over the age of 20 have completed Grade 12. Kangra Coal has implemented a policy where its minimum educational requirement is Grade 12 (or equivalent). This is documented in its SLP. Thus the locally available skills and qualification range required for most of the employment opportunities is limited. Thus, the ability of local residents to take advantage of the benefits of employment opportunities and concomitant improvements in the security of livelihoods is considered to be low.

The 745 people currently employed by Kangra Coal, together with their dependents, are assessed to be highly sensitive to the loss of jobs if the proposed Project does not go ahead and their livelihoods would be significantly undermined.

No details are available for the anticipated wage bill from skilled to unskilled labour making the actual economic benefits of these employment opportunities impossible to assess.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the impact from new employment opportunities is assessed to be **"Minor Positive"** while the retention of existing jobs is assessed to be a **"Major Positive Impact"** pre-mitigation (*Table 9.8*).

Table 9.8 Rating of Impacts Related to the Creation of 450 Construction Jobs and the Retention of 745 Existing Mining Jobs (Pre-Mitigation)

Type of Impact		
Direct Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local and Regional, National	250 construction jobs will be created for people from outside of the Study Area while 200 unskilled jobs will likely be filled locally. 745 jobs on which the employee and his/her dependents (local and from further afield) depend will be retained.
Duration	Medium-Long term	Construction will last for 18 to 24 months. Operations are expected to continue for 10 to 20 years.
Scale	450 jobs during construction and 745 jobs retained in operations	250 Skilled and semi-skilled jobs are likely to be filled from outside the Study Area with the remaining 200 unskilled opportunities anticipated to be locally filled. 745 current employees are resident locally.
Frequency	Intermittent	The impact of employment will begin at construction when contract positions are filled and will end at mine closure. However, the impact of new opportunities will be most intensely experienced during construction and early operation.
Likelihood	Likely	These jobs are necessary for construction and operations.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Adaptability / High Sensitivity		
Low levels of education reduce local residents ability to adapt to employment opportunities, where these are available. The sensitivity to loss of employment from those currently employed is high.		
Significant Rating Before Mitigation		
Positive Impact		

9.3.2 *Resentment and Anger from Unfulfilled Expectations of Improved Employment Opportunities and Related Livelihood Security*

Description of the Baseline Environment

As described above, over 30% of the population in the PKSLM and MLM are within the potentially economically active age range. Of this number approximately 30% are unemployed. In the Zones of Influence survey figures reported a 64% unemployment rate.

Stakeholders at public meetings related to the proposed Project emphasised high employment expectations as well as extremely high levels of community frustration and anger based on perceptions of limited local employment opportunities and benefits from current Kangra Coal projects. These feelings were echoed in the Zones of Influence surveys.

Proposed Project Activities

The proposed Project will create 450 new jobs for the duration of construction (18 to 24 months). Of these, Kangra Coal expects that 250 people will be semi-skilled and skilled positions and will be sourced from outside of the Study Area. The company anticipates local employment opportunities for this phase to number approximately 200 depending on local skills levels.

Sensitive Receptors

Levels of education in the Study Area as well as more broadly in the two affected local municipalities are relatively low with approximately 28% of people over the age of 20 having completed Grade 12. Kangra Coal has implemented a policy where its minimum educational requirement is Grade 12 (or equivalent). This is documented in its SLP. Thus the locally available skills and qualification range required for most of the employment opportunities is limited. Nevertheless, local communities, which will experience the most direct negative impacts from the proposed Project, expect, and in many instances have demanded, local employment opportunities. For these communities the extremely limited number of new jobs during construction will be a disappointment. People are already angry at what they perceive to be more employment of outsiders than locals and an absence of training opportunities to empower local residents with the skills to meet employment requirements. Thus the communities and individuals in and around the Study Area are assessed to be highly sensitive to this impact.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the magnitude of this impact is expected to be medium and the impact on local communities will be **"Major Negative"** pre-mitigation.

It seems peculiar to assess the possibility of even a handful of new jobs within a negative significance range. However, this rating must be understood as an overall weighing up of the very limited job opportunities against the high expectations and pre-existing levels of anger and frustrations. During construction the probability of employing non-local contractors is high and this will exacerbate existing perceptions from local residents (Table 9.9).

Table 9.9 Rating of Impacts Related to Resentment and Anger from Unfulfilled Expectations of Improved Employment Opportunities and Related Livelihood Security (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	People in the broader Study Area (including the Zones of Influence and Driefontein) are aware of the proposed Project and have expectations of new jobs and pre-existing perceptions and anger around existing employment patterns. These communities will see construction activities and contractor employment most clearly and will experience the very limited possibility of finding jobs on the proposed Project themselves.
Duration	Medium-term	Construction will last for 18 to 24 months and will be the time of most visible new job opportunities. During this time the significance of the impact will be greatest. People will expect additional new job opportunities at the start of operations and their expectations will not be met. The impact of unmet expectations should diminish after a few years of operations.
Scale	Residents of Driefontein and the Study Area	Driefontein and the Study Area and Zones of Influence will be affected.
Frequency	Intermittent	The impact will begin at construction when contract positions are filled and will end at mine closure. However, the impact will be most intensely experienced during construction and early operation.
Likelihood	Likely	The limited number of construction and operation related jobs are confirmed in Kangra Coal's Project planning and Social and Labour Plan and are therefore likely to be accurate. How local communities may respond to the unmet expectations regarding the scale of employment opportunities is the uncertain variable for likelihood. Based on comments made during the Social Study and during stakeholder engagement levels of disappointment, anger and frustration are anticipated to be high and the impact is therefore assessed to be likely.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Stakeholders have already vociferously expressed their opinions and expectation related to employment issues. For those communities experiencing this impact their level of sensitivity is high and the importance of the issue has been flagged.		
Significant Rating Before Mitigation		
Major Negative Impact		

Recommendations and Mitigation/Management Measures

The following mitigation measures will be used to reduce the significance of the impact:

- Commission or undertake a skills audit in Driefontein and the Study Area prior to allocating construction contracts. Use this information to maximise local contracting.

- Based on the outcome of the skills audit, identify individuals for training to increase their employment potential as contractors during construction as well as to take over from some of the non-local semi-skilled employees through an employment and procurement progression-planning programme.

- Include local employment as a tender condition for contractors and establish a measurable percentage for these local positions. Local employment must include contractor commitments to train local residents who have the potential to fill certain semi-skilled levels (e.g. drivers of construction equipment; builders etc.). Fulfilment of these commitments must be auditable.

- Establish on-going stakeholder engagement during which people's expectations of employment are realistically addressed PRIOR to the start of construction activities.

- Ensure that alternative benefits for local residents are visible and are understood as a trade-off for the limited employment opportunities. These benefits may include development projects where people's skills are developed for other employment opportunities or the establishment of entrepreneurial training for self-employment. The SLP highlights some of these possibilities.

- Implement Kangra Coals Community Skills and Capacity Development Programme, which aims to increase Grade 12 pass rates in maths and science as per the SLP.

Residual Impact (Post-mitigation)

The mitigation measures above will, over time, reduce the scale of the impact to **"Minor Negative"**. However, unless there is a concerted effort and resources focussed on this issue it is likely to remain "**Moderate Negative"** throughout construction and early operations (Table 9.10).

Table 9.10 Rating of Residual Impacts Related to Resentment and Anger from Unfulfilled Expectations of Improved Employment Opportunities and Related Livelihood Security (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	People in the Study Area (including Zones 1 and 2 of Influence and Driefontein) are aware of the proposed Project and have expectations of new jobs and pre-existing perceptions and anger around existing employment patterns. These communities will see construction activities and contractor employment most clearly and will experience the very limited possibility of finding jobs on the proposed Project themselves. However these will also be the communities who are the focus of mitigation measures and who should benefit both from the training opportunities and from on-going stakeholder engagement to contain levels of expectations.
Duration	Short-term (2-3 years)	Construction will last for 18-24 months and will be the time of most visible new job opportunities. People will expect additional new positions to be created at the start of operations. With full implementation of mitigation measures the impact should decrease in intensity during early operations.
Scale	Local	Driefontein and the broad Study Area and Zones of Influence will be affected.
Frequency	Intermittent	The impact will begin at construction when contract positions are filled and will end at mine closure. However, the impact will be most intensely experienced during construction and early operation. Mitigation measures around training and mentorships as well as entrepreneurial development should be recognised by affected residents as alternative opportunities to direct employment and also reduce the frequency and intensity of perceived unmet expectations.
Likelihood	Possible	Will successful implementation of mitigation measures that benefit local communities in ways other than employment the likelihood of this impact occurring would be reduced to possible.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Magnitude		
Stakeholders have already vociferously expressed their opinions and expectations related to employment issues. For those communities experiencing this impact their level of sensitivity is high and the importance of the issue has been flagged. However with mitigation fully implemented people's sensitivity to the issue of unmet expectations should be reduced.		
Significant Rating After Mitigation		
Minor to Moderate Negative Impact		

9.3.3 *Increased Spending by the Proposed Project will contribute to the Local Economy*

Description of the Baseline Environment

The economies of communities around the Study Area are small and are not focussed on construction or servicing of large industry. Furthermore, the Social Baseline Study shows that there are limited levels of education and skills in the broader Study Area that could service the construction and contracting needs of the proposed Project.

Kangra Coal currently employs 745 employees on underground mining operations in the area. These operations are anticipated to cease within the next three years and all employees will be transferred to the proposed Project if it takes place.

Proposed Project Activities

The Capital Expenditure (CAPEX) on the proposed Project is estimated to be around R1.2 billion. The vast majority of this expenditure will happen outside of the Study Area, and no details are currently available to suggest the distribution of expenditure within the Provincial or even National economy.

During construction, approximately 450 contractors will be employed and they will earn a monthly income. At this time no details of the range of salaries is available. Approximately 250 positions will be filled from outside the Study Area and the remaining 200 jobs are likely to be filled locally. Non-local contractors will be temporarily housed in on-site accommodation built for the proposed Project.

During operations no additional jobs will be created by the proposed Project over and above those 745 positions already existing in Kangra Coal's current workforce.

Sensitive Receptors

The local economies (in the Study Area and the larger towns in the vicinity of the proposed Project) are not positioned to take advantage of or benefit from broader CAPEX for the Project. The extent of expenditure would likely be confined to small-scale purchases related to servicing the temporary contractors' camp.

The development of the proposed Project would increase spending in the local economy during construction, when approximately 450 wage-earning contractors reside in the area for up to 2 years. The majority of these employees, who will come from outside of the area, will be housed and fed in a self-contained contractors camp, thereby limiting their salary-spend locally. Furthermore, the extent of income flowing into the local economies through salaries or direct expenditure cannot be estimated based on available information.

Most the Kangra Coal's requirements (technical, material, food etc) will be sourced from outside of the Study Area as they are not generally locally available.

Significance of Impact (<u>Pre-mitigation</u>)

Based on existing Kangra Coal operations in the area it is not anticipated that there will be significant additional direct economic benefits or indirect spin-offs for the local economy (and the Study Area in particular). Therefore the significance of this impact is assessed to be "**Minor Positive"** on the local economy (*Table 9.11*).

Table 9.11 Rating of Impacts Related to Increased Spending by the Proposed Project will Contribute to the Local Economy (<u>Pre-Mitigation</u>)

Type of Impact		
Positive Indirect Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	A very small amount of money will be spent in the Driefontein / Study Area economy. However some basic foodstuffs may be sources within the Province.
Duration	Short-term	A change in income will occur during construction through wages. Given that no new employment will be created during operations, the increased expenditure by employees will take place only in the 18 to 24 months of construction and return to the *status quo* thereafter.
Scale	450 contract workers and some day-to-day Project expenses in Driefontein and surrounding larger towns	A small amount of the proposed Project needs will be serviced at this level. Driefontein has no established infrastructure to service even the food requirements of the construction workforce. Therefore at most, small day-to-day running costs might be procured in the surrounding small towns and contractors may spend some of their salaries locally.
Frequency	Intermittent	The increased employment and associated monthly salaries will occur for the duration of construction after which it will cease.
Likelihood	Possible	Most expenditure is likely to happen outside of the Province and almost certainly outside of the Study Area. Very little local expenditure is anticipated.
Magnitude		
Positive Impact		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The local economic environment is not developed enough to cater to almost any of the possible Project needs. Therefore local expenditure into the economy will be extremely limited.		
Significant Rating Before Mitigation		
Positive Impact		

9.3.4 *Loss of Productive Land and Related Current and Future Income Opportunities as a Result of Proposed Project Infrastructure and the Division of Farms by the Overland Conveyor*

Description of the Baseline Environment

Land in the Zones of Influence is used for residential, agricultural and livestock farming, on commercial and subsistence scales as part of the owners' livelihood strategies. Current activities on CPA land also suggest plans for increased agricultural and livestock income generation through cultivation and livestock husbandry.

The proposed Project-affected land is divided into two forms of ownership – private and community based.

Private ownership is relevant to Kangra Coal's own farmland and therefore needs no negotiation around access. Mr CJF Greyling who is a commercial farmer, is the owner of the other private land (Donkerhoek Farm). The farms of Twyfelhoek and Kransbank are communally owned and used for residential as well as subsistence agriculture and livestock farming with intentions of expanding these activities into more commercially sustainable activities in the future.

Proposed Project Activities

The proposed Project infrastructure would be developed on privately and communally owned land. The footprint requirement is anticipated to be 46.8 ha and required access to mine infrastructure, once established, would traverse farms not owned by Kangra Coal (*Figure 9.2* overleaf). In addition, placement and fencing of the conveyor and associated maintenance road and power lines will restrict access across the CPA land of both farms.

Sensitive Receptors

CJF Greyling, as the owner of Donkerhoek, is a commercial farmer, farming cattle, sheep and maize and other crops. The portion of footprint requirement for Adit A on Donkerhoek 14-HT sub-division 4Re is approximately 8 ha. Mr Greyling has retained legal representation for negotiating proposed Project access to his farm and appropriate remuneration and compensation for loss of land and associated income. Based on the above his vulnerability to the impact is considered low.

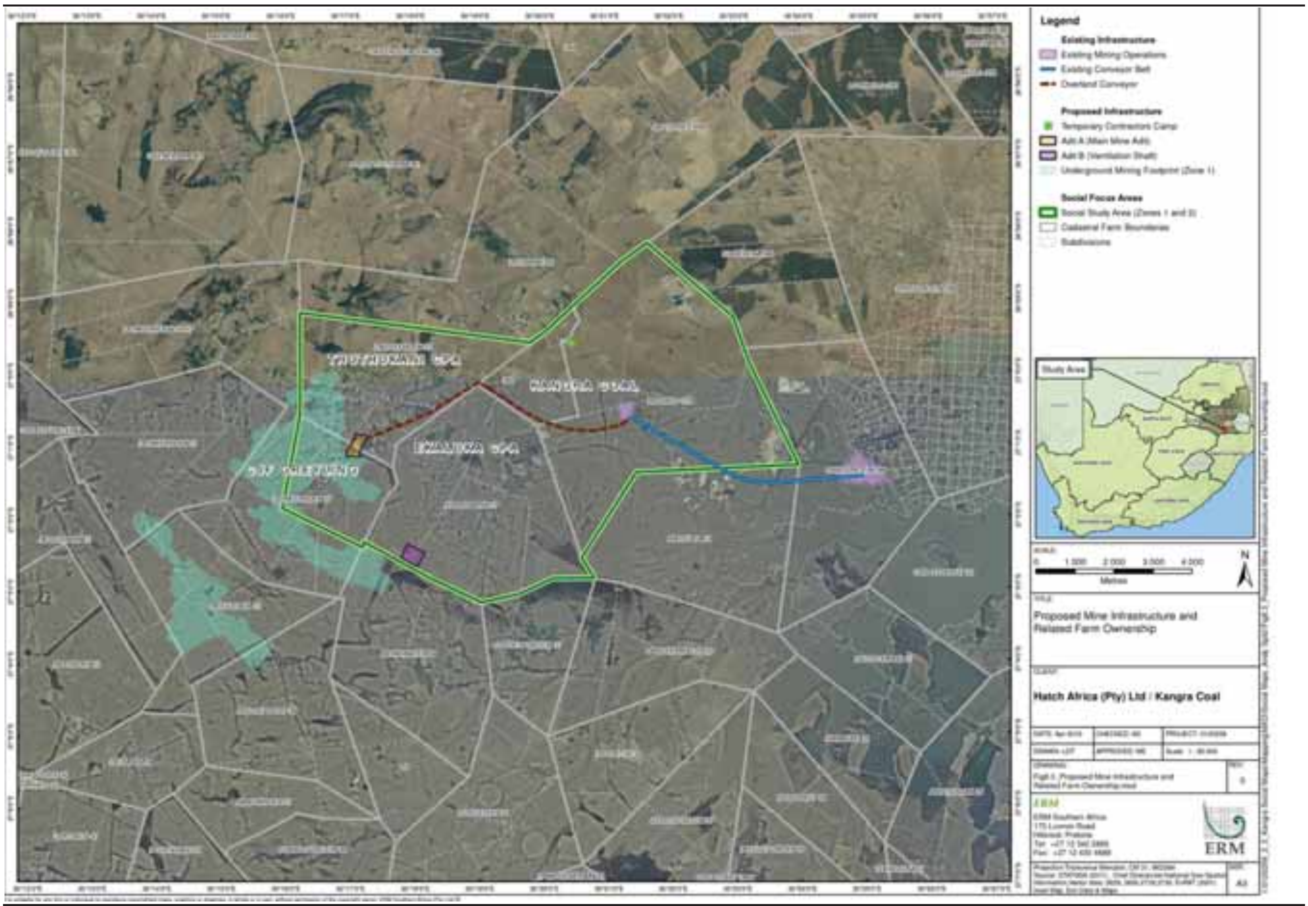
The Thuthukani and eKaluka CPAs are engaged in small-scale agriculture and livestock farming as part of mixed livelihood strategies (discussed above) and focused on future potential community development. The Project footprint on Twyfelhoek land (under Thuthukani CPA) is anticipated to be 10.3 ha for Adit A and 9.5 ha for the conveyor. Adit B (the ventilation shaft) will have a footprint of approximately 2.8 ha on Kransbank farm (eKaluka CPA). Access to and from these infrastructure sites will, of necessity, cross the various farm lands. While the direct loss of productive land is limited movement of animals across the area will be restricted and therefore impact on the feasibility of livestock farming in the medium to long-term.

The CPAs do not have their own legal representation, nor are they sufficiently empowered to undertake free and fair negotiations to allow the proposed Project access to and use of their land. In additional to actual loss of productive land and its contribution to current and future income, the long-term impact on land and water from undergound mining activities and dewatering is strongly perceived by community members as a threat to the lands productivity and sustainability.

CPA members and committee representatives have highlighted a lack of trust in Kangra Coal and a strong resistance to allowing the proposed Project access to their farms. This is predominantly based on previous examples that they provided of Kangra Coals activities in the area and people's beliefs that the land has been damaged and the owners have not been properly compensated. Concerns over water quality and quantity feed into this perception (see *Section 9.5.1*). There are fears that mining activities will damage the land and reduce its long-term viability during operations and post-closure.

The communities owning these farms are therefore considered to be highly sensitive to this impact, even though actual footprint requirements is limited.

Figure 9.2 Proposed Mine Infrastructure and Related Farm Ownership



Significance of Impact (Pre-mitigation)

Based on the analysis provided above and taking into account the relatively limited footprint but highly sensitive receptors, this impact is assessed to be of **"Moderate to Major Negative"** significance, pre-mitigation (Table 9.12).

Table 9.12 Rating of Impacts Related to Loss of Productive Land and related Current and Future Income Opportunities as a Result of Proposed Project Infrastructure and the Division of Farms by the Overland Conveyor (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The proposed Project footprint and affected farms.
Duration	Permanent	The impact will extend for the life of mine (10 to 20 years) and where land cannot be rehabilitated, the impact will be permanent.
Scale	Donkerhoek Twyfelhoek Kransbank	There are three affected farms that are not owned by Kangra Coal and that are identified as sites for proposed Project infrastructure.
Frequency	Continuous	From construction to mine closure, and depending on possible rehabilitation, perhaps beyond closure.
Likelihood	Likely	This requirement for land will occur if the proposed Project goes ahead. The extent of its impact on current and future income generation cannot be quantified in this study.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Affected communities and landowners are highly sensitive to material and symbolic impacts on their land and are vulnerable to the loss of this land-use and its related income (current and potential). This assessment is based on the historical sensitivity of land tenure issues and the role that land use plays in the owners' livelihood strategies, current and future. Donkerhoek farm owner, Mr CJF Greyling, is deemed less vulnerable to the impact as a result of his legal representation, which should enable him to negotiate fair remuneration for his loss.		
Significant Rating Before Mitigation		
Moderate to Major Negative Impact		

Recommendations and Mitigation/Management Measures

The following mitigation measures should be used to reduce the significance of the impact:

- As discussed under the mitigation of physical and economic displacement (*Section 9.2*) the proposed Project will negotiate in good faith with affected land owners to establish fair remuneration and compensation for loss of access to and productivity of land and for damage (long-term and permanent). Where appropriate, Kangra Coal will facilitate legal representation of CPAs to ensure agreements fully consider the needs of current and future generations of CPA members.

- A Community Benefit Agreement will be drawn up in which realistic benefits, financial and developmental, will be agreed to as recognition for the CPA's contribution to the proposed Project's development. Without access to the land the proposed Project could not go ahead and in a post-Marikana mining environment, it is necessary to recognise and share the benefits of a development with more than the Company's shareholders.

Residual Impact (Post-mitigation)

The mitigation measures above will transform the magnitude of the impact to a positive thereby changing the significance of the impact to a '**Positive Impact"**. Responsible implementation of a Community Benefit Agreement (as opposed to Corporate Social Responsibility spending) will also help to reverse existing negative perceptions of Kangra Coal and thereby reduce resistance to the proposed Project on CPA land.

9.3.5 Reduced Current and Future Tourism Potential as a result of Changes to the Natural Environment and Potential Impacts on Water Quality

Description of the Baseline Environment

The Study Area and Zones of Influence are predominantly rural and are used for a mix of residential and small-scale agricultural and livestock activities. The Heyshope Dam is the closest designated recreational area to the proposed Project and no other tourism ventures were reported to exist in the area at present. The dam is known as one of the prime largemouth bass fishing lakes in the country. It is fed by the Assegaai River and is within the same quaternary catchment as the proposed Project. Wakkerstroom has a thriving avian-based tourism (approximately 37km south of the Study Area but in a discreet catchment area).

Proposed Project Activities

The establishment of a coal mine with associated infrastructure in the Study Area will change the nature of the area in a number of ways, including from a visual and noise perspective. It will also impact on the quality and quantity of ground and surface water. Details of these impacts are addressed in the Groundwater and Surface Water Hydrology Specialists Reports associated with the Kusipongo Resource Expansion ESIA.

Sensitive Receptors

There are no current tourism activities in the Study Area. Additionally, economic activities related to tourism were reportedly non-existent for residents of Driefontein. There is the Kransbank Private Reserve; however, no plans for tourism development in the immediate future have been highlighted and no plans were identified by WWF or Bird Life Africa.

Tourism has been identified as a focus area of potential economic activity for the Province and the District in the Integrated Development Plans (see *Section 4.1* of the Baseline Report). Thus, even in the absence of formal tourism plans the impact on future potential for tourism and related income generation in the area should be recognised.

Heyshope Dam is the most sensitive tourism site in the vicinity of the Study Area. Its attraction nationally is angling activities for largemouth bass, as well as other fish species. The fish are dependent on the water quality and the tourism is directly dependent upon the fish. Although the local economy is not heavily dependent upon the related tourism, losing visitors to the dam would have some socio-economic impacts for surrounding towns (Piet Retief in particular).

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, this impact is assessed to be of **"Minor Negative"** significance pre-mitigation will be "**Minor Negative"** (Table 9.13).

This assessment of significance weighs up the limited impact on future tourism potential in the Study Area, based on the absence of planning to date and on the potentially small impact that undermining tourism in the Heyshope Dam and its surrounds would have on surrounding communities and towns economies.

Table 9.13 Rating of Impacts Related to Reduced Current and Future Tourism Potential as a result of Changes to the Natural Environment and Potential Impacts on Water Quality (Pre-Mitigation)

Type of Impact		
Direct, Cumulative Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	District (Pixley Ka Seme and Mkhondo)	Local impact is limited based on absence of existing or planned tourism in the Study Area. However, if the impact were to reach the Heyshope Dam, which lies within the proposed Project's catchment area, the extent could be district wide.
Duration	Long-term	The presence of the proposed Project would reduce the viability of the Study Area for tourism activities at the local level from construction and for the 10 to 20 year life of mine. Further degradation of the environment, particularly related to water quality for fish and bird life, could have impacts beyond the life of mine – perhaps permanently.
Scale	A small number of tourism service providers in nearby towns (e.g. Piet Retief)	The economy of the town of Piet Retief benefits to some degree from local tourism. Dependants of those employed in tourism (e.g. accommodation and food) could also be impacted.
Frequency	Intermittent	The impact may occur intermittently during tourist seasons.

Likelihood	Possible	The impact is likely to occur at some time during the life of the mine. Impacts on the water in the catchment are also possible.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Vulnerability of the receptors is dictated to by the low levels of dependence on tourism in the Study Area. People dependant on income from tourism activities in the Heyshope Dam may demonstrate a higher level of vulnerability due to the absence of alternative livelihood options.		
Significant Rating Before Mitigation		
Negligible to Minor Negative Impact		

Recommendations and Mitigation/Management Measures

There are no realistic mitigation measures to reduce the significance of this impact. The most pro-active initiatives would be to share information about the proposed Project with the District tourism industry and more broadly, to ensure that the nature of impacts are accurately communicated and understood.

Kangra Coal will look at the viability of spending some of its Social and Labour Plan budget for community development, training and entrepreneurial mentorship on nurturing local tourism projects.

Residual Impact (Post-mitigation)

The significance of the impact will remain unchanged.

9.4 SOCIO-CULTURAL IMPACTS

9.4.1 *Introducing Mining Activities into a Rural Environment together with the Disruption of Community Life through Resettlement and Restricted Movement will Undermine the Sense of Place and Residents' Community Identity and Sense of Emplacement*

Description of the Baseline Environment

There are different components to "identity" and "sense of place" operating in the Zones of Influence specifically and the Study Area more broadly. Summarised, these include Identity and Land as well as Identity and Sense of Emplacement. These are discussed below:

Identity and Land

Section 7.15 of the Baseline presents the detailed background to identity in relation to land. Perhaps the key component is expressed in relation to land ownership and tenure. For labour tenants their sense of community is derived from living together for over 15 years and feeling controlled by the landowner. This applies particularly to the five homesteads on Donkerhoek.

Residents surveyed on Nooitgezien and Rooikop express similar relationships to the land but are more geographically dispersed so show a limited sense of community identity. To exacerbate this, several of these respondents were moved to the area as a result of mining activities within the last five years.

For CPA respondents land ownership and its symbol of freedom was most commonly emphasised – freedom from a farmer; to have multiple head of cattle; to make decisions over their land. One CPA committee member stated, "*they can't start here until they've fixed what they started there*" pointing to exploration areas that had not been rehabilitated and emphasising his sense of power and control over exploitation of the land.

Survey respondents on CPA land also expressed the greatest sense of communal identity, even if they were relatively new to the area. The idea of land ownership, albeit communal, firmly establishes a sense of belonging and group identity that goes with longer-term development objectives. This was equally applicable on Twyfelhoek and Kransbank.

Further, identity amongst survey respondents on the different farms was also expressed in a fairly united opposition on the proposed Kangra Coal Project.

Identity and Sense of Emplacement

The sense of place valued by local residents related to the generally peaceful and tranquil nature of where they lived. Being part of a rural community with fertile soils for subsistence farming was valued, as was the dryness of the specific location of individual homesteads.

Irrespective of the nature of farms ownership, various respondents emphasised their sense of belonging or emplacement in relation to their neighbours and the supportive relationships between homesteads as part of what they valued about living where they do. People reported visiting one another from different sides of the main road and aerial images highlight some of these paths. The sense of space between homesteads and the absence of conflict were also seen to contribute to the sense of place.

One CPA committee representative summarised his view of mining in the Zone of Influence as follows: "We didn't buy this farm to see it scarred like that." He explained that he wanted to see farming and grazing but visible mining activities created cracking on the surface and reduced people's access to water. Mining damaged the feel of the land.

Proposed Project Activities

The establishment of mine infrastructure will change the rural, tranquil nature of the area. It will also necessitate resettlement of some homesteads for health, safety and livelihood reasons, which could dislocate people who have been living as neighbours for extended periods of time. The conveyor will cut an

8.4km line across the farms and restrict people's access from one side to the other.

During construction and operations mining activity will create noise and air pollution as well as physically alter the environment with large man-made structures. Construction vehicles will travel across the area and between homesteads. The 24hr operation of equipment and the conveyor will foreground the continuous presence of the mine. Details of these impacts are also presented in the specialist studies for Noise, Air pollution, and Visual Impact Assessment reports associated with the Kusipongo Resource Expansion ESIA.

Sensitive Receptors

Communities are not held together by strong traditional cleavages or leadership loyalties. In fact for many survey respondents that absence of clear leadership was what stood out. Nearly 25% of respondents recognised "no one" as a community leader or authority (See *Section 7.1*). As a possible result of this, people have formed smaller and more intimate informal community groupings based on location; history; period of residence in the area; membership of a CPA etc.

In the absence of strong leadership and direction it is anticipated that local residents in the Zones of Influence will be very sensitive to a changed sense of place and its concomitant impact on their sense of identity. This would be particularly true of the older generation as well as people who have lived in the area for many years. This sensitivity may be slightly lower for more recent residents, and particularly those from Driefontein or larger settlements.

Changes to the sense of place that hint at an unwelcomed imposition of power from outside (Kangra Coal or Government) are likely to be met with very sensitive responses and a vulnerable community. Furthermore, changes that could be interpreted as scars on the landscape will be hard to tolerate particularly for CPA members who feel a strong sense of ownership and title to their land, heightened by the history of farm exploitation and a lack of access to land tenure that many people will have experienced.

Identity and a sense of belonging, or emplacement, are important aspects of human well-being and undermining this places people in vulnerable positions.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the impact is assessed to be of **"Major Negative"** significance pre-mitigation (*Table 9.14*).

Table 9.14 Rating of Impacts Related to Introducing Mining Activities into a Rural Environment together with the Disruption of Community Life through Resettlement and Restricted Movement will Undermine the Sense of Place and Residents' Community Identity and Sense of Emplacement (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The five farms in the Study Area where proposed Project infrastructure will be established during construction and where activities will continue for the life of the mine (10 to 20 years).
Duration	Medium Term	People often feel fear of and resistance to change but, with support, somehow manage to adapt within a number of years of an event or change.
Scale	Residents within the Study Area	The changes triggered by the proposed Project will impact on people living within the Zones of Influence (particularly those in Zone 1) and the Study Area more broadly.
Frequency	Periodic	During construction and operation the mine-induced changes will be more and less noticeable. As people become accustomed to the reshaped physical environment their constant awareness of change will become more sporadic. If however, people feel undermined in relation to their decision-making power about these changes, their awareness and resistance is likely to be more constant a feature of their lives.
Likelihood	Likely	Based on fieldwork responses and the definite establishment of mine infrastructure should the Project go ahead, local residents are likely to experience significant changes to their area.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
A history of exploitation contrasted with new-found control over their lives will make many local residents highly sensitive to imposed or top-down changes. Furthermore, for those residents who value the peace and tranquillity of the area the constant activity during construction and operation will be strongly experienced. Given that well-being is closely tied to an individual's sense of security, familiarity and belonging, change will trigger vulnerability – in some individuals and groups more than in others.		
Significant Rating Before Mitigation		
Major Negative Impact		

Recommendations and Mitigation/Management Measures

This is a difficult impact to mitigate, as the construction and operation of the mine will unavoidably trigger the impact. However, the following mitigation measures should be used to reduce the significance of the impact:

- Establish open and transparent dialogue with residents of the Study Area as early as possible. This should be done while Kangra Coal is negotiating access to the affected farms with private and communal owners.

- Ensure that the sensitivity of land issues is fully understood and develop a consistent and clear approach to communicating proposed Project plans with affected residents.

- Include all affected residents in this discussion and negotiation process.

- Ensure that residents are PART OF the decision-making process and avoid token gestures of participation.

- Provide people with clear information about potential impacts and changes to their environments and their lives so that people feel able to take decisions.

- Partner with the District health department in the provision of mobile health services to the Zones of Influence (particularly for residents in Zone 1 who will be directly impacted) leading up to construction activities, including the medium-term provision of a social worker to monitor emotional and psychological changes in vulnerable individuals and groups.

- Empower residents, through the negotiation process and by facilitating CPA legal representation, so that their concerns and needs are identified, documented and fulfilled, where reasonable. This will prevent people from feeling alienated and disempowered and may foster relationships of trust. Such relationships create a productive environment for host land-owners and the new land-users – the mine.

Residual Impact (Post-mitigation)

The mitigation measures above should reduce the sensitivity of the receptor and thereby the magnitude of the impact to medium reducing the significance of the impact to a **'Moderate Negative Impact'**. If optimally implemented, the mitigations measures should empower residents in their understanding of the proposed Project and more importantly, in feeling that they are part of making life-changing decisions from which they benefit, rather than being the unwitting recipients of change. This would create a **'Positive Impact'** for those able to make use of the empowerment opportunity. Overall, therefore, the post-mitigation residual impact is assessed to be **'Minor Negative'** (*Table 9.15*).

Table 9.15 ***Rating of Residual Impacts Related to Introducing Mining Activities into a Rural Environment together with the Disruption of Community Life through Resettlement and Restricted Movement will Undermine the Sense of Place and Residents' Community Identity and Sense of Emplacement (Post-Mitigation)***

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The five farms in the Study Area where proposed project infrastructure will be established during construction and where activities will continue for the life of the mine (10-20 years).
Duration	Medium Term	People often feel fear of and resistance to change but, with support, somehow manage to adapt within a number of years of an event or change. The mitigation measures are intended to provide some of that support.
Scale	Residents within the Study Area	The changes triggered by the proposed Project will impact on people living within the Zones of Influence (Zone 1 in particular) and the Study Area more broadly.
Frequency	Periodic	During construction and operation the mine-induced changes will be more and less noticeable. Depending on people's sensitivity and vulnerability, as they become accustomed to the reshaped physical environment their constant awareness of change will become more sporadic. If however, people feel undermined in relation to their decision-making power about these changes, their awareness and resistance is likely to be more constant a feature of their lives. The mitigation measures are intended to fully recognise people's realistic powers and to fully include them into decisions that will affect their lives.
Likelihood	Likely	Based on fieldwork responses and the definite establishment of mine infrastructure should the Project go ahead, local residents are likely to experience significant changes to their area. Mitigation should empower them to understand and anticipate change – particularly if they have been directly involved in shaping the details of some of that change.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium to Low Sensitivity		
Full and successful implementation of the mitigation measures may reduce many people's vulnerability to this impact. For some individuals there is even the possibility of feeling empowered through the process.		
Significant Rating After Mitigation		
Minor Negative Impact		

9.4.2 Disturbance of Graves or Loss of Access to Graves Resulting from Placement of Project Infrastructure and Related Safety Risks

In the past many rural families would have chosen to bury their deceased in or around their homesteads or in family gravesites. Private landowners may have prohibited this but fieldwork in the area (both for this social baseline report and for the Heritage Impact Assessment Study associated with the ESIA for the proposed Project) has identified a number of single and multiple gravesites in the Zones of Influence.

Currently, people have the choice of using municipal graveyards or local, informal graves in and around homesteads. The Cultural Heritage Specialist study has addressed the impacts on graves in more detail.

Description of the Baseline Environment

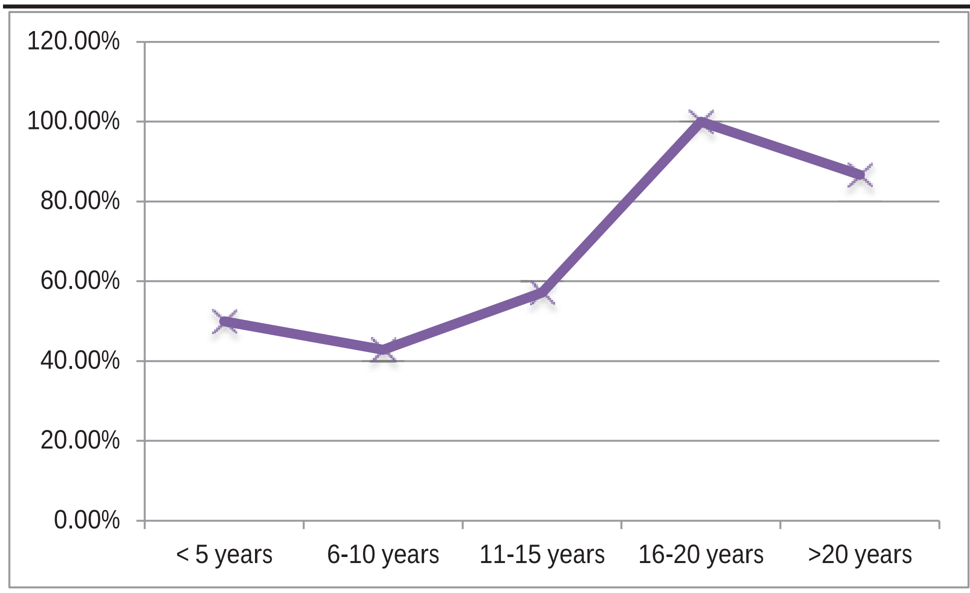
Burying the dead is an emotive and symbolic experience for many people. Choosing to use a cemetery or an historical family burial ground or to bury near the family's homestead are all options. Many families and communities hold traditional ceremonies at ancestral graves at least annually (*Section 7.10*).

More than two thirds (68.18%) [(1)] of the 45 homesteads surveyed in the Zones of Influence declared that they knew of graves that were located either within, or in close proximity to, the homestead. Within Zone 1, 24 out of 33 surveyed homesteads reported associated graves (73%).

In most instances, these were the graves of deceased relatives of long-term residents that were buried in accordance with traditional customs. Those households that did not reflect any awareness of graves located in the vicinity of their homesteads were generally either recent arrivals or chose to bury their dead in cemeteries in more urbanized centres like Driefontein.

Figure 9.3 below shows that the longer a family is settled in an area the more likely they are to have associated graves in or near their homesteads. In addition, *Table 9.16* highlights the relative percentages of surveyed homesteads per farm location that have associated gravesites.

Figure 9.3 Presence of Nearby Graves and Residential Period



[1] 30 of 44 homesteads surveyed.

Table 9.16 Presence of Nearby Graves and Farm Location

	Presence of Graves			
Farm	**No**	**Yes**	**TOTAL**	**%**
Donkerhoek 14-HT	0	5	5	100.00%
Kransbank 15-HT	8	10	18	55.56%
Nooitgezien 381-HT	1	0	1	0%
Rooikop 18-HT	1	4	5	80.00%
Twyfelhoek 379-IT	4	11	15	73.33%
TOTAL	**14**	**30**	**44**	**68.18%**

Proposed Project Activities

The location of the proposed Project infrastructure and its associated 48.4 ha footprint (Adits A and B as well as the length of the conveyor) will either destroy land on which graves currently lie or will reduce people's access to grave sites for health and safety reasons or from physical barriers created by mining activities. These impacts will be triggered during the construction phase and the loss of access will continue through the operation phase.

Sensitive Receptors

The above discussion highlights the likelihood that the majority of Zone 1 homesteads, particularly those settled for upward of 10 years, would have graves associated to their land and homestead. If the proposed Project footprint affects these homesteads, through resettlement or loss of access to an area, the graves will also be affected.

Graves serve multiple purposes. Practically, they are the resting place of a family's ancestor, but they are also markers of a community or family's history, rootedness and belonging. If graves are lost so too is that belonging – particularly for families that have been settled for a long time. Being resettled as mitigation for project-induced impacts triggers its own impacts on people's sense of belonging and any loss of connectedness to graves and ancestors would exacerbate this.

The precarious nature of land tenure and a sense of belonging experienced by labour tenants under apartheid and to a slightly lesser extent since then has been discussed in *Section 7.2* of this report. For this group of people, the loss of access to gravesites or the potential destruction of graves could create additional vulnerabilities to a sense of rootlessness, as they have no title deeds and the graves are physical markers of their continuous presence on the land.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, this impact is assessed to be of "**Major Negative"** significance pre-mitigation (*Table 9.17*).

A small number of survey respondents who have previously been relocated by Kangra Coal expressed dissatisfaction with the fulfilment of the company's commitments to relocating graves. These previous experiences will heighten concerns about any future grave relocation amongst local residents.

Table 9.17 Rating of Impacts Related to Disturbance of Graves or Loss of Access to Graves Resulting from Placement of Project Infrastructure and Related Safety Risks (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Affected homesteads and graves within the proposed Project footprint. Grave sites not relocated but where access becomes unsafe or difficult.
Duration	Permanent	Either gravesites will be destroyed by Project activities or access to the sites will be permanently altered (20 year life of mine).
Scale	Graves within the 48.6 ha footprint requirement	Not all homesteads within Zone 1 of Influence have associated graves but a large proportion of the survey group (73%) identified gravesites and it is likely that other graves will be identified during a 100% Resettlement Process.
Frequency	Continuous	The impact on graves would be triggered by construction activities and would continue to mine closure.
Likelihood	Likely	If the proposed Project goes ahead, based on the number of survey homesteads in the Zones of Influence with associated graves, it will certainly impact on some graves and make access to others more difficult.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The important role of graves as markers of rootedness, belonging and connection to deceased family members is almost universally recognised. In addition, local residents' histories around land tenure and rights probably increases this significance and increase people's vulnerability to a loss of these graves and their physical and symbolic roles.		
Significant Rating Before Mitigation		
Major Negative Impact		

Recommendations and Mitigation/Management Measures

The following mitigation measures should be used to reduce the significance of the impact:

- Relocate affected graves or ensure continued safe and convenient access to gravesites.
- Any grave relocation must be undertaken in a culturally appropriate manner in consultation with affected families.
- All costs of respectful and culturally appropriate re-interment must be covered by Kangra Coal.

- Identification of all affected graves should be carried out during Resettlement Planning.

- Where gravesites are not relocated establish a buffer zone to protect the site and establish safe and convenient access to the site (Heritage Impact Assessment Report for the ESIA associated with the Kusipongo Resource Expansion Project).

- Establish a Chance Finds protocol for graves discovered during construction activities.

Residual Impact (Post-mitigation)

The mitigation measures above implemented fully and respectfully should make affected families feel recognised, considered and respected. The relocation of graves undertaken in this manner (or the establishment of convenient and safe continued access to existing gravesites) should reduce the significance of the impact to "**Minor Negative**" (*Table 9.18*).

Table 9.18 Rating of Residual Impacts Related to Disturbance of Graves or Loss of Access to Graves Resulting from Placement of Project Infrastructure and Related Safety Risks (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Affected homesteads and graves within the proposed Project footprint
Duration	Short to Medium-term	Graves will either be relocated in the appropriate manner along with the affected homestead or access to the sites will be facilitated in a safe and convenient manner.
Scale	Graves within the 48.6 ha footprint requirement	100% of affected homesteads will either have their graves relocated with them in culturally respectful and appropriate manners (including the payment of all agreed costs), or access to remaining graves will be secured.
Frequency	Intermittent	The impact on graves would be triggered by construction activities and would continue to mine closure. However, relocating graves or providing safe access to them would reduce the frequency of the impact.
Likelihood	Likely	If the proposed Project goes ahead, based on the number of survey homesteads in the Zones of Influence with associated graves, it will certainly impact on some graves and make access to others more difficult.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Negative Impact		

9.5 NATURAL RESOURCES

9.5.1 Reduced Water Quality and Availability for People, Agriculture and Livestock Resulting from Mine Activities (Water Use, Dewatering, Contamination)

The proposed Project is anticipated to have impacts on the groundwater level, groundwater quality, and the level and quality of surface water including streams and wetlands.

The Groundwater Impact Assessment Report for the ESIA associated with the Kusipongo Resource Expansion Project addresses the technical details of these anticipated impacts. However, given the significance of this water to local users, it is important to highlight the impacts from a social perspective.

Description of the Baseline Environment

The Study Area has numerous wetlands as well as springs, rivers and streams. There are also a number of boreholes (approximately 20) in the area. The springs, rivers and streams are the main sources of water for local residents, farmers and livestock.

The Study Area in general and the Zones of Influence in particular have been the focus of a range of government-led development interventions in the post-apartheid period. Recently, this has included development and upgrading of water supply infrastructure to homesteads directly. Most survey respondents (over 66%) reported having water connections in their homesteads drawn from springs, streams and rivers. The table below summarizes where sampled homesteads obtained their water.

Table 9.19 Sources of Household Drinking Water

Water Source	n=	%
Borehole or well	1	2.22%
House connection	30	66.67%
Neighbour	1	2.22%
Spring	1	2.22%
River	12	26.67%
TOTAL	**45**	**100.00%**

It is significant that two thirds of households surveyed had "household connections" within their homes. In many cases, these connections were recent developments and were only installed within the year prior to the survey.

According to the Surface Water and Groundwater Impacts Assessment Reports compiled for the proposed Kusipongo Resources Project, ground and surface water quality are generally within the prescribed screening levels identified for ground and water, although microbiological contaminants were not sampled.

Proposed Project Activities

Construction and operation of the proposed Project has the potential to affect water in the Study Area in two main ways. The first is groundwater contamination (reduced water quality) from:

- **Underground Workings** – where coal surfaces exposed to the atmosphere within underground workings have the potential to generate acid mine drainage;

- **Overburden Dumping** – where there the exposure of pyrite-bearing coal from mining activities may lead to oxidation of metal sulphides, leading to a reduction of pH and the establishment of acidic conditions causing leaching of metals (acid rock drainage); and

- **Coal Dust Fallout** – where rain that interacts with coal dust and sweepings that have fallen off the conveyor can become contaminated and adversely affect groundwater (and surface water) quality.

The second impact on water in the Study Area begins as an impact of reduced availability for local users but in the long-term becomes an impact of reduced water quality.

Dewatering which will be necessary to prevent groundwater from affecting both surface and underground operations will trigger reduced availability of water. Dewatering is the intentional pumping of ground and surface water to prevent its infiltration into working areas. Such actions can reduce groundwater levels. According to the Groundwater Impact Assessment Report for the proposed Project, simulated drawdowns induced by dewatering activities for the proposed operations generally range from 5 to 15m, but are as high as 260m in one private borehole.

The Groundwater Impact Assessment Report for the proposed Project suggests significant impacts on wetlands and streams, especially the oHlelo River in the area of the proposed mine, due to the mining induced groundwater level drawdowns which result in a decrease of baseflow to rivers, streams and wetlands.

When dewatering ceases at closure, water will continue to decant into the underground workings where, given the acid generating potential of the rocks, it is probable that this decanted water will be of poor quality and require treatment prior to being released into the natural environment. The treatment of any such decant water will need to meet the RWQOs at the time for both surface and groundwater.

Sensitive Receptors (Effect)

Everyone in the Study Area relies exclusively on water from at least one of these sources for drinking and for livelihood sustaining activities. In the Zones of Influence an existing agricultural development as well as the introduction of bulls to impregnate local cows and increase herd sizes highlight short-to-long-term planning around agriculture and livestock farming – both dependent on reliable access to good quality water.

Several CPA community members raised concerns about water loss and reduced quality resulting from the proposed Project. Members highlighted examples of boreholes near to current Kangra Coal activities running dry as proof of lower water tables and the need for deeper borehole pumps.

The use of borehole water within the Zones of Influence is reportedly limited as the large majority of homesteads have drinking quality potable spring or river water piped to their homes. If any untreated water from the mining operations is accidentally released into the natural environment it will negatively affect the quality of water in streams and rivers and therefore have a detrimental effect on communities reliant on them as a source of water. In addition, pollution of groundwater that may recharge these surface water systems will adversely affect the community users. Springs, which many survey respondents identified as their main water source, have the potential to be impacted by contamination from polluted groundwater.

The potential pollution of water in the area would be a long-term problem that would be increasingly experienced after the proposed Project has closed and for generations to come.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, this impact is assessed to be of **"Major Negative"** significance, pre-mitigation (*Table 9.20*).

Table 9.20 Rating of Impacts Related to Reduced Water Quality and Availability for People, Agriculture and Livestock Resulting from Mine Activities (Water Use, Dewatering, Contamination) (Pre-Mitigation)

Type of Impact		
Direct, Cumulative Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional in the Assegaai and Hlelo catchment	The Baseline Groundwater Impact Assessment Report suggests that the impacts on water quality and availability will be confined to adjacent and nearby properties.
Duration	Permanent	Drawdown and impacts on water quality will continue beyond the life of the mine. Water levels may recover approximately 90 years after dewatering for the proposed Project ceases and pollution of groundwater is conservatively estimated to last at least 60 years.

Scale	Large	The entire water system on which local residents depend for potable water, agriculture and livestock watering will be impacted.
Frequency	Periodic to Continuous	The impact will begin during construction when dewatering activities will start but water levels are likely to rebound post-closure. Acid mine drainage will be triggered once mining activities begin and over-burden is dumped and decant in the underground workings will begin post- closure.
Likelihood	Likely	Depressed groundwater levels will result from mine dewatering and water quality is likely to be adversely affected as a result of the exposure of elements in the mined rock (above and below the surface) to water and related chemical processes.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The anticipated reduction of recharge to springs and streams from groundwater as a result of mine dewatering will be marked, permanent and likely to adversely impact ecosystem processes and communities reliant on surface water. Post closure, large volumes of decant water will have to be dealt with and will contaminate streams if released untreated. Furthermore, the potential for precipitation, surface or groundwater to interact with coal in overburden dumps, conveyor belts, and underground workings, is likely to lead to acid rock drainage and contamination of groundwater. These impacts will effect current and future generation living in the Study Area and would put human health and the productivity of the land at severe risk.		
Significant Rating Before Mitigation		
Major Negative Impact		

Recommendations and Mitigation/Management Measures

The Groundwater Impact Assessment Report for the proposed Project details a number of mitigation measures that the specialists believe, if successfully implemented, will reduce the significance of the proposed Project's impacts on ground and surface water in the Study Area. One of the mitigation measures identified is the supply of alternative water to communities if water quality or quantity is adversely affected. For this mitigation measure to be successful Kangra Coal would need to ensure permanent water replacement piped to people's homesteads and available for agriculture and livestock watering at convenient places and in appropriate quantities. This mitigation measure will need to be met for decades after mine closure, given the slow recovery of impacts associated with water quality impact.

The following mitigation measures will be used to reduce the significance of the impact:

- Strict controls to prevent accidental release of untreated mine-water into the natural environment as well as seepage of water through the overburden dump and coal-handling areas as well as along the conveyor route will be implemented.

- All water coming out of the mine area will be treated and returned to meet the RWQO prescribed for surface and ground water quality.

- If water access by communities is adversely affected, Kangra Coal will establish an alternative water source that will deliver water to the homesteads as is currently the case. This water delivery will continue for decades until the existing baseline quality of water is achieved.

These mitigation measures are achievable in the short-to-medium term, pre-closure. However, the supply of acceptable quality water to people and for livestock and agricultural purposes post closure must be maintained.

Residual Impact (Post-mitigation)

The mitigation measures above, if successfully implemented for the duration of the impact, will reduce the scale of the impact to medium reducing the significance of the impact to a '**Moderate Negative Impact'**. Kangra Coal is committed to the provision of alternative water supplies to those water users affected by Project activities and will be obliged to treat water post closure to ensure the RWQO at the time are met (*Table* 9.21).

Table 9.21 Rating of Residual Impacts Related to Reduced Water Quality and Availability for People, Agriculture and Livestock Resulting from Mine Activities (Water Use, Dewatering, Contamination) (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local / Catchment	The Baseline Groundwater Specialist Report suggests that the impacts on water quality and availability will be confined to adjacent & nearby properties.
Duration	Permanent	Drawdown and impacts on water quality will continue beyond the life of the mine. Water levels may recover approximately 90 years after dewatering for the proposed Project ceases and pollution of groundwater is conservatively estimated to last at least 60 years.
Scale	Current and future generations living in the affected catchment area	The entire water system on which local residents depend for potable water, agriculture and livestock watering will be impacted. If the full range of mitigation measures is successfully implemented pollution of ground and surface water during operations may be limited.
Frequency	Periodic to Continuous	The impact will begin during construction when dewatering activities will start but water levels are likely to rebound post-closure. Acid mine drainage will be triggered once mining activities begin and over-burden is dumped and decant in the underground workings will begin post-closure.
Likelihood	Likely	Depressed groundwater levels will result from mine dewatering and water quality is likely to be adversely affected as a result of the exposure of elements in the mined rock (above and below the surface) to water and related chemical processes.
Magnitude		
Large Magnitude		

Significant Rating After Mitigation
Moderate Negative Impact

9.5.2 *Reduced Access to Wood for Cooking and Heating Resulting from Tree-Clearing in the Project Footprint and from Limited Access across the Conveyor*

Description of the Baseline Environment

Approximately 89% of the 45 homesteads surveyed in the Zones of Influence rely primarily on wood for cooking and heating. While many homesteads have access to electricity this is sparingly used because it is expensive. Wood is reportedly collected from nearby woodland/forested areas around the Zones and in the broader Study Area.

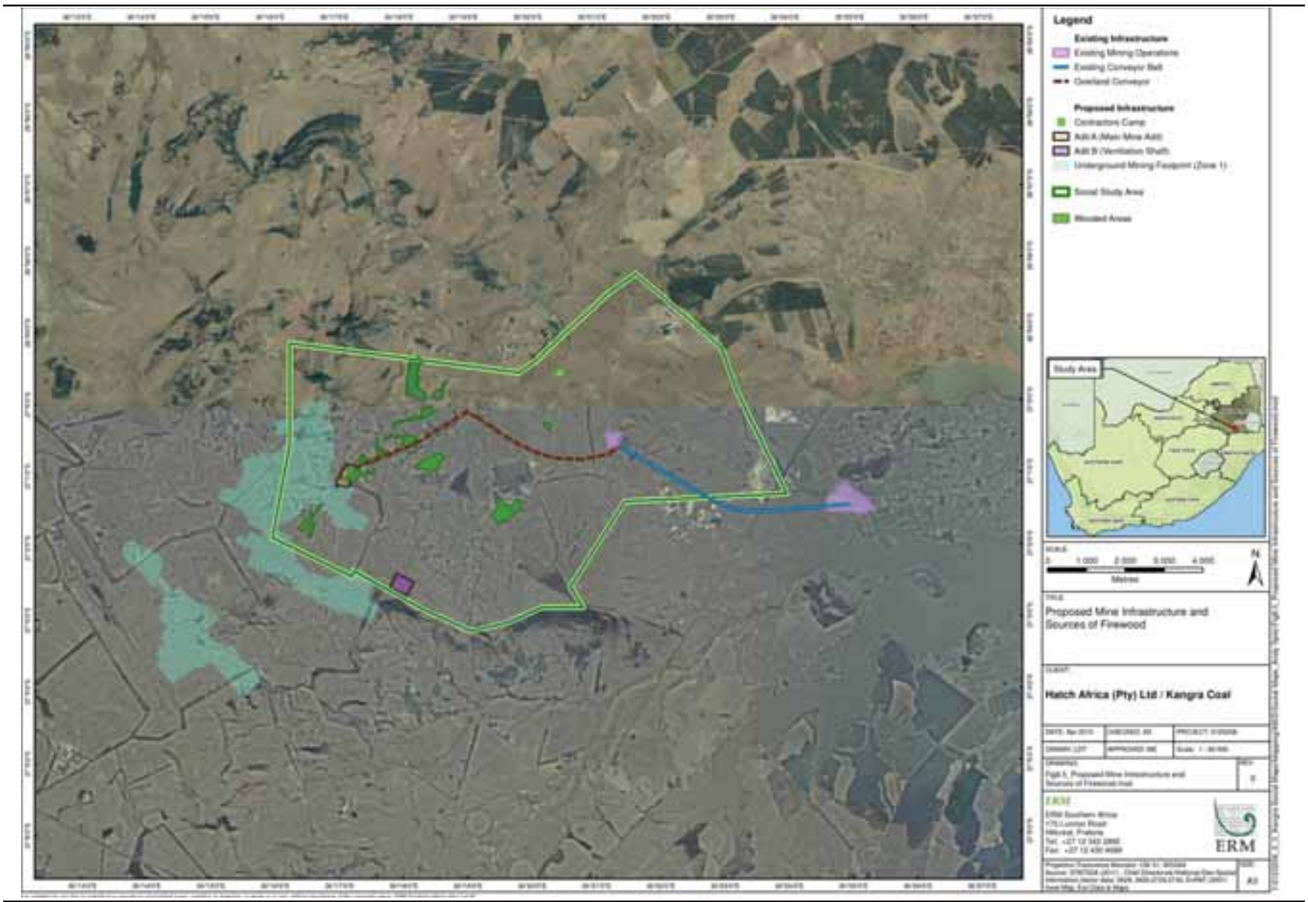
Proposed Project Activities

The establishment of the proposed Project infrastructure, particularly Adit A and the conveyor route will respectively eliminate a number of wooded areas for Donkerhoek, Twyfelhoek and Kransbank or cut off access to these areas from different parts of the above mentioned farms (*Figure 9.4*).

Sensitive Receptors

The high percentage of survey respondents using wood as their primary source of energy suggests that the majority of homesteads in the Zones of Influence would be vulnerable to a loss of access to this "free" natural resource. In addition, the need to supplement this energy source with paid electricity would put increased pressure on people to draw on their limited cash incomes. Wood is also used in homestead construction to a limited degree.

Figure 9.4 Proposed Mine Infrastructure and Sources of Firewood



Significance of Impact (<u>Pre-mitigation</u>)

Based on the analysis provided above, this impact is assessed to be of **"Minor to Moderate Negative"** significance pre-mitigation (*Table 9.22*).

Table 9.22 Rating of Impacts Related to Reduced Access to Wood for Cooking and Heating Resulting from Tree-Clearing in the Project Footprint and from Restricted Access across the Conveyor (<u>Pre-Mitigation</u>)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The clearing of wooded areas within the proposed Project footprint and the establishment of the conveyor which will create a physical barrier about 8.4kms long will reduce the amount of wood available and its accessibility for community use.
Duration	Long-term	Trees will be cleared for mining infrastructure and may be re-established post closure (20 years). The conveyor would be removed at closure and would therefore no longer create a physical barrier.
Scale	Local residents in Zone 1 of Influence and possibly broader Study Area	The fact that the majority of local residents rely on wood for cooking and heating in the Zones of Influence, and that their cash income to pay for alternative sources of energy is limited, makes the scale of the impact medium even though the hectares of land cleared is relatively small.
Frequency	Continuous	The loss of wood and reduced access to remaining wooded areas will begin with construction and will continue for approximately 20 years.
Likelihood	Likely	The establishment of the infrastructure will definitely occur if the proposed Project goes ahead.
Magnitude		
Minor Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Survey respondents in the Zones of Influence overwhelmingly favour the use of wood over electricity, which is expensive. Their limited cash incomes make them very vulnerable to increased costs of living that would occur if access to wood was lost or significantly reduced and if electricity became the only realistic source of energy for cooking and heating.		
Significant Rating Before Mitigation		
Minor to Moderate Negative Impact		

Recommendations and Mitigation/Management Measures

The following mitigation measures should be used to reduce the significance of the impact:

- Ensure that communities are involved in the clearing of wooded areas pre-construction and that harvested wood is freely available for local consumption. Assist in transporting collected wood from more remote areas to central communal areas;

- Establish underpasses that allow people access across the conveyor so that reduced access to collecting wood becomes a minor inconvenience.

- Communities have demanded a share (50%) of the coal mined from their land. This is obviously impractical. However Kangra Coal should negotiate the supply of coal to residents and communities within the Study Area and particularly the Zone 1 of Influence as part of their discussions to gain access to CPA land. This SIA recognises that an arrangement that empowers people to use clean energy is preferable to an exchange for coal. However, buying electrical equipment for cooking and heating has its own related costs, which may be beyond the scope of most local residents and if this is the case then solar energy has limitations for the affected homesteads and communities that are currently equipped for the use of coal.

Residual Impact (Post-mitigation)

The mitigation measures above will reverse the impact to a significance rating of a "**Positive Impact"** (Table 9.23).

Table 9.23 Rating of Residual Impacts Related to Reduced Access to Wood for Cooking and Heating Resulting from Tree-Clearing in the Project Footprint and from Restricted Access across the Conveyor (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The clearing of wooded areas within the proposed Project footprint and the establishment of the conveyor which will create a physical barrier about 8.4kms long and will reduce the amount of wood available and its accessibility for community use. Underpasses will ensure that people walking across the area are not significantly inconvenienced.
Duration	Medium-term	Trees will be cleared for mining infrastructure and may be re-established post closure (20 years). The conveyor would be removed at closure and would therefore no longer create a physical barrier. If trees are planted on both sides of the conveyor and in other appropriate areas to replace those lost (obviously in consultation with the affected land owners) the impact duration would be reduced. Furthermore, if the other mitigation measures are implemented the vulnerability of communities reliant on wood for cooking and heating would immediately be significantly reduced.
Scale	Local residents dependent on wood in Zones 1 and 2 and possibly the broader Study Area	The fact that the majority of local residents rely on wood for cooking and heating in the Zones of Influence, and that their cash income with which to pay for alternative sources of energy is limited, makes the scale of the impact large. Replacement of lost sources would make the mitigation extent large.

Frequency	Limited	The loss of wood and access to remaining wooded areas will begin with construction and will continue for approximately 20 years. However if properly mitigated the frequency of the impact will be reduced until the replacement sources are established (new trees; small quantities of coal; and solar panels).
Likelihood	Likely	The establishment of the infrastructure will definitely occur if the proposed Project goes ahead. The scale of wood clearing is relatively small and the number of local homesteads makes mitigation of this impact relatively manageable.
Magnitude		
Positive Impact		
Significant Rating After Mitigation		
Positive Impact		

9.6 COMMUNITY HEALTH AND SAFETY

9.6.1 Reduced Community Health and Safety Resulting from Project Activities, Air, Water, Noise and Traffic Impacts as well as the Presence of Outsider Contract Workers

Description of the Baseline Environment

The Study Area is currently a quiet and tranquil rural setting in which people engage in small-scale subsistence agriculture and livestock farming. Cash incomes in the area are limited but people reported that their subsistence activities significantly contribute to their livelihoods, relieving some of the pressures to engage extensively in a cash economy.

The social survey made a limited enquiry into chronic health concerns for adults and children. The results did not reveal any widespread public health concerns or environmentally-related diseases. While the area is not completely remote it is protected to some degree for the spread of communicable health risks by the limited migration of people into and out of the Study Area.

Health services to the Study Area are poor. A mobile clinic is supposed to visit monthly but this has been increasingly erratic. People have to travel to Driefontein for basic primary health care and further afield for more complicated medical treatment.

Air and water quality in the Study Area is within accepted World Health Organisation standards with little pollution as a result of low levels of industrialisation or mechanised agriculture. Potable water is sourced from springs, rivers and streams in the area and the Groundwater Impact Assessment associated with the ESIA for the Kusipongo Resource Expansion Project identified generally good quality of drinking water.

There is limited traffic moving through the Study Area and there is only one main road along which this traffic can travel. The often poor quality of this road and fencing off of farms from the main road reduces the potential for traffic accidents with local pedestrians. In addition, the majority of children of school-going age (over 90%) spend term-time away from home at the nearby Ezakheni Combined Boarding School.

Many residents reported choosing to live in the area for its peacefulness as well as their sense of community. 45% of surveyed residents have lived in the Study Area for over 15 years (prior to the establishment of the CPA farms). 75% of respondents are landowners as part of the CPAs. People's attachment to the Area is, amongst other things, related to this sense of place and ownership of land and contributes to their emotional well-being.

Local residents acknowledged some incidents of family violence but emphasised that this was minimal. Levels of social conflict in the Study Area are also reportedly low and people's quality of life, in relation to their sense of place and belonging, is reportedly good.

Proposed Project Activities

During construction there will be a marked increase in traffic in the Study Area as large vehicles transport equipment and machinery for establishing the mine. The current route is planned to use the main road that runs from the site towards Driefontein. Construction Vehicles will also use the smaller roads running between homesteads in Zone 1 of Influence.

Traffic and construction activities, as well as 24hr operation phase activities will increase levels of noise in the area, particularly noticeable at night. Mining activities, including the stockpiling of coal and conveyor transport will contribute to increased air pollutants. There will also be regular traffic to and from Adit A and B during operations and for maintenance along the conveyor. This will add to dust creation and risks of road, pedestrian and horse accidents.

During construction a number of contractors from outside of the Study Area (250 skilled and semi-skilled employees) will be resident locally (although generally in the contractors' camp, separate from local residents). The influx of single men with access to cash often has spinoff effects on local communities including increased sex-work; increased risks of communicable diseases; increased incidents of teenage pregnancies; increased conflicts within families. These risks are particularly high in environments where levels of employment and income are low, as is the case in the Study Area.

Blasting during construction and to some degree during operations will create health and safety risks for local residents.

Sensitive Receptors

The sensitivity of the receptors (local residents) to proposed Project activities and related impacts on health and safety are assessed by considering a number of different baseline characteristics expressed directly by social survey respondents or judged in context of the baseline environment. Therefore, local residents are expected to be highly sensitive receptors to the changes and activities mentioned above and their associated health and safety impacts. These include increased traffic accident risks; reduced quality of water and air as well as higher levels of noise and increased risks of social conflict and risk-taking behaviour.

A number of survey respondents highlighted fears of blasting and even though these currently take place several kilometres from the Zones of Influence they were perceived as a significant risk to adults and children. The development of sinkholes resulting from underground activities was also described as a health risk. Sinkholes are seen as a danger to children and animals.

In contrast to the high sensitivity, the limited number of jobs created by the proposed Project will help to contain the health risks associated with communicable diseases. 450 construction contractors will be employed, approximately 200 from the surrounding area and 250 from outside of the area. No jobs will be created during operations and therefore the influx of job-seekers and employed migrants is expected to be limited.

Where health impacts are experienced these will be exacerbated because of poor provision of services to the Area and the potential for a drop in people's overall sense of well-being is possible.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, this impact is assessed to be of **'Moderate Negative'** significance pre-mitigation (*Table 9.24*).

Table 9.24 Rating of Impacts Related to Reduced Community Health and Safety Resulting from Project Activities, Air, Water, Noise and Traffic Impacts as well as the Presence of Outsider Contract Workers (Pre-Mitigation)

Type of Impact		
Direct, Induced, Cumulative Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact will be experienced in the Study Area and particularly for residents in Zone 1 of Influence.
Duration	Medium to long-term	The impact will begin with construction activities and will extend into the life of the mine. Impacts on water quality that affect people's health could be experienced beyond the life of the mine
Scale	Residents in the Zones of Influence and broader Study Area	Homesteads near to infrastructure or along transport routes will be primarily at risk, while residents of the broader Study Area will experience the changes to the nature of the environment and with that may experience potential impacts on their health and sense of well-being.

Frequency	Periodic	The impact will be experienced during specific times of high activity during construction and then at times when water, air and noise pollution are particularly high. A decrease in water quality may become a more permanent impact with its concomitant health effects. As residents become used to the changed sense of place the emotional effect on their well-being may be less prevalent.
Likelihood	Possible	The presence of the proposed Project will definitely trigger some of the impact causes mentioned above. Other causes, like traffic accidents or increased conflict are less likely to occur.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
People's sensitivity to anticipated changes, in context of their current levels of health and well-being, is expected to be high. In addition, the absence of health services increases levels of vulnerability.		
Significant Rating Before Mitigation		
Moderate Negative Impact		

Recommendations and Mitigation/Management Measures

Little can be done to mitigate this impact on people's health and safety based on the direct relationship to proposed Project activities. However, the following mitigation measures should be used to reduce the significance of the impact:

- Environmental mitigation measures highlighted in the various specialist studies should be implemented to limit the proposed Project's impact on air, water and noise at source.

- Strict traffic controls should be implemented prior to and during the construction and operational phases of the proposed Project. Including:

    - Training of all drivers (contractor and Project employed);
    - The introduction of traffic signs to the Study Area, in consultation with local government;
    - Enforcement of speed limits for all vehicles (45km/h);
    - Monitoring and maintenance of road degradation resulting from proposed Project use.

- An education programme should be run, in partnership with the District department of transport sensitising Study Area residents and local school children to traffic hazards.

- Education and awareness programmes should also be run in partnership with the District health services to raise awareness of health risks related to the proposed Project including the transmission of HIV/AIDS. These programmes should be implemented in local schools, communities and amongst employees.

- Kangra Coal should partner with the local health department to support monthly mobile health visits to the Study Area, including the involvement of a social worker tasked with identifying negative changes to local levels of emotional health and well-being. This service should be integrated into activities highlighted as mitigation measures for resettlement management and monitoring (under *Section 9.2.1*).

- Contract workers should be inducted to the Project through a programme that includes sensitivity to the local social environment. Health risks should also be highlighted in a standard Health and Safety programme that includes a focus on HIV/Aids.

- The contractors' camp should be equipped with recreational and entertainment facilities. Further, the camp should be closed to outsider visitors and hawking should be discouraged from the fence-line. Free condoms should be made available at the camp and Kangra Coal should have free confidential HIV testing and counselling for its employees.

- An emergency preparedness plan should be developed by Kangra Coal and should be communicated to local residents with regular safety drills undertaken to ensure that people know what to do in the event of an accident.

Residual Impact (Post-mitigation)

The mitigation measures above if fully implemented will reduce the magnitude of the impact to small and the sensitivity of some of the local residents to medium thereby reducing the significance of the impact to a **'Minor Negative Impact'** (*Table 9.25*).

Table 9.25 ***Rating of Residual Impacts Related to Reduced Community Health and Safety Resulting from Project Activities, Air, Water, Noise and Traffic Impacts as well as the Presence of Outsider Contract Workers (Post-Mitigation)***

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact will be experienced in the Study Area and particularly for residents in Zone 1 of Influence.
Duration	Medium to long-term	The impact will begin with construction activities and will extend into the life of the mine. Impacts on water quality that affect people's health could be experienced beyond the life of the mine.
Scale	Residents in Zone 1 of Influence and broader Study Area	Homesteads near to infrastructure or along transport routes will be primarily at risk, while residents of the broader Study Area will experience the changes to the nature of the environment and with that may experience potential impacts on their health and sense of well-being.
Frequency	Periodic	The impact will be experienced during specific times of high activity during construction and then at times when water, air and noise pollution are particularly high. A decrease in water quality may become a more permanent impact with its concomitant health effects. As residents become used to the changed sense of place the emotional effect on their well-being may be less prevalent.
Likelihood	Possible	The presence of the proposed Project will definitely trigger some of the impact causes mentioned above. Other causes, like traffic accidents or increased conflict are less likely to occur.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Magnitude		
People's sensitivity to environmental changes to water and air quality will remain unchanged. However, with time some of the changes to the natural environment and ambient noise levels will become less noticeable and thus people's sensitivity to the changes will reduce. With the implementation of education programmes around traffic and communicable disease risks local residents and contract workers should be less vulnerable that they would be prior to construction.		
Significant Rating After Mitigation		
Minor Negative Impact		

9.7 SOCIAL INFRASTRUCTURE AND GOVERNANCE

9.7.1 Increased Pressure on Driefontein Infrastructure and Service Delivery Resulting from an Influx of Job-Seekers to the Study Area and Possible Increased Incidents of Crime

Description of the Baseline Environment

Driefontein is a relatively small settlement of about 15 000 to 16 000 inhabitants. It includes old and new residential areas comprising formal and informal housing structures. Older structures are more traditional homesteads with some small subsistence agriculture fields, whilst new RDP houses and other brick and cement buildings have been built in the new area. The new area is also laid out in a more formal grid-like arrangement that enables easier construction of infrastructure and provision of municipal services.

There are a number of schools in the area (primary and high) and two primary health care facilities, but no fulltime doctors. Most of the roads are unpaved. There is access to electricity across many of the houses.

Levels of unemployment are high and tax contributions to the local municipality are low.

Proposed Project Activities

If the proposed Project moves into the construction phase there is likely to be some anticipation of employment opportunities from outside of the area (different districts or provinces). Such expectations in the context of a country with high unemployment (over 25%) are likely to trigger in-migration to the Project Area. However, as emphasised several times above, the proposed Kusipongo Resource Expansion Project is not an entirely new project but rather an extension of existing operations in the area and, besides creating 450 jobs for the 18 to 24 months of construction (200 of which will be filled by local residents), no new jobs will be created during operations. However, people will still have expectations of job opportunities and may be induced to settle in Driefontein to access these perceived opportunities.

The temporary construction camp will house approximately 250 people but will be located on Kangra Coal's land, some 8.5km from the beginning of Driefontein settlements. The camp will be closed and will provide for most of the daily needs of resident contractors. However contractors are likely to spend some of their free time in Driefontein, as it is the nearest large settlement. This will place some additional pressure on local infrastructure and resources (mainly recreational). The potential for increased petty crime related to the presence of salaried individuals, could require additional policing to that which is currently available.

Sensitive Receptors

Municipal infrastructure and service provision in Driefontein are already limited. If migrants were to enter the area they would most probably settle in Driefontein out of necessity - it is relatively near the proposed Project, and other land in the Study Area is privately and communally owned, making access to settle difficult. Even a moderate influx of migrants seeking employment on the proposed Project would exacerbate pressure on existing Driefontein service delivery and infrastructure.

Any increase in crime (thefts, muggings, increased prostitution and related family conflicts, and violent crimes) would place existing limited policing resources under pressure to respond.

Significance of Impact (<u>Pre-mitigation</u>)

Based on the analysis provided above, this impact is assessed to be of **'Moderate Negative'** significance pre-mitigation (*Table 9.26*).

Table 9.26 Rating of Impacts Related to Increased Pressure on Driefontein Infrastructure and Service Delivery Resulting from an Influx of Job-Seekers to the Study Area and Possible Increased Incidents of Crime (<u>Pre-Mitigation</u>)

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	An influx of employment-seekers would likely be experienced in Driefontein as it is the closest large settlement in the area and farms in the Study Area are either privately or communally owned so not accessible to in-migration. Increased incidents of crime are likely to be focused around Driefontein.
Duration	Short-term	The impact of in-migration is anticipated to occur prior to construction and possibly again prior to operations. However, the absence of actual job opportunities, in conjunction with limited alternative opportunities in Driefontein, would probably result in people leaving the area again in the short-term. Impacts related to the presence of contract workers could occur during for the 18-24 month duration of this phase.
Scale	Difficult to estimate but anticipated to be moderate	The fact that the proposed Project will not create significant employment opportunities is likely to limit employment related in-migration.
Frequency	Intermittent	In-migration would probably be experienced at specific moments in the proposed Project cycle – pre-construction and pre-operations. And events of crime would also be intermittent focused mainly around the construction phase.
Likelihood	Possible	The extent of in-migration and its related pressure on infrastructure and service delivery in Driefontein would depend on the circulation of information about the proposed Project and the level of expectation created around employment opportunities.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Municipal service delivery and infrastructure in Driefontein is already limited and in the absence of significant income with which to upgrade these services, the in-migration of a moderate number of job-seekers would place significant pressure on the local municipality. Additionally, the limited policing resources locally available would be sensitive to any increased levels of crime.		
Significant Rating Before Mitigation		
Moderate Negative Impact		

Recommendations and Mitigation/Management Measures

In a country with high levels of unemployment information about potentially large developments spreads easily and people are willing to uproot themselves in search of possible employment. The following mitigation measures should be used to reduce the significance of the impact:

- A coherent and rigorous communication plan should be developed to ensure that a clear message about the realistic limits to job opportunities from the proposed Project should be developed and widely disseminated. The plan should include the use of different appropriate media including local newspapers and local radio stations.

- Local communities and Kangra Coal employees should be informed regularly about upcoming Project decisions and activities. This should contain levels of expectations, particularly regarding job opportunities. It is anticipated that this will reduce the scale of in-migration.

- A small office should be set up within the Study Area to deal with Project-related enquiries from local residents.

- A central Project office should be set up in Piet Retief which will provide information about job opportunities and will handle all job applications besides those submitted by residents in the Study Area (including Driefontein). The office should disseminate regular Project information. Situating the office away from the Study Area is intended to draw job-seekers to a central point and discourage temporary settlement in Driefontein.

Mitigating Project-induced increase in crime and its concomitant pressure on policing resources is difficult. Therefore Kangra Coal should establish communication channels with the local police and community police forums and explore ways in which to support local policing if there is increased pressure on the limited resources as a result of the Project.

Residual Impact (Post-mitigation)

The mitigation measures above should reduce the magnitude of the impact of in-migration to Driefontein and its associated pressure on infrastructure and service delivery to negligible reducing the significance of the impact to a '**Minor Negative Impact"** (*Table 9.27*).

Table 9.27 Rating of Residual Impacts Related to Increased Pressure on Driefontein Infrastructure and Service Delivery Resulting from an Influx of Job-Seekers to the Study Area and Possible Increased Incidents of Crime (<u>Post-Mitigation</u>)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	An influx of employment-seekers would likely be experienced in Driefontein as it is the closest large settlement in the area and farms in the Study Area are either privately or communally owned so not accessible to in-migration.
Duration	Short-term	The impact is anticipated to occur just prior to construction and possibly again prior to operations. However, the absence of actual job opportunities, in conjunction with limited alternative opportunities in Driefontein, would probably result in people leaving the area again in the short-term.
Scale	Difficult to estimate but anticipated to be minor	The fact that the proposed Project will not create significant employment opportunities is likely to limit employment related in-migration. If mitigation measures around communication and information dissemination are successfully implemented the number of job seekers should be further reduced.
Frequency	Intermittent	In-migration would probably be experienced at specific moments in the proposed Project cycle – pre-construction and pre-operations
Likelihood	Possible	The extent of in-migration and its related pressure on infrastructure and service delivery in Driefontein would depend on the circulation of information about the proposed Project and the level of expectation created around employment opportunities.
Magnitude		
Negligible Magnitude		
Significant Rating After Mitigation		
Minor Negative Impact		

9.8 LEGACY

9.8.1 The Poor Relationship Between Kangra Coal and Local Communities, in Conjunction with Perceived Unfulfilled Promised by the Company, will undermine Levels of Trust and Chances of a Social Licence to Operate from Affected Communities and Stakeholders

Description of the Baseline Environment

Kangra Coal has been extracting coal from the Savmore Colliery and operating the current washing plant neighbouring the Driefontein community since the late 1990s. The operations include underground and open pit mining methods.

In carrying out its operations the company has had impacts on the physical and social environments in which it works. It has also resettled a small number of homesteads within its own properties and has made compensation agreements with affected parties. The company has also contracted third parties to undertake numerous construction activities, including replacement housing and the provision of other two-roomed housing in some homesteads on the neighbouring farms. The strategy and approach to supplying these houses is unclear and residents in the Study Area were also unable to provide clarity on this issue.

A total of 745 people are currently employed in Kangra Coal's operations. It is unknown how many employees are from the local communities and how many are from other areas. The required skills levels for these positions are also not available.

There has been no ongoing communication with affected communities and no formal grievance mechanism is in place. A Community Liaison Officer (CLO) has recently been employed but prior to this there was no dedicated community liaison position in current operations.

Kangra has already drawn up and submitted its Social and Labour Plan (SLP) for the proposed Project, which was received by the Department of Mineral Resources in July 2012. Amongst other items the SLP outlines spending on:

- Literacy training for employees;
- Learnerships and bursaries for employees for training at the Coal Colliery Training Centre in Witbank and at engineering departments at various universities;
- Capacity development programmes in the neighbouring community (focused on maths and science in local schools); and
- Small medium enterprise training and mentorship for local communities.

The SLP also identifies approximately 30 homesteads that it says would need to resettle and further states that it has identified the resettlement sites.

Past and Current Kangra Coal Activities

The proposed Project wishes to develop an underground mining operation and associated infrastructure affecting the farms of Donkerhoek, Twyfelhoek, Kransbank, and Kangra Coal's own farms Rooikop and Nooitgezien. To do this it will require permission from the private and communal landowners as well as negotiated agreements to resettle approximately 42 homesteads that would otherwise be directly impacted by its activities.

Stakeholder meetings in Driefontein highlighted high levels of anger and frustration from local residents towards the company. A number of people expressed resistance to the proposed Project citing on previous unmet expectations and unfulfilled commitments as the cause. Sentiments were similar within the Study Area and particularly the Zones of Influence. The following actions by Kangra Coal were raised as factors contributing to people's mistrust of the company and resistance to its presence on their land:

- Poor resettlement practices where compensation had not been fully implemented and where homesteads felt worse-off than before;

- Poor oversight of sub-contractors. People highlighted examples of local employment and infrastructure development promises made by third-party contractors to gain access to the Study Area that had not been fulfilled. People also emphasised that Kangra Coal should not evade its ultimate accountability for this by claiming a lack of responsibility for the contractors and their quality of work;

- A top-down and non-participatory approach to activities in the Study Area, including *ad hoc* building of houses for some homesteads and not for others without providing clear motivation for its approach;

- Impacts on water availability in areas where mining is already taking place. These impacts have raised fears amongst Zone of Influence residents about long-term impacts on their water quality and supply once the company closes operations in the area and communities are left to deal with the on-going impacts;

- A lack of visible benefits, including local development and employment, from over a decade's Kangra mining activities in the Study Area and more broadly; and

- Sinkholes and road degradation resulting from company activities that have not been rehabilitated.

At present, 77.7% of social survey respondents felt that there had been no community benefits from current Kangra Coal operations. 53% of respondents felt that they had been negatively affected by Kangra Coal's operations and only 4.4% felt they had been positively affected. Anticipating potential benefits of the proposed Project, 56.7% of respondents anticipated "no benefits" to be forthcoming based on experiences of the past.

Sensitive Receptors

The proposed Kusipongo Resource Expansion Project is the sensitive receptor of this impact. It is already clear that there is resistance to the presence of the proposed Project by many local residents (as well as other stakeholders). Withholding of access to their land could increase the vulnerability of the proposed Project as it can only access and transport the mineral resources via surface areas outside of its control.

It is possible, based on mining legislation, that permission to go ahead with the proposed Project could be given even in the face of community mistrust and resistance. Furthermore, the fact that government paid for the CPA farms may give them power to enforce acceptance of the proposed Project on CPA land. However, a heavy-handed approach is likely to leave the Project increasingly vulnerable to resistance from local residents and would almost certainly wipe out the company's chances of achieving a social license to operate.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, this is assessed as a **'Major Negative Impact'** pre-mitigation (*Table 9.28*).

Table 9.28 Rating of Impacts Related to the Poor Relationship Between Kangra Coal and Local Communities, in Conjunction with Perceived Unfulfilled Promised by the Company will undermine Levels of Trust and Chances of a Social Licence to Operate from Affected Communities and Stakeholders

Type of Impact		
Cumulative Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact of community mistrust and anger towards Kangra Coal would affect the proposed Project.
Duration	Medium to Long-term	Resistance has already been triggered and could continue through construction and operations.
Scale	The proposed Project	Levels of resistance based on previous legacy issues impact on the proposed Project as a whole – particularly in its social license to operate.
Frequency	Periodic	Resistance is likely to be expressed at moments in the Project development process rather than continuously. However, the intensity and duration of these moments are likely to vary.
Likelihood	Likely	Many residents in the Study Area, Zones of Influence and broader Stakeholder groups have already clearly expressed their resistance to the proposed Project based on Kangra Cola's legacy in the area.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Among the basic requirements for the Kusipongo Resource Expansion Project to go ahead is permission from landowners to access their land. High levels of residents' resistance to the company threaten the granting of that permission.		
Significant Rating Before Mitigation		
Major Negative Impact		

Recommendations and Mitigation/Management Measures

The following mitigation measures should be used to reduce the significance of the impact:

- A comprehensive communication and engagement approach should be developed and implemented immediately to engage with affected communities and landowners. This should include residents on privately owned land (Donkerhoek, Rooikop and Nooitgezien). The approach should be facilitated through appropriately trained communications and community practitioners and should focus on establishing open lines of communication that can initiate relationships of trust between parties.

- From the above interactions, a list of immediate remedial actions should be drawn up and a timeframe established for implementation. Kangra Coal should address issues on the list and report back to communities on completion of each item.

- Negotiations for access to privately and communally owned land should be initiated in an open and transparent manner. These interactions should be undertaken as per the mitigation recommendations for Resettlement processes described in *Sections 9.2.1* and *9.2.2* above.

- A Community Benefit Agreement should be drawn up between Kangra Coal and each affected community as described in these two impacts as well as in *Section 0* above.

- The CLO should establish on-going and regular interaction between the company, residents of the Study Area and particularly Zone 1 of Influence.

- A grievance mechanism should be drawn up through which local residents can log their grievances. A formal procedure of receiving, evaluating, addressing and finalising these grievances should be communicated to local residents.

- Kangra Coal should re-evaluate its control of third-party contractors and should take direct responsibility for promises made and work undertaken on its behalf.

- All community related development planning should be undertaken with participation of affected communities. The plans should be formally documented with objectives, required actions, performance indicators and monitoring and reporting requirements. These should be made accessible in appropriate languages and formats to affected communities.

- All Kangra Coal activities related to social development or social investment projects should be fully documented and communicated so that residents of the Study Area and surrounding communities can see community benefits from the presence of the company in their area.

- Kangra Coal should develop a company-wide communication strategy for all its operations in and around the Study Area. This will focus on clear and consistent messages and regular interactions between the company and local communities. A key component of this strategy should be the two-way nature of communication where communities are provided with relevant and accessible information and where their concerns and suggestions are heard, documented and responded to. If implemented, this will be an important step in establishing relationships of trust between the company and its hosts and neighbours.A concerted effort need to be made by Kangra Coal to remedy its poor image in the community and to establish constructive relationships that will facilitate its social license to operate going forward.

Residual Impact (Post-mitigation)

The mitigation measures above are extensive and require significant commitment from the company. However, failure to address the current situation will leave the proposed Project vulnerable to local resistance. If fully implemented the mitigation measures should reduce the magnitude of the impact to small reducing the significance of the impact to a '**Moderate Negative Impact'** in the short term. Ideally, through on-going interactions and the establishment of trust between parties the significance of the impact can be further reduced to **'Minor Negative'** in the medium term *(Table 9.29*).

Table 9.29 Rating of Residual Impacts Related to the Poor Relationship Between Kangra Coal and Local Communities, in Conjunction with Perceived Unfulfilled Promised by the Company will undermine Levels of Trust and Chances of a Social Licence to Operate from Affected Communities and Stakeholder (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact of community mistrust and anger towards Kangra Coal would affect the proposed Project.
Duration	Medium to Long-term	Resistance has already been triggered and could continue through construction and operations. Successful mitigation measures implemented immediately could reduce the duration of the impact too short to medium term
Scale	The proposed Project	Levels of resistance based on previous legacy issues impact on the proposed Project as a whole – particularly in its social license to operate.
Frequency	Sporadic	Resistance is likely to be expressed at moments in the Project development process rather than continuously. However, the intensity and duration of these moments are likely to vary. Successful mitigation could decrease the frequency with which this resistance is experienced and expressed.
Likelihood	Possible	Many residents in the Study Area, Zones of Influence and broader Stakeholder groups have already clearly expressed their resistance to the proposed Project based on Kangra Cola's legacy in the area. Successful implementation of mitigation measures would reduce the likelihood of local residents and other stakeholders resisting the proposed Project.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The Company's sensitivity remains high. However, improved relations with communities in the Study Area that would result from successful mitigation would reduce the vulnerability of the proposed Project to resistance from landowners and residents.		
Significant Rating After Mitigation		
Minor to Moderate Negative Impact		

10 CUMULATIVE IMPACTS AND MITIGATION

10.1 INTRODUCTION

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This chapter considers the cumulative impacts that would result from the combination of the proposed Kangra Coal Expansion Project and other actual or proposed future developments in the broader Project Area.

10.2 IDENTIFIED CUMULATIVE IMPACTS

In identifying cumulative impacts that would result from a combination of this proposed Project and other actual or proposed future developments in the broader Project area the following has been considered:

- Kangra Coal has plans to expand existing operations to include eight new opencast pits; the expansion of existing opencast pits; two new underground mining areas and expanded discard dumps. The new operations are planned to take place on Kangra Coal's Nooitgezien and Maquasa West farms, while extensions will happen on Maquasa and Roodekraal farms, which neighbour Driefontein.

No other current or future activities have been considered.

The cumulative impacts that would result from a combination of the proposed Project and activities identified above include:

- Continual Land Requirement in the Area;
- Impacts on Homesteads and Adjacent Fields and Graves;
- Loss of Land for Grazing and Agriculture;
- Further Undermining of Relationships of Trust between Communities and Kangra Coal's;
- Reduced Water Quality and Quantity in the Area;
- Increased Risks to Community Health and Safety;
- Disruption of Community Access;
- Increased Expectations of Employment Opportunities and Community Benefits; and
- Further Undermining of Tourism Potential in the Area.

Each of these potential cumulative impacts is described below.

10.2.1 Continual Footprint Requirement in the Study Area

When looking at the mapping of new opencast pits, underground workings and waste dumps in conjunction with the Kusipongo Resource Expansion mapping, it would be reasonable to anticipate the identification and proposed mining of further coal deposits in the area besides those already identified. If this happens the entire nature of the area will be changed over time from rural (green field) to industrial (brown field). The quality of life of communities and individuals living and owning land in the area would be significantly undermined, as would their livelihoods.

10.2.2 Impacts on Homesteads and Adjacent Fields and Graves

There are not many additional homesteads within the newly identified cumulative areas of influence. However there are a few that are visible and that would be impacted and probably need to be resettled in order to secure their health and safety. Based on the current survey it's likely that these homesteads would have associated fields and graves attached to them.

The resettlement process would need to follow the same recommendations as those outlined in the Impact section of this report.

If, over time, the majority of land between current Maquasa operations and Kusipongo planned operations will be mined then it would be appropriate, in discussion with affected communities to identify and purchase alternative farms land of the same financial and natural resource value and to resettle communities as a whole, rather than to disrupt relationships and livelihoods with piecemeal resettlements at on-going intervals.

10.2.3 Loss of Land for Grazing and Agriculture

Additional footprint requirement for mining activities will reduce the amount of land available for agriculture and livestock grazing. Although the new areas of activity lie on Kangra Coal's land and would not impact on CPA grazing, there are residents who use the land for their livestock, albeit on a small scale.

Aerial images show at least one large livestock watering point, which would be lost.

A continual reduction in available land for agriculture and grazing will increase pressure on remaining resources in the area. This could also affect people's food-security and aspects of their livelihood strategies.

10.2.4 Further Undermining of Relationships of Trust between Communities and Kangra Coal's

There are already high levels of mistrust towards Kangra Coal from local residents. The addition of a new project, which has further footprint requirement implications and which will add to the changes in the sense of place of the area as well as levels of noise and other aspects of resource pollution, is likely to feed into people's suspicion that they are being incrementally overtaken by mining activities.

The fact that there will be new information circulating in the community with new maps and new employment figures and a host of new concerns for local residents needs to be sensitively addressed with a comprehensive communication and engagement approach to avoid confusion and increased levels of mistrust and suspicion.

Any lack of fulfilment of Kangra Coal's commitments in current operations or in relation to the proposed Kusipongo Resource Project will also have knock-on effects when approaching the social aspects of future projects.

10.2.5 Reduced Water Quality and Quantity in the Study Area

Additional water use and extraction of water from opencast pits and underground operations, particularly in an area where the water table is already very shallow, may increase the impacts on water availability in the current Zones of Influence as the drawdown area expands.

Additional issues of acid mine drainage are likely to have cumulative impacts on water in the catchment and downstream of activities. These will affect downstream water users, possibly including the Heyshope Dam.

10.2.6 Increased Risks to Community Health and Safety

Cumulative impacts on air quality, water quality and noise, as well as increased traffic in the area could increase health and safety risks for local residents. An influx of employment-seekers with concomitant changes in social behaviour and increased risks of the spread of communicable diseases also increases health and safety risks.

10.2.7 Disruption of Community Access

Aerial images of footpaths between farms and homesteads, plus social research in the Study Area, highlight the common movement of people across the Study Area for social and livelihood reasons. Establishing underpasses across the conveyor mitigates some of this impact. However, if new mining activities and related infrastructure further restrict access for safety reasons, the establishment of underpasses becomes insignificant.

10.2.8 Increased Pressure on Service Delivery in Driefontein

Pressure on service delivery and infrastructure in Driefontein has not been identified as an impact of major negative significance. However, if there are numerous possible employment opportunities (actual or perceived) then the migration of job-seekers to Driefontein may become a significant impact for authorities attempting to supply services and meet infrastructural needs in the area.

10.2.9 *Increased Expectations of Employment Opportunities and Community Benefits*

If numerous mining projects take shape in the broader Study Area, local residents' expectations of employment opportunities and community benefits are likely to be fuelled. If as in the past, these expectations are not met, the possibility of conflict between residents and the company, or between residents and "outsiders" could increase.

10.2.10 *Further Undermining of Tourism Potential in the Area*

Cumulative mining impacts in the broader Study Area may over time preclude any potential tourism development. In addition, cumulative water quality impacts could affect the largemouth bass fishing at the Heyshope Dam.

11 CONCLUSION

This SIA presents a picture of the Zones of Influence, within their broader socio-economic and geographical environment. One of the key issues emerging from the study is related to land and shows CPA residents symbolically empowered by their land ownership starkly contrasted with labour tenants who seem largely powerless to control the proposed Project's impact on their lives.

Most respondents expressed low expectations of benefits from the Project often combined with vocal resistance to it. The vast majority expressed a lack of trust towards Kangra Coal based on legacy issues and this will need to be thoroughly addressed if the Project hopes to get permission to go ahead and a social license to operate from its neighbouring residents and from the landowners on whose farms it hopes to operate.

In addressing the impacts of the proposed Project on its environment, Kangra Coal will need to review its past approach to community engagement and recognise land-owners on whose property it wants to mine as partners and shareholders in its proposed Project. Such an approach will ensure the appropriate degree of consideration and respect and will foster productive relationships between parties for the duration of current and possible future projects.

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Appendix A

Questionnaire

QUESTIONS	ANSWER OPTIONS				
1. Interviewer Name	Andy Spitz	Lauren Messing	Tsietsi Monare	Graeme Rodgers	
2. Household Number (from ERM database)					
3. Zone of Impact	Zone 1	Zone 2	Zone 3	Other	
4. GPS Coordinates (if available)	Latitude:		Longitude:		
5. Gender of Respondent	Male		Female		
6. Age Category of Respondent	Child (17 & Under)	Youth (18-25)	Mid (26-50)	Senior (50-70)	Elder (70+)
7. Occupation of Respondent	Attending school				
	Attending tertiary institution				
	Unemployed				
	Employed at Kangra Mine				
	Employed by another company (non-Kangra)				
	Farm worker				
	Government worker				
	Tribal authority				
	Piece work (casual labourer)				
	Own business – formal				
	Own business - informal				
	Small-scale farmer				
	Commercial farmer				
	No answer				
	Other				
8.What is the total number of people that live in this household?					
9. How many Children are there in this household, aged between 6 and 18 years of age?					
10. Of these children, how many are presently registered in school?					
Notes:					

QUESTIONS	ANSWER OPTIONS
11. What is the main source of income for your household?	Salary from employment
	Income from business
	Remittance from migrants
	Small-scale-farming
	Commercial Farming
	Informal trading
	Informal “piece work”
	Pensions
	Other state welfare grants (e.g. disability)
	No answer
	Other
12. What kind of house do you live in?	Brick / Cement
	Corrugated Iron
	Mud Brick
	Other
13. How long has your family lived on this site?	Less than 5 years
	Between 5 and 10 years
	Between 10 and 15 years
	Between 15 and 20 years
	More than 20 years
	No answer
14. Who owns the land that your house is located on?	A resident of the household
	The owner of the farm
	The local tribal authority
	A Community Trust
	Don’t know
	No answer
	Other
15. Are you aware of any graves located within or nearby your residence?	Yes
	No
	No answer
16. Is anyone in your household currently employed by Kangra Mine?	Yes
	No
	No answer
17. What is the main source of drinking water for the household	House Connection
	Stand Pipe
	Borehole or well
	Water Vendor
	Surface (River, dam, etc.)
	Bottled water (purchased)
	No answer
	Other

Notes:

<table>
<tr><th>QUESTIONS</th><th colspan="4">ANSWER OPTIONS</th></tr>
<tr><td rowspan="7">18. What is the main source of fuel for cooking, for the household?</td><td colspan="4">Metered electricity</td></tr>
<tr><td colspan="4">Pre-paid electricity</td></tr>
<tr><td colspan="4">Paraffin stove</td></tr>
<tr><td colspan="4">Wood fire</td></tr>
<tr><td colspan="4">Coal fire</td></tr>
<tr><td colspan="4">No answer</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>19. Does anyone in the household own a working cell phone?</td><td>Yes</td><td>No</td><td colspan="2">No answer</td></tr>
<tr><td rowspan="9">20. What is the most common health complaint of CHILDREN in the household?</td><td colspan="4">Diarrhoea</td></tr>
<tr><td colspan="4">Fever</td></tr>
<tr><td colspan="4">Headache</td></tr>
<tr><td colspan="4">Cough</td></tr>
<tr><td colspan="4">Colds and Flu</td></tr>
<tr><td colspan="4">Skin problems</td></tr>
<tr><td colspan="4">NOT APPLICABLE (no children)</td></tr>
<tr><td colspan="4">No answer</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td rowspan="8">21. What is the most common health complaint of ADULTS in the household?</td><td colspan="4">Diarrhoea</td></tr>
<tr><td colspan="4">Fever</td></tr>
<tr><td colspan="4">Headache</td></tr>
<tr><td colspan="4">Cough</td></tr>
<tr><td colspan="4">Colds and Flu</td></tr>
<tr><td colspan="4">Skin problems</td></tr>
<tr><td colspan="4">No answer</td></tr>
<tr><td colspan="4">Other</td></tr>
<tr><td rowspan="9">22. When you have a serious problem in your household, whom do you approach first for help?</td><td colspan="4">Local police</td></tr>
<tr><td colspan="4">Local Tribal authority</td></tr>
<tr><td colspan="4">Local civic structures</td></tr>
<tr><td colspan="4">Farm owner</td></tr>
<tr><td colspan="4">Neighbours</td></tr>
<tr><td colspan="4">Nearby relatives</td></tr>
<tr><td colspan="4">No one …</td></tr>
<tr><td colspan="4">No answer</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>23. In general, do you think that Kangra Mine has brought benefits to your community?</td><td>Yes</td><td>No</td><td>No opinion / not sure</td><td>No answer</td></tr>
<tr><td>24. In general, has Kangra Mine had a positive or negative effect on you, personally?</td><td>Positive</td><td>Negative</td><td>No effect</td><td>No answer</td></tr>
<tr><td>25. Are you aware of plans to expand Kangra Mine?</td><td>Yes</td><td>No</td><td colspan="2">No answer</td></tr>
<tr><td colspan="5">Notes:</td></tr>
</table>

QUESTIONS	ANSWER OPTIONS	
26. If “yes” to the above question, where did you first hear about the planned expansion?	Directly from Kangra Mine	
	ERM public participation events	
	Local community leaders	
	Rumours within the community	
	No answer	
	Other	
27. What are you most concerned about, regarding the proposed expansion of Kangra Mine?	Loss of access to land	
	Contamination of water sources	
	Influx of work seekers from outside	
	Noise from mining operations	
	Dust from mining operations	
	Damage to houses from underground blasting	
	Visual changes to the landscape	
	Negative impact on local tourism	
	No answer	
	Other	
28. What do you see as the main possible benefits of the expansion of operations at Kangra Mine?	No expected benefits	
	Increased local employment opportunities	
	Increased opportunities for business	
	Increased opportunities for tourism development	
	No answer	
	Other	
29. Was additional semi-structured data collected from this respondent?	Yes	No
30. Additional themes covered in narrative data	Attitudes to Kangra Mine	
	Livelihood activities	
	Services and infrastructure	
	Community structures	
	Emplacement, belonging & Identity	
	General community relations	
	Health and well-being	
	Education	
	Social problems	

Appendix B

Semi-structured qualitative guidelines

<u>Kangra Mine Expansion: ERM Social Impact Assessment Qualitative Guidelines, February 2013</u>

Note: The qualitative guideline below is intended to "get the ball rolling" on the qualitative enquiry. The questions are simply examples and may be drawn on selectively and modified, depending on the situation. Our enquiry with be refined further as our understanding of the local social environment develops and more locally-tailored and relevant questions are likely to develop from these.

Attitudes to Kangra Mine

- Perceptions of Kangra role in community development
  - *Has the development of Kangra mine been good or bad for the community? Explain*
  - *What has Kangra done, if anything, which has improved the situation for local communities?*
  - *Has Kangra done anything that has annoyed or angered local communities in the past? Explain*
- Impacts of Kangra Mine on the local community
  - *How has the development of Kangra changed life for people living close by?*
  - *Does the location of a coal mine so close to your home created any problems? Explain (pollution, safety, noise, damage from blasting …)*
- Dynamics of employment at Kangra
  - *Where do the workers at Kangra come from? Do many come from the local community?*
  - *Do you know anyone that works at Kangra? How did they get their job?*
  - *Are many people attracted from beyond the local community to seek work at Kangra? Where do they come from and how are their relations with the local communities?*

Livelihood Activities

- Range of sources of household income
  - *Can you list the range of different activities that bring income into the household on a regular basis? Approximately how much does each activity bring in, on average, on a monthly basis?*
- Role of gardening/subsistence agriculture & animal husbandry
  - *Apart from cash income, does the household grow any crops or that are consumed directly by the household? Explain (type, amount, seasonal production)?*
  - *Does anyone in the household keep any animals (cattle, goats, chickens etc.)? How do they contribute towards improving the lives of people living in this household?*
- Essential shopping patterns
  - *Where does your family usually shop for food and other essential items?*
  - *What food items do you usually buy on a monthly basis?*
- Patterns and histories of employment of household members
  - *How many people within the household are employed at the moment, including those that work far away? What work do they do? How long have they been employed for?*
- Formal sources of support (pensions, disability grants, child support etc.)
  - *Does anyone in the household receive a regular grant from the government? How important are these sources of income for the household?*
- Informal sources of support (charities, churches etc.)
  - *Does the household receive any direct support (financial or in kind) from any organizations such as churches or NGOs? If so what are the names of the organizations and where are they from?*

Services and Infrastructure

- Location and access to health facilities
    - *Where do you and members of your family go when you are ill?*
    - *How do people in this area get to hospitals when there is an emergency?*
    - *Based on your past experience, is it easy to access healthcare? What are tha challenges?*
    - *Are you satisfied with the quality of the healthcare that you have access to?*
    - *Where are babies your community generally born? At home or in the hospital?*
- Health seeking behaviour
    - *What are the major causes of ill health in the community?*
    - *Who do you approach first, when you are ill?*
    - *Do people in this community rely on traditional healers?*
    - *What are the advantages (and disadvantages) of traditional healers, compared to hospitals and clinics?*
    - *Based on your observations, what are the major illnesses that people suffer from in this area?*
- Location and access to schools
    - *Where do children from this household go to school? (Distance, location)*
    - *Are there many children in the community that do not go to school? What are the main reasons for their failure to go to school?*
    - *What are the costs associated with sending children to school (direct and indirect)?*
- Availability of electricity supply
    - *Do you have access to electricity? If so, what major electrical appliances does your household own?*
    - *Are you able to afford electricity for the whole month?*
    - *Where do you normally charge your cell phone (if have)?*
- Options for water supply
    - *Where do you get your water from?*
    - *Who, within the household is responsible for collecting water?*
    - *Are you satisfied with the quality of the water that you have access to?*
    - *Do you have access to enough water to meet your household needs? If not, what are the problems associated with having insufficient access to water?*
- Options for sanitation
    - *What kind of toilet do members of your household have access to*
    - *Does your household have its own toilet, or do you share with other households*
    - *Are there any specific problems associated with the toilet facilities that you have access to?*
- Transport options
    - *What transport options are available for members of your household to get to work, school, shops, clinics or hospitals etc?*
    - *Is transport a significant cost to the household? Explain?*

Community Structures

- Recognized community organization structures
    - *What structures are responsible for governing and administering this area? (simplify wording if necessary?)*
    - *What do you regard as the most important governing structure in this area?*
    - *How effective are local governing structures in this area?*
- Role of community structures
    - *What do you think is the role of local government, tribal authorities, civics etc?*
- Perceptions of local authorities
    - *What individual or organization is able to help you solve problems that you encounter in your household? Examples*
- Memberships of organizations (churches, political parties etc)
    - *Do you belong to any churches, clubs or organizations?*
    - *What benefit does such membership bring to you?*

Emplacement, Belonging and Identity

- Family residential history
    - *How long has your family lived here?*
    - *Is your family originally form here or did they move in from elsewhere? Explain*
    - *Do you regard this place as home? Explain*
- Historical experiences of displacement
    - *Has your family been forced to relocate in the past? Explain*
- Changing patterns of migration (motives etc.)
    - *Does your family rely going away from here to find work? Who, where, what kind of work (changes over successive generations).*
- Security of tenure
    - *On what basis do you live at this site (own, rent, sharecrop, squatter etc)*
    - *Do you have rights to live in this place? Explain*
    - *Has anyone ever tried to force you to move from this place? Explain*

General Community Relations

- Relationships between neighbors
    - *How frequently do you interact with your neighbors?*
    - *What is the nature of your interactions with neighbors? Explain*
    - *Are neighbors an important source of support during time of stress or hardship? Explain?*
- Race relations
    - *How do people of different races get along in this area? Explain*
    - *Are there any specific issues that reflect tensions around race? (simplify wording)*
- Perceptions of safety and experiences of crime
    - *Do you generally feel safe in this area?*
    - *Is the area becoming safer, less safe, or staying the same? Explain*
    - *Who can you rely on when you encounter a problem related to your safety?*
- Social problems
    - Domestic violence ….
    - Drug abuse ….
    - Teenage pregnancy …

Appendix C

Land Claims Letter

rural development
& land reform

Department:
Rural Development & Land Reform
REPUBLIC OF SOUTH AFRICA

REGIONAL LAND CLAIMS COMMISSION: MPUMALANGA PROVINCE
30 SAMORA MACHELL DRIVE, RESTITUTION HOUSE, NELSPRUIT
PRIVATE BAG X 11330
NELSPRUIT, 1200
TEL : 013 756 6000
FAX : 013 752 3859

Enq: Ms M. De Kock
Our Ref: TY Ncamphalala

Attention: SOZABILE NKUNA

LAND RESTITUTION IN TERMS OF THE RESTITUTION OF LAND RIGHTS ACT NO. 22 OF 1994

I refer to your enquiry, received on the 17 July 2012, refers.

Property Description	Comments	File number	Claim Status
Province: Mpumalanga **Magisterial District: Wakkerstroom** **Property:** ❖ **The farm Donkerhoek 14 HT** ❖ **The farm Twyfelhoek 379 IT**	❖ According to our database there is currently registered land claim which was lodged against the mentioned farms. Further verification kindly contact Ms Nomthandazo Ndlovu @ 013 756 6056 / 082 378 8467	**KRP 416** **KRP 11496**	❖ **Donkerhoek 14 HT(Portion 13,14 & 15) – Gazetted** ❖ **Twyfelhoek 379 IT - Research**

It is not within the powers of the Commission on Restitution of Land Rights to grant or withhold permission for the development or alienation in respect of land being claimed until such a claim has been gazetted, unless such development would constitute an obstruction to the achievement of the aims and objectives of the Restitution of Land Rights Act 22 of 1994. In such instances application can be made in the Land Claims Court in terms of Section 6(3) of the Restitution Act; this can be done at any stage after the claim has been lodged - even before the publishing of such a claim in terms of Section 11 of the Restitution of Land Rights Act 22 of 1994.

While the Regional Land Claims Commission: Mpumalanga
has taken reasonable care to ensure the accuracy of the above-mentioned information, the Commission cannot be held accountable if, through the process of further investigation, additional information is found that contradicts this communication.

Kind regards

MDeKock

pp **MR. LH MAPHUTHA**
ACTING : REGIONAL LAND CLAIMS COMMISSIONER: MPUMALANGA
DATE: 2012/07/18

Appendix D

Farm Title Deeds (Twyfelhoek; Kransbank; Nooitgezien; Rooikop; Donkerhoek)

Property	Owner	Deed/Document	LPI Enquiry	Interdict	Document Request	Transfers	Bulk Properties	User Admin	Billing

Property Enquiry Details

Property enquiry results for "IT, 379, 2" in the Deeds Registry at "MPUMALANGA"

FOR INFORMATION
Do not use for Construction
HATCH

090427

Property detail:

Deeds registry	MPUMALANGA
Property type	FARM
Farm name	TWYFELHOEK
Farm number	379
Portion	2 (REMAINING EXTENT)
Province	MPUMALANGA
Registration division/Administrative district	IT
Local authority	MKHONDO LOCAL MUNICIPALITY
Previous description	LG617/66
Diagram deed number	T17376/938
Extent	206.9666 H
LPI Code	T0IT00000000037900002

Title Deeds detail:

Document	Registration date	Purchase date	Amount	Microfilm reference	Document copy?
T53617/1998	19980521	19971211	R950000.00	1998 0654 3527	Yes

Owners detail:

Document	Full name	Identity Number	Share	Person Enquiry?
T53617/1998	YENDE FARMERS TRUST	113/97	-	Yes

Endorsements / Encumbrances:

Endorsement / Encumbrance	Holder	Amount	Microfilm reference	Document copy?
K2822/2001RM	ANGLO OPERATIONS LTD	-	2002 1037 1147	Yes
K3065/2001RM	ANGLO OPERATIONS LTD	-	2003 0852 2403	Yes

| Property | Owner | Deed/Document | LPI Enquiry | Interdict | Document Request | Transfers | Bulk Properties | User Admin | Billing |

Property Enquiry Details

Property enquiry results for "IT, 379, 3" in the Deeds Registry at "MPUMALANGA"

FOR INFORMATION
Do not use for Construction
HATCH

Property detail:

Deeds registry	MPUMALANGA
Property type	FARM
Farm name	TWYFELHOEK
Farm number	379
Portion	3
Province	MPUMALANGA
Registration division/Administrative district	IT
Local authority	MKHONDO LOCAL MUNICIPALITY
Previous description	PTN2-LG617/66
Diagram deed number	T20578/971
Extent	64.2399 H
LPI Code	T0IT00000000037900003

090427

Title Deeds detail:

Document	Registration date	Purchase date	Amount	Microfilm reference	Document copy?
T53617/1998	19980521	19971211	R950000.00	1998 0654 3527	Yes

Owners detail:

Document	Full name	Identity Number	Share	Person Enquiry?
T53617/1998	YENDE FARMERS TRUST	113/97	-	Yes

Endorsements / Encumbrances:

Endorsement / Encumbrance	Holder	Amount	Microfilm reference	Document copy?
INFO FROM PRETORIA DEEDS REGIS	-	-	-	Not available
IT,379,3	-	-	1987 0723 1701	Yes

E338512-2500-00-313-0085

het en dat hy in sy voornoemde hoedanigheid hierby sedeer en transporteer aan en ten gunste van -

THUTHUKANI COMMUNAL PROPERTY ASSOCIATION
REGISTRATION NR. CPA 02/0457/A
~~Hierin verteenwoordig duer LUCKY SANGWENI~~

Die se opvolgers in titel of regsverkrygendes in volle en vrye eiendom -

GEDEELTE 1 VAN DIE PLAAS TWYFELHOEK 379

Registrasie Afdeling I.T. Provinsie MPUMALANGA

GROOT: 662,5642 (SES SES TWEE komma VYF SES VIER TWEE) hektaar

AANVANKLIK GETRANSPORTEER kragtens Akte van Verdelingstransport T17375/1938 met kaart daarby aangeheg en gehou kragtens Akte van Transport T6~~4~~5217/2001

ONDERHEWIG aan die volgende voorwaardes:

A. Kragtens Notarële Akte van Sessie NR K3504/1982, gedateer 24 November 1982 en geregistreer op 17 Desember 1982, is alle Steenkoolregte tesame met alle regte tot Minerale in terme van mynregte Wet 1969, soos gewysig gesedeer aan KOBAR MINING (PROPRIETARY) LIMITED.

EN VERDER onderhewig aan sodanige voorwaardes soos in gemelde aktes vermeld is of na verwys word.

WESHALWE die Komparant afstand doen van al die regte en titel wat die genoemde-

25-44

UITVOERING — EXECUTION

PTA 002
Adams & Adams

2

TEL: 481-1500

B379/00

A. VIR AKTEKANTOOR GEBRUIK/FOR DEEDS OFFICE USE:

(a) Datum van Indiening/Date of lodgement:

FINALE BLOCKBOOK
12 SEP 2000
FINALE DAGBOEK

ONTVANG
2000-08-30
PRETORIA
RECEIVED

(b)

30-10-00

	Ondersoekers/Examiners	Kamers Rooms	Skakeling/Linking		Verwerp/Reject	Passeer/Pass
1	~~M.K. BOOYSEN~~ pidsi	249	3	1		
2						
3	T. BESTER					

B. VIR AKTEBESORGER SE GEBRUIK/
FOR CONVEYANCER'S USE:
Aard van Akte byv.: Transport, Verband, ens.
Nature of Deed e.g.: Transfer, Bond, etc.
Transport

T 0001138957 2000

Verw. No./Ref. No.:
B379/00

Skakeling/Linking	
3	1

GELYKTYDIGES/SIMULS

	Kode Code	Name van Partye/Names of Parties	Firma No. Firm No.	No. in stel/batch	Titelaktes ens. binne Titles etc. within
1	T	B/W Kemp / BJ Kemp	2	1	T.20574/71
2	T	" / Donkerhoek Trust	2	2	
3	T	" / Naalbank Trust	2	3	+2
4					
5		TEL: 5+(2)		5	
6		TEL			
7					
8		44			
9					
10					

(Kort beskrywing van eiendom (slegs para. 1 in Akte)/Brief description of property (only para. 1 in Deed))

Ged 4 (9/9 2) Twyfelhoek 379

Registrasie Versoek deur:
Registration requested by:

DATUM:
DATE:

00000752077

| Property | Owner | Deed/Document | LPI Enquiry | Interdict | Document Request | Transfers | Bulk Properties | User Admin | Billing |

Property Enquiry Details

Property enquiry results for "IT, 379" in the Deeds Registry at "MPUMALANGA"

Property detail:

Deeds registry	MPUMALANGA
Property type	FARM
Farm name	TWYFELHOEK
Farm number	379
Portion	0 (REMAINING EXTENT)
Province	MPUMALANGA
Registration division/Administrative district	IT
Local authority	MKHONDO LOCAL MUNICIPALITY
Previous description	LG617/66
Diagram deed number	DB324/30
Extent	993.8569 H
LPI Code	T0IT00000000037900000

LT4960

Title Deeds detail:

Document	Registration date	Purchase date	Amount	Image Scanned reference	Document copy?
T53617/1998	19980521	19971211	R950000.00	20090312 14:27:43	Yes

Owners detail:

Document	Full name	Identity Number	Share	Person Enquiry?
T53617/1998	YENDE FARMERS TRUST	113/97	-	Yes

Endorsements / Encumbrances:

Endorsement / Encumbrance	Holder	Amount	Image Scanned reference	Document copy?
K124/1967RM	-	-	20010101 12:06:14	Yes
INFO FROM PRETORIA DEEDS REGIS	-	-	-	Not available
IT,379	-	-	1987 0723 1692	Yes

E338512-2500-00-313-0082

en genoemde Komparant het verklaar dat sy Prinsipaal waarlik en wettig verkoop het, en dat hy, in sy voornoemde hoedanigheid hierby in volle en vrye eiendom sedeer en transporteer aan en ten gunste van

DIE TRUSTEES VAN TYD TOT TYD
VAN DIE
YENDE FARMERS TRUST
I TRUSTNOMMER : 113/97

diese Ampsopvolgers of Regverkrygendes

1. **RESTERENDE GEDEELTE VAN DIE PLAAS TWYFELHOEK 379 REGISTRASIE AFDELING I.T., PROVINSIE VAN MPUMALANGA**
   GROOT : 993,8569 (NEGE HONDERD DRIE EN NEGENTIG KOMMA AGT VYF SES NEGE) HEKTAAR
   AANVANKLIK OORGEDRA KRAGTENS GRONDBRIEF MET KAART WAT DAAROP BETREKKING HET GEDATEER 27 DESEMBER 1866 EN GEHOU KRAGTENS AKTE VAN TRANSPORT T59329/1981

ONDERHEWIG AAN die volgende voorwaardes :

1. **ONDERHEWIG** aan 'n voorbehoud van alle regte tot steenkool ten gunste van die AFRICAN AND EUROPEAN INVESTMENTS COMPANY LIMITED soos meer ten volle sal blyk uit Akte van Sessie 124/1967R.M.

EN VERDER ONDERHEWIG aan al sodanige voorwaardes as in gemelde Akte vermeld staan of na verwys word.

2. **GEDEELTE 3 ('N GEDEELTE VAN GEDEELTE 2) VAN DIE PLAAS TWYFELHOEK 379**
   REGISTRASIE AFDELING I.T., PROVINSIE VAN MPUMALANGA
   GROOT : 64,2399 (VIER EN SESTIG KOMMA TWEE DRIE NEGE NEGE) HEKTAAR
   AANVANKLIK OORGEDRA KRAGTENS AKTE VAN TRANSPORT T20578/1971 MET KAART DAARAAN GEHEG EN GEHOU KRAGTENS AKTE VAN TRANSPORT T59329/1981

WERKSMANS ATTORNEYS
155 - 5th Street
Sandown
Sandton 2196

SEELHED ....
STAMP DUTY
FOOI R200.00
FEES

Prepared by me

CONVEYANCER
JOHANNES L R

DEED OF TRANSFER

T 001131 04

BE IT HEREBY MADE KNOWN THAT

~~HESTER MARGARETHA DIOTI~~ ELNA OOSTHUYSEN

appeared before me, REGISTRAR OF DEEDS at PRETORIA, he the said Appearer being duly authorised thereto by a Power of Attorney signed at SANDTON on 27 November 2003 and granted to him by

KANGRA GROUP (PROPRIETARY) LIMITED
No. 1957/003935/07

VENETIA
2004 -01- 23
CAPTURER

MAGGY
2004 -01- 24
VERIFIED

UITVOERING – EXECUTION

A. VIR AKTEKANTOOR GEBRUIK/FOR DEEDS OFFICE USE:

(a) Datum van indiening/Date of lodgement:

FINAL BLACKBOOK
2004 -01- 13

LODGED
18 DEC 2003
PRETORIA DEEDS
INGEDIEN

(b)

FINAL BL

MUST BE REGISTERED BY
2004 -01- 12

31/03/04

	Ondersoekers/Examiners	Kamers Rooms	Skakeling/Linking		Verwerp/Reject	Passeer/Pass
1	GERTY BOKABA	A26	3	3		✓
2	H. G. GLUTZ					✓
3						

B. VIR AKTEBESORGER SE GEBRUIK/ FOR CONVEYANCER'S USE:

Aard van Akte byv.: Transport, Verband, ens.
Nature of Deed e.g.: Transfer, Bond, etc.

Transfer

T 001131 04

Verw. No./Ref. No.:
W 515

Skakeling/Linking	
3	3

GELYKTYDIGES/SIMULS

	Kode Code	Name van Partye/Names of Parties	Firma No. Firm No.	No. in stel batch	Titelaktes ens. binne Titles etc. within
1	T 1	Kangra Graphite / Kangra Coal	165	1	with No 1
2	T	" / "	165	2	
3	T 1	" / "	165	3	of batch.
4					
5					
6					
7					
8					
9					
10					
11					
12					

(Kort beskrywing van eiendom (slegs para. 1 in Akte)/Brief description of property (only para. 1 in Deed))

Ptn 1 farm Rooikop 18 [illegible]

Registrasie Versoek deur:
Registration requested by:

DATUM:
DATE:

000002411082

UITVOERING - EXECUTION

A. VIR AKTEKANTOOR GEBRUIK / FOR DEEDS OFFICE USE:

(a) Datum van indiening / Date of lodgement:

LODGED
11 JUN 2004
2004-06-01
PRETORIA DEEDS
INGEDIEN

(b)

MUST BE REGISTERED BY
21 JUN 2004
MOET GEREGISTREED WEES TEEN

30/6/04

	Ondersoekers / Examiners	Kamers Rooms	Skakeling / Linking		Verwerp / Reject	Passeer / Pass
1	A.S. BADENHORST		/	/		
2	M.J. MAMABOLO	A788				
3						

B. VIR AKTEBESORGER GEBRUIK / FOR CONVEYANCER'S USE:
Aard van Akte byv.: Transport, Verband, ens.
Nature of Deed e.g.: Transfer, Bond, etc.
Transfer

T 78816 04

Verw. Nr. / Ref No.: ZW 6665

Skakeling / Linking	
/	/

R/E Form Rooikop no 18

(Kort beskrywing van eiendom (slegs para. 1 in Akte) / Brief description of property (only para. 1 in Deed))

	Kode Code	Name van Partye / Names of Parties Coal	Firma Nr. Firm No.	No. in stel / batch	Titelaktes ens. binne Titles etc. within
1	T	Kangra Group/Kangra	92	1	T 138039/99
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					

HANDED IN FOR EXECUTION
11 JUN 2004
PRETORIA
INGEDIEN VIR UITVOERING

000003001356

UITVOERING — EXECUTION

A. VIR AKTEKANTOOR GEBRUIK/FOR DEEDS OFFICE USE:

(a) Datum van indiening/Date of lodgement:

LODGED
18 DEC 2003
PRETORIA DEEDS
INGEDIEN

FINAL BLACKBOOK

(b)

MUST BE REGISTERED BY
2004-01-12

31/03/04

	Ondersoekers/Examiners	Kamers Rooms	Skakeling/Linking		Verwerp/Reject	Passeer/Pass
1	GERTY BOKABA	A220				
2			3	1		
3	~~H. C. GLUTZ~~					

B. VIR AKTEBESORGER SE GEBRUIK/
FOR CONVEYANCER'S USE:
Aard van Akte byv.: Transport, Verband, ens.
Nature of Deed e.g.: Transfer, Bond, etc.

Transfer

T 001129 04.

Verw. No./Ref. No.:

W 411

Skakeling/Linking	
3	1

GELYKTYDIGES/SIMULS

	Kode Code	Name van Partye/Names of Parties	Firma No. Firm No.	No. in stel/batch	Titelaktes ens. binne Titles etc. within
1	T	Kangra Group / Kangra Coal	165	1	
2	T	" / "	165	2	T 18210/98
3	T	" / "	165	3	
4					
5					
6					
7					
8					
9					
10					
11					
12					

Registrasie Versoek deur:
Registration requested by:

DATUM:
DATE: 7/1

000002411080

UITVOERING — EXECUTION

A. VIR AKTEKANTOOR GEBRUIK/FOR DEEDS OFFICE USE:

(a) Datum van indiening/Date of lodgement:

LODGED

18 DEC 2003

INGEDIEN

FINAL BLACKBOOK

(b)

MUST BE REGISTERED BY

2004-01-12

31/03/04

	Ondersoekers/Examiners	Kamers Rooms	Skakeling/Linking		Verwerp/Reject	Passeer/Pass
1	GERTY BOKABA	R226	3	2		
2	H. G. GLUTZ					
3						

B. VIR AKTEBESORGER SE GEBRUIK/
FOR CONVEYANCER'S USE:
Aard van Akte byv.: Transport, Verband, ens.
Nature of Deed e.g.: Transfer, Bond, etc.

Transfer

T 001130 04

Verw. No./Ref. No.:

W 512

Skakeling/Linking	
3	2

GELYKTYDIGES/SIMULS

	Kode Code	Name van Partye/Names of Parties	Firma No. Firm No.	No. in stel/batch	Titelaktes ens. binne Titles etc. within
1	T	Kangra Group / Kangra Coal	165	1	with No 1 of batch.
2	T	" / "	165	2	
3	T	" / "	165	3	
4					
5					
6					
7					
8					
9					
10					
11					
12					

(Kort beskrywing van eiendom (slegs para. 1 in Akte)/Brief description of property (only para. 1 in Deed))

Ptn 2 (Ptn of Ptn 1) Naudesbank 381

Registrasie Versoek deur:
Registration requested by:

DATUM:
DATE:

00002411081

SPECIFIED
STAMP DUTY R55-00
FOOI
FEES

WERKSMANS ATTORNEYS
155 - 5th Street
Sandown
Sandton 2196

Prepared by me

CONVEYANCER
KEW B M

T 036896 /06

DEED OF TRANSFER

BE IT HEREBY MADE KNOWN THAT

YOLANDA VILJOENS

appeared before me, REGISTRAR OF DEEDS at PRETORIA, he the said Appearer being duly authorised thereto by a Power of Attorney signed at SANDTON on 27 January 2006 and granted to him by

KANGRA GROUP (PROPRIETARY) LIMITED
No. 1957/003935/07

LETTA
2006 -04- 08
CAPTURED

UITVOERING - EXECUTION

A. VIR AKTEKANTOOR GEBRUIK / FOR DEEDS OFFICE USE:

WEAVIND & WEAVIND INC
Tel. 346-3096

(a) Datum van indiening / Date of lodgement:

LODGED
15 MAR 2006
PRETORIA DEEDS
INGEDIEN

(b)

	Ondersoekers / Examiners	Kamers Rooms	Skakeling / Linking		Verwerp / Reject	Passeer / Pass
1	Zahira B. Rahman					
2						
3						

B. VIR AKTEBESORGER GEBRUIK / FOR CONVEYANCER'S USE:
Aard van Akte byv.: Transport, Verband, ens,
Nature of Deed e.g.: Transfer, Bond, etc.
Transfer

T 036896 /06

Verw. Nr. / Ref No.
ZW37038

Skakeling / Linking	
/	/

	Kode Code	Name van Partye / Names of Parties	Firma Nr. Firm No.	No. in stel / batch	Titelaktes ens. binne Titles etc. within
1	T	Kangra Group / Kangra Coal	92	1	T 18210/98
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

010004653754

(Kort beskrywing van eiendom (slegs para. 1 in Akte) / Brief description of property (only para. 1 in Deed))

R/E Farm Nooitgedacht 381

Property	Owner	Deed/Document	LPI Enquiry	Interdict	Document Request	Transfers	Bulk Properties	User Admin	Billing

Property Enquiry Details

Property enquiry results for "HT, 15, 2" in the Deeds Registry at "MPUMALANGA"

FOR INFORMATION
Do not use for Construction
HATCH

Property detail:

Deeds registry	MPUMALANGA
Property type	FARM
Farm name	KRANSBANK
Farm number	15
Portion	2
Province	MPUMALANGA
Registration division/Administrative district	HT
Local authority	SEME LOCAL MUNICIPALITY
Previous description	-
Diagram deed number	T21311/980
Extent	661.2056 H
LPI Code	T0HT00000000001500002

1078-53 +

Title Deeds detail:

Document	Registration date	Purchase date	Amount	Microfilm reference	Document copy?
T139369/2000	20001110	20000920	R100000.00	2000 1172 3094	Yes

Owners detail:

Document	Full name	Identity Number	Share	Person Enquiry?
T139369/2000	EKALUKA COMMUNAL PROP ASSOCIATION	-	-	Yes

Endorsements / Encumbrances:

Endorsement / Encumbrance	Holder	Amount	Microfilm reference	Document copy?
K895/1989RM	STRYDOM MARTHA SOPHIA KOLBE	-	1989 0798 0115	Yes
			1986 0157	

UITVOERING – EXECUTION

KEMP & DE BEER
38
TEL: (012) 21-1105

A. VIR AKTEKANTOOR GEBRUIK/FOR DEEDS OFFICE USE: Nie registreer
(a) Datum van Indiening/Date of lodgement: 10/11/2000
Baulcher

(b)

31/12/2000

	Ondersoekers/Examiners	Kamers Rooms	Skakeling/Linking		Verwerp/Reject	Passeer/Pass
1	K.P. MTHOMBENI	106	1	1		
2						
3	AMY BOTHA	254				

B. VIR AKTEBESORGER SE GEBRUIK/ FOR CONVEYANCER'S USE:
Aard van Akte byv.: Transport, Verband, ens.
Nature of Deed e.g.: Transfer, Bond, etc.
Transport

T 000139369 / 2000

Verw. No./Ref. No.: D643

Skakeling/Linking: 1 | 1

GELYKTYDIGES/SIMULS

	Kode Code	Name van Partye/Names of Parties	Firma No. Firm No.	No. in stel/batch	Titelaktes ens. binne Titles etc. within
1	T	De Villiers / The Ekaluka	38	1	T 16193/89
2					
3					
4					
5		FEES OK:			
6					
7					
8					
9					
10					
11					
12					
13					

000000063261

REGISTRASIE ... / REGISTRY ... DATUM: DATE:

(Kort beskrywing van eiendom (slegs para. 1 in Akte)/Brief description of property (only para. 1 in Deed))

R/G, Ged. 1 & Ged 2 Kransbank 15 H.T.

PROD DEEDS REGISTRATION SYSTEM - MPUMALANGA DATE : 20110721 TIME : 13:25:42.2 PAGE : 1
PREPARED BY : DRS01380 - MUILA KS

PICKING SLIP NR : 1616613
FIRM FILE NR... : PREP

PROPERTY DETAILS PRINT FOR PORTION 2
FARM NO 15
REG DIV HT

PROVINCE	MPUMALANGA
PREV DESCRIPTION	
DIAGRAM DEED NO	T21311/980
EXTENT	661.2056 H
CLEARANCE	SEME LOCAL MUNICIPALITY
FARM NAME	KRANSBANK

NO INTERDICTS

DOCUMENTS	HOLDER & SHARE	AMOUNT	O/P/A	SCAN/MICRO REF	MMDD
K895/1989RM	STRYDOM MARTHA SOPHIA KOLBE	R0.00		19890101043747	
HT,15,2				19860101010330	
INFO FROM PRETORIA DEEDS REGIS					0630

OWNER DETAILS

FULL NAME & SHARE	PURCH DATE	AMOUNT/REASON	O/P/A	IDENTITY	TITLE DEED	MMDD	SCAN/MICRO REF
EKALUKA COMMUNAL PROP ASSOCIATION					T139369/2000	1110	20000101163057
	20000920	R100000.00	P				

* O/P/A - O - MULTIPLE OWNER P - MULTIPLE PROPERTY A - MULTIPLE OWNER AND PROPERTY

** PLEASE NOTE : THE INFORMATION APPEARING ON THIS PRINTOUT IS FURNISHED FOR PURPOSES OF INFORMATION ONLY.
FOR MORE DETAILED INFORMATION, PLEASE REFER TO THE REGISTERED SOURCE DOCUMENTS.

* * * END OF REPORT * * *

| Property | Owner | Deed/Document | LPI Enquiry | Interdict | Document Request | Transfers | Bulk Properties | User Admin | Billing |

Property Enquiry Details

Property enquiry results for "HT, 14, 4" in the Deeds Registry at "MPUMALANGA"

FOR INFORMATION
Do not use for Construction
HATCH

mpl = 110607-C34534

Property detail:

Deeds registry	MPUMALANGA
Property type	FARM
Farm name	DONKERHOEK
Farm number	14
Portion	4 (REMAINING EXTENT)
Province	MPUMALANGA
Registration division/Administrative district	HT
Local authority	SEME LOCAL MUNICIPALITY
Previous description	-LG656/63
Diagram deed number	T6660/906
Extent	337.6421 H
LPI Code	T0HT00000000001400004

Title Deeds detail:

Document	Registration date	Purchase date	Amount	Microfilm reference	Document copy?
T102893/2005	20050815	20041129	R600000.00	2006 0163 0286	Yes

Owners detail:

Document	Full name	Identity Number	Share	Person Enquiry?
T102893/2005	UKUCHUMA FARMING PTY LTD	200300354507	-	Yes

Endorsements / Encumbrances:

Endorsement / Encumbrance	Holder	Amount	Microfilm reference	Document copy?
B114604/2005	FIRSTRAND BANK LTD	R500000.00	2006 0163 0321	Yes
	ANGLO		2002 1037	

E338512-2500-00-313-0061

Property	Owner	Deed/Document	LPI Enquiry	Interdict	Document Request	Transfers	Bulk Properties	User Admin	Billing

Property Enquiry Details

Property enquiry results for "HT, 14, 22" in the Deeds Registry at "MPUMALANGA"

FOR INFORMATION
Do not use for Construction
HATCH

MPL-110607-090512

Property detail:

Deeds registry	MPUMALANGA
Property type	FARM
Farm name	DONKERHOEK
Farm number	14
Portion	22
Province	MPUMALANGA
Registration division/Administrative district	HT
Local authority	SEME LOCAL MUNICIPALITY
Previous description	PTN11-LG656/63
Diagram deed number	T9851/954
Extent	53.4062 H
LPI Code	T0HT00000000001400022

Title Deeds detail:

Document	Registration date	Purchase date	Amount	Image Scanned reference	Document copy?
T52059/1999	19990511	19980811	R1091000.00	20061122 07:27:42	Yes

Owners detail:

Document	Full name	Identity Number	Share	Person Enquiry?
T52059/1999	CORNEELS GREYLING TRUST	7036/1994	-	Yes

Endorsements / Encumbrances:

Endorsement / Encumbrance	Holder	Amount	Microfilm reference	Document copy?
HT,14,22	-	-	1986 0157 2133	Yes
INFO FROM PRETORIA DEEDS REGIS	-	-	-	Not available

Appendix E

Curriculum Vitae of Specialists

ANDREA SPITZ – CURRICULUM VITAE

PERSONAL DETAILS

SOUTH AFRICAN

FEMALE

BORN 1965

Andy Spitz is a highly experienced social impact assessment consultant and documentary filmmaker who has worked across Africa, parts of the Middle East, Europe and Asia Pacific for the past 17 years.

CURRENT POSITIONS

Senior Social Consultant undertaking socio-economic impact assessments, livelihood analyses, stakeholder engagement, management plan development, risk assessments and managing social teams. She works closely with biophysical and other specialists to ensure the full range of environmental/social information is incorporated into the SIAs and is accessibility to affected stakeholders through video and alternative visual methods during ESHIA feedback processed. Since 2006 most of Andy's work has been on projects applying IFC Performance Standards.

Documentary film Producer and Director focusing on social justice, historical, political, environmental and gender issues.

EDUCATION

BA DRAMATIC ART (HONS) 1984-1987

AWARDED A FULLBRIGHT SCHOLARSHIP 1989

MPhil – ENVIRONMENTAL SCIENCES (*cum laude)* 1994-1995

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Swaziland, Lesotho, Namibia, Botswana, Ghana, Burkina Faso, Angola

Iran, Sweden, Papua New Guinea

Germany, Italy, Lithuania, UK

SELECTED PROFESSIONAL EXPERIENCE

INDEPENDENT CONSULTING EXPRERIENCES

ERM Consulting **2013**
Lead Social Consultant for an SIA on a coal project in **South Africa**

Synergy Global Consulting **Nov 2012 – March 2013**
Co-Facilitator for international oil and gas company's internal online Social Impact Management Pilot Training Course. Participant from across all regions of the company

ERM Consulting **2012**
Lead Social Consultant – Risk Assessment for a transport route for mining activities in Limpopo

Gold Mining Company **2012**
One of several consultants developing a Strategic Social Management Plan for a multi national miner operating in Tanzania and other east African countries

ERM Consulting **2012**
Lead Social Consultant - Stakeholder Engagement and Social Impact Assessment for a port development in **Ghana**

ERM Consulting UK/SA **2011**
Senior social scientist undertaking a livelihood study in a small village in **Angola**, with emphasis on gender and resettlement.

ERM Consulting Australia **2010**
Team Leader for stakeholder engagement on a LNG project in **Papua New Guinea**. Disseminating information about the construction of a 750km gas pipeline through the forest and under the bay of Papua New Guinea.
I was contracted for a year but after 3 months withdrew from the Stakeholder Engagement team and the project as a whole based on concerns about the approach to community/village engagement processes and content.

ERM Consulting UK **2009/10**
Lead social consultant on an Environmental Impact Assessment to IFC Performance Standards for a proposed Iron Ore mining project in rural northern **Sweden**. Following an audit of the local impact assessment I was responsible to draw up a plan to ensure appropriate social research and engagement was undertaken to meet Equator Principles and IFC Performance Standards, which are stricter on social issues than Swedish regulations require. This included developing a full SIA with appropriate levels of stakeholder consultation and including health impacts into the SIA; an indigenous people's study and plan; basic RAP for a very small resettlement programme. I also developed a framework for the client's communication procedure.

Afrisearch Consulting **2009**
Editing and reversioning of Gender Mainstreaming Toolkit for Limpopo Department of Water and National Department of Water Affairs for accessibility to stakeholders.

ERM Consulting RSA **2006/8**
Co-ordinated the public involvement process and was lead social consultant on the SHIA and Management Plans for the ESHIA of the a mine and power plant project in **Botswana**. This project was the first ESHIA applying IFC Performance Standards 2006. My role included field research for the baseline and social impact assessment; overall co-ordination and facilitation of the Stakeholder Engagement process and the development of the PCDP; review of the Health Impact Assessment and the development of Management Plans from these aspects.

As a component of active, participatory and accessible stakeholder engagement in a project of this complexity I also produced and co-directed a video in Setswana summarising the ESHIA for access by local stakeholders. This included my review and scripting of all specialist studied into key baseline information and impacts and filming some visual aspects of the project that would work to illustrate these impacts. Interviews with local residents; local to national authorities and various specialists were key components of the video summary which was screened as part of the feedback process in villages and at the national authorities' levels.

ERM Consulting UK **2005**
Ran Public Involvement women's meetings in rural Iranian villages as part of a Social Impact Assessment on a proposed mining project in western **Iran**. The meetings were held over two stages (September 2005 and December 2005). I was involved in scoping of issues and identification of key impacts. I created a short video that allowed men and women in their separate meetings to transparently see what issues had been raised in other meetings and the responses that the project team had provided. The project was stopped partly due to stakeholder resistance to project design and placement of tailings facilities.

AICC **2003-2005**

Project Manager for Public Involvement and Social Impact Assessment for a proposed gold mine in the New Abirem District of **Ghana**. Worked with Dr Agymang-Mensah and a local team or researchers. Report was developed in keeping with World Bank Safeguards relating to environmental assessments, involuntary resettlement, indigenous peoples, cultural property, local capacity building and economic development. The project was undertaken in English and local dialects.

De Beers Group, Premier Mine **2002**
Worked with Dr Graeme Rodgers to design, implement and report back on a research study of "Community Attitudes to Development Priorities in the Cullinan/Refilwe Area" in **South Africa**. Study included qualitative interviews and a quantitative survey of approximately 200 respondents (Study was undertaken with Dr Graeme Rodgers).

Coastal Environmental Services **2000 - 2002**
Worked as part of a team of social and environmental scientists contracted to conduct Social Impact Assessments and Resettlement Plan to World Bank Safeguard policies (particularly environmental assessments, involuntary resettlement and cultural property) for the proposed titanium mining projects in Gaza Province and Nampula, **Mozambique**, and Moma.

Anglo American Corporation **2001**
Undertook the writing up of a Social Impact Assessment on the proposed Konkola mine project, **Zambia**, based on updating previous SIA work on the project and assessing impacts and recommending action plans.

Institute of Natural Resources **2000**
Undertook an audit via video documentation of the pre-resettlement and resettlement phase of an aspect of the Maguga Dam development, **Swaziland**. This footage formed part of fine tuning a Social Monitoring Plan developed by the INR and UCT's Environmental Evaluation Unit. It also highlighted where expectations of impacts and mitigation has been inconsistent with realities on the ground.

Anglo American Corporation **1999**
Prepared comprehensive reports describing the social environments of four mine license areas on the **Zambian** Copperbelt and the development of Social Management Plans for each mine area. Developed a preliminary "Resettlement Action Plan" for two affected villages in one of the mine areas. The report was developed to World Bank standards and used in support of a successful application for financial support from the International Finance Corporation (IFC) (project conducted with Dr Graeme Rodgers).

FULL TIME CONSULTING POSITION

SRK Consulting Engineers (Senior Social Scientist) **1997-1999**

Selected projects Tigen Social Impact Assessment and Video; (Billiton) Mozambique **1997-2000**

This project was the first known to use video as a feedback tool in illiterate communities. It used English, Portuguese and was simultaneously presented in Macua. The video involved my summarizing key aspects of all the specialist reports and translating these into visual images. The baseline social research and ethnobotanical study were also undertaken with video as a documentation tool.

Belahourou Gold Feasibility Study; (BHP/Resolute JV) Burkina Faso **1999**

Moma Titanium Scoping Study; (Kenmare) Mozambique **1999**

Taparko High River Gold Scoping Study; (HRG) Burkina Faso **1998**

Palabora Mining Company Closure Planning; (PMC) RSA **1998**

DOCUMENTARY FILM DIRECTING AND CAMERA (Selected work)

Attachment Made Visible (ongoing) 2011 -

Producer/Director/Cinematographer on a film project exploring the development of relationships between infants and their primary nurturers for a year. The film will be used in various forms for education of psychologists/social workers and others dealing with nurturer/infant relationships and for new parents. Filmed weekly with each infant and nurturer the project is developing a baseline of intimate footage across race, culture, language and class watching how attachment develops and hoping to intervene in the development of more healthy generations in the future.

Two child/caregiver groups have been filmed over a 1 year period to date and a second group of participants is planned for 2013.

Heritage and Roots 2011

Producer, Director, Cinematographer for internal video for induction of McKinsey Consulting worldwide partners. The video presented an overview of history and heritage and the future potential of Africa in the global economy.

Rhinos Under Threat 2011

Cinematographer and assistant director of a video for the UN's CITES (International Convention on the Trade in Endangered Species). The video explores the situation in Swaziland and South Africa and follows the trade to Vietnam. The film was launched at the Rio+20 summit 2012.

Diversity Video 2011

Conceptualised, shot and edited a corporate video exploring diversity issues within a multi-national management consulting company – pushing staff across all levels and roles in the organization to be aware of and actively engage in issues of diversity in the organization.

We are nowhere 2010

Filmed and direct a 60 min documentary over a two year period, following people affected by the xenophobic violence in South Africa in 2008. This film presents the views of both non-national migrants as well as South Africans who were ordinary residents; bystanders or perpetrators of the violence. The film explores views as well as issues around government service delivery among a more complex set of issues. The film was first screened at the Tri-Continental Film Festival, focusing on Human Rights, in South Africa in October 2010.

Where is Kovno? (Director and Camera) **2009**

An experimental film following the process of production of a textile art and sound installation for the Kaunas Textile Biennale in Lithuania in October 2009. The film will be used as part of the installation when it returns to South Africa in 2010.

Forced Sterilization Of HIV+ Women (Camera person) **2009**

An investigative piece exploring the sterilization of HIV+ women without their informed consent. The film is shot in KwazuluNatal and Namibia.

WHO DO YOU THINK YOU ARE – Jonathan Shapiro (Director and camera) **2009**

An Episode of SABC's version of the BBC series. 48 minute episode tracing the ancestry of Jonathan

Shapiro (Zapiro) the controversial South African cartoonist from South Africa, through Scotland, Germany to Lithuania.

WHO DO YOU THINK YOU ARE – Nthati Moshesh (Director and camera) **2008/9**

An Episode of SABC's version of the BBC series. 48 minute episode tracing the ancestry of Nthati Moshesh, a South African actress who is the great great granddaughter of King Moshoeshoe I of the Bashotho.

"Corrective Rape" (camera and facilitator) **2009**

Researched and set up shoot for Action Aid (international aid organization) to make a film component for their campaign focusing international attention on so-called "corrective rape" (the rape of lesbians to "turn them straight"). Filmed interviews in Johannesburg with victims of such rapes as well as with people on the streets to capture a variety of attitudes towards this "practice".

In Our Blood (Director, camera person) **2004-present**

A feature length documentary of oral histories of mining across South Africa and its neighbouring states. The final product will include an archive of oral histories. The film includes interviews with CEOs (eg AngloGold Ashanti, Shanduka) underground miners and family members, and will be narrated by Cyril Ramaphosa.

Angels on our shoulders (Producer, Director and Camera) **2008**

A 24 min film looking at trauma amongst children and teachers fat the Rand Airport Displacement Shelter following xenophobic attacks in areas around Germiston and Primrose. It looks at "victims teaching victims" and the resilience of humans in the face of extreme trauma. Premiered at the Berlin International Film Festival and has shown around the world. Awarded the African Art Institute film award for 2010.

Mmamabula ESHIA Video Summary **(**Producer and co-director) **2007**

A visual summary of the Mmamabula Energy Project (Coal Mine) Environmental Social Health Impact Assessment used for public disclosure in English and Setswana in Botswana.

Oprah Winfrey Academy for Girls (Camera) **2006**

Camera person and unit director for components of the Oprah Winfrey CBS Special on the building of her school and the girls who were, and were not selected to attend.

Hot Wax (Director, camera and sound) **2003-2004**

This 48 minute social exploration was part of a series of 13 films commissioned by the SABC as part of a 10 Years of Democracy series. The film premiered at the Berlin International Film Festival and screened in Toronto; Nyon; Cannes and Rio as well as locally and in several other countries. It is a story about a black beautician and her predominantly wealthy white clients and their relationships over the past 30 years.

I Will Not Go Gently (Co-director and sound) **2003**

A 26 minute documentary for SABC3 about an elderly white woman's courage and tenacity in continuing to live in a residential hotel in Hillbrow occupied mainly by pimps, prostitutes and drug dealers.

Voices Across the Fence (Director and camera person) **2000-2002**

A 26 minute documentary for etv which recorded and screened video messages between Mozambican refugees living in Bushbuck Ridge, South Africa, and their families in the Massingir District of Mozambique. The documentary included English, Shangaan and Portuguese. Shot over 2 years during which return visits across the border were undertaken with messages between participants. This documentary has been screened locally and internationally.

Xenophobia (Director) **2001**

This Public Service Announcement was a 30 second advert for the Human Rights Commission of South Africa, raising awareness of Xenophobia in the country. It was awarded the Best Grassroots Advert in the Vuka Awards.

ACADEMIC PUBLICATIONS

"Video messaging in Contexts of Forced Migration: 'Amplifying' Social relatedness across the Mozambique-South Africa Border" in A. Grossman and A. O'Brien (eds.) *Projecting Migration: Transcultural Documentary Practice*, (book and DVD-ROM), Wallflower Press, 2007. (co-authored with Dr Graeme Rodgers)

ACADEMIC PANELS AND TEACHING WORK

2009 Filmmaker and guest speaker on documenting xenophobia and citizen filmmaking and activism – University of Oriental Studies, Naples, Italy

2009 Panelist and filmmaker - European Conference of African Studies, Leipzig – "Visualising Migration, Exclusion, and Representation in South Africa"

2008 Panelist and filmmaker – Unisa - Towards problematising xenophobia: understanding its complexities

2006 Guest Lecturer, Washington State University, Seattle – "Architectural and Cinematic Spaces"

2004/5 Occasional Tutor in Documentary Film, University of the Witwatersrand

2004/5 Camera tutor and cinematographer for the Gay & Lesbian Filmfestival "Out in Africa" Documentary workshop and short film productions

Volume III Annex C.7

Soil and Agricultural Impact Assessment Report

Version 5.0

May 2013

Document Ref.	Prepared By	Reviewed By	Date Submitted to Kangra Coal for Review
0120258_V5.0_SAIA	Garry Patterson – Agricultural research Council (ARC)	Dieter Rodewald	May 2013

CONTENTS

LIST OF ACRONYMS

Abbreviation	Full Definition
ARC-ISCW	ARC-Institute for Soil, Climate and Water
CARA	Conservation of Agricultural Resources Act
DAFF	Department of Agricultural, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEDET	Department of Economic Development, Environment and Tourism
DMR	Department of Minerals and Resources
DWA	Department of Water Affairs
EAP	Environmental Assessment Practitioner
ERM	Environmental Resources Management Southern Africa (Pty) Ltd.
ESIA	Environmental and Social Impact Assessment
MPRDA	Mineral and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NEMWA	National Environmental Management Waste Act
NWA	National Water Act
SAIA	Soil and Agricultural Impact Assessment
SALA	Subdivision of Agricultural Land Act

1 INTRODUCTION

1.1 TERMS OF REFERENCE

Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) were appointed by Kangra Coal (Pty) Ltd. (Kangra Coal) to undertake the function of independent Environmental Assessment Practitioner (EAP) and undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Kusipongo Resource Expansion Project (the proposed Project) and compile an associated Environmental and Social Management Plan. The ESIA is been undertaken as the proposed Project requires the following environmental authorisations/licenses:

- **Mining Rights** from the Regional (Mpumalanga) Department of Minerals and Resources (DMR) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA).

- **Environmental Authorisation** from the Regional (Mpumalanga) Department of Economic Development, Environment and Tourism (DEDET) in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA).

- **Waste License** from the National Department of Environmental Affairs (DEA) in terms of the National Environmental Management Waste Act (No. 59 of 2008) (NEMWA).

- **Water Use Licenses** from the National Department of Water Affairs (DWA) in terms of the National Water Act (No. 36 of 1998) (NWA).

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by ERM to undertake a Soil and Agricultural Impact Assessment for the proposed Project. The purpose of the investigation is to assess soil characteristics and general agricultural potential in the proposed Project Site and to develop a Soil and Agricultural Impact Assessment (SAIA) Report (this report).

1.2 PROJECT BACKGROUND

Kangra Coal is considering expanding their coal mining operations at the Savmore Colliery, located within the Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities (which form part of the Gert Sibane District Municipality) in Mpumalanga, which is approximately 51km west-south-west from Piet Retief and 64km south east from Ermelo (refer to Figure *1.1*). This expansion is proposed to include the Kusipongo coal resource, situated to the west of existing operations. The proposed Project will be restricted to underground mining; however, surface infrastructure to support this underground expansion will include (*Figure 1.2*):

- **A Main Mine Adit (Adit A) –** entrance to the proposed underground mine which is inclined and through which people, equipment and coal will pass. The Adit A footprint will also include offices, workshops, stores, change house, silos, etc.

- **A Ventilation Shaft (Adit B) –** an adit used solely for ventilation intake. Adit B will include only a ventilation opening. Access to the underground working via this ventilation opening will be restricted by the installation of a metal grid that will prevent access by humans and animals. Adit B will require approximately 500m^2. Fresh air drawn in through this Adit will be returned directly to the main exhaust fans at Adit A.

- **An Overland Conveyor System –** this system will be approximately 8.4 km in length with a servitude width of 32m, and will be used to transport coal from the underground operations at the proposed Adit A to the existing Maquasa West Adit conveyor system. This in turn will transport mined coal to the existing wash plant facilities at the Savmore Colliery.

- **A Temporary Construction Camp –** to provide accommodation for semi-skilled and skilled workers and supervisory workers during the construction phase of the proposed Project, provisionally located 6 km away (towards the east) from the proposed site for the Main Mine Adit A along the extension of the D2548. This will be decommissioned at the end of the construction phase.

Figure 1.1 Project Locality

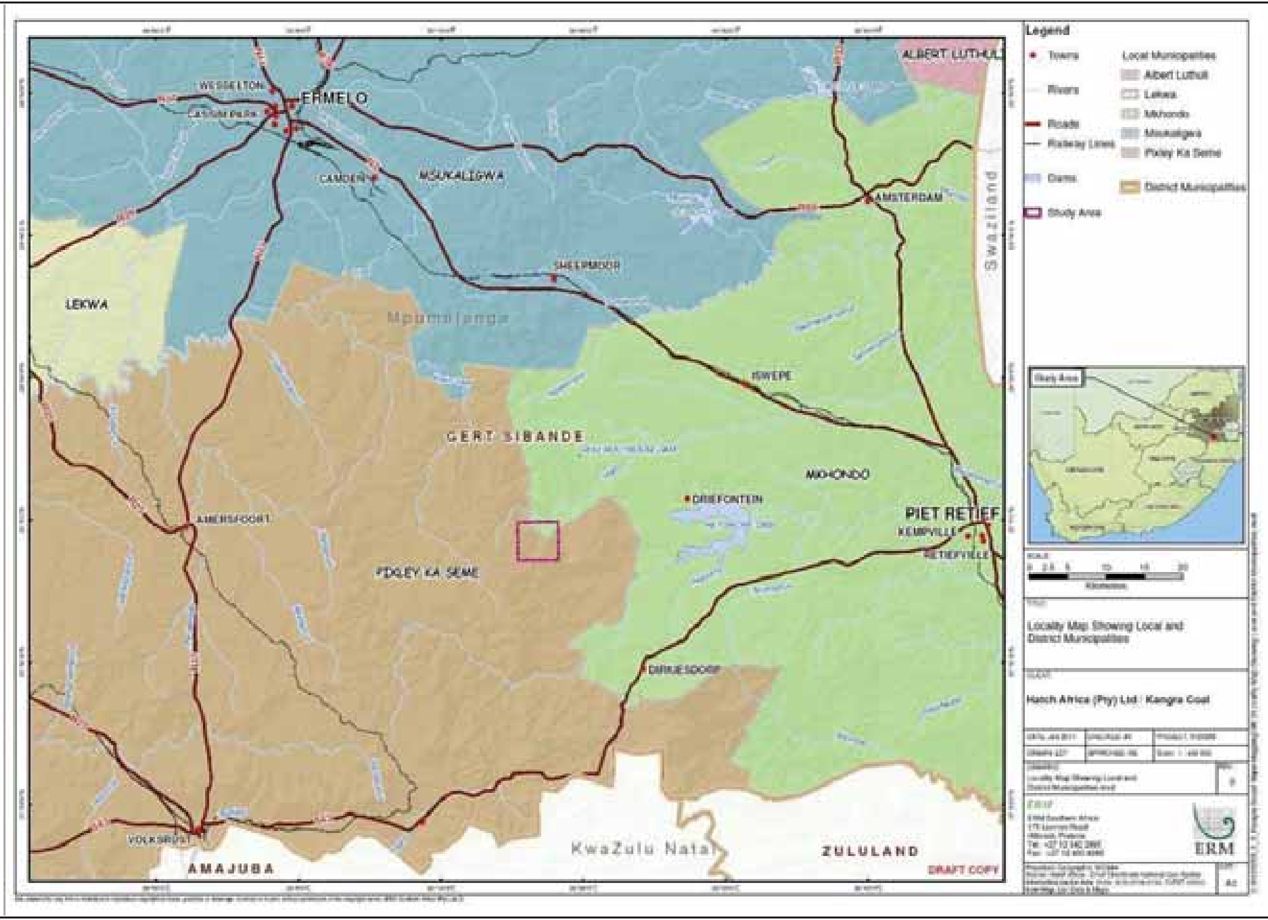
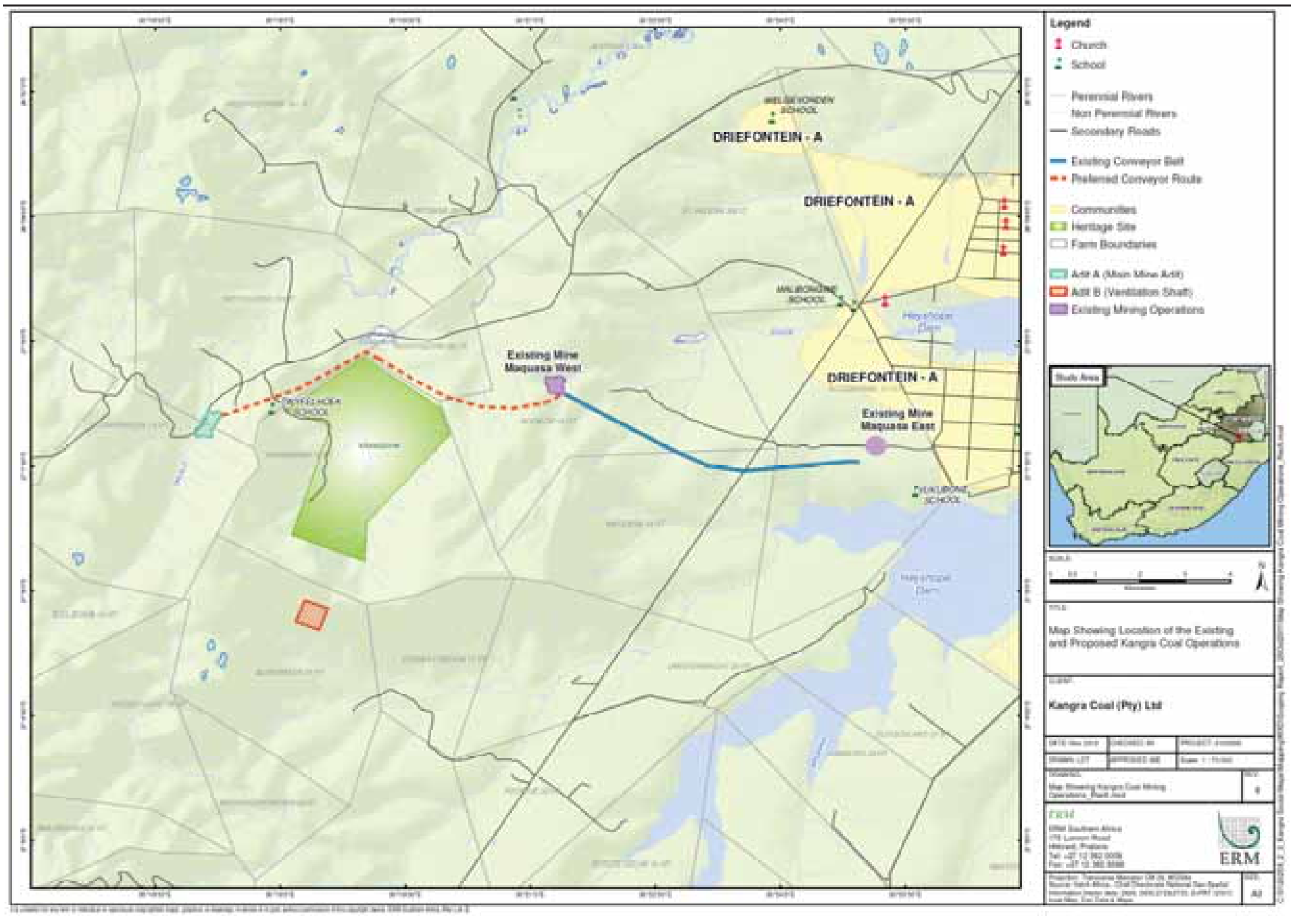


Figure 1.2 *Location of Mine Site Infrastructure*



1.3 *STUDY OBJECTIVES*

The objectives of the SAIA are to:

- Understand the existing environmental context from the perspective of soils and agricultural potential, and provide a benchmark of pre-Project conditions to help predict proposed Project-induced changes and inform the impact predictions.

- Provide an analysis of the direct and indirect impacts to the physical environment that are expected to result from the construction, operation and decommissioning phases of the proposed Kusipongo Expansion Project.

1.4 *ABOUT THE AUTHOR*

Garry Paterson was born in Scotland, where he obtained his BSc (Hons) degree in Geography from the University of Strathclyde, Glasgow. He is currently a senior soil scientist with the ARC-Institute for Soil, Climate and Water in Pretoria, where he has worked since 1981, obtaining his MSc degree (*cum laude*) in Soil Science from the University of Pretoria in 1998. He is currently completing his PhD degree (in soil erosion control using geotextiles) through the same University.

Garry has been involved in soil classification and mapping across the whole of South Africa for most of his career, including land type surveys, irrigation surveys and a range of soil investigations for a wide range of purposes, including environmental impact assessments. He is the past President of the Soil Science Society of South Africa (SSSSA), as well as the current Vice-Chairman of the South African Chapter of the International Erosion Control Association and Convenor of the South African Soil Classification Working Group. He is the author of several research articles, and was the recipient of the SSSSA award for the best soil science article in the SA Journal of Plant and Soil for 2011.

2 *LEGAL FRAMEWORK AND GOOD PRACTICE STANDARDS*

This Section details the legal requirements that are relevant to the SAIA.

2.1 *NATIONAL REGULATORY FRAMEWORK*

2.1.1 *Constitution of the Republic of South Africa (No. 108 of 1996)*

Summary of Constitution

The Constitution of the Republic of South Africa is the legal source for all law, including environmental law, in South Africa. The Bill of Rights is fundamental to the Constitution of the Republic of South Africa and in Section 24 states that:

Everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Applicability to Project

The residents of the immediate and surrounding area have the basic constitutional right to a protected environment that is not unnecessarily and/or irreparably damaged by any industrial or related development.

2.1.2 *National Environmental Management Act (Act No. 107 of 1998)*

Summary of Act

The National Environmental Management Act (NEMA) creates the legal framework that ensures the environmental rights guaranteed in Section 24 of the Constitution are abided by.

As such the fundamental principles that apply to environmental decision making are laid out, the core environmental principle being the promotion of ecological sustainable development. These principles serve as a guideline for any organ of state when exercising any function in the process of decision making under NEMA.

NEMA introduces the duty of care concept which is based on the policy of strict liability. This duty of care extends to the prevention, control and rehabilitation of significant pollution and environmental degradation. It also dictates a duty of care to address emergency incidents of pollution. A failure to perform this duty of care may lead to criminal prosecution, and may lead to the incarceration of managers or directors of companies for the conduct of the legal persons.

Applicability to Project

Any mining-related or other industrial development has the potential to impact on the receiving physical (including soils), biophysical and social environments. As such potential impacts need to be thoroughly and competently assessed prior to execution of the proposed Project.

2.1.3 Subdivision of Agricultural Land Act (Act No. 70 of 1970)

Summary of Act

The Subdivision of Agricultural Land Act (SALA) was enacted as a measure by which the Legislature, in the national interest, seeks to prevent the fragmentation of agricultural land into small uneconomic units, by (a) curtailing the common law right of landowners to subdivide their agricultural property; and (b) imposing the requirement to obtain the written consent of the National Department of Agriculture, Forestry and Fisheries (DAFF) Minister prior to any subdivision of agricultural land (which may be refused by the Minister if such subdivision will result in the uneconomic fragmentation of agricultural land). SALA also prohibits, amongst others, the change in land use of agricultural land (from use for agricultural purposes to use for any other purpose) without the prior written recommendation of the DAFF Minister.

Applicability to Project

If agricultural land, that is productive in terms of food and/or fibre production, becomes subdivided in some way as to make the reduced land parcel(s) uneconomic or unsustainable, then agricultural production is diminished. Such actions should be resisted wherever possible, especially where the prevailing agricultural potential is high.

2.1.4 The Conservation of Agricultural Resource Act (Act No. 43 of 1983)

Summary of Act

The Conservation of Agricultural Resources Act (CARA) aims at controlling the utilisation of natural agricultural resources in order to ensure that soil, water sources and vegetation are conserved, and that alien and invasive plants are combatted. The Act aims to prevent agricultural practices that contribute to the degradation of the environment.

Applicability to Project

CARA aims to protect the prevailing natural agricultural resources of South Africa from change of land use away from agriculture. This is especially important where high potential soils are present. It is an unfortunate fact that the majority of the coal resources of South Africa occur beneath moderate to high potential arable soils, and every time some of these soils are removed from agricultural production, the local, and by implication, regional and national food security situation is affected.

2.2 *KANGRA COAL POLICIES*

Kangra Coal is committed to responsible environmental stewardship and sustainable business practices; Kangra Coal pledges to improve their overall environmental performance across all their business activities. Kangra Coal encourages their business partners and members of the entire Kangra group to participate in this endeavour.

In accordance with this Environmental Policy, Kangra Coal strives for compliance with all environmental laws and commits to manage all of its activities in the environment. Of applicability to this study, Kangra Coal pledges to:

- Adopt the highest environmental standards in all areas of its operations, meeting and exceeding all relevant legislative requirements to which Kangra subscribes to.

- Regularly evaluating the existing and potential impact of its operations (including those relating to work undertaken by all staff) on the environment.

- Continuously improving on the overall company's environmental performance.

- Continuously conducting research to increase the knowledge on the environmental effects of Kangra Coal's relative activities and development or adoption of appropriate processes, technologies and equipment to meet anticipated environmental needs.

3 IMPACT ASSESSMENT METHODOLOGY

The impact assessment stage comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors. The steps involved in the impact assessment stage are described in greater detail below.

3.1 IMPACT ASSESSMENT

The impact characteristic terminology to be used is summarised in *Table 3.1*.

Table 3.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value]

In the case of type, the designations are defined universally (i.e., the same definitions apply to all resources/receptors and associated impacts). For these universally-defined designations, the definitions are provided in *Table 3.2*.

Table 3.2 Designation Definitions

Designation	Definition
	Type
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
	Extent

Designation	Definition
Local	Defined on a resource/receptor-specific basis.
Regional	
International	
Duration	
Temporary	Defined on a resource/receptor-specific basis.
Short-term	
Long-term	
Permanent	

In the case of *extent* and *duration*, the designations themselves (shown in *Table 3.1*) are universally consistent, but the definitions for these designations will vary on a resource/receptor basis (e.g., the definition of what constitutes a "short term" duration for a noise-related impact may differ from that of a "short term" duration for a habitat-related impact). This concept is discussed further below.

In the case of *scale* and *frequency*, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of acres affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

An additional characteristic that pertains only to unplanned events (e.g., traffic accident, operational release of toxic gas, community riot, etc.) is *likelihood*. The likelihood of an unplanned event occurring is designated using a qualitative (or semi-quantitative, where appropriate data are available) scale, as described in *Table 3.3*.

Table 3.3 Definitions for Likelihood Designations

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource/receptor sensitivity/vulnerability/importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (e.g., modelling, frequency charts) where available.

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. As in the case of extent and duration, the magnitude designations themselves (i.e., negligible, small, medium, large) are universally used and across resources/receptors, but the definitions for these designations will vary on a resource/receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *negligible* magnitude. In the case of positive impacts no magnitude will be assigned.

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource/receptor is biological or cultural (for example, the marine environment or a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact.

Impact significance is designated using the matrix shown in *Table 3.4*.

Table 3.4 Impact Significances

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box 3.1* provides a context for what the various impact significance ratings signify.

Box 3.1 ***Context of Impact Significances***

An impact of ***negligible*** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of ***minor*** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of ***major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

3.2 MITIGATION OF IMPACTS

Once the significance of a given impact has been characterised using the above matrix, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any impact assessment is to help our clients develop a consentable Project, and to help them achieve their business objectives in a responsible manner. Impact assessment is about identifying the aspects of a Project that need to be managed, and demonstrating how these have been appropriately dealt with and left a good quality and appropriate development. As key influencers in the decision making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an ALARP level.

Embedded controls (i.e., physical or procedural controls that are planned as part of the Project design and are not added in response to an impact significance assignment), are considered as part of the Project (prior to entering the impact assessment stage of the impact assessment process).

3.3 *RESIDUAL IMPACT*

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

3.4 *CUMULATIVE IMPACTS/EFFECTS*

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process should predict any cumulative impacts/effects to which the Project may contribute. The approach for assessing cumulative impacts and effects resulting from the Project and another activity affecting the same resource/receptor is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

This description of the baseline environment is essential in that it represents the conditions of the environment before the construction of the proposed Kusipongo Resource Expansion Project. The description of the baseline environment therefore provides a description of the current environment against which the impact of the proposed Project can be assessed and future changes monitored.

The information presented in this Section has been collected from desktop studies and supplemented with site visits to the Study Area.

4.1 REGIONAL CONTEXT

4.1.1 Climate

The climatic regime of the Study Area is characterized by warm, moist to wet summers and cool to cold, dry winters (Kotze, 1985). The main long-term climatic indicators are provided in *Table 4.1*.

Table 4.1 ***Climatic Data***

Month	Average Rainfall (mm)	Evap. (mm/day)	Average Min. Temp ($^{\circ}$C)	Average Max. Temp ($^{\circ}$C)	Average frost dates
Jan	135.1	6.5	12.9	23.6	Start date: 16/06
Feb	107.5	6.0	12.8	23.3	End date: 29/07
Mar	94.0	5.5	11.9	22.6	Days with frost: 4
Apr	47.7	4.9	9.6	21.4	
May	20.2	4.8	6.1	19.1	
Jun	8.6	4.6	3.1	16.9	
Jul	12.8	4.9	2.9	17.2	Heat units (hrs > 10°C)
Aug	11.9	6.0	4.8	19.6	Summer
Sep	34.5	7.0	7.7	22.0	(Oct to Mar): 1 694
Oct	81.5	6.5	9.9	22.9	
Nov	129.1	6.7	11.4	23.1	Winter
Dec	139.1	7.0	12.5	23.8	(Apr to Sept): 725
Year	821.9 (Tot.)	5.78 (Ave.)	15.1°C (Ave.)		

The extreme high temperature for the area is 38.0°C and an extreme low of 7.0°C. Majority of the rainfall is received during the period November through March. Both temperatures and precipitation are generally favourable for rain-fed arable cultivation of grain crops, either as the main agricultural activity or as part of a mixed farming (livestock and arable) enterprise.

4.1.2 Geology

The geology of the area comprises rocks of the Karoo Sequence, mainly grit, sandstone and shale of the Vryheid Formation in the east, with some shale of the Volksrust Formation in the west. Smaller areas of dolerite occur in the north and north-east (Geological Survey, 1987).

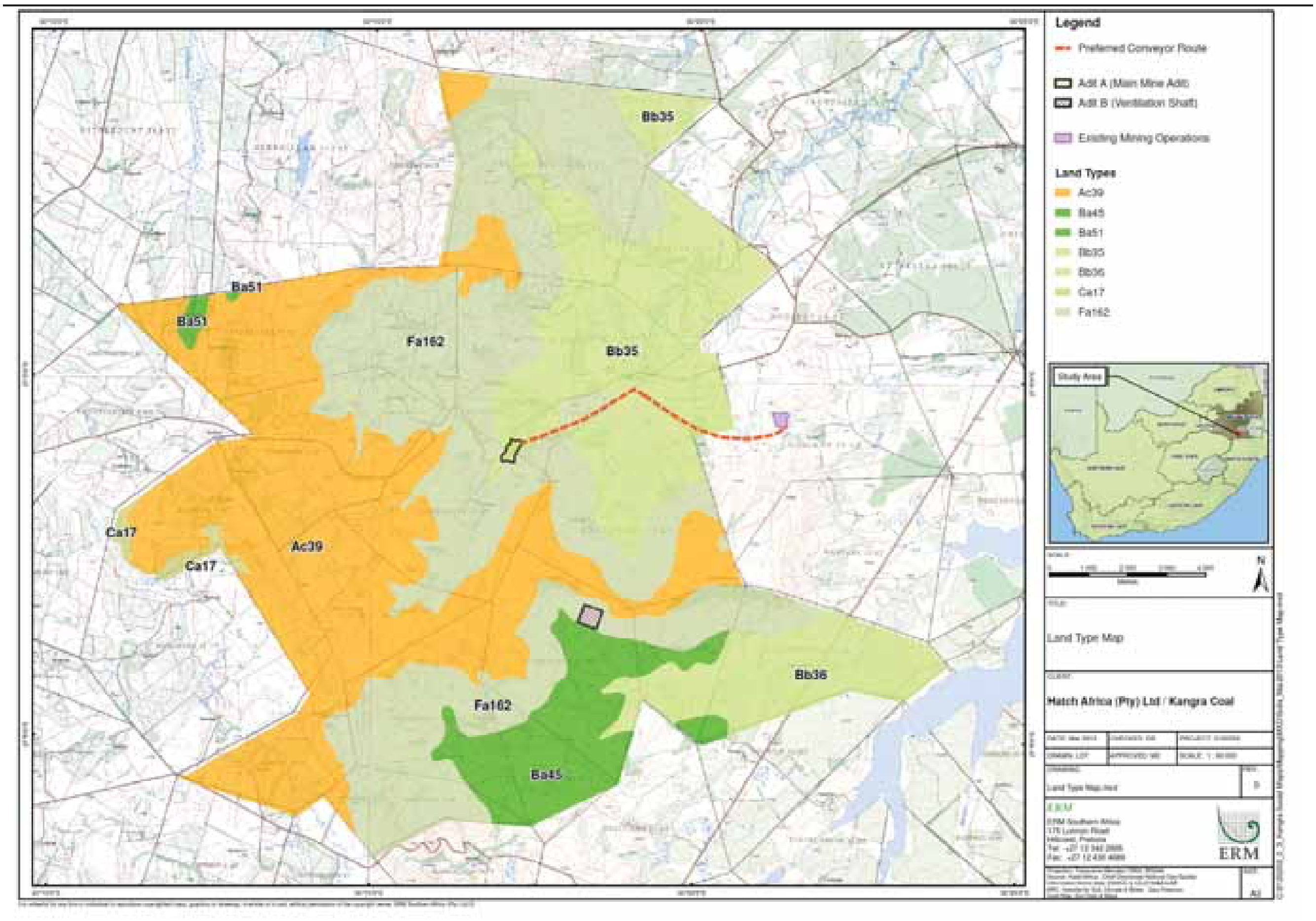
4.1.3 Soils

Figure 4.1 illustrates the soil types in the broader Study Area, as originally supplied by ERM. Predominately, the soils are brown to yellow brown, light textured, structureless and relatively deep (600-1200+ mm). These soils are typically found in land type **Ac39**, to the west (shown in orange), where the dominant soil form is Clovelly. This zone lies at a higher elevation than the rest of the area, and land type **Fa162** (shown in grey-green) comprises a zone of more sloping topography where the landscape falls away to the east. Here, the soils are grey-brown, light-textured, structureless and comparatively shallow (300-600 mm). The dominant soil forms are Glenrosa, Mispah and shallower versions of the Clovelly soils found in Ac39. Surface rock also occurs in places

To the east of Fa162, the landscape that falls towards the Heyshope dam (land type **Bb35**, shown in light green) contains similar soils to those in Ac39, but the soils often have a grey mottled subsoil plinthic horizon, usually at a depth of around 600-1 000 mm), so that the dominant soil forms are Avalon and Glencoe, with some shallower Mispah soils also occurring in places.

In general, the soils in land types **Ac39** and **Bb35** are of moderate to high potential for arable agriculture, with depth being the most common limiting factor. Most of the shallower soils of land type Fa162 have a low arable potential, due to the slopes, shallow soils and occasional rockiness.

Figure 4.1 Land Type Map of the Regional Study Area



4.2 LOCAL CONTEXT

A detailed soil investigation field survey was carried out on the Project Site in September 2011. The areas investigated included the proposed footprint of Main Mine Adit (Adit A) and the proposed route for the overland conveyor system (*Figure 1.2*). The proposed site for Adit B (*Figure 1.2*) is in a rocky steep area that was comparatively inaccessible, although a visual assessment from the landscape below suggested that the site can be characterised as having low to very low agricultural potential due to the sloping topography and rocks in the vicinity. Furthermore, the fenced footprint of Adit B (500m^2) will be relatively insignificant in comparison to the footprint for the Project as a whole. As such, no soil survey was thus carried out for Adit B.

4.2.1 Soil Type

Main Mine Adit (Adit A)

Figure 4.2 illustrates the distribution of soil types over the footprint of the site proposed for Adit A [(1)].

Majority of the Adit A footprint (58.7%) comprised of deep, yellow Clovelly soils (**Cv map unit**), with approximately 17.4% of the footprint having shallower Avalon soils (**Av map unit**) in the lower areas towards the Ohlelo River. The tributary of the Ohlelo stream in the south has wet (hydromorphic) soils (8.7% of the Adit A footprint – **Tu map unit**), while the extreme southern part has shallow rocky soils, with steeper slopes (6.7% of the Adit A footprint - **Ms/R map unit**) (*Table 4.2*).

The watercourse in the north of the Adit A footprint has been excavated, with a deep quarry-like excavation occurring resulting in a Mispah 1000 Rock soil type (8.5% of the Adit A footprint – **Exc map unit**) (*Table 4.2*). The reason for the excavation and removal of soil could not be determined at the time of the study.

Overland Conveyor Route

Figure 4.3 illustrates the distribution of soil types over the route of the proposed overland conveyor [(1)].

The soils along the conveyor route are similar to those occurring at Adit A. They are generally a mixture of moderately deep, yellow-brown, structureless soils, sometimes with subsoil plinthite (map units Cv and Av), along with shallow (<400 mm) soils with occasional rock outcrops. These soils are similar to the Ms/R map unit in the Adit A footprint, but the terrain is flatter and there are only very occasional rocky outcrops (map unit Ms). The route crosses

(1) Please note the following definitions – Av (Avalon 1200),Cv (Clovelly 1200), Exc (Excavated), Ms/R (Mispah 1000, Rock) and Tu (Tukulu 1120)

streams at two points, where wet soils, similar to the Tu map unit occur (refer to *Table 4.2* for soil legend for the overland conveyor route).

Figure 4.2 Main Mine Adit A Soils Map

Figure 4.3 *Overland Conveyor Route Soils Map*

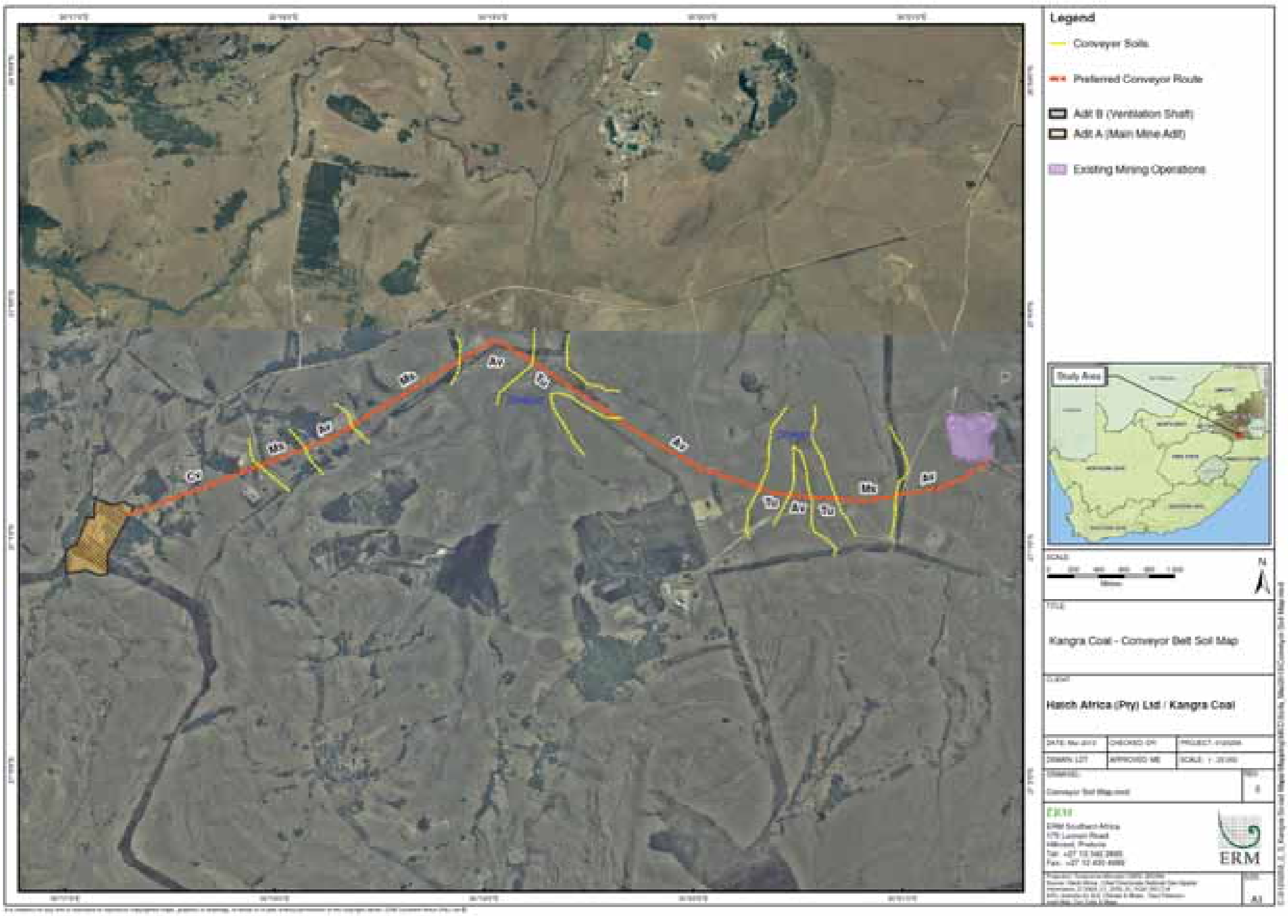


Table 4.2 Soil Legend for the Main Mine Adit (Adit A) and the Overland Conveyor System

Map Unit	Depth (mm)	Dominant Soil Form and Family	Subdominant Soil Form and Family	Soil characteristics	Adit A		Overland Conveyor Route *	
					Area* (ha)	Percentage Occurrence	Area* (ha)	Percentage Occurrence
Cv	900-1200+	Clovelly 1200	Avalon 1200, Glencoe 1200	Brown, sandy clay loam, structureless to weakly structured topsoil on yellow-brown to yellow, sandy clay loam to sandy clay, structureless to weakly structured subsoil on weathering rock.	10.08	58.7	2.69	10
Av	450-900	Avalon 1200	Glencoe 1200	Brown, sandy clay loam, structureless to weakly structured topsoil on yellow-brown to yellow, sandy clay loam to sandy clay, structureless to weakly structured subsoil on grey, mottled, soft (occasionally hard cemented) plinthite.	2.98	17.4	16.14	60
Tu	500-900	Tukulu 1120	Katspruit 1000	Brown to dark brown, sandy clay loam, weakly structured topsoil on brown, mottled, sandy clay loam to sandy clay, weakly structured subsoil on grey, mottled, structured clay subsoil. Occurs in low-lying areas close to streams – water tables occur.	1.50	8.7	1.35	5
Ms/R	50-250	Mispah 1000, Rock	Clovelly 1200	Brown to yellow-brown, sandy loam to sandy clay loam, structureless to weakly structured topsoil on rock. Abundant rock outcrops also occur.	1.15	6.7	-	-
Ms	50-400	Mispah 1000,	Clovelly 1200, Glenrosa 1211	Brown to yellow-brown, sandy loam to sandy clay loam, structureless to weakly structured topsoil on rock. Occasional rock outcrops also occur.			6.73	25
Exc	-	Map unit has been excavated to a significant (>20 m) depth, with removal of soil material. A stream flows along the bottom of the excavation, but accurate soil classification is difficult, if not impossible.			1.46	8.5	-	-
				TOTAL	**17.17**	**100**	**26.90**	**100**

*** Due to changes in alignment, a detailed systematic survey was not carried out for the eastern portion of the overland conveyor – i.e. from the transfer point through to the existing Maquasa West conveyor. However, the soils along the conveyor system are similar to those in the footprint of Adit A. As such, enough soil information was collected to be able to** produce a soil map using the same map units as for Adit A

4.3 LAND CAPABILITY AND AGRICULTURAL POTENTIAL

4.3.1 *Land Capability*

The pre-mine classes for land capability of Adit A and the overland conveyor route are presented in *Table 4.3* below.

Over 70% of the footprint for Adit A is classed as having a ***moderate to high arable*** potential, with a similar approximate proportion of the length of the conveyor belt alignment (*Table 4.3*).

Table 4.3 Land Capability Classes for the Sites Proposed for Adit A and the Overland Conveyor System

LAND CAP. CLASS	MAP UNIT	RESTRICTIONS/LIMITATIONS	ADIT A (%)	CONVEYOR ROUTE (%)
Arable (high)	*Cv*	Almost none. Deep, friable soils, possible slight impeded drainage in places due to high clay content.	58.7	10
Arable (moderate)	*Av*	Moderate to shallow depth to underlying gleyed plinthite in places. Somewhat imperfect drainage.	17.4	60
Grazing	*Ms*	Shallow soils, and occasional surface rock outcrops.	-	25
Wilderness	*Ms/R*	Shallow soils, steep slopes and abundant surface rock outcrops.	6.7	-
Wetland	*Tu*	Low-lying areas with wet, clayey subsoils. Poorly drained, with occasional flood hazard in rainy season.	8.7	5
Wetland (disturbed)	*Exc*	Widespread soil removal. Probably originally a small stream bed, now deep quarry-like pit.	8.5	-

4.3.2 *Agricultural Potential*

Some areas of arable cultivation were observed in the vicinity of the site proposed for Adit A and the adjoining portion of the route of the proposed overland conveyor, but for most of the route, no cultivation was present, even where relatively deep soils were found.

The shallow soils in the area do not have a significant potential for cultivation, and can be used for grazing at best. Where there is a significant occurrence of rock (map unit Ms/R), with steeper slopes, the grazing potential is reduced.

In terms of the areas surrounding the proposed Project area, there is little cultivation being practised, with only isolated fields, many of which are adjacent to the various rural homesteads present in the Study Area. The Adit A site is partially covered with wattle trees, and there is steeper, rocky topography to the south and north. The significance of this area, which totals 17ha, is not that great to the broader agricultural environment at this stage.

4.4 SOIL EROSION POTENTIAL

The soils in the Study Area are not inherently susceptible to erosion. They have a relatively homogenous structure and texture down the soil profile, and the relatively high rainfall in the area means that vegetation growth is usually strong. However, any soil is susceptible to erosion if disturbed, even on the relatively gentle slopes in the Study Area.

Both Adit A and Adit B are situated in sloping areas, so the erosion hazard will be higher there than that of the route proposed for the overland conveyor system.

5 IMPACT ASSESSMENT

The predicted impacts to soils and the resulting agricultural potential of the Study Area as a result of the proposed Kusipongo Resource Expansion Project are described in this Section.

5.1 IMPACTS ON SOIL AND AGRICULTURAL POTENTIAL

5.1.1 *Description of the Baseline Environment*

The Project Site can be characterised as having deep soils with a moderate to high agricultural potential and shallow soils with a lower agricultural potential. Over 70% of the Project Site can be classified as having a moderate to high arable potential.

5.1.2 *Proposed Project Activities*

The following activities associated with the construction phase of the proposed Project will result in an impact on soils and the agricultural potential of the Project Site.

- **Main Mine Adit (Adit A)** – the infrastructure that is planned will result in land no longer being available for agricultural production, due to removal of topsoil and/or subsoil, as well as the subsequent storage and rehabilitation process. The construction of Adit A will necessitate the removal of existing topsoil over an area of approximately 17ha. The Adit A footprint will be unusable for agricultural production for the life of the mine. Once the mine closes, rehabilitation may be possible, but it is likely that the pre-mining agricultural potential, and associated land capability, will be reduced to a lower level due to the soil handling and replacement process, as well as the time that the soil is likely to be stockpiled.

- **Ventilation Adit (Adit B)** – the removal of topsoil and establishment of infrastructure may result in degradation of the soil body, if not mitigated. The construction of Adit B will necessitate the removal of approximately 500m^2 of existing topsoil.

- **Overland Conveyor System** – the establishment of an overland conveyor system and associated gravel service road will result in removal and disturbance of the topsoil, but to a much smaller degree than with Adit A and Adit B. Most of the *in situ* soil profile would not be dramatically disturbed, so that, after mine closure, the removal of the conveyor infrastructure should enable the soil potential to be regained, with certain straightforward rehabilitation measures.

5.1.3 *Sensitive Receptors*

Soil with a moderate to high arability potential in the Project Site will be lost during the construction phase of the proposed Project. This will be specifically relevant where excavations are made, such as Adit A and to a lesser extent at Adit B where access needs to be obtained through the soil profile and into the coal reserve below. Not only will any soil that is removed need to be stored, but the spoil material removed will also have to be stored for the life of the Adit, causing problems to the existing topsoil. It is likely that the long-term production potential of the Project Site will be affected.

5.1.4 *Significance of Impact (Pre-mitigation)*

Based on the analysis provided above and in *Table 5.1*,
Table 5.2 and *Table* 5.3 below, it is the opinion of this SAIA that construction of the following Project components will have the following pre-mitigation impact significance:

- **Main Mine Adit (Adit A)** – the impact from the construction of Adit A is considered a "**Major Negative Impact**".
- **Ventilation Adit (Adit B)** – the impact from the construction of Adit B is considered a "**Moderate Negative Impact**".
- **Overland Conveyor System** – the impact from the construction of the overland conveyor system is considered a "**Moderate Negative Impact**".

Table 5.1 Rating of Impacts Related to the Loss of Soil and Agricultural Potential for the Main Mine Adit (Adit A) (Pre-mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The loss of soil will be confined within the footprint of the site proposed for Adit. This loss is relatively small and will not significantly affect the agricultural potential in the surrounding area; however, possible indirect downstream impacts are likely (pre-mitigation).
Duration	Long-term	Will continue as long as coal extraction takes place and to a lesser degree post-closure
Scale	17ha +	The entire footprint of Adit A will be cleared and utilised and possible indirect downstream impacts. However, the site boundary should be strictly controlled.
Frequency	Continuous	The presence of infrastructure developments would have a continuous impact
Likelihood	Likely	Will occur as a result of site clearing during the construction phase
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The soil resource to be affected is fragile and difficult to restore		
Significant Rating Before Mitigation		
Major Negative Impact		

Table 5.2 Rating of Impacts Related to the Loss of Soil and Agricultural Potential for the Ventilation Adit (Adit B) (Pre-mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to the footprint of the site proposed for Adit B only. This loss is relatively small and will not significantly affect the agricultural potential in the surrounding area; however, possible indirect downstream impacts are likely (pre-mitigation).
Duration	Long-term	Will continue as long as coal extraction takes place and to a lesser degree post-closure
Scale	$500m^2$ +	The entire footprint of Adit B will be cleared and utilised and possible indirect downstream impacts. However, the site boundary and planned access routes should be strictly controlled.
Frequency	Continuous	The presence of infrastructure developments would have a continuous impact
Likelihood	Likely	Will occur as a result of site clearing during the construction phase
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soil resource to be affected is fragile and difficult to restore		
Significant Rating Before Mitigation		
Moderate Negative Impact		

Table 5.3 Rating of Impacts Related to the Loss of Soil and Agricultural Potential for the Overland Conveyor System (Pre-mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to the footprint of the route proposed overland conveyor only. This loss is relatively small and will not significantly affect the agricultural potential in the surrounding area; however, possible indirect downstream impacts are likely (pre-mitigation).
Duration	Long-term	Will continue as long as coal extraction takes place and to a lesser degree post-closure
Scale	26.9 ha +	The entire footprint of the route proposed for the overland conveyor corridor will be cleared and utilised and possible indirect downstream impacts
Frequency	Continuous	The presence of infrastructure developments would have a continuous impact
Likelihood	Likely	Will occur as a result of site clearing during the construction phase
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Loss of soil will not be as severe or as permanent as for the Adit sites		
Significant Rating Before Mitigation		
Moderate Negative Impact		

5.1.5 *Recommendations and Mitigation/Management Measures*

The following mitigation measures will be used to reduce the significance of the impact.

Main Mine Adit (Adit A)

- All usable (non-plinthite) soil material to be stripped and stored for rehabilitation. The average depth of usable topsoil can be equated to the depth per map unit as shown in *Table 4.2* above. The depth of stockpiling is not covered by any regulations or even guidelines (Coaltech, 2007); however, the depth of stockpile should ideally not exceed 2.5 to 3 m. Soil should be stockpiled separately from any underlying spoil material and cross-contamination should not be allowed. The soil and spoil stockpiles should be stabilised and restricted on the downslope side to avoid erosion of the stockpiles by water runoff. The stockpiles should be re-vegetated using a creeping indigenous grass seeding to ensure stability as well as possible organic material accumulation.

  The amount of usable (non-plinthite) soil material stripped and stored for rehabilitation purposes will be less for the overland conveyor system than for the Adits A and B. Reason being is that construction of foundations for the proposed overland conveyor system and establishment of the associated gravel service road will not involve deep excavation or removal of the whole profile and underlying material.

- Wetland soils (map unit Tu) to be avoided as far as possible. This is important so as to ensure that contamination of natural drainage flow paths and subsequent downstream sediment transport (possibly with coal contamination) does not occur. Where possible, a buffer zone of at least 30 m should be established next to all stream beds.

  For the overland conveyor system, detailed design and construction should ensure that water flow in wetlands and streams is unhindered. Furthermore, watercourse embankments should be adequately stabilised so as to ensure long-term stability and avoid the transport of sediment downstream.

- Clearing of vegetation in any given area should only occur immediately before construction is due to commence in that area. Exposure of open bare soil surfaces should be avoided, so as to avert the risk of water runoff induced erosion. Although the prevailing soil erosion hazard is not high, where surface vegetation is removed (for example to create roads or access ways), measures should be put in place so as to prevent excess surface water flow (*viz.* the inclusion of cut-off channels, culverts etc.). Such structures will need to be designed by a transport engineer with specialist knowledge.

Slopes along the conveyor route are not excessive (range of 2 to 6% on average), so increased surface water flow speeds will unlikely be a problem. However, distance of flow can result in erosion problems even on gentle slopes. As such, water should be directed off the road at regular intervals (such measures also to be specified and applied by a roads engineer).

5.1.6 *Residual Impact (Post Mitigation)*

As such, given that the above mentioned mitigation/management measures are implemented, construction of the following Project components will have the following post-mitigation (residual) impact significance:

- **Main Mine Adit (Adit A)** – while the disturbance and subsequent replacement of the soil resource will lead to a deterioration in agricultural potential, soil replacement increases the possibility that soils could eventually be used for arable production, although it is more likely that only grazing of livestock would be possible. As such, the residual impact can be considered a "**Moderate Negative Impact**" (refer to *Table 5.4* overleaf).

- **Ventilation Adit (Adit B)** – while the disturbance and subsequent replacement of the soil resource will lead to a deterioration in agricultural potential, the small area involved, as well as the prevailing conditions (steep slopes, rocks, shallow soils) in the vicinity of Adit B, means that as long as rehabilitation is carried out the residual impact can be considered a "**Minor Negative Impact**" (refer to *Table 5.5* overleaf).

- **Overland Conveyor System** – the limited width of the overland conveyor system, along with the fact that only a thin layer of topsoil will be disturbed for the maintenance road, will mean that successful post-mining rehabilitation is possible. The impact from the construction of the overland conveyor system is therefore considered a "**Minor Negative Impact**" (refer to *Table 5.6* overleaf).

Table 5.4 *Rating of Impacts Related to the Loss of Soil and Agricultural Potential for the Main Mine Adit (Adit A) (Post-mitigation)*

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to the footprint of the site proposed for Adit A only
Duration	Long-term	Will continue as long as coal extraction takes place and to a lesser degree post-closure
Scale	17 ha	The entire footprint of Adit A will be cleared and utilised; however, minimisation of the downstream impacts of the development activities can reduce the scale of this impact
Frequency	Continuous	The presence of infrastructure developments would have a continuous impact
Likelihood	Possible	Will occur as a result of site clearing during the construction phase; however, mitigations applied to clearing activities and preservation of soil resources will reduce the likelihood of impacts
Magnitude		
Medium Magnitude		
Significant Rating After Mitigation		
Moderate Negative Impact		

Table 5.5 *Rating of Impacts Related to the Loss of Soil and Agricultural Potential for the Ventilation Adit (Adit B) (Post-mitigation)*

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to the footprint of the site proposed for Adit B only
Duration	Long-term	Will continue as long as coal extraction takes place and to a lesser degree post-closure
Scale	500m²	The entire footprint of Adit B will be cleared and utilised; however, minimisation of the downstream impacts of the development activities can reduce the scale of this impact
Frequency	Continuous	The presence of infrastructure developments would have a continuous impact
Likelihood	Possible	Will occur as a result of site clearing during the construction phase; however, mitigations applied to clearing activities and preservation of soil resources will reduce the likelihood of impacts. Furthermore, given the baseline conditions (steep slopes, rocks, shallow soils) in the vicinity of Adit B, restoration of the footprint means that a post-closure landuse/state to near pre-Project baseline is possible

Magnitude
Small Magnitude
Significant Rating After Mitigation
Minor Negative Impact

Table 5.6 Rating of Impacts Related to the Loss of Soil and Agricultural Potential for the Overland Conveyor System (Post-mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Restricted to the footprint of the route proposed overland conveyor only
Duration	Long-term	Will continue as long as coal extraction takes place and to a lesser degree post-closure
Scale	26.9 ha	The entire footprint of the route proposed for the overland conveyor corridor will be cleared and utilised; however, minimisation of the downstream impacts of the development activities can reduce the scale of this impact
Frequency	Continuous	The presence of infrastructure developments would have a continuous impact
Likelihood	Possible	Will occur as a result of site clearing during the construction phase; however, mitigations applied to clearing activities and preservation of soil resources will reduce the likelihood of impacts. Furthermore, given that the amount of soil material stripped and stored for rehabilitation purposes will be less for the overland conveyor system than for the Adits A and B means that successful post-mining rehabilitation is possible.

Magnitude
Small Magnitude
Significant Rating After Mitigation
Minor Negative Impact

6 *CUMULATIVE IMPACTS AND MITIGATION*

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This Section considers the cumulative impacts that would result from the combination of the proposed Kangra Coal Expansion Project and other actual or proposed future developments in the broader Study Area.

6.1 *IDENTIFIED CUMULATIVE IMPACTS PERTAINING TO THE SUSTAINABILITY OF SOIL AND AGRICULTURAL POTENTIAL IN THE STUDY AREA*

In addition to the proposed Kusipongo Resource Expansion Project, the Study Area may experience cumulative impacts due to continued operation of existing mining activities in the Study Area, the expansion of existing mining activities (the Maquasa Expansion Project where the expansion of existing opencast pits as well as the addition of eight new opencast pits is proposed) and the implementation of the proposed Driefontein housing project.

While there are agriculturally productive soils in the vicinity, they are not being extensively utilized at present. The most potentially serious cumulative impact relating to soils in the Study Area would be if current mining activities and/or future development activities result in medium to long-term exposure of bare soils without any preventative measures put in place, as this would lead to increased soil erosion and subsequent downstream impacts. This would be especially serious in the vicinity of any of the streams in the area, such as along the conveyor route.

It is recommended that a detailed soil and agricultural potential assessment be undertaken for future developments, as this would identify the deeper, higher potential soils and would aim to recommend, as far as possible, the siting of infrastructure away from such zones.

7 CONCLUSION

The soil and agricultural potential investigation identified that over 70% of the Project footprint can be characterised as having soil with a moderate to high potential for arable agriculture; however, utilisation of these soils for crop production is limited in the vicinity of the proposed Project Site.

It is anticipated that, due to the scale of soil removal and infrastructure establishment, the Main Mine Adit (Adit A) site will result in the highest negative impact to agricultural potential in the Study Area. If proper mitigation measures (such as stockpiling and utilizing the minimum possible footprint) are put in place, the impact can be reduced, although a long-term reduction in agricultural potential is likely. Rehabilitation is a complicated and sometimes unpredictable process, with restoration of arable potential unlikely.

While the disturbance and subsequent replacement of the soil resource for Adit B will lead to a deterioration in agricultural potential, the small area involved ($500m^2$), as well as the prevailing conditions (steep slopes, rocks, shallow soils) in the vicinity of Adit B, means that as long as rehabilitation is carried out the residual impact is considered minor.

For the overland conveyor system servitude, the amount of soil material stripped and stored for rehabilitation purposes will be less than for Adits A and B. Furthermore, should infrastructure be properly established taking consideration of wetland crossings and using proven engineering measures to minimise surface water runoff, then the long-term impact should be minor. The existing conveyor (eastward from the Maquasa mine) would appear to be in good condition and the road running parallel to the conveyor seems to be well maintained, with a relatively smooth surface and little sign of any erosion caused by excessive and/or poorly managed runoff. Similar standards for any new construction (which would need to be specified in conjunction with engineers) are anticipated as a minimum standard.

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Appendix A

Curriculum Vitae of Specialists

CURRICULUM VITAE: D G Paterson

SURNAME: PATERSON
FIRST NAME(S): David Garry
KNOWN AS: Garry
DATE OF BIRTH: 25-08-1959 in Bellshill, Scotland
NATIONALITY: South African
I.D. No.: 5908255258088
LANGUAGE PROFICIENCY: English, Afrikaans (both fluent), French (poor)
MARITAL STATUS: Married, one son

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E-MAIL ADDRESS: garry@arc.agric.za

ACADEMIC QUALIFICATIONS:

- Matriculated: 1976, Dalziel High School, Motherwell, Scotland
- BSc (Hons) Geography, 1980, University of Strathclyde, Glasgow, Scotland
- MSc (Soil Science) *cum laude*, 1998, University of Pretoria

PROFESSIONAL CAREER:

- 1981-1987: Soil Scientist: Soil and Irrigation Research Institute, Pretoria
- 1987-1992: Senior Soil Scientist: Soil and Irrigation Research Institute, Pretoria
- 1992-present: Senior Soil Scientist: ARC-Institute for Soil, Climate & Water

FIELDS OF SPECIALITY AND COMPETENCE:

- Soil classification and mapping
- Soil interpretations
- Soil survey project management
- Environmental assessment
- Soil survey and land capability course presentation
- Ground penetrating radar

PUBLICATIONS (see attached list):

- Three refereed articles (S.A. Journal of Plant and Soil)
- Nine Congress papers/posters
- S.A. Soil Classification (1991) (Member of working group)
- Seven 1:250 000 Land Type Maps
- Three Land Type Memoirs
- More than 200 soil survey reports and/or maps

COURSES COMPLETED:

- Course in Project Management (University of Stellenbosch)
- Course in Junior Personnel Management (Dept of Agriculture)
- Course in Handling of Grievances and Complaints (Dept of Agriculture)
- Course in Marketing (ARC-ISCW)
- Course in National Qualifications Framework Assessment, ARC-CO
- Training Course in Ground Penetrating Radar (GSSI, USA)
- Introduction to ArcGIS 8, GIMS, 2004

PROFESSIONAL STATUS:

- ➤ Registered Natural Scientist: Soil Science (SA National Council for Natural Scientific Professions) – registration number 400463/04
- ➤ Member of South African Soil Classification Working Group
- ➤ Member of Soil Science Society of South Africa (1982-present)
- ➤ President of Soil Science Society of South Africa (2005-2007)
- ➤ Member of South African Soil Survey Organisation (2000-present)
- ➤ Council Member of South African Soil Survey Organisation (2002-2003)
- ➤ Scientific Referee, S.A. Journal for Plant and Soil
- ➤ External Examiner, University of Pretoria, University of Witwatersrand, University of Venda

AWARDS:

Best article on Soil Science, South African Journal for Plant and Soil, 2011

MISCELLANEOUS:

Editor, Soil Science Society newsletter, 1993-present
Member, Clapham High School (Pretoria) Governing Body 1998-2002
Member, Northern Gauteng Football Referee's Association
Committee Member, Rosslyn Golf Club (Club Champion 2002 and 2007)

INTERESTS:

Sport, especially golf and soccer; wildlife; reading; music

REFEREES:

Mr T.E. Dohse, ARC-Institute for Soil, Climate and Water.
Tel: (012) 310-2504; 082 324 5389

Prof A.S. Claassens, Faculty of Plant Production and Soil Science, University of Pretoria
Tel: (012) 420-3213; 084 581 6488

Prof M.C. Laker (retired), (012) 361-2900; 082 785 5295

PUBLICATIONS LIST:

Refereed Articles:

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* Co-author as member of Working Group

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Congress Papers:

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Plus ARC-ISCW Reports on:

- Ground penetrating radar investigations in: Kruger National Park; Enseleni, Natal; Weatherly, Maclear; Kleinkopje Mine

- Soil survey investigations at: Roodeplaat, Kathu, Steelpoort River, Palala River, Zeekoegat (Roodeplaat), Limpopo River, Lydenburg, Kendal, Clewer Sand (Witbank), Botha Sand (Witbank), Balmoral Colliery, Bafokeng (Rustenburg), Towoomba (Warmbaths), Hoeveld Stene (Middelburg), Quality Bricks (Witbank), Visagie Sand (Middelburg), Rosslyn, Coalbrook (Sasolburg), Stewart Coal (Delmas), Forzando Coal (Hendrina), Vaalgro (Vereeniging), Ratanda (Heidelberg), Elspark (Boksburg), Thorncliffe Mine (Steelpoort), Jan Smuts Quarry (Boksburg), Ennerdale (Phase I & II), Thokoza, North Riding, Natalspruit (Alberton), Arnot, Kroondal (Phase I & II), Ga-Rankuwa, Hartebeespoort Dam, Kosmos, Assen, Grasmere, Magalies Moot (Pretoria), Valpre (Paulpietersburg), Cargo Carriers (Sasolburg), Waterval (Rustenburg), Rayton, Bronkhorstspruit, Zwavelpoort (Pretoria), Pietersburg, Trojan Mine (Steelpoort), Platinum Highway (Rustenburg), Moutse, Centurion, Salique (Klaserie), Northam, Greenside Colliery (Witbank), South Deep Mine (Westonaria), Bank Colliery, Steelpoort Platinum, Gautrain Route (Pta/Jbg), Rietspruit Mine (Ogies), Potgietersrus Platinum, Atok Mine (Lebowa), Blue Ridge Mine (Groblersdal), Ngodwana, Estancia (Breyton), Twickenham Mine (Steelpoort), Marikana

Volume III Annex C.8

Surface Water Impact Assessment Report

Version 5.0

May 2013

Document Ref.	Prepared By	Reviewed By	Date Submitted to Kangra Coal for Review
0120258_V5.0_SWIA	Anna van Vuuren – WSM Leshika Consulting (Pty) Ltd.	Dieter Rodewald, Mike Everett	May 2013

CONTENTS

LIST OF ACRONYMS

Abbreviation	Full Definition
A	Area
AEV	Acute Effect Value
CEV	Chronic Effect Value
DARDLA	Mpumalanga Department of Agriculture, Rural Development and Land Administration
DEA	Department of Environmental Affairs (National)
DEDET	Department of Economic Development, Environment and Tourism(Mpumalanga)
DMR	Department of Minerals and Resources (Mpumalanga)
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry (pre 2009)
EAP	Environmental Assessment Practitioner
EBA	Ecological Baseline Assessment
ECSA	Engineering Council of South Africa
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessment
HGM	Hydro-geomorphic
IWULA	Integrated Water Use Licence Application
GIS	Geographical Information System
GN 704	Government Notice 704 of June 1999
HecRas	Hydraulic Engineering Centre's River Analysis System
LOM	Life of Mine
M2	1:2-year 24 hour rainfall event
MAE	Mean Annual Evaporation
mamsl	metre above mean sea level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MPRDA	Mineral and Petroleum Resources Development Act (Act 28 of 2002)
MRA	Mining right application
NEMA	National Environmental Management Act (Act 107 of 1998)
NEMWA	National Environmental Management Waste Act
NSS	Natural Scientific Services CC
NWA	National Water Act (Act 36 of 1998)
OHTL	Overhead Transmission Line
PCD	Pollution Control Dam
PDF	Probability Distribution Function
Pr Eng	Professional Engineer
Ref.	Reference
RMF	Regional Maximum Flood
ROM	Run of Mine
SANBI	South African National Biodiversity Institute
SANRAL	South African National Roads Agency
SEMP	Social and Environmental Management Programme
SMD	Stormwater Management Dam
SWIA	Surface Water Hydrology Impact Assessment
TWQR	Target Water Quality Range
WR90	Surface Water Resources 1990 study
WR2005	Water Resources 2005 study
WUL	Water Use Licence
WULA	Water Use Licence Application

1 INTRODUCTION

1.1 TERMS OF REFERENCE

Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) were appointed by Kangra Coal (Pty) Ltd. (Kangra Coal) to undertake the function of independent Environmental Assessment Practitioner (EAP) and undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Kusipongo Resource Expansion Project (the proposed Project) and compile an associated Environmental and Social Management Plan. The ESIA is been undertaken as the proposed Project requires the following environmental authorisations/licenses:

- **Mining Rights** from the Regional (Mpumalanga) Department of Minerals and Resources (DMR) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA).

- **Environmental Authorisation** from the Regional (Mpumalanga) Department of Economic Development, Environment and Tourism (DEDET) in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA).

- **Waste License** from the National Department of Environmental Affairs (DEA) in terms of the National Environmental Management Waste Act (No. 59 of 2008) (NEMWA).

- **Water Use Licenses** from the National Department of Water Affairs (DWA) in terms of the National Water Act (No. 36 of 1998) (NWA).

WSM Leshika Consulting (Pty) Ltd. (WSM Leshika) was contracted by ERM to undertake the Surface Water Hydrology Impact Assessment for the proposed Project. The purpose of the investigation is to assess the hydrological characteristics for the Study Area associated with the proposed Project and to develop a Surface Water Hydrology Impact Assessment (SWIA) Report (this report).

1.2 PROJECT BACKGROUND

Kangra Coal is considering expanding their coal mining operations at the Savmore Colliery, located within the Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities (which form part of the Gert Sibane District Municipality) in Mpumalanga, which is approximately 51km west-south-west from Piet Retief and 64km south east from Ermelo (refer to *Figure 1.1*). This expansion is proposed to include the Kusipongo coal resource, situated to the west of existing operations. The proposed Project will be restricted to underground mining; however, surface infrastructure to support this underground expansion will include (*Figure 1.2*):

- **A Main Mine Adit (Adit A)** – entrance to the proposed underground mine which is inclined and through which people, equipment and coal will pass. The Adit A footprint will also include offices, workshops, stores, change house, silos, crushing and screening, etc. Adit A is located in the Hlelo River Quaternary Catchment W51A.

- **A Ventilation Shaft (Adit B)** – an adit used solely for ventilation intake. Adit B will include only a ventilation opening. Access to the underground working via this ventilation opening will be restricted by the installation of a metal grid that will prevent access by humans and animals. Adit B will require a construction area of approximately 500m^2. Fresh air drawn in through this Adit will be returned directly to the main exhaust fans at Adit A. Adit B is located in the Assegaai River Quaternary Catchment W52B.

- **An Overland Conveyor System** – this system will be approximately 8.4km in length with a servitude width of 32m, and will be used to transport coal from the underground operations at the proposed Adit A to the existing Maquasa West Adit conveyor system. This in turn will transport mined coal to the existing wash plant facilities at the Savmore Colliery.

- **A Temporary Construction Camp** – to provide accommodation for semi-skilled and skilled workers and supervisory workers during the construction phase of the proposed Project, provisionally located 6km away (towards the east) from the proposed site for the Main Mine Adit A along the extension of the D2548. This will be decommissioned at the end of the construction phase.

Figure 1.1 Project Locality

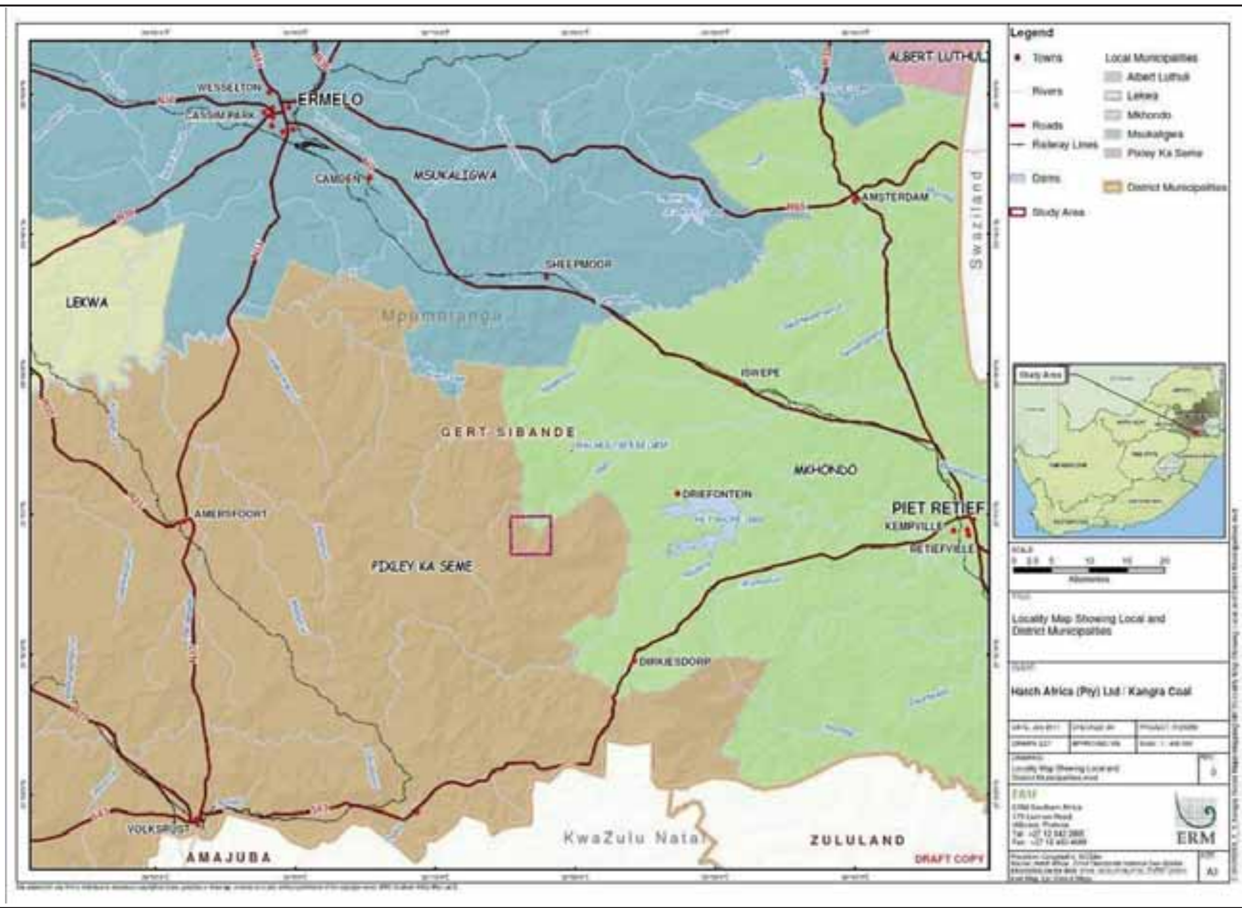
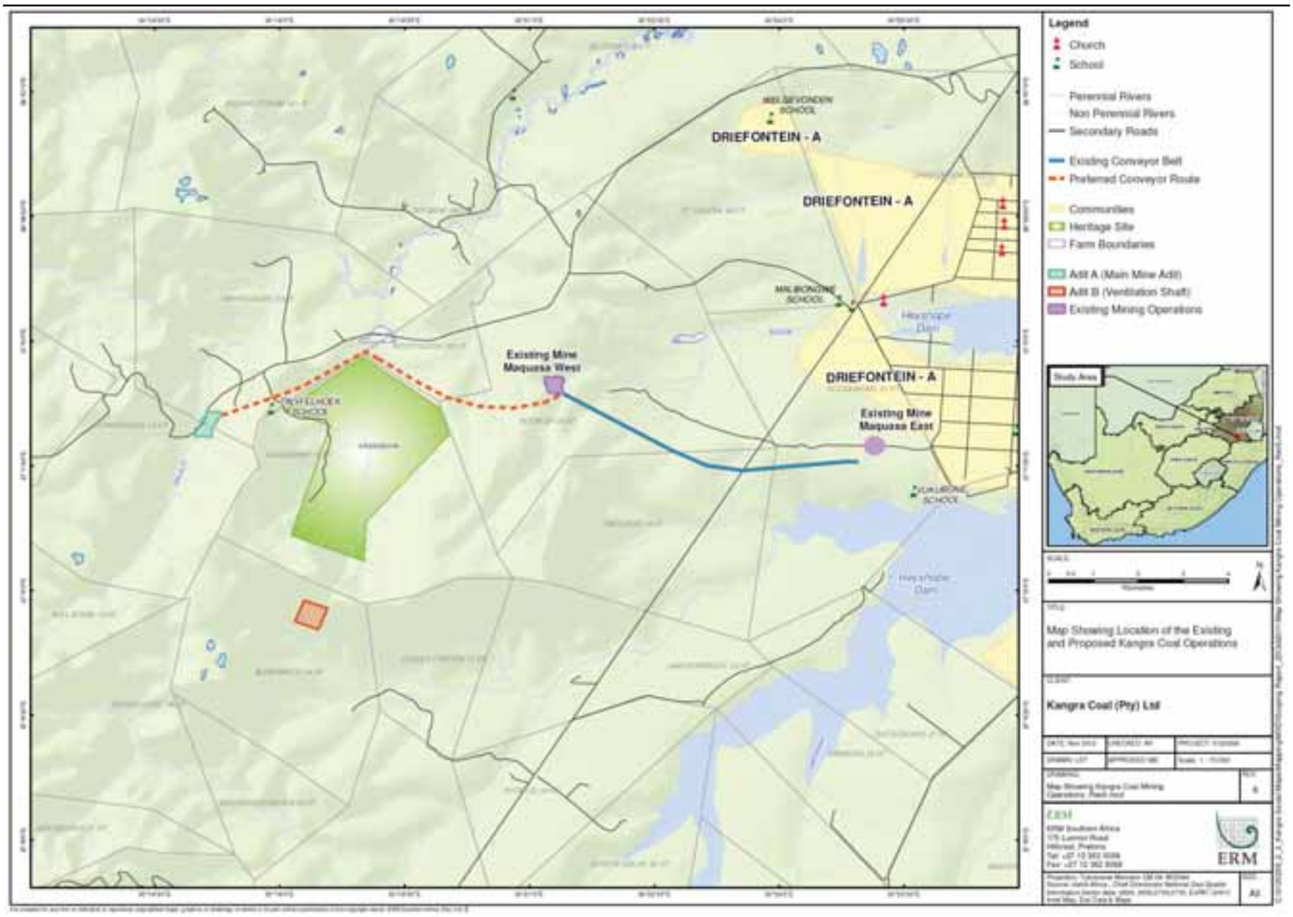


Figure 1.2 Location of Mine Site Infrastructure



1.3 STUDY OBJECTIVES

The objectives of the SWIA are to:

- Understand the existing environmental context from the perspective of surface water hydrology, and provide a benchmark of pre-Project conditions to help predict proposed Project-induced changes and inform the impact predictions.

- Provide an analysis of the direct and indirect impacts to surface water that are expected to result from the construction, operation and decommissioning phases of the proposed Kusipongo Expansion Project.

The SWIA is based on existing available information and evaluation of floods and estimated flood lines. Existing water quality data has been augmented by additional surface water sampling, obtained during a site visit in September 2011 and in February 2013, as well as a description of the flood peak calculations and flood width estimations. The study also takes into account previous hydrology studies undertaken in the greater Study Area. The anticipated impact of the proposed Project is described and illustrated where appropriate. The scope of the report is guided by the legal requirements as summarised in *Section* 2 below.

1.4 PROJECT TEAM

The team consisted of Anna M Jansen van Vuuren Pr Eng, hydrology and hydraulics expert, assisted by Rian Coetzee, a senior technician experienced in surface water analyses. Their qualifications and relevant experience are summarised below.

AM Jansen Van Vuuren. Civil Professional Engineer (ECSA Reg. No. 770359)

Years of experience:	36
Academic qualifications:	M Eng (Hydraulics), University of Pretoria, 1983 B Eng (Hons)(Civils) University of Pretoria, 1977 B Eng (Civils) University of Pretoria, 1972
Professional societies:	Fellow of SA Institute of Civil Engineering
Key experience:	Anna van Vuuren is a water engineer working in the field of water supply, stormwater management, hydrology and specialised hydraulic designs. Expert in the analysis of flood lines, hydraulic characteristics related to bridge and large drainage structures, as well as urban flood studies and stormwater management. Experience is widespread and includes planning,

analysis, design and construction supervision of water supply schemes and in the field of hydrology, the calculation of main catchment area runoffs and routing of flows as well as assessment of spillway capacity for dam safety inspections. She has attended post-graduate courses on flood hydrology jointly presented by Pretoria University and the Department of Water Affairs and Forestry, RSA. She is external examiner (Hydraulics, final year) at the University of Pretoria and has contributed to the SANRAL Drainage Manual (Chapter 8).

Rian Coetzee. Senior Civil Engineering Technician

Years of experience:	16
Academic qualifications:	National Diploma (Civil Engineering) Diploma (Project Management)
Professional societies:	None
Key experience:	Rian Coetzee is a specialist in the water and sanitation fields and hydrology. He is particularly experienced in the planning of civil engineering infrastructure projects and in stormwater studies. He was responsible for the design and site supervision of the Glen Alpine Dam flood damage repair work and rehabilitation work of the flood damaged Capes Thorn Dam in the Limpopo Province (Spies Dam). He has undertaken numerous flood studies for development projects and his tasks included site inspections, calculations and drafting of reports. Recent involvement in related fields includes the following:

1.5 STRUCTURE OF THE REPORT

The following two chapters (Chapter 2 and 3) describe the legal framework and impact assessment methodology respectively.

An account of the receiving environment in the Study Area is presented in Chapter 4, including the following aspects:

- Climatic data;
- Catchments and river systems;
- Water use; and

- Current water quality as determined over a period of 5 years as the Project concept was developed.

The effect that the proposed Project is expected to have on the natural system (*viz*. encroachment into the prescribed flood zones, reduction of natural runoff etc.) is then discussed in Chapter 5.

Chapter 6 includes a detailed impact assessment of the proposed project on the receiving surface water environment completed using the methodology described in Chapter 3. A high level surface water monitoring programme for all phases associated with the proposed Project is then presented in Chapter 7.

Chapter 8 provides a qualitative assessment of the anticipated cumulative impacts associated with impacts arising from the proposed Project and other developments (both existing and proposed) in the Study Area. Chapter 9 presents a conclusion to the Surface Water Impact Assessment.

2 LEGAL FRAMEWORK AND GOOD PRACTICE STANDARDS

The methodology to be followed in surface water assessments is largely prescribed by the national legal requirements and best practice guidelines compiled by the National Department of Water Affairs (DWA). In this regard this *Chapter* provides a review of legislation (both National and Regional) applicable to surface water aspects of the proposed Project.

2.1 NATIONAL LEGISLATION

2.1.1 Constitution of the Republic of South Africa (No. 108 of 1996)

Summary of Constitution

The Constitution of the Republic of South Africa is the legal source for all law, including environmental law, in South Africa. The Constitution enshrines the basic, fundamental and inalienable rights of the citizens of the Republic.

Applicability to Project

The Constitution stipulates under Section 24 that everyone has a right to an environment that is not harmful to their health or well-being. This right extends to protecting the environment for the benefit of present and future generations through legislative and other measures that are aimed at preventing pollution and ecological degradation, promoting conservation and secure ecologically sustainable development and use of natural resources. Sustainable development and use of natural resources must promote justifiable economic and social development.

2.1.2 National Environmental Management Act (Act No. 107 of 1998)

Summary of Act

The National Environmental Management Act (NEMA) creates the legal framework that ensures the environmental rights guaranteed in Section 24 of the Constitution are abided by.

As such the fundamental principles that apply to environmental decision making are laid out, the core environmental principle being the promotion of ecological sustainable development. These principles serve as a guideline for any organ of state when exercising any function in the process of decision making under NEMA.

NEMA introduces the duty of care concept which is based on the policy of strict liability. This duty of care extends to the prevention, control and rehabilitation of significant pollution and environmental degradation. It also dictates a duty of care to address emergency incidents of pollution. A failure to perform this duty of care may lead to criminal prosecution, and may lead to the incarceration of managers or directors of companies for the conduct of the legal persons.

Applicability to the Project

The proposed Project has the potential to impact on the receiving physical (including surface water), biophysical and social environments. As such potential impacts need to be thoroughly and competently assessed prior to execution of the proposed Project.

2.1.3 National Environmental Management Amendment ACT (Act No. 62 of 2008) EIA Regulations

Summary of Regulations

The NEMA provides the environmental legislative framework for South Africa. The NEMA Environmental Impact Assessment (EIA) Regulations provide two categories of activities, namely GN.R544 activities, which potentially only require a Basic Assessment before authorisation, and GN.R545 activities, which potentially require a comprehensive assessment (Scoping and an EIA). In other words, GN.R544 activities are perceived to have a lower impact than GN.R545 activities.

Applicability to Project

The following listed activity pertaining to water courses is deemed to be applicable to the proposed Project:

GN.R544 (11) – *the construction of –*

(iii) bridges;
(v) weirs;
(x) buildings exceeding 50 square meters in size; or
(xi) infrastructure or structures covering 50 square meters or more.

Where such construction occurs within a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.

The applicability of this activity requires that a Basic Assessment be undertaken. As a detailed Scoping and EIA is already been undertaken, this will fulfil the requirements necessary for the above mentioned, triggered activity.

2.1.4 *National Environmental Management: Waste Act (Act No. 59 of 2008) Regulations*

Summary of Act

The National Environmental Management: Waste Act is coupled with and supports the legislation to the NEMA. The Act gives legal effect to the White Paper on Integrated Pollution and Waste Management, and provides the basis for the regulation of waste management in South Africa. Further, the Act contains policy elements and provides a mandate for additional waste regulations that are to be promulgated.

Applicability to Project

Of relevance to the proposed Project is GN.R719 (July 2009), which comprises a list of waste management activities that have, or are likely to have, a detrimental effect on the environment. Activities included in this list require a Waste License. In order to obtain a Waste License, it is necessary that a Basic Assessment (for Category A activities) or Scoping and EIA (for Category B activities) be undertaken, in terms of the NEMA EIA Regulations.

The following listed activity pertaining to surface water management is deemed to be applicable to the proposed Project:

- **GN.R718 A (3)** – *The storage including the temporary storage of general waste in lagoons.*

  This activity will be triggered, as the proposed Project will have settling ponds to allow for the containment and possible treatment of stormwater emanating from the site.

- **GN.R718 B (7)** - *The treatment of effluent, wastewater or sewage with an annual throughput capacity of 15,000 cubic meters or more.*

  This activity will be triggered. The proposed mine will treat approximately 41m^3 of sewage per day (14 965m^3/annum). As this annual amount is essentially equal to the applicable threshold, a conservative approach will be adopted and it will be assumed that the annual volume of sewage treatment will be in excess of 15 000m^3.

  In addition, decanted groundwater (from mine inflow) will only be chemically treated if necessary (during the operational phase) and, solids in the water will be settled out in a silt trap and settling pond (20 000m^3 volume) prior to on-site use.

Kangra Coal are committing to a Zero Effluent Discharge policy for the proposed Kusipongo Resource Project. As such, it is anticipated that all process water will be reused and will not be discharged into the natural environment.

The applicability of the above mentioned activities requires that both Basic Assessment and a detailed Scoping and EIA be undertaken. As such, a detailed Scoping and EIA will be carried out, as this will fulfil the legal requirements necessary for all triggered activities.

2.1.5 National Water Act (Act No. 36 of 1998)

Summary of Act

The purpose of the National Water Act (NWA) is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in an environmentally sustainable way.

Applicability to Project

The following Sections of the NWA are deemed applicable to the proposed Kangra Coal Kusipongo Resource Project, given the presence of water courses, streams and wetlands at Adit A and along the route of the conveyor, as well as to the identified users of water in the Project area.

Definition of Watercourse

In terms of the NWA, a *watercourse* is defined as follows (Section 1.1 (xxiv)):

- *A river or spring;*
- *A natural channel in which water flows regularly or intermittently;*
- *A wetland, lake or dam into which the Minister may, by notice in the Gazette, declare to be a watercourse, and reference to a watercourse includes, where relevant, its beds and banks.*

Based on the above definition, even small drainage lines are defined as *watercourses*.

Section 1.1 (xxix) defines a *wetland* as –

… land that us transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

Water Use

Section 21 of the NWA defines Water Use as including:

- Taking water from a water resource;
- Storing water;
- Impeding or diverting the flow of a water course;
- Engaging in a stream-flow reduction activity;
- Engaging in a controlled activity identified in s31(1) or declared under s38(1);
- Discharging waste or water containing waste into a water resources through a pipe, canal, sewer, sea outfall or other conduit;
- Disposing of waste in a manner that may detrimentally impact on a water resource;
- Disposing in any manner of water containing waste from or which has been heated in any industrial or power generation process;
- Altering the bed, banks, course or characteristics of a water course;
- Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for human safety; and
- Using water for recreational purposes.

Water Use Licenses

In terms of Section 39 of the NWA, there are a number of activities, which are stipulated in GN.R1191, that require varying authorisations. Water uses that need to be licensed under Section 21 of the Act include:

- Taking water from a water resource;
- Storing water;
- Impeding or diverting the flow of water in a watercourse;
- Engaging in a stream flow reduction activity contemplated in section 36;
- Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
- Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
- Disposing of waste in a manner which may detrimentally impact on a water resource;
- Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
- Altering the bed, banks, course or characteristics of a watercourse;
- Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
- Using water for recreational purposes.

A number of water use licenses (number still to be confirmed) will be required for the proposed Project. These license requirements will be coupled with a variety of activities associated with the proposed Project. A specialist has been appointed to identify Project related activities that will require the need for applications for Water Use Licenses. The identification and application of these licenses will take place post ESIA.

Pollution Prevention

Also of relevance to the proposed Project is Section 19 of this Act, which deals with pollution prevention (Part 4).

Part 4 deals with pollution prevention and in particular the situation where pollution of a water resource occurs or might occur as a result of activities on land. The person who owns, controls, occupies or uses the land in question, is responsible for taking reasonable measures to prevent pollution of water resources. If the measures are not taken, the catchment management agency concerned, may itself do whatever is necessary to prevent the pollution or remedy its effects and recover all reasonable costs from the persons responsible for the pollution.

The 'reasonable measures' which have to be taken may include measures to:

- Cease, modify or control any act or process causing the pollution;
- Comply with any prescribed waste standard or management practice;
- Contain or prevent the movement of pollutants;
- Eliminate any source of pollution;
- Remedy the effects of pollution; and
- Remedy the effect of any disturbance to the bed and banks of a watercourse.

With respect to pollution and all alterations of rivers, water courses, water flow systems (above or below ground), the following definition is relevant when considering the potential impacts of development on water resources. Pollution may be deemed to occur when the following are affected:

- The quality, pattern, timing, water level and assurance of flow;
- The water quality, including the physical, chemical and biological characteristics of the water.

A further relevant definition is that of 'waste' which is defined as including:
"…..*any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, a water resource to be polluted*".

2.1.6 *National Water Act (Act No.36 of 1998) Government Notice No. 704. Government Gazette Vol. 408, No. 20119: Regulations on Use of Water for Mining and Related Activities aimed at the Protection of Water Resources*

Summary of Government Notice

Mining and associated infrastructure development is guided by the provisos in the Government Notice number 704 (GN.R704), particularly Regulations 4, 6 and 7, which are described as follows:

- **Regulation 4** – this regulation addresses the locality of developments, where estimated flood zone widths are set as buffer zones for development, or zone widths are prescribed. These include the following:
  - No facility, including residue deposits, dam, reservoir to be located within the 1:100-year floodline or within 100m from any watercourse, borehole or well.
  - No underground or opencast mining or any other operation or activity under or within the 1:50-year floodline or within a horizontal distance of 100m, whichever is the greatest.
  - No disposal of any residue or substance likely to cause pollution of a water resource in the workings of any underground or opencast mine.
  - No placement of any sanitary convenience, fuel depots or reservoir for any substance likely to cause pollution within the 1:50-year floodline.

- **Regulation 6** – this regulation addresses the capacity requirements of clean and dirty water systems. The relevant issues in this regard include:
  - Clean water systems should not spill into any dirty water system more than once in 50 years.
  - Likewise, any dirty water system should not spill into clean water systems more than once in 50 years.
  - Any dam that forms part of a dirty water system to have a minimum freeboard of 0.8m above the full supply level.
  - In summary, the water systems should be designed, constructed and maintained to guarantee the serviceability for flows up to and including the 1:50-year flows.

- **Regulation 7** – this regulation addresses the measures to protect water resources and includes the collection and re-use, evaporation or purification of water containing waste; measures to be taken to minimise the flow of any surface water into any mine or opencast workings; prevention of erosion or leaching of materials from any stockpile; ensuring that process water is recycled as far as practicable.

The *major stormwater management principle* prescribed in GN 704 is the one indicating that clean and contaminated stormwater should be kept separate by draining contaminated water dams or ponds for re-use or evaporating and diverting clean stormwater around dirty areas.

Applicability to Project

Based on the above requirements, the Surface Water Assessment and associated Impact Assessment needs to estimate the flood peaks along affected drainage lines and determine the associated flood zone widths. Flood peak estimation is undertaken through application of methods such as the Rational Method or through statistically analysing available flood data. Site survey data is used in flood modelling software for the determination of flood widths for the stipulated floods as per the recommendations above.

Finally, by overlaying the proposed Project on a site map, the layout of an adequate stormwater management system can be determined and conceptually designed, as required in the Social and Environmental Management Programme (SEMP), thereby limiting the impact of the proposed Project on surface water sources in the greater Study Area.

2.2 REGIONAL STRATEGY

The Usutu River Water Quality Strategy (Department of Water Affairs Internal Strategic Perspective No. 6.3 of 2004) is applicable to the proposed Project in that the strategies objective is to maintain the pristine nature and very high quality of water in the upper Usutu so that it remains suitable for cooling requirements of Eskom's power stations. Furthermore, the strategy of this Strategy that is applicable to the proposed Project is as follows:

Assess the mining potential (especially for coal) in the upper Usutu catchment. There should be no further coal mining within this catchment, although a long term plan for the possible development of these reserves should be considered in the light of future demand.

2.3 NATIONAL STANDARDS

2.3.1 South African National Standards (SANS) as published by the South African Bureau of Standards (SABS)

In terms of the Standards Act, 2008 (Act No.8 of 2008), the Council of the South African Bureau of Standards (SABS) published the South African National Standards (SANS). The SABS is responsible for maintaining South Africa's database of more than 6 500 national standards, as well as developing new standards and revising, amending or withdrawing existing standards as required. The SABS commercial services can be divided into the following clusters:

1. Chemicals;
2. Electro-technical;
3. Food and Health;
4. Mechanical and Materials;
5. Mining and Minerals;
6. Services; and
7. Transportation.

Applicability to Project

The Project will need to comply to the SANS water quality and noise standards. These standards are discussed in this section.

Water Quality

Of applicability to this Project is the South African National Standard for drinking water (SANS 241-1:2011), applicable to both the potable use of surface and ground water.

2.4 NATIONAL GUIDELINES

2.4.1 DWA Procedure for Identification and Delineation of Wetland Riparian Areas

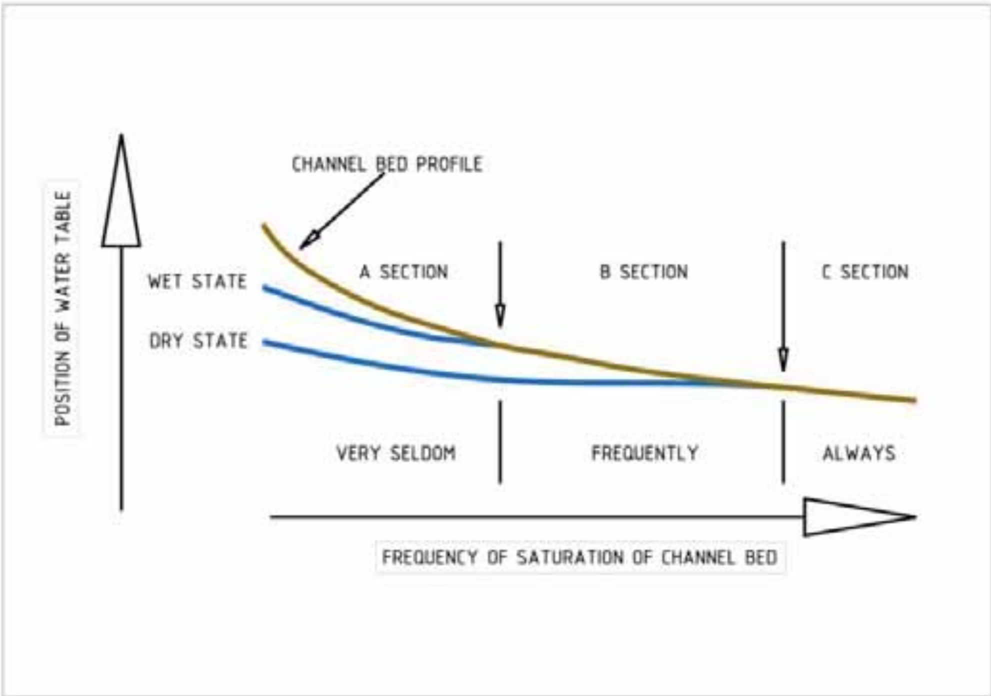
Summary of Guideline

Natural channels may be classified according to guidelines by the DWA in "*A practical field procedure for identification and delineation of wetlands and riparian areas*" as shown in *Figure 2.1* (taken from DWA, 2005). Three sections (namely Sections A to C) along the length of a watercourse are defined as follows:

- **Section A**: above the zone of saturation and does not carry baseflow. Are mostly too steep to be associated with alluvial deposits and are not flooded with sufficient frequency to support riparian habitat or wetlands. This type does however carry stormwater runoff during fairly extreme rainfall events but the flow is of short duration. Section A watercourse sections are the least sensitive watercourses in terms of impacts on water yield from the catchment.

- **Section B**: those channels that are in the zone of the fluctuating water table and only have baseflow at any point in the channel when the saturated zone is in contact with the channel bed. In this Section B **baseflow is intermittent**, with flow at any point in the channel depending on the current level of the water table. Because the channel bed is in contact with, or in close proximity to, the water table, residual pools are often observed when flow ceases. The gradient of the channel bed is flat enough in these Sections for deposition of material to take place. Initial signs of flood plain development may be observed.

Figure 2.1 Classification of Natural Channels (DWA 2005)



- **Section C**: the water table is always above river bed level and river flow in this section is perennial.

The hydro-geomorphic types of wetlands include floodplain, valley bottom with channel, valley bottom without channel, hillslope seepage feeding a water course, hillslope seepage not feeding a water course and depressions (pans) as illustrated and described below (Kotze *et al.* 2007). It must be noted that the system excludes artificial wetlands from the classification.

- **Floodplain** – Valley bottom areas with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs occur from the main channel (when the channel banks overspill) and from adjacent slopes.

- **Valley Bottom with a Channel** – Valley bottom areas with a well-defined stream channel but lacking the characteristic floodplain features. May be gently sloped characterised by the net accumulation of alluvial deposits, or may have steeper slopes and be characterised by the net loss of sediment.

Water inputs occur from the main channel (when channel banks overspill) and from adjacent slopes.

- **Valley Bottom with No Channel** – Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs occur mainly from the channel entering the wetland and also from adjacent slopes.

- **Hillslope Seepage Linked to a Stream Channel** – Slopes of hillsides which are characterised by colluvial (transport by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.

- **Isolated Hillslope Seepage** – Slopes of hillsides which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through a diffuse sub-surface and/or surface flow, but no direct surface water flow connection to a stream channel.

- **Depression (includes pans) -** A basin-shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.

Applicability to Project

A wetland delineation assessment following the DWA delineation guideline was undertaken for the site at Adit A, and along the conveyor route.

Both valley bottom wetlands with a channel and valley bottom wetlands without a channel were identified and mapped at Adit A, and the layout of Adit infrastructure amended accordingly.

Along the conveyor route, numerous wetlands, including valley bottom with a channel, valley bottom without a channel, isolated hillslope seepage and hillslope seepage linked to a channel were identified.

2.4.2 Water Quality Guidelines

Water quality guidelines for surface are applicable to the Project, based on the following water users identified for the Project area:

- Aquatic ecology; and
- Stock watering.

The following guidelines published by DWAF are applicable:

- DWAF, 1996. *South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems*; and
- DWAF, 1996. *South African Water Quality Guidelines. Volume 5: Livestock Watering*.

Derivation of Surface and Groundwater Screening levels using the Water Quality Standards and Guidelines

Using baseline surface water and groundwater quality results, the South African Water Quality Standards for Drinking Water (i.e. SANS241:2011), and the South African Water Quality Guidelines for both Aquatic Ecosystems and Livestock Watering, site specific surface water screening levels were derived.

Surface Water Criteria

The following rationale was followed to develop the surface water standards:

- The most conservative of the aquatic ecology/drinking water/livestock watering guidelines was adopted as the screening level, except in the instance where the average baseline surface water quality exceeded the screening level.

- Where the baseline surface water quality exceeded the screening level, the screening level was set to a value two standard deviations higher than the mean for that parameter in baseline surface water.

- In the case of the major cations and anions, the most conservative screening level was for drinking water. However, due to the extremely low TDS of the baseline surface water, if the drinking water screening levels are adopted, this will result in the TDS exceeding the aquatic ecology screening levels of less than a 15% change in baseline conditions. In order to account for this, screening levels for major cations and anions were calculated assuming stoichiometric dissolution of $CaSO_4$ or NaCl to the point at which the TDS was 15% above the baseline value.

The screening level derivation for surface water is shown in *Table 2.1* overleaf.

Please Note:

- The derivation of these screening levels is based on a total of 18 spring and 12 river samples from the wet season only, and the screening levels should be continually updated using additional baseline surface water monitoring data from all seasons.

- The screening levels are intended to be used to assess the quality of water in natural surface water systems. The screening levels are not discharge standards.

- The General Authorisations in Terms of Section 39 of the National Water Act (1998) would apply for waste discharge into surface water systems.

Table 2.1 Derivation of <u>Surface</u> Water Screening Levels

SampleID	Units	Springs		oHlelo Stream		DWAF Aquatic Ecology	SANS241 Drinking Water Quality	DWAF Livestock watering (most conservative species)	Derived screening level	Rationale
		Mean concent-ration	Mean+2SDs	Mean concen-tration	Mean+2SDs	TWQR		TWQR		
Lab pH		7.00	8.5	8.2	8.4	7.9-8.5	5 - 9.7		**6.9-8.5**	Aquatic ecology & baseline
Lab EC	mS/m	7.22	17.1	8.8	10.7		170			
Lab TDS	mg/L	32.06	73.0	41.0	49.0	33 - 49	1200	1000	**30-50**	Aquatic ecology
Ca	mg/L	4.32	11.8	5.2	6.3			1000	**12**	Calculated based on TDS limits
Mg	mg/L	2.93	7.8	3.2	3.7			500		
Na	mg/L	3.53	7.1	5.9	7.7		200	2000	**16**	Calculated based on TDS limits
K	mg/L	0.94	3.1	1.5	4.5					
Cl	mg/L	5.52	14.5	2.7	4.7		300	1500	**22**	Calculated based on TDS limits
SO4	mg/L	1.96	4.7	2.9	4.2		250	1000	**31**	Calculated based on TDS limits
NO3	mg/L as N	0.29	0.71	0.12	0.22	0.22	11	23	**0.75**	Baseline
F	mg/L	0.37	0.76	0.23	0.27	0.75	1.5	2	**0.75**	Aquatic ecology
Alkalinity	mg/L as CaCO3	20.09	53.5	32.7	37.3					
Al	mg/L	0.14	0.456	0.017	0.018	0.0100	0.3	5	**0.50**	Baseline
Fe	mg/L	0.19	1.113	0.075	0.185	0.2031	0.3	10	**0.20**	Aquatic ecology
Mn	mg/L	0.06	0.320	0.001	0.001	0.1800	0.1	10	**0.18**	Aquatic ecology
Ni	mg/L	0.01	0.028	-	-		0.07	1	**0.07**	Drinking water
Zn	mg/L	0.01	0.030	0.012	0.012	0.0020		20	**0.03**	Baseline
Co	mg/L	-	-	-	-		0.5	1	**0.50**	Drinking water
Cd	mg/L	-	-	-	-	0.0003	0.003	0.01	**0.00025**	Aquatic ecology
Pb	mg/L	0.02	0.020	-	-	0.0005	0.01	0.1	**0.05**	Baseline
V	mg/L	0.02	0.033	0.007	0.014		0.2	1	**0.20**	Drinking water

2.4.3 Regional Plans and Policies

The following table highlights a selection of provincial plans and policies seen to be most pertinent to this study and the proposed project.

Table 2.2 Regional Development Policy Context

Policy	Key Aspects/Objectives
Usutu River Water Quality Strategy (Department of Water Affairs Internal Strategic Perspective, No. 6.3 of 2004)	The *objective* of this strategy is to maintain the pristine nature and very high quality of water in the upper Usutu so that it remains suitable for cooling requirements of Eskom's power stations. The section of this strategy that is applicable to the proposed Project is as follows: *Assess the mining potential (especially for coal) in the upper Usutu catchment. There should be no further coal mining within this catchment, although a long term plan for the possible development of these reserves should be considered in the light of future demand.*

2.5 PROPONENTS CORPORATE ENVIRONMENTAL POLICY

Kangra Coal is committed to responsible environmental stewardship and sustainable business practices; Kangra Coal pledges to improve their overall environmental performance across all their business activities. Kangra Coal encourages their business partners and members of the entire Kangra group to participate in this endeavour.

In accordance with this Environmental Policy (ENV-P-001), Kangra Coal strives for compliance with all environmental laws and commits to manage all of its activities in the environment.

3 IMPACT ASSESSMENT METHODOLOGY

The impact assessment stage comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors. The steps involved in the impact assessment stage are described in greater detail below.

From information gathered in the baseline data collection Phase and information made available by the Project Team, potential impacts are identified, be it physical or in the biological or cultural sphere. These Impacts are best assessed in a structured manner as described below.

3.1 IMPACT ASSESSMENT

The impact characteristic terminology to be used is summarised in *Table 3.1*.

Table 3.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value]

In the case of type, the designations are defined universally (i.e., the same definitions apply to all resources/receptors and associated impacts). For these universally-defined designations, the definitions are provided in *Table 3.2*.

Table 3.2 Designation Definitions

Designation	**Definition**
	Type
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
	Extent
Local	Defined on a resource/receptor-specific basis.
Regional	
International	
	Duration
Temporary	Defined on a resource/receptor-specific basis.
Short-term	
Long-term	
Permanent	

In the case of *extent* and *duration*, the designations themselves (shown in *Table 3.1*) are universally consistent, but the definitions for these designations will vary on a resource/receptor basis (e.g., the definition of what constitutes a "short term" duration for a noise-related impact may differ from that of a "short term" duration for a habitat-related impact). This concept is discussed further below.

In the case of *scale* and *frequency*, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of acres affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

An additional characteristic that pertains only to unplanned events (e.g., traffic accident, operational release of toxic gas, community riot, etc.) is *likelihood*. The likelihood of an unplanned event occurring is designated using a qualitative (or semi-quantitative, where appropriate data are available) scale, as described in *Table 3.3*.

Table 3.3 Definitions for Likelihood

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource/receptor sensitivity/vulnerability/importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (e.g., modelling, frequency charts) where available.

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. As in the case of extent and duration, the magnitude designations themselves (i.e., negligible, small, medium, large) are universally used and across resources/receptors, but the definitions for these designations will vary on a resource/receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *negligible* magnitude. In the case of positive impacts no magnitude will be assigned.

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource/receptor is biological or cultural (for example, the marine environment or a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact.

Impact significance is designated using the matrix shown in *Table 3.4*.

Table 3.4 Impact Significances

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box 3.1* provides a context for what the various impact significance ratings signify.

Box 3.1 Context of Impact Significances

An impact of ***negligible*** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of ***minor*** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of ***major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

3.2 MITIGATION OF IMPACTS

Once the significance of a given impact has been characterised using the above matrix, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any impact assessment is to help our clients develop a consentable Project, and to help them achieve their business objectives in a responsible manner. Impact assessment is about identifying the aspects of a Project that need to be managed, and demonstrating how these have been appropriately dealt with and left a good quality and appropriate development. As key influencers in the decision making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an ALARP level.

Embedded controls (i.e., physical or procedural controls that are planned as part of the Project design and are not added in response to an impact significance assignment), are considered as part of the Project (prior to entering the impact assessment stage of the impact assessment process).

3.3 RESIDUAL IMPACT

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

3.4 CUMULATIVE IMPACTS/EFFECTS

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process should predict any cumulative impacts/effects to which the Project may contribute. The approach for assessing cumulative impacts and effects resulting from the Project and another activity affecting the same resource/receptor is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

4 RECEIVING ENVIRONMENT

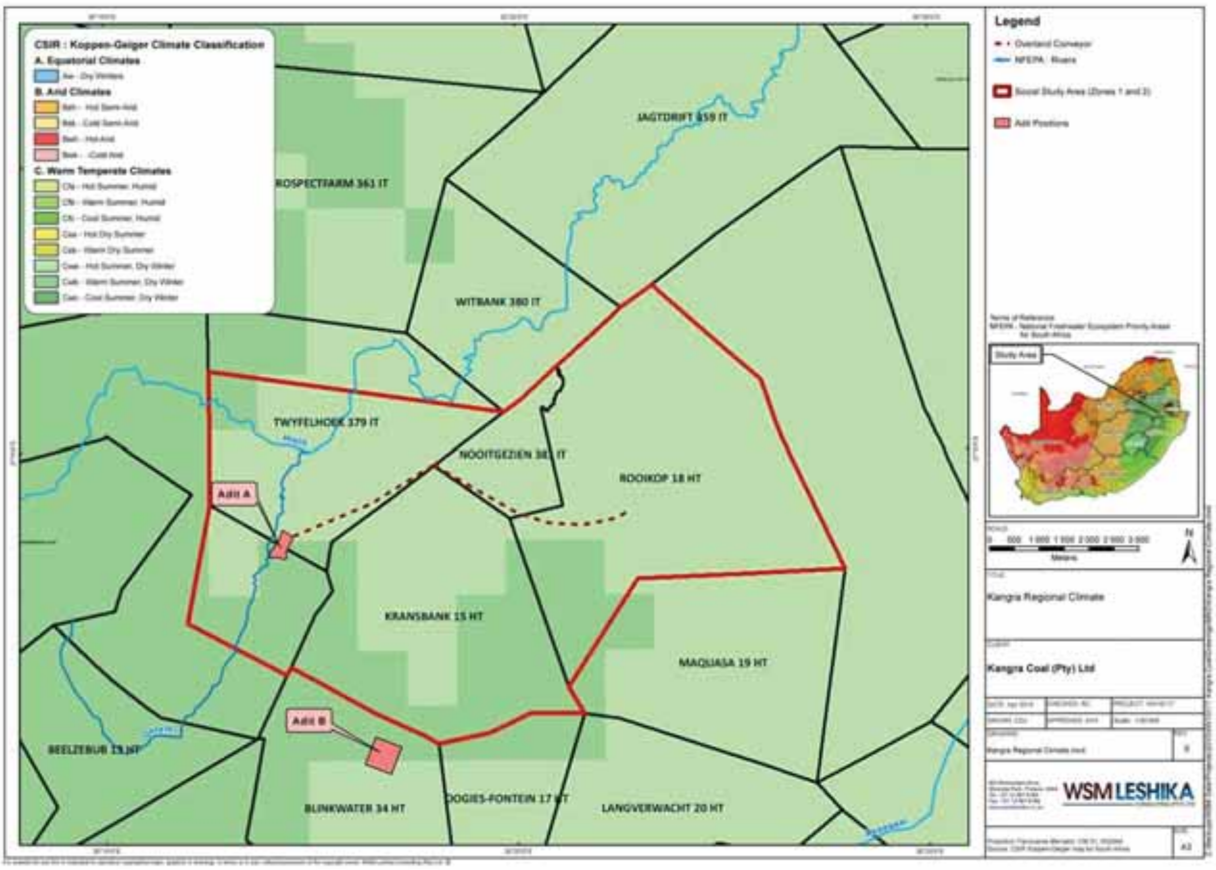
This description of the baseline environment is essential in that it represents the conditions of the environment before the construction of the proposed Kusipongo Resource Expansion Project. The description of the baseline environment therefore provides a description of the current environment against which the impact of the proposed Project can be identified, assessed and future changes monitored.

The information presented in this Section has been collected from desktop studies and supplemented with site visits to the Study Area.

4.1 CLIMATE

The proposed Project is located on the border of two climatic zones, based on the Köppen-Geiger classification for South Africa (Van Dyk and Kumirai 2012), namely the 'Warm Temperate Hot Summer Dry Winter' (Cwa) to the east and the 'Warm Temperate Warm Summer Dry Winter' (Cwb) to the west, as shown in *Figure 4.1*. The higher elevation to the west towards the Vaal River catchment area leads to cooler temperatures. During the warm summer months of December and January the average daily temperature is between 20 and 26°C, while the minimum temperatures in winter drops as low as 4°C.

Figure 4.1   Köppen-Geiger Climate Classification

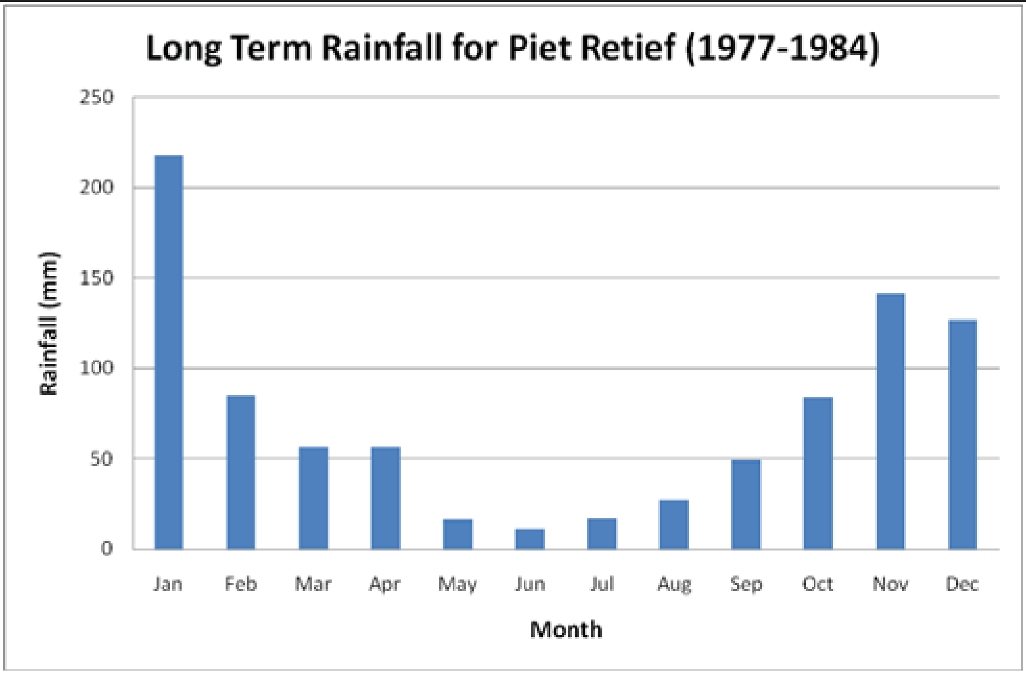


4.1.1 *Precipitation*

The orography associated with the escarpment to the west of the Project Area has an impact on the local wind and rain climate. Increased precipitation is generally found slightly upwind from the prevailing winds at the crests of mountain ranges, where they relieve and therefore the upward lifting is greatest. As the air descends on the lee side of the mountain, it warms and dries, creating a rain shadow.

Piet Retief lies in the summer rainfall region of South Africa, in which more than 80% of the annual rainfall occurs from October to March, with a peak in January. The rainfall events are highly localised in the form of conventional thunderstorms. These storms are sometimes accompanied by hail. Long-term monthly average rainfall figures for Piet Retief are depicted in *Figure 4.2*. Long-term average total annual rainfall is in the range of 800 to 890 mm (Weather Bureau, 1986). (Further data up to 2005, is presented in *Table 4.1*.

Figure 4.2 Long-term Monthly Rainfall for Piet Retief (1977 to 1984)



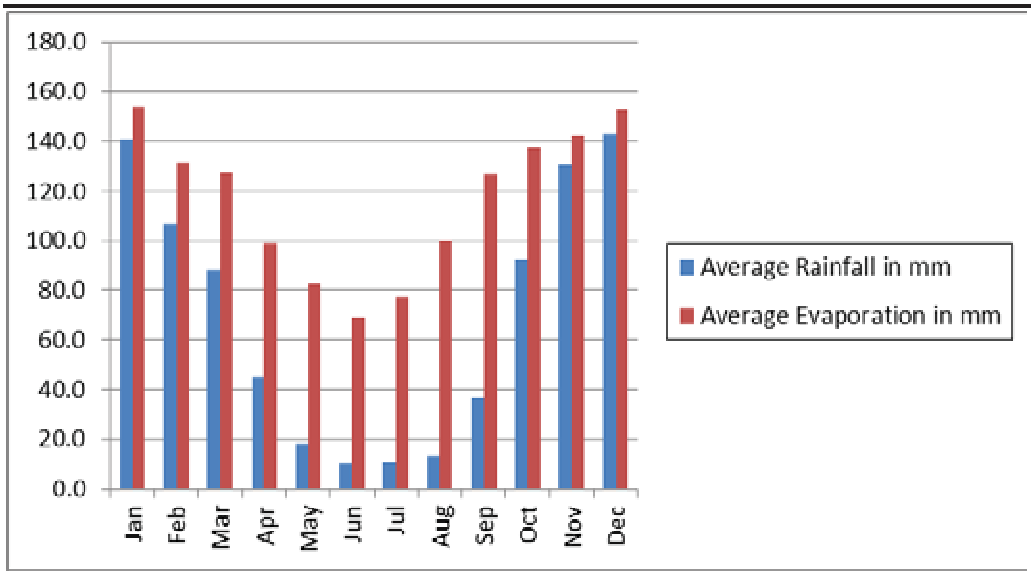
Considering the changing climate pattern to the west as described above, the rainfall and evaporation data published by the Water Research Commission in the Water Resources 2005 study (Middleton and Bailey, 2009) is used. The country is divided into quaternary catchment areas and the data for the upper Hlelo River catchment area, quaternary catchment number W52A, is deemed to be more representative of the Project Area and is shown below.

In the Water Resources 2005 study, monthly precipitation data was generated by considering data from up to eleven rain gauges in the Hlelo River region, for an 85 year period. From this record, the average monthly values and the average annual values were calculated. The mean annual precipitation (MAP) is 836mm while the mean annual Symons Pan evaporation is 1 400mm. The data is shown in *Table 4.1* and *Figure 4.2* overleaf.

Table 4.1 Mean Annual Precipitation and Evaporation (Source: WR2005)

Month	Average Rainfall (mm)	Average Evaporation (mm)
January	140.9	153.72
February	107.1	131.46
March	88.1	127.26
April	44.8	98.98
May	17.9	82.32
June	10.5	69.16
July	11.0	77.56
August	13.4	100.10
September	36.7	126.98
October	92.3	137.06
November	130.5	142.66
December	142.7	152.74
Total:	**836.0**	**1 400.00**

Figure 4.2 Monthly Average Rainfall and S-pan Evaporation



From the above, it is evident that the Project Area receives the majority of its rainfall during the summer months (October through to March) with an average rainfall of just over 800mm/annum. Average annual evaporation is approximately 1 400mm/annum.

4.1.2 Maximum Rainfall – Storm Events

The eastern part of Mpumalanga is part of the landmass in Southern Africa that is affected by cyclones, and in January 1984 Cyclone Domoina resulted in the highest observed rainfall in the area. This was the first cyclone centre to penetrate the country (and the only one to date) (Kovaćz *et al.*, 1985).

In Piet Retief, Domoina caused a maximum daily rainfall of 186mm, with ha total rainfall over three days of 511mm. The risk of large rainfall and flood events occurring in the area is higher than regions in the moderate central parts of the country.

4.1.3 *Wind*

Since no on-site meteorological data are available, hourly average meteorological data from the South African Weather Service (SAWS) station in Piet Retief for the period 2002 to 2005 was analysed. This station is located approximately 40km east of the proposed Project area. The prevailing winds are presented in the form of wind roses (1) in *Figure 4.3*.

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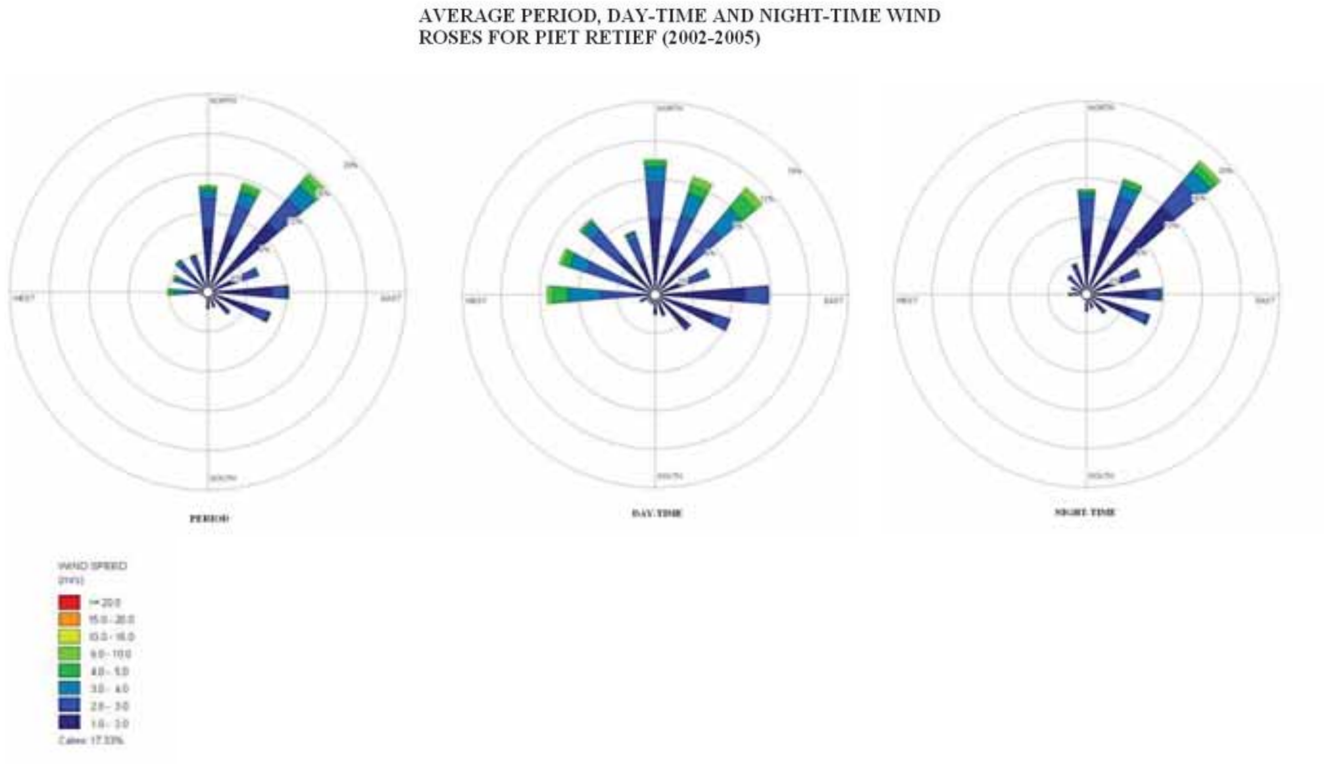
(1) Wind roses comprise 16 spokes which represent the directions from which winds blew during the given period. The colours reflect the different categories of wind speeds, the grey area, for example, representing winds of 1 to 3 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. For the

Figure 4.3 Wind Roses for the Period 2002 to 2005 Recorded at Piet Retief



Source: South African Weather Service

The predominant wind direction is from the north-east with a frequency of occurrence of 16%. Winds from the northern sector are also predominant, occurring 10% of the total period. During day-time, strong winds from the north and north-easterly sectors occur frequently (9% and 10% of the time, respectively). There is an increase in north easterly flow with a decrease in westerly and north-westerly air flow during the night-time.

4.1.4 Ambient air Temperature

Long-term average maximum, mean and minimum temperatures for Piet Retief are summarised in *Table 4.2*. An annual mean temperature for Piet Retief is 16.6°C.

Table 4.2 Long-term Minimum, Maximum and Mean Temperature for Piet Retief (Schulze, 1986)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	26.4	26.2	25.7	24.1	21.8	19.2	18.9	20.8	21.4	23.4	24.6	26.4
Mean	20.9	20.7	19.7	17.3	14	10.9	11.2	13.4	15	17	18.7	20.1
Min	15.3	15.1	13.6	10.5	6.3	2.7	3.5	6	8.9	10.8	12.9	13.9

4.2 SURFACE WATER HYDROLOGY

4.2.1 Catchments Applicable to the Project Area

The Project Area is situated in the northern part of primary area "W", which includes a number of eastward draining rivers, including all tributaries of the Usutu River system. The Ohlelo River is one of the southern tributaries of the Usutu River system. The major components of the planned Kusipongo expansion are situated in the Ohlelo River catchment area of the Usutu River catchment, which forms part of the Maputo River Basin. The Ohlelo River flows eastwards from the escarpment to converge with the Nwempisi River in Swaziland. Drainage on top of the escarpment is westwards via the Vaal River to the Orange River system.

The site proposed for the main mine adit (Adit A) and temporary contractor's camp is located within quaternary river catchment areas W52A on the Ohlelo River and its tributaries (refer to *Figure 4.4*). The site proposed for the ventilation adit (Adit B) is located south of Adit A in the headwaters of catchment W51B of the Assegaai River (*Figure 4.4)*. The proposed overland conveyor system will traverse both catchment W52A and W51B, linking Adit A and the existing Maquasa West conveyor system (*Figure 4.4)*. The locality of quaternary catchment areas W52A and W51B are illustrated in *Figure 4.5* and the characteristics of the catchment are given in *Table 4.3*.

Table 4.3 Details of Quaternary Catchment Areas

ADIT	QUATERNARY CATCHMENT	TOTAL AREA (km^2)	MEAN ANNUAL PRECIPITATION (mm)	MEAN ANNUAL EVAPORATION (mm)	MEAN ANNUAL RUNOFF (mm)
A	W52A	289	836	1 400	107
B	W51B	496	864	1 400	90

Source: Middleton and Bailey (2009)

A description of each quaternary catchment follows below.

Figure 4.4 Locality of Proposed Project in Relation to Catchments

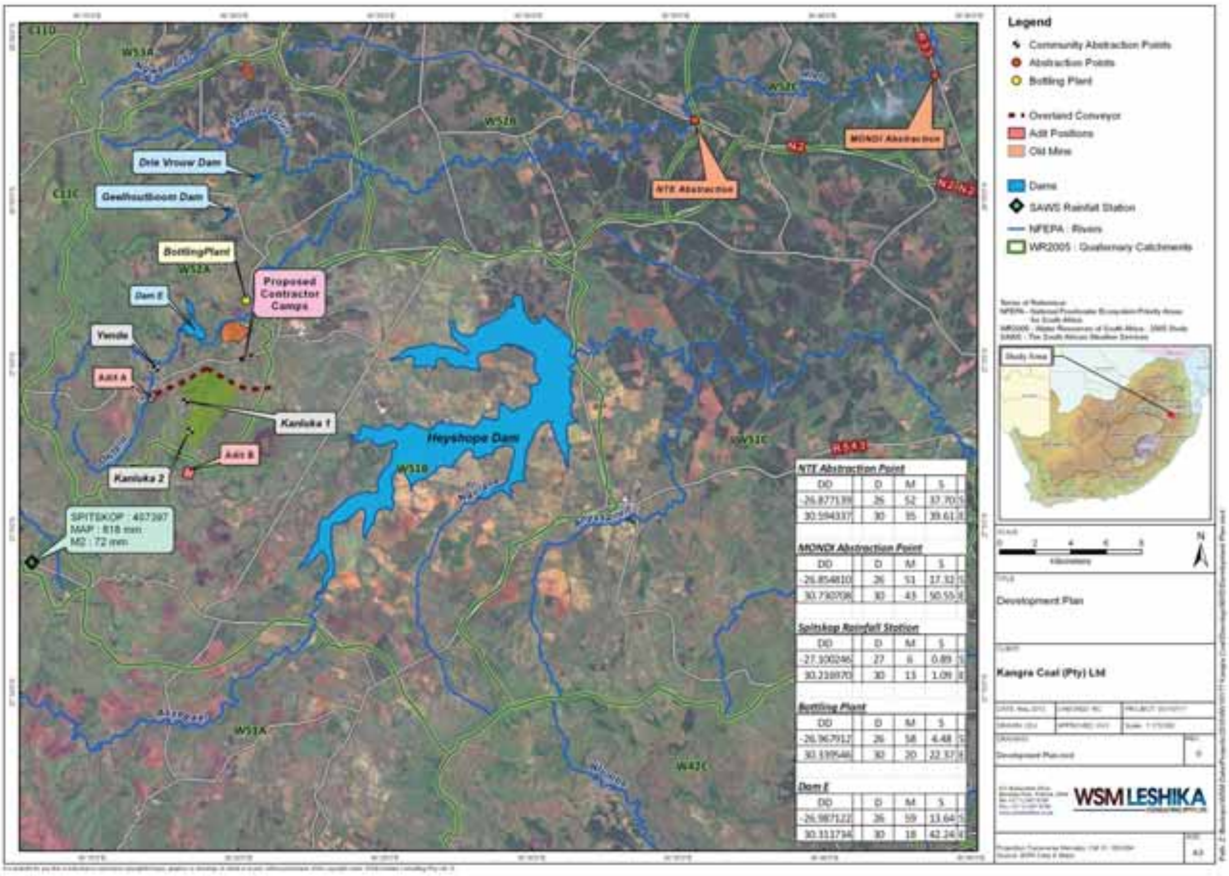
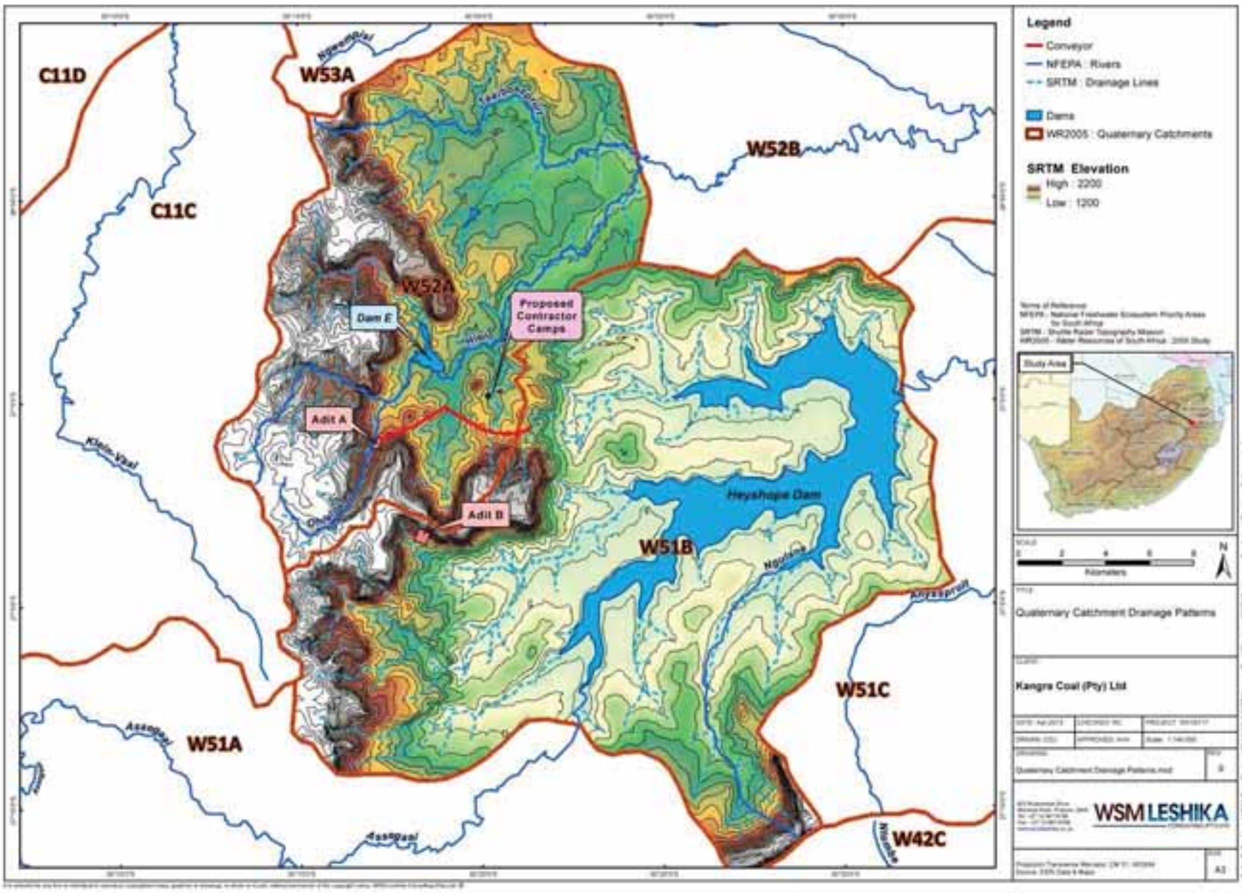


Figure 4.5 Quaternary Catchment Drainage Patterns



4.2.2 *Catchment W52A (Ohlelo River Catchment)*

Description

The water resources of the upper Usutu River catchment have been developed to transfer water westwards to the Vaal River system where it is allocated for use by Eskom, and transferred directly to the power stations in the Olifants Water Management Area. This development consists of the Heyshope Dam in the W51 catchment, the Morgenstond and Jericho dams in the W53 catchment, and the Westoe Dam in the W54 catchment.

This is in contrast to the Ohlelo River, which is largely undeveloped with no major impoundments. This adds to this river's uniqueness in that its flow system is relatively undisturbed.

The exception in the Ohlelo River catchment is the Geelhoutboom Balancing Dam on a northern tributary of the Ohlelo River, which functions as a large pumping pond: water is transferred by canal from the Heyshope Dam on the Assegaai River to the Geelhoutboom Dam where a high-lift pump station transfers water to the bulk water supply system in the Vaal River catchment area.

There is one registered farm dam located on a northern tributary of the Ohlelo River. The dam (indicated in *Figure 4.5*, and located at coordinates; 26°54'16.14''S 30°20'51.54''E), is known as the "Drie Vrouw Dam" (as registered with DWA) and is a dam safety category Class 1 dam, with height 5.1m and volume of 300 000 m^3.

An un-rehabilitated coal mine and its appurtenant works are situated 11km downstream from the proposed main mine adit (Adit A), along both sides of the Ohlelo River at co-ordinates; 26°58'26.34'' S 30°20'02.88''E. Discarded coal can be found on the flood plain alongside the main channel of the river. Stormwater control dams below the product storage sites, which are outside the river floodplain, have been breached allowing contaminated stormwater to drain into the Ohlelo River at this location.

Another worked-out mine situated on the farm Taaiboschspruit at co-ordinates 26°51'08.28'' S 30°20'28.75'' E, occurs on a tributary to the Ohlelo River, which has its confluence with the Ohlelo River approximately 29km from the site proposed for Adit A.

Water Users in the Ohlelo River Catchment

The major direct consumer of water from the Ohlelo River is industry (*viz*. Mondi and NTE Company Ltd (refer to *Figure 4.4*)). Low weirs in the river are used to abstract water. Water is abstracted from NTE where the river crosses the National Highway 2 (N2) (26°52'37.92"S 30°35'39.55"E) and Mondi abstracts further downstream where the Ohlelo River crosses road R33 to Amsterdam (26°51'14.9" S; 30°43'50.36"E). These abstraction points are 35km and 50km downstream of the site proposed for Adit A respectively.

There are no major irrigation developments in the catchment; Middleton and Bailey (2009) estimate the area under irrigation in this catchment is 1.45 km^2 (0.5% of the catchment area). Small scattered areas under irrigation occur below the Drie Vrouw Dam (*Figure 4.5*). Further downstream afforestation dominates the land use as identified from satellite imagery.

Alien vegetation (regarded by the DWA in its strategy document for invasive alien plants in the Usutu-Mhlatuze WMA as a water user; as indicated in *Appendix C*) covers 1.1 km^2 of this catchment (0.4% of the catchment area). Water use by irrigation and alien vegetation is therefore low.

As per the hydrocensus presented in the Specialist Groundwater report (*Annex C.3* of the SEMP Document), water is also abstracted from boreholes for use as potable water, and for livestock watering. Water abstraction from boreholes ranges from 0.7 m^3/d for boreholes using submersible hand pumps to 57.8m^3/d for windmill driven pumps.

The Socio-economic Impact Assessment (*Annex C.6* of the SEMP Document) found that flow from the higher lying springs and boreholes are mostly used for domestic water supply and for stock watering by local farmers. The Kanluka (Kransbank) and Yende (Twyfelhoek) communities are, however, reliant on stream/river flow for domestic use. These communities draw surface water from the Ohlelo and Kransbank Rivers directly; these abstraction points are given in *Table 4.4* below.

Table 4.4 Community Surface Water Abstraction Points

SW Abstraction Point Number	Stream/River	X (LO31)	Y (LO31)	User
Point1	Ohlelo	-70690	-2988121	Yende Community
Point2	Kransbank	-68724	-2991597	Kanluka Community
Point3	Kransbank	-69017	-2989965	Kanluka Community

Recently, water supply infrastructure has been developed and upgraded to homesteads directly. While the Socio-economic Impact Assessment (*Annex C.6* of the SEMP document) captured this data as house connections in order to describe the fact that water was transported directly to people's homesteads, the source of this water remains untreated water directly from springs, streams and rivers. The 45 sampled homesteads sampled in the SIA obtained their water from the following sources:

Means of Water Supply	Percentage of Sampled Homesteads
Borehole or well	2.2%
House connection	66.7%
Neighbour	2.2%
Spring	2.2%
River	26.7%
Total	**100.0%**

Proposed Developments in Catchment W52A

In 2009, the Mpumalanga Department of Agriculture, Rural Development and Land Administration (DARDLA) selected the Donkerhoek area to be developed as a Comprehensive Rural Development Project (CRDP). The main aim of the CRDP, apart from infrastructure development (roads, culverts etc.), is to provide the communities of Donkerhoek, Kwangema and Emahhashini with household water from springs and to improve agriculture by developing a storage dam for irrigation purposes. This dam (given as Dam E in *Figure 4.4* and *Figure 4.6*), and located on the Ohlelo River on the farm Twyfelhoek 379 IT, will, depending on the allowable abstraction, need to be approved by the tripartite member countries of the Incomati Accord (DARDLA, 2010). Following approval, it is the aim of the CRDP to develop an irrigation project.

The project boundaries of this CRDP, shown in *Figure 4.6*, overlay the proposed Kusipongo Resource Expansion Project boundaries.

A water bottling plant is currently under construction in the Donkerhoek area. This bottling plant will utilise borehole water, from boreholes drilled on the farm Witbank 380 IT.

Hydrology of the Ohlelo River

The "naturalized" (or gross) mean annual runoff in the Ohlelo River at the site proposed for Adit A, is 2.66 million m^3/a (Middleton and Bailey, 2009). The average monthly flow data for the period 1920 to 2004 is shown in *Table 4.5*.

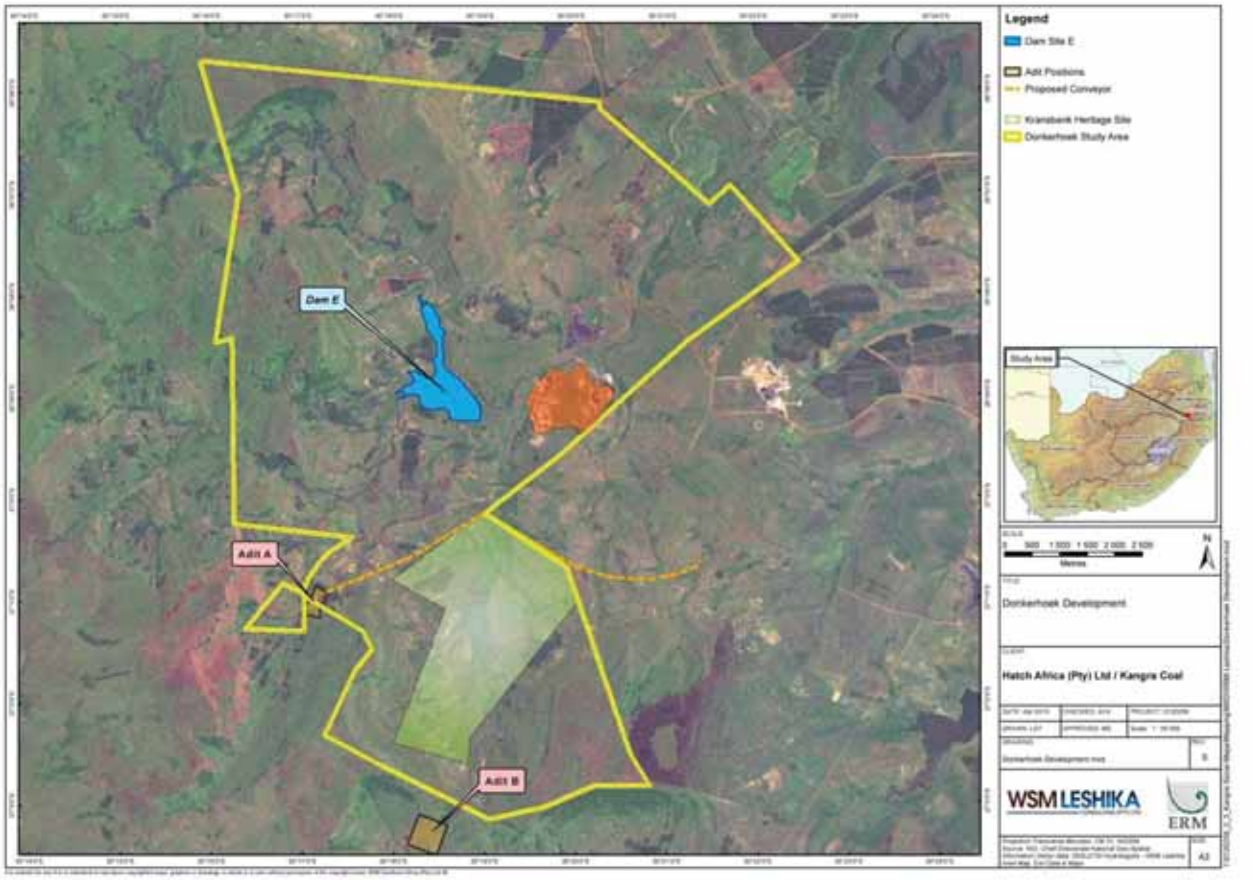
Table 4.5 Naturalized Average Monthly Runoff in the Ohlelo River at Adit A (in million m^3)

Month	Runoff (million m^3)
OCT	0.11
NOV	0.26
DEC	0.433
JAN	0.523
FEB	0.479
MAR	0.34
APR	0.206
MAY	0.115
JUN	0.064
JUL	0.046
AUG	0.039
SEP	0.042
TOTAL ANNUAL FLOW	2.657

Source: Middleton and Bailey (2009)

On analysis of *Table 4.5*, it is clear that the three driest months, on average, are July to September. The Normal Dry Weather Flows have been calculated as 1 081m^3/day, based on the average of the median flow in each of the three driest months.

Figure 4.6 Proposed Donkerhoek Development



Floodline and Flood Volume Estimates

The river flows on the western boundary of the site, proposed for Adit A, has a narrow, overgrown flow channel (*Figure 4.7*). In addition to the Ohlelo River, a number of small tributaries that drain the hillside to the north east bisect the site. All these tributaries are non-perennial whereas the Ohlelo River is perennial.

Flood peaks have been calculated for the Ohlelo River and associated tributaries that may affect infrastructure proposed on the Adit A site, based on the catchment characteristics provided in *Table 4.6* and *Table 4.7* below.

Figure 4.7 Ohlelo River at the Site Proposed for Adit A (2011)

Table 4.6 Ohlelo Catchment Characteristics

DESCRIPTION	VALUE
Catchment area (km^2)	24.83
Length of watercourse to boundary (km)	9.61
Average tributary slope (m/m)	0.0308
Runoff factor	0.383

Table 4.7 Tributary Catchment Characteristics

DESCRIPTION	VALUE
Catchment area (km^2)	0.414
Length of watercourse to boundary (km)	1.31

DESCRIPTION	VALUE
Average tributary slope (m/m)	0.153
Runoff factor	0.337

Results of flood peak estimations are provided in *Table 4.8*. Floodlines have been determined for the Ohlelo River and for the larger tributary that crosses the site on the eastern boundary. The modelling was based on the available contour maps, with preference given to the 1m contours available for the site, so as to enhance model accuracy.

Table 4.8 Results of Flood Peak Calculations (m^3/s) for the Adit A Site

CATCHMENT	Flood peak per recurrence period (m^3/s)					
	1:2	1:5	1:10	1:20	1:50	1:100
Ohlelo Catchment Area	48.1	86.5	120.2	157.2	207.7	251.9
Tributary Catchment Area	2.9	5.3	7.3	9.6	12.7	15.4

The associated natural 1:100-year and 1:50-year floodlines for the Adit A site area illustrated in *Figure 4.8*.

The 1:50-year floodline (illustrated in red in *Figure 4.8*) and the 1:100-year floodline (illustrated in blue in *Figure 4.8*) are similar for this site, especially on the steep right hand bank.

Figure 4.8 1:50 and 1:100-Year Floodlines at for the Proposed Adit A Site

4.2.3 *Catchment W51B (Assegaai River Catchment)*

Kangra Coal's current operations at Maquasa and the communities of Driefontein and St Helena are located to the north and north-west of this catchment. Kangra Coal's currently operating and closed mines within this catchment are detailed in *Table 4.9*, and depicted in *Figure 4.9*.

Table 4.9 Kangra Coal Mines within the Model Area

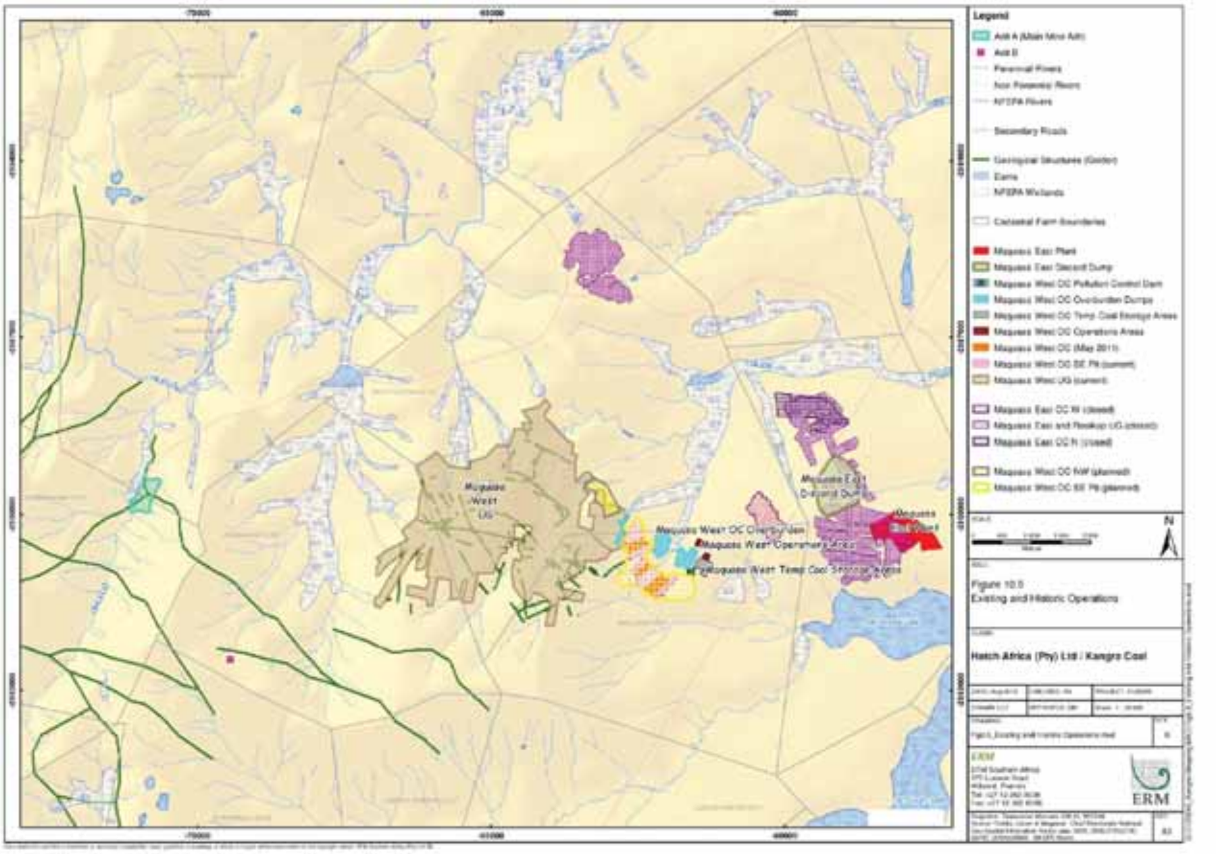
Reserve	Mining Method	Current Status
Maquasa West U/G	Underground, B&P, stooping	Active
Maquasa West O/C	Open Cast, roll-over method	Active and planned
Maquasa East U/G	Underground, B&P, stooping	Closed
Maquasa East O/C 1	Open Cast, roll-over method	Closed
Maquasa East O/C 2	Open Cast, roll-over method	Closed
Rooikop U/G	Underground, B&P, stooping	Closed

Only a small portion of the proposed Project will fall within this catchment. The site proposed for Adit B (ventilation shaft) is located within the upper reaches of quaternary catchment W51B (refer to *Figure 4.5*), which largely drains in an easterly direction to join the Mpundu River, which subsequently discharges into the Heyshope Dam.

Two tributaries pass through the proposed footprint of Adit B (*Figure 4.10*). The one originates from a natural spring located on the watershed of quaternaries W52A and W51B. This tributary passes through the north-easterly corner of the footprint area. The second tributary is a stormwater drainage channel that flows during rainfall events.

Both tributaries contribute towards run-off to the larger tributaries of the Mpundu River, which subsequently drain into the Heyshope Dam.

Figure 4.9 Existing Mining Activities



Due to the catchment area of the Adit B site being small and as no contours are yet available for this site, except the large-interval lines from the 1:50 000 scale topographical maps, no sensible flood lines could be derived for the site. However, flood peaks were estimated for this site, as shown in *Table 4.10* below.

Table 4.10 Estimated Flood Peaks for Two Drainage Lines within the Adit B Site

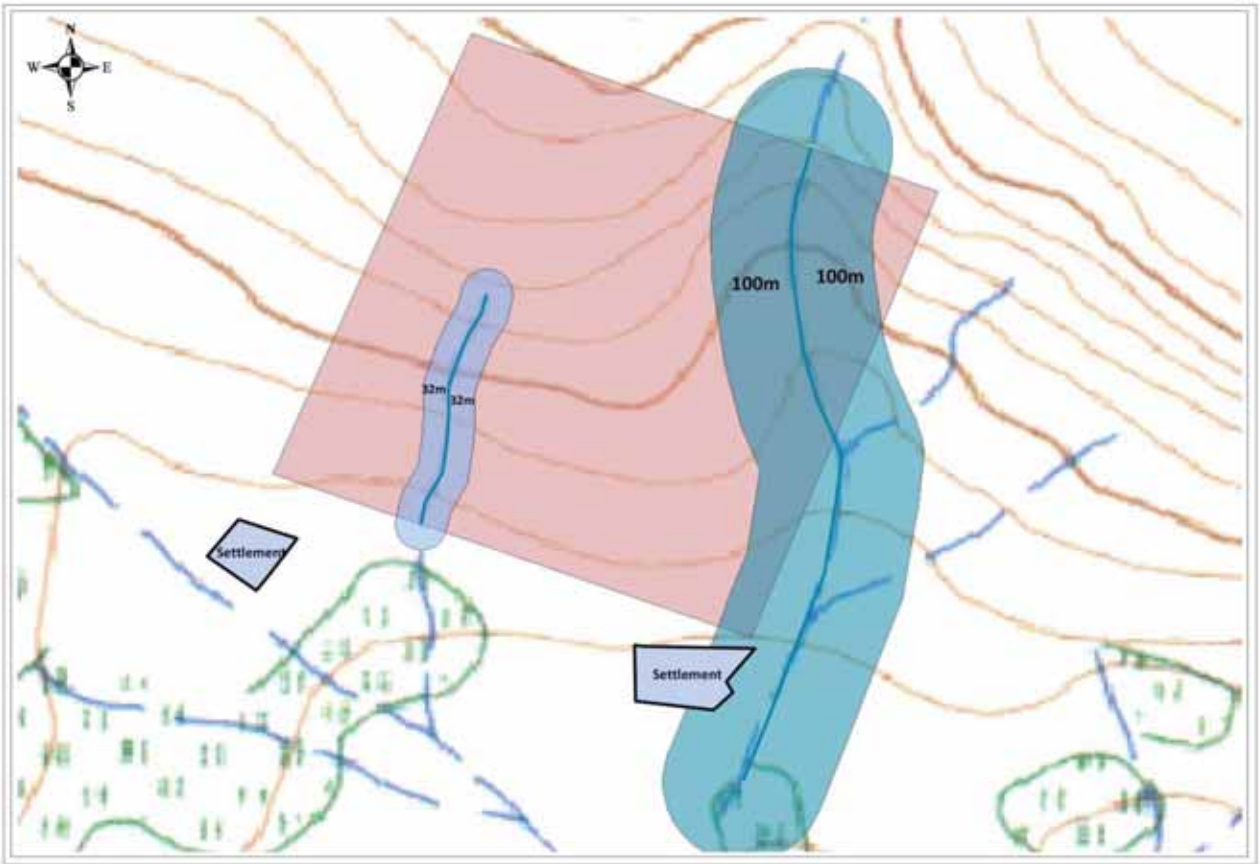
CATCHMENT	Flood peak per recurrence period (m^3/s)					
	1:2	1:5	1:10	1:20	1:50	1:100
Larger eastern drainage line: Catchment Area 0.57km^2	8.02	14.44	20.07	26.25	34.69	42.08
Smaller western drainage line: Catchment Area 0.06km^2	0.97	1.75	2.43	3.18	4.20	5.10

Floodline buffer strips are provided for the two tributaries (*Figure 4.10*) based on the following buffer distances:

- 100m for the natural spring originating tributary; and
- 32m for the stormwater drainage channel tributary.

The buffer distances provided, in the absence of calculated floodlines, are recommended in the *Figure 4.10*.

Figure 4.10 Proposed Flood Zones at the Site Proposed for the Ventilation Adit (Adit B) (based on 1:50 000 Topographical Map)



4.2.4 *Proposed Route for the Overland Conveyor System*

The proposed overland conveyor route crosses 13 wetlands and seven of these crossings were typified as having a valley bottom (with or without a channel). From an engineering perspective, six streams (A to F) for which the flood peaks could be determined, were identified. The flood peaks for this portion of the proposed Project were determined using the same method used for the site proposed for Adit A.

Catchment characteristics for each of the six streams (A to F) are provided in *Table 4.11* below. Flood peak estimations for each of six streams are provided in *Table 4.12.* Floodlines calculated using this data, as well as the 1m contour interval data provided below, are indicated for each of the six streams in *Figure 4.11*.

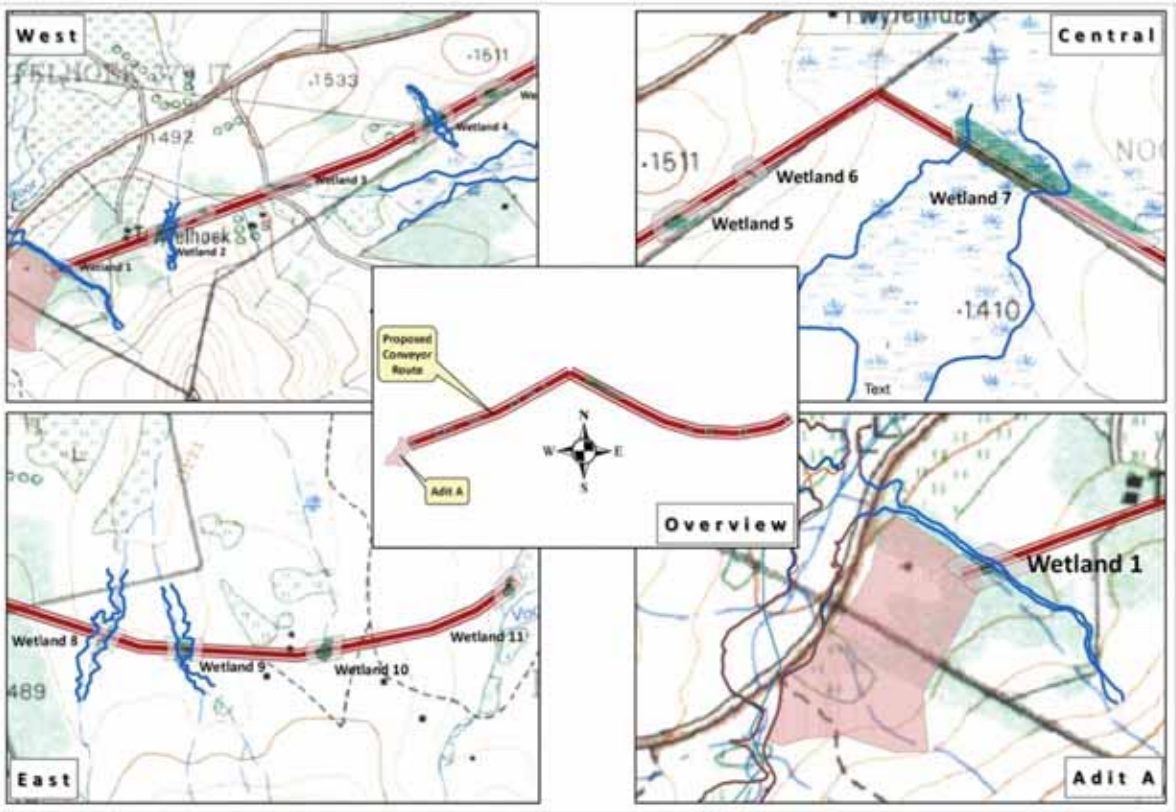
Table 4.11 Catchment Characteristics of the Proposed Route for the Overland Conveyor System

Catchment Characteristics	A	B	C	D	E	F
Wetland Number	1	2	4	7	8	0
Area (km^2)	0.31	0.17	0.49	17.91	1.81	0.55
Length of longest watercourse (km)	0.75	0.75	0.59	5.59	3.32	1.27
Average tributary Slope (m/m)	0.2044	0.2556	0.1333	0.019	0.0749	0.1281
Runoff Factor C	0.472	0.508	0.415	0.428	0.441	0.486

Table 4.12 Flood Peaks of the Proposed Route for the Overland Conveyor System

Peak Discharges (m^3/s)	A	B	C	D	E	F
Q_{50}	14.3	8.6	20.0	175.5	35.8	20.8
Q_{100}	19.8	12.0	27.7	243.6	49.7	28.9

Figure 4.11 Floodlines along the Proposed Route for the Overland Conveyor System



4.2.5 Water Quality

Derived Water Quality Screening Levels

Using baseline surface water (springs and Ohlelo River) and groundwater quality results, the South African Water Quality Standards for Drinking Water (i.e. SANS241:2011), and the South African Water Quality Guidelines for both Aquatic Ecosystems and Livestock Watering, site specific surface water screening levels were proposed.

The derivation of the site specific surface and groundwater screening levels was discussed in detail in *Chapter 4*.

It is important to note that the derivation of these screening levels is based on a total of 18 spring and 12 river samples from the Ohlelo River during the wet season only. The screening levels should therefore be continually updated using additional baseline surface water monitoring data from all seasons.

Also to note is that the screening levels are intended to be used to assess the quality of water in natural surface water systems. The screening levels are not discharge standards. In this regard, the General Authorisations in Terms of Section 39 of the National Water Act (1998) will apply for waste discharge into surface water systems.

Water Quality Sampling Locations

Assegaai River Catchment

Water quality data presented for this catchment were obtained from the Maquasa West Amendment EMP Report compiled by Oryx Environmental (January 2006). (1) This data is of importance as it reflects water quality in streams downstream of existing active and closed Kangra Coal mines.

Dry (August) and wet season (November) water samples were taken in 2001 at six localities (SW1 to SW6) on streams downstream of the mining areas, as shown in *Figure 4.12.*

Ohlelo River Catchment

Water samples were collected at points along the Ohlelo and Hlelo Rivers in October 2009, September 2011 and in February 2013. Although coordinates of the sampling points were not provided for the 2009 sampling run, their locations can be approximated given the site descriptions provided in Donkerhoek Dam Development Project undertaken for DARDLA.

(1) No surface water samples were collected in the Assegaai River catchment; only spring and borehole water quality samples were collected in this catchment as part of the hydrocensus.

Sampling identifications used for the 2009, 2011 and 2013 water sample collections are as follows:

- October 2009: Water 1, Water 3 and Water 4
- September 2011: 1, 2, 3, 4
- February 2013: C1, C2, C3, C4, C5, C6

Although different names are used for the different sampling points in sampling rounds, some of the locations are the same. Details on the sampling locations are shown in *Table 4.13* and *Figure 4.13.*

It should be noted that springs were not sampled during the surface water sampling campaign. Springs were sampled as part of the overall groundwater study, and sampling and identification of springs occurred during the groundwater hydrocensus.

Table 4.13 Details of Water Sampling Localities in W52A

SAMPLE ID AND YEAR SAMPLED	LOCALITY	DESCRIPTION	X (DMS)	Y (DMS)
1 (2011) and C1 (2013)	Donkerhoek	Tributary of the Ohlelo River, upstream of Adit A	27^0 01′ 9.92″ S	30^0 16′ 50.46″ E
Water 1 (2009) and C2 (2013)	Donkerhoek	Ohlelo River, upstream of Adit A	27^0 01′ 3.94″ S	30^0 16′ 59.67″ E
C3 (2013)	Twyfelhoek	Ohlelo River, downstream of Adit A	27^0 0′ 49.5″ S	30^0 17′ 8.53″ E
2 (2011) and C4 (2013)	Twyfelhoek	Ohlelo River, upstream of confluence with Hlelo River	27^0 0′ 10.14″ S	30^0 17′ 14.61″ E
Water 3 (2009)	Twyfelhoek	Dam Site E (Hlelo River)	26^0 59′ 26.05″ S	30^0 18′ 57.61″ E
4 (2011)	Twyfelhoek	Downstream of Kransbank Wetland on Road D2548	26^0 59′ 54.79″ S	30^0 19′ 13.23″ E
3 (2011)	Kransbank	Stream in upper reaches of Kransbank Wetland	27^0 02′ 5.93″ S	30^0 18′ 24.93″ E
Water 4 (2009) and C5 (2013)	Witbank	Hlelo River, bridge crossing Road D273	26^0 58′ 11.01″ S	30^0 20′ 38.38″ E
C6 (2013)	Driepan	Hlelo River, downstream of confluence with Taaibosch Spruit, on Road D803	26^0 54′ 0.98″ S	30^0 27′ 10.96″ E

Figure 4.12 Water Quality Sampling Locations in Assegaai River Catchment (2001)

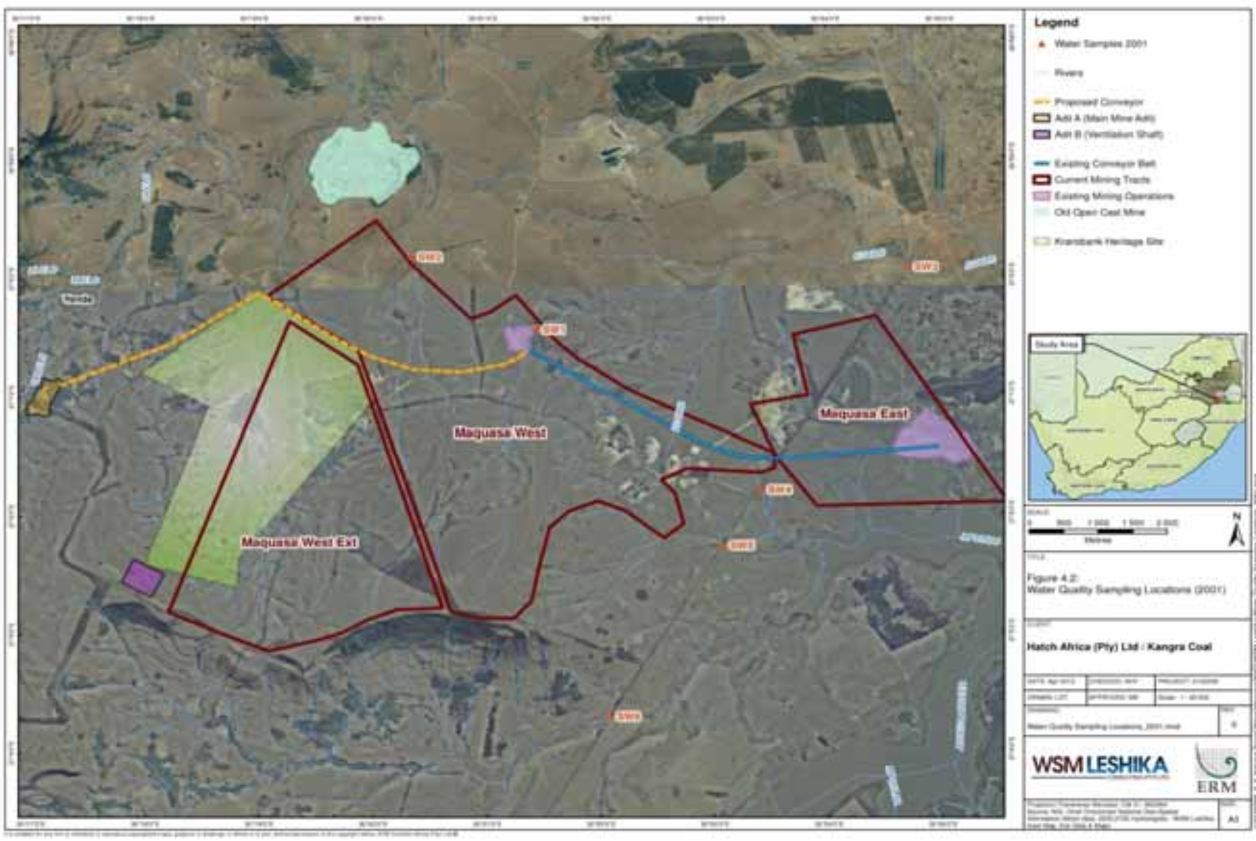
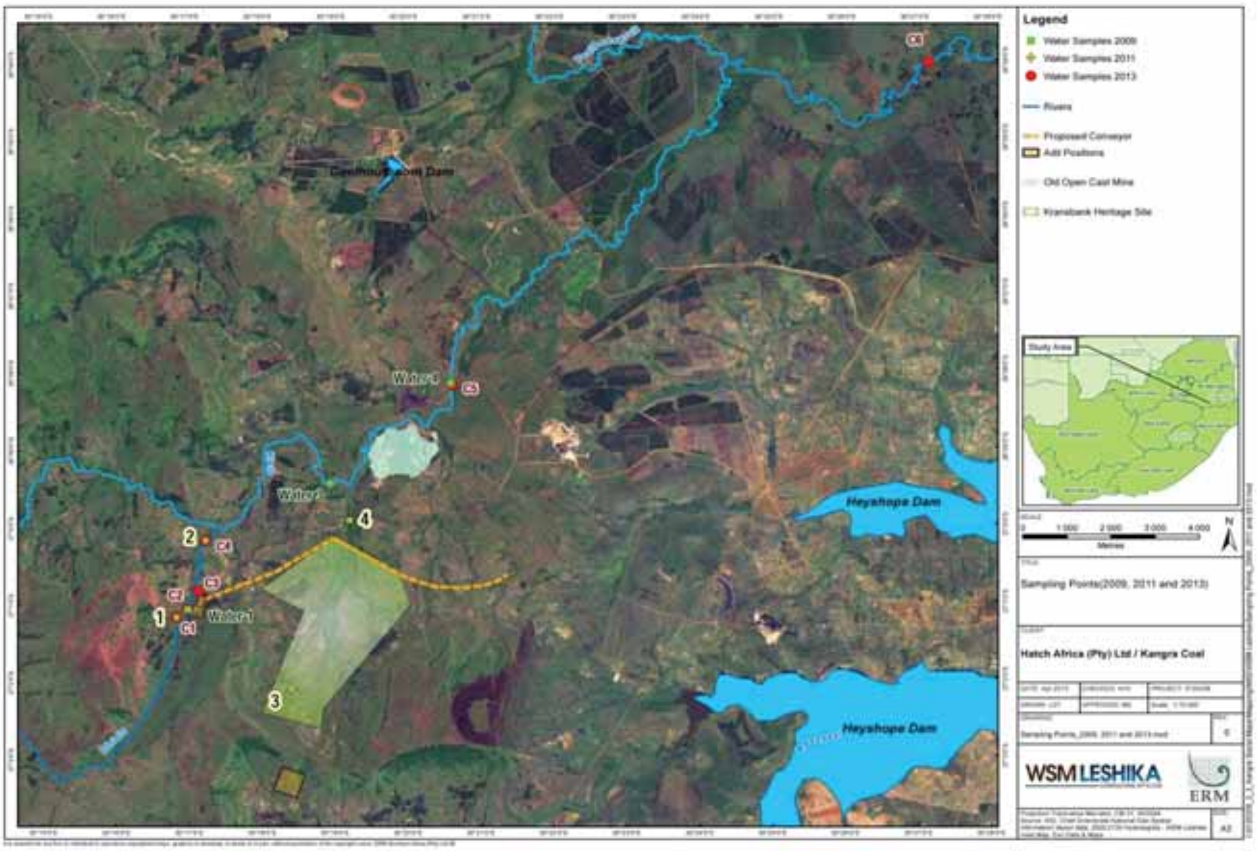


Figure 4.13 Water Quality Sampling Locations in Hlelo River Catchment (2009, 2011 and 2013)



Water Quality Results

Assegaai River Catchment

Water quality data for this catchment area are presented in *Table 4.14*.

In general the water quality is within the proposed RQWO with the following exceptions:

- EC/TDS – As EC is a measure of the total dissolved salt content of water, the TDS results are only discussed here. Sample SW1 (Aug 01) marginally exceeds the screening level for TDS, and this is not considered significant. Both samples from SW3 exceed the TDS screening level. SW3 is the furthest downstream sample and is likely to be affected by agricultural and mining activities in the upstream catchment. TDS and EC are high level screening values, and exceedances should be investigated to evaluate what chemical element is resulting in the TDS or EC exceeding the screening level. In SW3, none of the major ions and only aluminium marginally exceeds the specified screening level. The Aug 01 sample from SW6 significantly exceeds the TDS screening level. This is due to elevated calcium and possibly alkalinity concentrations (alkalinity was not determined in these samples). SW6 appears to be located in a different catchment and may be affected by a different underlying geology.

- Calcium exceeds the specified screening level in SW5 and SW6 in Aug 01. The calcium screening level was derived based on the anticipated acid rock drainage (ARD) reactions which would be expected to occur in the mining areas, resulting in elevated sulphate and calcium concentrations. As such, increases in calcium concentration would provide an early warning of potential impact related to ARD, and calcium at these levels is not expected to have adverse effects on water use in the catchment.

ARD reactions related to mining of sulphidic material would be expected to result in decreased pH and increased sulphate concentrations. The pH and sulphate concentrations in the Assegaai catchment are shown in *Figure 4.14*. Both pH and sulphate concentrations are within the respective RWQO, showing no impact from ARD. Sulphate concentrations are notably higher in the November sampling round than during the August sampling round. This could be explained by flushing of salts that accumulated on mining waste during the dry season by the early summer rains. The effect is most pronounced in samples SW3 and SW4. SW3 is the furthest downstream sample and would show effects from the catchment as a whole, including parts of the Maquasa East mining area, and SW4 is in the tributary that originates immediately to the south of the Maquasa East operations. Hardly any change is noted in SW1 and SW2 which are in unaffected catchments.

The surface water data for the Assegaai Catchment show that surface water has been impacted by neutral mine drainage, but the water generally conforms to the derived RWQO. A round of surface water sampling should be conducted after early summer rains to ensure that RWQO exceedances are not occurring as salts that accumulated during the dry winter period are flushed into the surface water system.

Figure 4.14 ***pH and sulphate concentrations in water samples from the Assegaai Catchment***

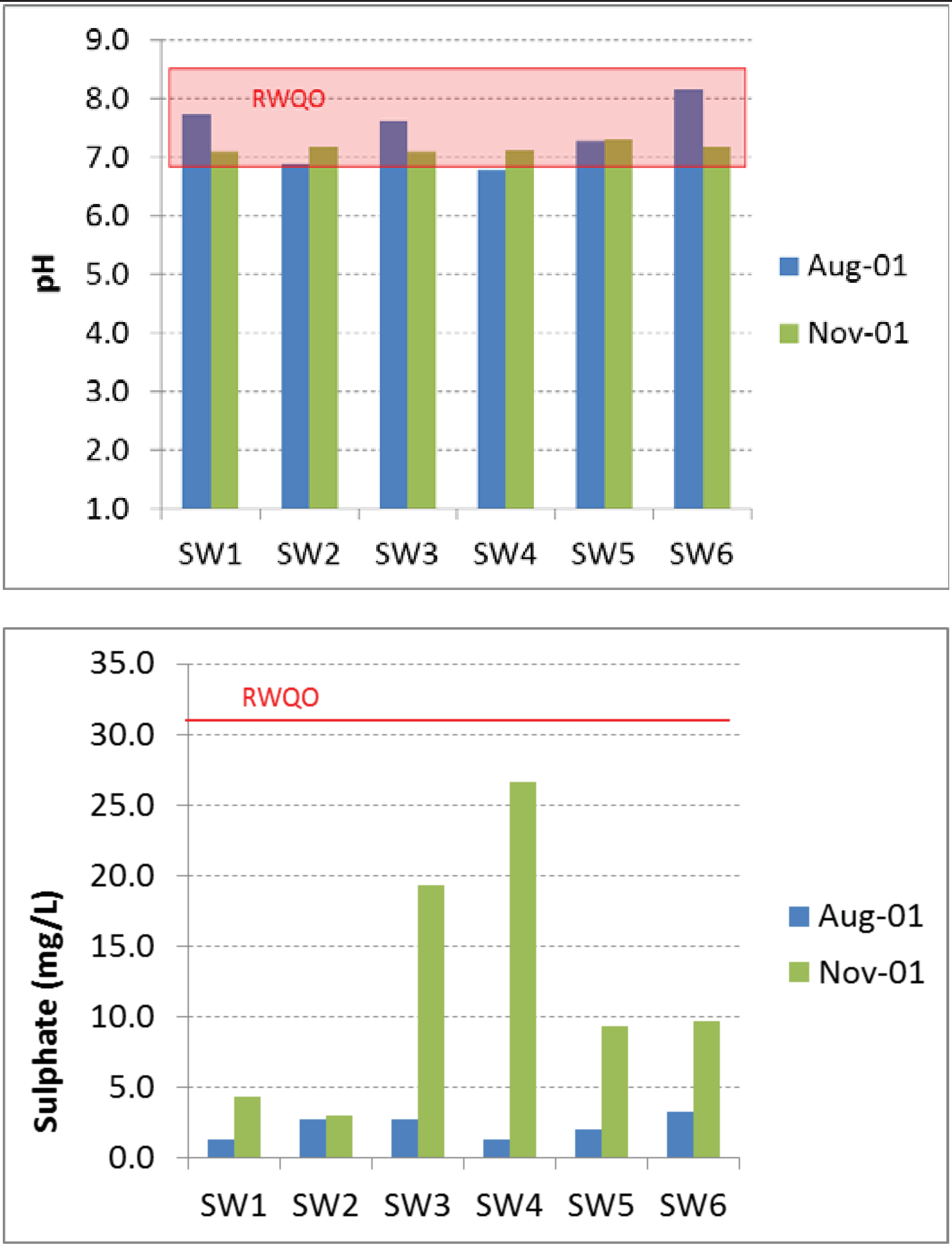


Table 4.14 Water Quality for Surface Water Sampling Sites SW1 to SW6 in the Assegaai River Catchment (2001)

Analyte	**Unit**	**SAMPLING POINTS**												**PROPOSED RWQO**
		SW1	SW1	SW2	SW2	SW3	SW3	SW4	SW4	SW5	SW5	SW6	SW6	
DATE		Aug-01	Nov-01	Aug-01	Nov-01	Aug-01	Nov-01	Aug-01	Nov-01	Aug-01	Nov-01	Aug-01	Nov-01	
pH		7.7	7.1	6.9	7.2	7.6	7.1	6.8	7.1	7.3	7.3	8.1	7.2	6.9-8.5
EC	mS/m	7.8	4.3	5.7	3.8	8.7	10.0	6.8	9.9	12.1	7.0	24.5	8.2	5.5-9.1
TDS	mg/l	52	28	40	30	70	64	48	60	86	48	160	50	20-50
F	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	0.03	<0.01	0.75
SO_4	mg/l	1.3	4.3	2.7	3.0	2.7	19.3	1.3	26.6	2.0	9.3	3.3	9.7	31
Cl	mg/l	6	4	5	4	4	4	13	3	4	5	9	5	22
Ca	mg/l	5.9	2.5	3.6	3.5	7.2	9.2	5.8	5.9	12.3	5.2	23.7	5.6	12
Mg	mg/l	3.4	1.8	1.8	1.7	4.0	3.2	2.4	3.8	4.8	2.6	11.9	2.8	-
Na	mg/l	2.7	2.3	2.2	1.9	3.5	3.0	3.5	3.6	2.8	3.1	5.4	3.0	16
N	mg/l	<0.1	0.10	<0.1	0.43	<0.1	0.2	0.6	0.1	0.2	0.1	0.2	0.2	0.75
Alkalinity	mg/l as CaCO3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Al	mg/l	0.05	<0.01	0.78	0.09	0.52	<0.01	0.02	<0.01	<0.01	0.33	0.15	0.29	0.5
Fe	mg/l	<0.01	<0.01	0.12	<0.01	<0.01	0.1	<0.01	<0.01	<0.01	0.27	0.08	0.21	0.2
Mn	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	0.18
Cu	mg/l	<0.01	<0.01	<0.01	0.02	<0.01	0.03	<0.01	<0.01	<0.01	0.19	<0.01	0.10	
Pb	mg/l	<0.01	<0.01	<0.01	0.02	NA	<0.01	0.03	<0.01	0.02	<0.01	0.02	<0.01	0.050

Note: Values in red show constituents where screening levels are exceeded
NA: No test results

Source: Maquasa West Amendment EMP Report (Oryx Environmental (January 2006).

Ohlelo River Catchment

Water quality data for sampling sites in this catchment are presented in *Table 4.15* and *Table 4.16.*

In general the water quality is within the proposed RQWO with the following exceptions:

- pH is below the RWQO in one sample, C4. C4 is the most downstream sample on the Ohlelo River, just before the confluence with the Hlelo River.

- EC/TDS – As EC is a measure of the total dissolved salt content of water, the TDS results are only discussed here. Sample 1 (Sep 11), Sample 4 and Sample Water 4 exceed the RWQO for TDS. In all cases, none of the major ions that constitute the elevated TDS exceeds the specified screening level.

- Iron exceeds the RWQO in Water 1, C4, Water 3, Water 4, C5 and C6. These exceedances are likely to be natural and may be due to the presence of suspended solids in the samples which are analysed as part of the sample. Iron is not naturally soluble in the pH range of the samples.

- Manganese exceeds the RWQO in sample C4. This sample has the lowest pH of the analysed samples.

- Cadmium exceeds the RWQO in three samples, Water 1, Water 3 and Water 4. However, the RWQO for cadmium is very low as no the baseline samples used to determine the RWQOs did not have cadmium detections; therefore the DWAF aquatic toxicology screening levels are used. The RWQOs could be amended to reflect these detections, which are likely to represent baseline conditions.

ARD reactions related to mining of sulphidic material would be expected to result in decreased pH and increased sulphate concentrations. The pH and sulphate concentrations in the Hlelo catchment from February 2013 are shown in *Figure 4.15*. The samples are arranged from upstream to downstream. Apart from pH in sample C4, both pH and sulphate concentrations are within the respective RWQO. Sulphate concentrations increase downstream in the Ohlelo River, from sampling location C1 to C4, and pH decreases from location C2 to C4, with highest sulphate and lowest pH being detected in sample C4. This could indicate a slight ARD related effect due to mining activities in the catchment. However, dilution by the Hlelo River appears to limit the extent of this effect to the lower reaches of the Hlelo River.

The surface water data for the Ohlelo Catchment show that surface water has been slightly affected by mine drainage in the Ohlelo River, but the water generally conforms to the derived RWQO. Dilution in the Hlelo River limits the extent of the ARD effect to the Ohlelo River. No assessment of seasonal changes could be made due the lack of routine monitoring results. A round of surface water sampling should be conducted after early summer rains to ensure that RWQO exceedances are not occurring as a result of salts, that accumulate during the dry winter period, are flushed into the surface water system.

Table 4.15 Macro-element Water Quality in the Hlelo River Catchment

Element	Unit	SAMPLING LOCATIONS													PROPOSED RWQO (Table 4.18)
	Sample ID	1	C1	Water 1	C2	C3	2	C4	Water 3	4	3	Water 4	C5	C6	
	DATE	Sep-11	Feb-13	Oct-09	Feb-13	Feb-13	Sep-11	Feb-13	Oct-09	Sep-11	Sep-13	Oct-09	Feb-13	Feb-13	
pH		7.2	7.5	8.2	7.8	7.5	7.6	6.6	8.0	7.4	7.4	8.0	7.9	7.7	6.9-8.5
E.C	mS/m	9.8	6.4	13.0	7.2	9.4	9.5	8.2	9.8	11.7	7.6	14.6	8.2	8.4	5.5-9.1
TDS	mg/l	81.0	NA	42.0	NA	NA	48.0	NA	39.0	61.0	41.0	61.0	NA	NA	20-50
NO_3	mg/l	0.7	0.3	0.1	0.3	0.3	0.5	0.0	0.1	0.2	0.4	0.1	0.3	0.4	0.75
F	mg/l	<0.18	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	<0.18	0.2	0.2	0.2	0.75
SO_4	mg/l	5.3	1.3	0.3	2.1	2.8	2.3	4.1	1.6	7.3	2.3	19.7	2.5	2.5	31
Cl	mg/l	19.9	<0.423	1.4	<0.423	<0.423	<1.4	<0.423	2.2	4.9	<1.4	2.1	<0.423	<0.423	22
Ca	mg/l	10.3	4.2	6.9	5.0	4.5	7.9	2.5	5.5	8.2	7.1	9.6	0.2	0.2	12
Mg	mg/l	5.8	2.5	3.7	3.1	2.2	4.9	1.4	3.1	4.6	3.8	4.5	3.1	3.3	-
Na	mg/l	12.0	0.5	4.9	0.3	1.9	4.3	2.0	4.7	8.2	4.7	5.0	0.2	0.2	16
Turbidity	NTU	1.0					3.7			76.3	97.3				-
Alkalinity	mg/l as CaCO3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-
P	mg/l		<0.008		<0.008	<0.008		<0.008					<0.008	<0.008	-
B	mg/l	0.012	<0.003		<0.003	<0.003	0.008	<0.003		0.01	0.01		<0.003	<0.003	

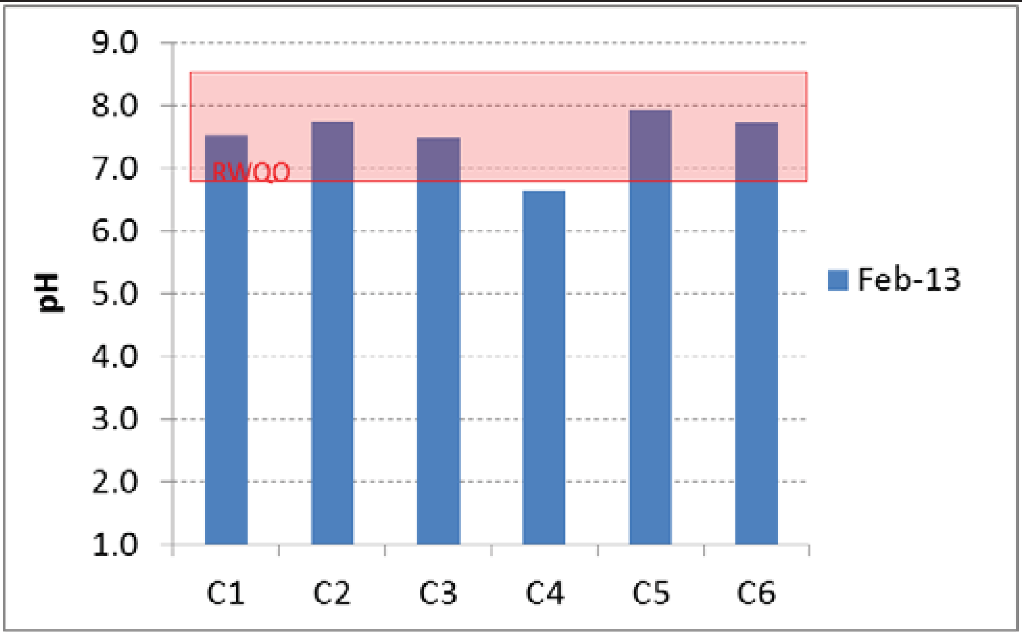
Note: Values in red show constituents where threshold range is exceeded
NA : No test results

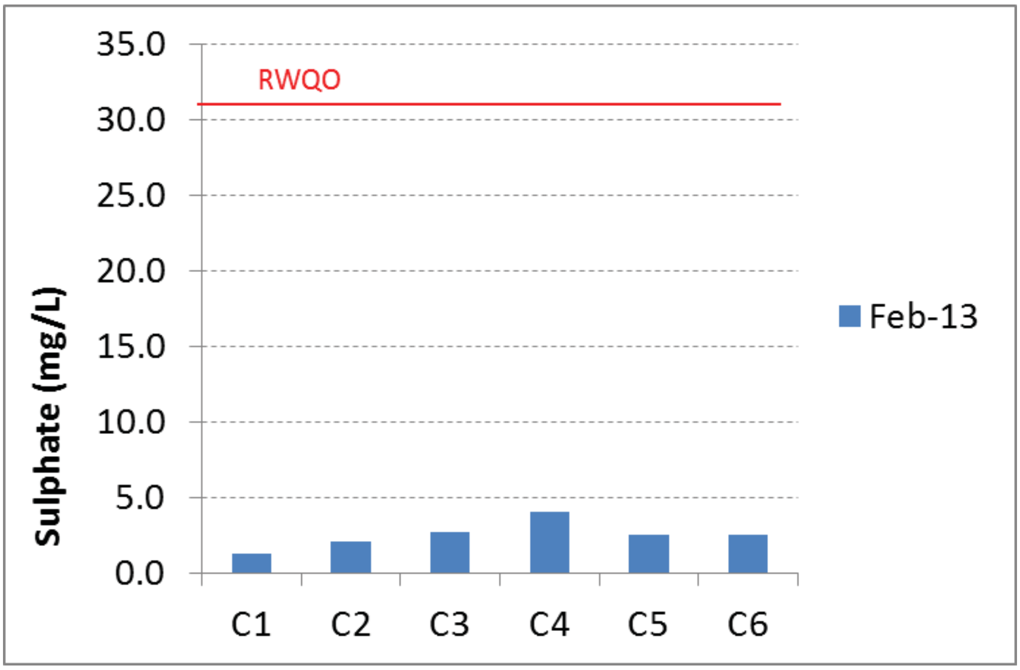
Table 4.16 Trace-element Water Quality in the Hlelo River Catchment

Element	Unit	SAMPLING LOCATIONS													PROPOSED RWQO
	Sample ID	1	C1	Water 1	C2	C3	2	C4	Water 3	4	3	Water 4	C5	C6	
	DATE	Sep-11	Feb-13	Oct-09	Feb-13	Feb-13	Sep-11	Feb-13	Oct-09	Sep-11	Sep-13	Oct-09	Feb-13	Feb-13	
As	mg/l		<0.007		<0.007	<0.007		<0.007					<0.007	<0.007	
Sr	mg/l		0.020		0.022	0.035		0.037					0.042	0.046	
Ba	mg/l		0.007		0.009	0.032		0.071					0.018	0.022	
Al	mg/l	<0.006	<0.003	0.137	<0.003	<0.003	<0.006	<0.003	0.283	0.146	0.140	0.222	<0.003	<0.003	0.5
V	mg/l	0.027	<0.001		<0.001	<0.001	0.024	<0.001		0.021	0.023		<0.001	<0.001	0.2
Cr	mg/l	<0.002	<0.001	0.003	<0.001	<0.001	<0.002	<0.001	0.003	<0.002	<0.002	0.003	<0.001	<0.001	
Mo	mg/l		0.008		0.008	0.007		0.008					0.007	0.008	
Fe	mg/l	<0.006	<0.003	0.302	<0.003	<0.003	<0.006	0.242	0.667	0.108	0.032	0.513	0.236	0.306	0.2
Mn	mg/l	0.002	<0.001	0.001	<0.001	<0.001	<0.001	0.321	<0.001	<0.001	0.001	0.001	<0.001	<0.001	0.18
Ni	mg/l	0.013	<0.001	0.007	<0.001	<0.001	0.003	<0.001	0.007	0.003	0.003	0.007	<0.001	<0.001	0.07
Cu	mg/l	0.004	<0.001	0.018	<0.001	<0.001	0.011	<0.001	0.017	0.019	<0.001	0.017	<0.001	<0.001	
Zn	mg/l	0.036	<0.002	0.010	<0.002	<0.002	0.008	<0.002	0.010	0.010	<0.004	0.010	<0.002	<0.002	0.03
Cd	mg/l	<0.001	<0.001	0.007	<0.001	<0.001	<0.001	<0.001	0.007	<0.001	<0.001	0.007	<0.001	<0.001	0.00025
Pb	mg/l	<0.01	<0.004	0.024	<0.004	<0.004	<0.01	<0.004	0.024	<0.01	<0.001	0.024	<0.004	<0.004	
Ag	mg/l	<0.002	<0.001		<0.001	<0.001	<0.002	<0.001		<0.002	<0.002		<0.001	<0.001	
Be	mg/l		<0.001		<0.001	<0.001		<0.001					<0.001	<0.001	
Co	mg/l	<0.002	<0.001	0.003	<0.001	<0.001	<0.002	<0.001	0.003	<0.002	<0.002	0.003	<0.001	<0.001	0.5
Se	mg/l		<0.007		<0.007	<0.007		<0.007					<0.007	<0.007	

Note: Values in red show constituents where threshold range is exceeded
NA : No test results

Figure 4.15 Variation in pH and Sulphate Concentrations from Upstream to Downstream





5 IMPACT ASSESSMENT

The predicted impacts to surface water hydrology of the Study Area as a result of the proposed Kusipongo Resource Expansion Project are described in this Section.

5.1 IMPACTS TO SURFACE WATER QUALITY AS A RESULT OF THE ACTIVITIES AT MAIN MINE ADIT (ADIT A)

5.1.1 Description of the Baseline Environment

Water quality in the Study Area, as well as downstream of the Study Area in the Ohlelo catchments, is compared to the derived screening levels detailed in *Chapter 4*. Water quality within the Ohlelo River catchment is, in general, within the proposed RQWO.

ARD reactions related to mining of sulphidic material, and the presence of abandoned mines in this catchment, would be expected to result in decreased pH and increased sulphate concentrations in the catchment.

Sulphate concentrations increase downstream in the Ohlelo River, from sampling location C1 to C4, and pH decreases from location C2 to C4, with highest sulphate and lowest pH being detected in sample C4. This could indicate a slight ARD related effect due to mining activities in the catchment. However, dilution by the Hlelo River appears to limit the extent of this effect to the lower reaches of the Hlelo River.

5.1.2 Proposed Project Activities

The following activities which may be associated with the proposed main mine adit, have the potential to cause surface water contamination:

- *Land Clearing:* Earthworks associated with construction activities, primarily at the site of the main mine adit excavation.

- *Overburden Dumping*: The overburden is anticipated to contain 70,000m^3 of material consisting of sandstone (~70%), weathered material (~15-20%), siltstone (~5-8%), dolerite (~2%), carbonaceous shale (~1.5%) and potentially small amounts of coal from the Alfred seam (~1.3-1.9%). No geochemical data is currently available from which to estimate the chemistry of water leaching from overburden rocks, although the waste rocks to be dumped are relatively inert. The exposure of pyrite-bearing coal via mining activities may lead to oxidation of metal sulphides, leading to a reduction of pH and the establishment of acidic conditions causing leaching of metals (acid rock drainage). Where neutralising minerals occur in the material these may offset the acidity so produced. The pH of the resultant leachate will be influenced by the relative proportions and reaction rates of acid-generating and acid-neutralising minerals present in the material.

- *Coal Dust Fallout*: Rainfall that interacts with coal dust and sweepings which have fallen off the conveyor can become contaminated and adversely affect groundwater and surface water quality.

- *A Sanitation System for 300 Mine Workers, including a Sewage Treatment Plant with an associated Sewage Sludge Treatment Facility*: Untreated sewage will result in nutrient loading of streams and elevated levels of *E. Coli*.

- *Storage of Chemical and Paints as well as Storage of Fuel and Oil in a Depot accommodating a Cumulative Volume of between 80 to 500m³:* Fuel storage and dispensing, and fuel/oil/paint spillages from maintenance workshops and vehicle wash bays may result in soil contamination and resultant localised elevated levels of total petroleum hydrocarbons in ground and surface waters. The risk of a spill or chronic low level discharge can affect water quality.

- *The Washing of Mining Equipment and Light Duty Vehicles in a Wash Bay:* As above.

- *The Temporary Storage of Waste in Facilities to Accommodate General and Hazardous Waste:* May result in soil contamination and resultant localised elevated levels of total petroleum hydrocarbons (TPH) and heavy metals in ground and surface waters.

5.1.3 Sensitive Receptors

Sensitive receptors that may be affected by adverse changes to the quality of surface water include communities reliant on surface water as drinking water. Surface water abstraction points are located in the Yende (one) and Kanluka (two) communities.

In addition, the biodiversity study shows the sensitivity of the Ohlelo system to be high; aquatic macro-invertebrate integrity indicated generally few modifications, and the PES of the ichthyofauna assemblage ranged from near natural to moderately modified.

5.1.4 Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the impact from the proposed mining activities on the surface water quality at Adit A will be a '**Major Negative Impact**' pre-mitigation (refer to *Table 5.1).*

Table 5.1 ***Rating of Impacts Related to Surface Water Quality at Adit A (Pre-Mitigation)***

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The sulphate plume related to the overburden dump and the crushing and conveyor belt area is simulated in the groundwater study to remain localised around Adit A. Contamination of surface waters will be more widespread than groundwater, although present sampling results show water quality deterioration in the catchment is not regional.
Duration	Long-term	The most conservative of the order-of-magnitude estimates of the duration of oxidation of sulphide samples and potential resulting acid rock drainage suggest at least 60 years.
Scale	Altered	The interaction of surface/rain water with coal on conveyors, handling yards and potentially the overburden dump, could lead to the contamination of surface water, especially through groundwater/surface water interaction.
Frequency	Continuous	The risk for the contamination of surface water would continue for the duration of mining, overburden dumping and coal transport/storage until the site is rehabilitated post-closure.
Likelihood	Likely	Given the presence of sulphides in coal material, it is likely that surface water quality will be adversely affected by the generation of sulphates, as well as increased turbidity from surface runoff.
Magnitude		
High Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Surface- and groundwater resources are used for domestic water supply and stock watering, and support aquatic ecology in riverine and wetland habitats.		
Significant Rating Before Mitigation		
Major Negative Impact		

5.1.5 Recommendations and Mitigation/Management Measures

The following mitigation measures are recommended to reduce the significance of the impact of the proposed Project to surface water quality at Adit A:

- The proposed Project has committed to a policy of Zero Effluent Discharge. This policy commitment will be maintained and enforced. In addition, Project activities will be routinely audited to ensure this policy commitment is maintained.

- Appropriate management of dust and sweepings and the construction of hard-standing can be used to minimise potential runoff and interaction of water with coal in the Study Area.

- Apply best-practice water management at the adit, e.g. clean- and dirty water separation and appropriate containment of dirty water.

- Dirty water to be recycled as far as practicable; otherwise to be evaporated.

- Prevention of the erosion or leaching of materials from any residue deposit or stockpiles from any area and contain material or substance so eroded or leached in pollution control dams, or stormwater control dams.

- Line all containment facilities used to store contaminated water.

- Inbuilt controls in the Project design should include the separation of clean and dirty runoff water; wash bays for cleaning of light and heavy vehicles will be installed that have both silt ponds and oily water separators; fuel storage and dispensing areas will be built as per the Project description (bunding, hardstanding, etc.); temporary waste areas will be hardstanding, and the facility for the temporary storage of hazardous wastes will be covered by a roof.

- Rehabilitation of the adit after mine closure to limit on-going risk of water contamination.

5.1.6 *Residual Impact (Post-mitigation)*

Based on the implementation of the proposed mitigation measures, the significance of the impact to water quality at Adit A will be a '**Moderate Negative Impact**' post mitigation (*Table 5.2*).

Table 5.2 Rating of Residual Impacts Related to Surface Water Quality at Adit A (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Unchanged.
Duration	Long-term	Unchanged.
Scale	Altered	Implementation of the proposed mitigation measures will reduce the potential for contamination of water but will not prevent contamination of water.
Frequency	Constant	The risk for the contamination of water would continue for the duration of mining, overburden dumping and coal transport/storage, irrespective of mitigation measures implemented.
Likelihood	Likely	The presence of coal handling facilities at surface is likely to result in contamination of water.
Magnitude		
Medium Magnitude		
Significant Rating After Mitigation		
Moderate Negative Impact		

5.2 IMPACTS ON THE QUALITY OF SURFACE WATER RESOURCES ASSOCIATED WITH THE PROPOSED VENTILATION ADIT (ADIT B)

5.2.1 *Description of the Baseline Environment*

The site proposed for Adit B is located within the upper reaches of quaternary catchment W51B, which largely drains in an easterly direction to join the Mpundu River, which subsequently discharges into the Heyshope Dam. Kangra Coal's current operations at Maquasa and the communities of Driefontein and St Helena are respectively located in the north and north-west of this catchment.

The Adit B site is crossed by small streams and floodlines. The slope of the site is steep (an overall average slope of approx. 20%). The site is undeveloped, in a rural environment.

5.2.2 *Proposed Project Activities and Impacts*

Activities associated with the construction of the Ventilation Adit (Adit B) that could impact on surface water features, include the construction of an access road to the proposed site.

The Adit will be constructed from below the ground surface and no coal product will be brought to ground surface at Adit B.

5.2.3 *Sensitive Receptors*

Tributaries identified on the site proposed for Adit B contribute towards run-off to the larger tributaries of the Mpundu River, which subsequently drains into the Heyshope Dam. Furthermore, small rural settlements are located downstream from the proposed Adit B site. These communities may potentially use water from the tributary originating from a natural spring.

5.2.4 *Significance of Impact (Pre-mitigation)*

Based on the analysis provided above, the impact from the proposed mining activities on the surface water quality at Adit B will be '**Minor Negative Impact**' (pre-mitigation) (*Table 5.3*).

Table 5.3 Rating of Impacts Related to Surface Water Quality associated with the Proposed Ventilation Adit (Adit B) (Pre-mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Erosion from the establishment of access roads will be minor and the extent of the impact will be limited to receptors immediately downstream from the proposed Adit B site.

Duration	Long-term (10 to 20 years)	For life of mine, although the construction of the adit will happen after the construction of Adit A.
Scale	Local	Downstream to immediate receptors, following dilution of sediment will result in the impact becoming negligible. The footprint of the actual ventilation shaft is small.
Frequency	After rainfall events	Erosion would occur during and directly after rainfall events.
Likelihood	Likely (prevalent in the summer months)	Erosion of the access road (pre-mitigation) would likely occur, mainly during the summer months.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Although a small spring likely acts as a water source for a community down-slope of the proposed adit B, sediment loadings as a result of erosion from the access road is likely to be minimal, and the receptor will likely not be affected. Construction of the adit B infrastructure is not major – this includes one shaft built from below ground surface.		
Significant Rating Before Mitigation		
Minor Negative Impact		

5.2.5 *Recommendations and Mitigation/Management Measures*

The following mitigation/management measures are recommended so as to reduce the impact:

- During design and construction of the access road to the adit B site, storm water control measures (*viz*. flow retardation structures) should be provided to minimise the impact associated with erosion. Flow retardation structures will control run-off velocities (and subsequent erosion) by converting the flow pattern to sheet flow.

- During the construction phase, temporary stormwater control berms should be placed on the downstream perimeter of the adit B footprint, so as to minimise silt ingress into the receiving tributaries. Over flow from the temporary berm should be relatively clean.

- Construction of adit B and associated access road should take place during the winter months. The adit B access road is to follow the alignment of existing tracks to the greatest extent possible.

- The footprint of adit B is to be kept as small as possible. During construction, laydown areas for construction equipment, vehicles etc. are to be demarcated and no access outside of the demarcated area should be allowed.

- The location of the actual ventilation adit should be located outside of the calculated 1:50 year floodline.

5.2.6 Residual Impact (Post Mitigation)

Based on the implementation of the proposed mitigation measures, the impact from the proposed mining activities on the surface water quality at Adit B will be a '**Negligible Negative Impact'** (post-mitigation) (*Table 5.4*).

Table 5.4 Rating of Impacts Related to Surface Water Resources associated with the Proposed Ventilation Adit (Adit B) (Post-mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Erosion from the establishment of access roads will be minor and the extent of the impact will be limited to receptors immediately downstream from the proposed Adit B site.
Duration	Long-term (10 to 20 years)	For life of mine, although the adit B will be constructed after the construction of the main mine adit.
Scale	Local	Mitigation/management measures will decrease the risk of erosion as a result of the access road. Maintaining as small a footprint as possible will also further reduce the risk of erosion and soil disturbance to site.
Frequency	After rainfall events	Erosion would occur during and directly after rainfall events, but at a local scale.
Likelihood	Unlikely	Erosion control measures for the access road will reduce the likelihood of erosion.
Magnitude		
Negligible Magnitude		
Significant Rating Before Mitigation		
Negligible Negative Impact		

5.3 IMPACTS TO STREAMS, WETLANDS AND SURFACE WATER QUALITY ASSOCIATED WITH THE PROPOSED OVERLAND CONVEYOR ROUTE

5.3.1 Description of the Baseline Environment

The route crosses six tributaries with defined streams and seven associated wetlands.

The baseline surface water quality of the Hlelo River catchment (W52A) was described above.

Water quality data for the Assegaai catchment area is, in general, within the proposed RQWO. The pH and sulphate concentrations in the Assegaai catchment are within the respective RWQO, showing no impact from ARD. Sulphate concentrations are, however notably higher in November when compared to August, indicating flushing of salts that accumulated on mining waste during the dry season by the early summer rains. The effect is most pronounced in samples SW3 and SW4. SW3 is the furthest downstream sample and would show effects from the catchment as a whole; SW4 is in the tributary that originates immediately to the south of the Maquasa East operations.

5.3.2 *Proposed Project Activities*

The following activities which may be associated with the conveyor have the potential to cause surface water contamination:

- *Construction of Conveyor:* The conveyor has to be installed over a number of stream crossings, all designated wetlands. Installation of the pylons and steelwork for the elevated conveyor will require the use of heavy construction equipment and an access road.

- *Transport of Mined Coal via Conveyor:* This will also include routine maintenance and clean-up of spills along the conveyor route. A maintenance road along the conveyor route will provide access to the conveyor for inspection and routine maintenance.

5.3.3 *Sensitive Receptors*

The proposed conveyor route and associated service road will cross the headwaters (mostly wetlands) of small tributaries feeding the Assegaai and Hlelo Rivers, which will have subsequent effects on receiving wetlands, the users of those wetlands (both social and ecological users). Wetlands are a key resource for the provision of ecosystem services (refer to the Biodiversity Specialist Study; *Annex C.2* in the SEMP document).

5.3.4 *Significance of Impact (Pre-mitigation)*

Based on the analysis provided above, the impact from the proposed conveyor route on surface water quality will be a '**Major Negative Impact**' pre-mitigation (refer to *Table 5.5*).

Table 5.5 Rating of Impacts Related to Streams, Wetlands and Surface Water Quality associated with the Proposed Overland Conveyor System (Pre-mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Length of the proposed overland conveyor system is 7km and traverses seven tributaries and associated wetlands that form the headwaters of greater catchment areas in the region (the Assegaai and Hlelo Rivers).

Duration	Long-term	Impacts to tributaries and associated wetland systems would be immediate during the construction phase and will (if not effectively mitigated) result in deterioration to downstream systems over time. Furthermore, should impacted wetlands not be suitably rehabilitated, the effects will be long-term.
Scale	About 2 km	Total width of wetlands that will be affected by the construction of the overland conveyor and associated service road is approx. 2km.
Frequency	Continuous - for the full duration of the proposed Project	Should detailed design not take into account measures for unimpeded flow, the impact will be continuous for the duration of the LOM through to the decommissioning and closure phase.
Likelihood	Likely	The service roads and conveyor will be constructed within the overland conveyor servitude and will need to traverse wetland systems.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity /Importance		
Wetlands play a crucial role in the provision of ecosystem services. Furthermore, the tributaries and associated wetlands that the proposed overland conveyor system will traverse are at the headwaters of major catchments (the Ohlelo River and Assegaai River).		
Significant Rating Before Mitigation		
Major Negative Impact		

5.3.5 *Recommendations and Mitigation/Management Measures*

When the gravel service road and conveyor crosses the ***wetland to the north of the Kransbank Private Nature Reserve*** the following mitigation measures will be adopted:

- The contractor's access path of no more than 5m wide comprising of steel tracks laid on plastic sheeting over a geofabric should be installed through the wetland systems where piles are to be installed. Once construction of the overland system is completed, the temporary construction "roadway" should be removed and vegetation re-instated. Vegetation re-instatement should be undertaken by a reputable ecologist.

- As the road approaches the 1:100 year floodline adjacent to the wetland, it will be diverted out to district road D2548.

- The access road that runs between the conveyor corridor and the district road will be unfenced, and built to the same standard as the conveyor gravel service road.

- The fence that restricts access to the conveyor corridor, including the service road, will come to an end outside the 1:100 year floodline as the conveyor gantry ramps up to cross the wetland.

- The gantry support structure consists of pylons that will be spaced approximately 23m apart within the 1:100 year floodline and wetland, which is the maximum distance they can be spaced to provide support to the structure.

- The base footing of each pylon will measure approximately 4m x 2m, and will be established lengthwise, parallel to the flow in wetlands.

- From these base footings, two columns will extend from each up to support the gantry.

The following environmental precaution measures will be adopted for ***other water/river crossings***:

- Unlike the crossing detailed above, all other water crossings occur within a defined valley.

- Rectangular culverts will be installed in parallel (lengthwise in line with the flow).

- Culverts will span the distance between the 1:100 year floodlines so that no damming occurs during flood conditions.

- Erosion protection gabion structures will be installed at the entrance and exit points of culverts. "Reno" mattresses will also be installed so as to reduce flow velocities and turbulence.

- The service road will be narrowed to one lane (approximately 4m) over water crossings.

- In the operational phase, the entire raised section which will have a bunded concrete floor, will contain any product (coal) spillages. The spillages will be swept to concrete bunded collection areas placed at ground level well outside of the 1:100-year flood level, on both sides of the crossing to shorten the sweep length. Spilled coal will be collected and returned to the Main Mine Adit.

5.3.6 *Residual Impact (Post-mitigation)*

Based on the implementation of the proposed mitigation measures, the impact from the proposed conveyor on surface water quality will be a '**Moderate Negative Impact'** (post-mitigation) (*Table 5.6*).

Table 5.6 Rating of Impacts Related to Rivers, Streams and Surface Water Quality associated with the Proposed Overland Conveyor System (Post-mitigation)

Type of Impact
Direct Negative Impact
Rating of Impacts

Characteristic	Designation	Summary of Reasoning
Extent	Regional	As above
Duration	Long-term	As above
Scale	Less than 2 km	As above
Frequency	Periodic	Unimpeded flow during operations, along with appropriate design of the conveyor service road, will decrease the risk of impeded flow and impacts to water quality as a result of spillages.
Likelihood	Possible	With mitigation, the likelihood is possible.
Magnitude		
Moderate Magnitude		
Significant Rating Before Mitigation		
Moderate Negative Impact		

5.4 IMPACTS OF REDUCED BASEFLOW ON SURFACE WATER AND WETLANDS

Please Note – this impact was assessed in the Groundwater Impact Assessment Report for the Proposed Kusipongo Resource (*Annex C.3* of the SEMP document).

5.5 IMPACTS TO THE MAIN MINE ADIT (ADIT A) AS A RESULT OF STORMWATER RUNOFF

5.5.1 Description of the Baseline Environment

The site proposed for the Main Mine Adit (Adit A) is located within quaternary river catchment areas W52A on the Ohlelo River and its tributaries. The river flows on the western boundary of the site, proposed for Adit A, has a narrow, overgrown flow channel. In addition to the Ohlelo River, a number of small tributaries that drain the hillside to the north east bisect the site. All these tributaries are non-perennial whereas the Ohlelo River is perennial.

Flood peaks and volumes have been calculated for the Ohlelo River and associated tributaries that may affect infrastructure proposed on the Adit A site, based on the catchment characteristics. Based on the calculations of flood peaks and volumes, floodlines have been determined for the Ohlelo River and for the larger tributary that crosses the site on the eastern boundary. Values for flood peaks, flood volumes, and floodline boundaries are provided in *Section 4*.

5.5.2 Proposed Project Activities

- *Clean Water Cut-off Berms:* A clean water cut-off berm is proposed up slope of the proposed Adit A site, to divert flow from the catchments to the south western and northern ends of the proposed Main Mine adit site into the water course.

- *Storage of Stormwater in two Stormwater Ponds:* Two storm water ponds of capacity 8,200m³ and 13,000m³ pond. The total storage thus provided is 21,200m³. The provided capacity is 50% more than the estimated required capacity, based on a 1:50 year rainfall event. A groundwater balancing dam, having an approximate capacity of 4,000m³, adds a further margin of safety.

5.5.3 Sensitive Receptors

In this case, the sensitive receptor would be the adit itself. Uncontrolled stormwater could threaten adit infrastructure, and flooding of the adit area could cause contamination and dirty water discharge into the surrounding environment. In this case, the sensitive receptors are as for the impacts as a result of adit activities on surface water quality, as described above.

5.5.4 Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the impact from floodwaters on the adit itself, and on the water quality of the area surrounding the adit as a result of stormwater discharges, will be a '**Major Negative Impact**' pre-mitigation (refer to *Table 5.7*).

Table 5.7 Rating of Impacts as a Result of Stormwater Discharges on Adit A, and into the Surrounding Environment (Pre-Mitigation)

Type of Impact		
	Direct Negative Impact	
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to regional	Without mitigation, the effects of flood waters may cause contamination to surface waters, which will impact downstream water quality, possibly to the confluence with the Ohlelo River.
Duration	Medium-term	Although rainfall/runoff is of short duration, contamination downstream will be longer term.
Scale	Altered	To the confluence with the Ohlelo River as a worst case scenario.
Frequency	Periodic	The risk for the contamination of surface water would continue for the duration of mining, overburden dumping and coal transport/storage until the site is rehabilitated post-closure.
Likelihood	Definite	The Project area does experience high intensity/short duration rainfall events.
	Magnitude	
	High Magnitude	
	Sensitivity/Vulnerability/Importance of the Resource/Receptor	
	High Sensitivity	
Surface- and groundwater resources are used for domestic water supply and stock watering, and support aquatic ecology in riverine and wetland habitats.		
	Significant Rating Before Mitigation	
	Major Negative Impact	

5.5.5 *Recommendations and Mitigation/Management Measures*

- Mitigation measures should be evaluated in terms of the requirements of GN 704 (DWAF, 1995) and guidelines in the Best Practice Guideline G1: Stormwater Management, DWAF, August 2006.
- During the construction phase, temporary stormwater control berms should be placed on the downstream perimeter of the Adit A footprint, so as to minimise silt ingress into the Ohlelo River and associated tributaries. Over flow from the temporary berm should be relatively clean.
- The minimum required dam capacity to retain a 1:50 year stormwater run-off event for the dirty water catchment was.
- It is a requirement that all facilities associated with the Main Mine Adit be placed above the estimated 1:100 year floodline of the Ohlelo River.
- In-built controls in the Project design (refer to *Chapter 3*) include the adequate design of drains, ditches, oil/water separators, and silt traps, the bunding of major contamination sources (fuel depot, temporary hazardous waste storage area), roofing of temporary hazardous waste areas etc.

5.5.6 *Residual Impact (Post-mitigation)*

Based on the implementation of the proposed mitigation measures, the impact of stormwater on the adit itself, and on the surrounding environment as a result of stormwater discharges, will be a '**Minor Negative Impact**' (*Table 5.8*).

Table 5.8 Rating of Impacts as a Result of Stormwater Discharges on Adit A, and into the Surrounding Environment (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	As above.
Duration	Long-term	As above.
Scale	Altered	To the confluence with the Ohlelo River as a worst case scenario
Frequency	Infrequent	With mitigation, the risk of contamination of surface water would be less frequent, especially with safety factors built I to the design of flood control infrastructure.
Likelihood	Possible	With mitigation, the likelihood of flood damage and contamination will decrease.
Magnitude		
Medium Magnitude		
Significant Rating After Mitigation		
Minor Negative Impact		

6 SURFACE WATER MONITORING PROGRAMME

Monitoring of surface water is recommended for the following purposes:

1. To detect the actual impact on surface water quality timeously.

2. To assess the cumulative impacts on surface water quality from current operational and abandoned mines in the catchment areas.

3. To assess whether the mitigation/management measures provided in *Chapter 9* are effective, supporting the update of mitigation measures where necessary.

The recommended surface water monitoring plan is presented in *Table 6.1* below. This monitoring plan fulfils the monitoring actions required to address items 1 and 2 above.

Table 6.1 Surface Water Monitoring Plan

ID	Latitude	Longitude	Location	Primary Purpose	Water Quality Monitoring Frequency
C1	27^0 01′ 9.92″ S	30^0 16′ 50.46″ E	Tributary of the Ohlelo River, upstream of Adit A	To assess water quality that will not be influenced by any activities at Adit A	Monthly
C2	27^0 01′ 3.94″ S	30^0 16′ 59.67″ E	Ohlelo River, upstream of Adit A	To assess water quality that will not be influenced by any activities at Adit A	Monthly
C3	27^0 0′ 49.5″ S	30^0 17′ 8.53″ E	Ohlelo River, downstream of Adit A	To assess water quality immediately downstream of activities occurring at Adit A	Monthly
C4	27^0 0′ 10.14″ S	30^0 17′ 14.61″ E	Ohlelo River, upstream of confluence with Hlelo River	To assess water quality downstream of activities occurring at Adit A, before any dilution effects occur as a result of flows from the Hlelo River	Monthly
C5	26^0 58′ 11.01″ S	30^0 20′ 38.38″ E	Hlelo River, bridge crossing Road D273	To assess water quality immediately downstream of old mining activities	Monthly
C6	26^0 54′ 0.98″ S	30^0 27′ 10.96″ E	Hlelo River, downstream of confluence with Taaibosch Spruit, on Road D803	To assess water quality in the Hlelo River and to establish changes in water quality as a result of inflows from the Taaibosch Spruit	Monthly
C7	260 53′ 43.078″ S	300 24′ 1.971″ E	Taaibosch Spruit, before its confluence with the Hlelo River	To assess water quality in the Taaibosch Spruit, uninfluenced by water quality in the Hlelo River	Monthly
C8	260 59′ 45.597″ S	300 20′ 19.405″ E	Tributary to the Hlelo River upstream of the abandoned mine, and adjacent to the planned temporary construction camp	To assess water quality in the tributary and any impacts as a result of the temporary construction camp and operation of the conveyor	Monthly
C9	270 3′ 30.919″ S	300 18′ 29.957″ E	Tributary adjacent to ventilation Adit B	To assess water quality immediately downstream of activities occurring at Adit A	Monthly
C10	260 59′ 55.591″ S	300 19′ 12.080″ E	Tributary to the Hlelo River downstream of the conveyor belt route	To assess water quality in the tributary and any impacts as a result of the temporary construction camp and operation of the conveyor	Monthly

The monitoring plan should be considered a living document that needs to be updated as monitoring data results are generated. Details in support of *Table 6.1* are listed as follows:

- Each surface water sampling location was selected in order to monitor particular mining infrastructure, or applicable rivers and tributaries, which is detailed as the 'primary purpose'.

- Surface water quality should initially be monitored monthly. Monitoring frequency will be reviewed once monitoring data is available.

- The list of chemical constituents to be analysed should be routinely updated based on previous results. Parameters to be tested include, but are not limited to:

    - Major constituents pH, EC, (if not measured in the field), TDS, Cl, SO_4, NO_3, total N, F, Ca, Mg, Na, K, total alkalinity.
    - Major metals by inductively coupled plasma – mass spectrometry (ICP-MS): Al, Cd, Co, Cu, Fe (Ferric and Ferrous iron), Mn, Ni, Pb, Sb, Zn, U.
    - Parameters identified as contaminants of concern include Sulphate, Iron, Cobalt Nickel.

- Samples should be submitted to a SANAS accredited laboratory within recommended holding times.

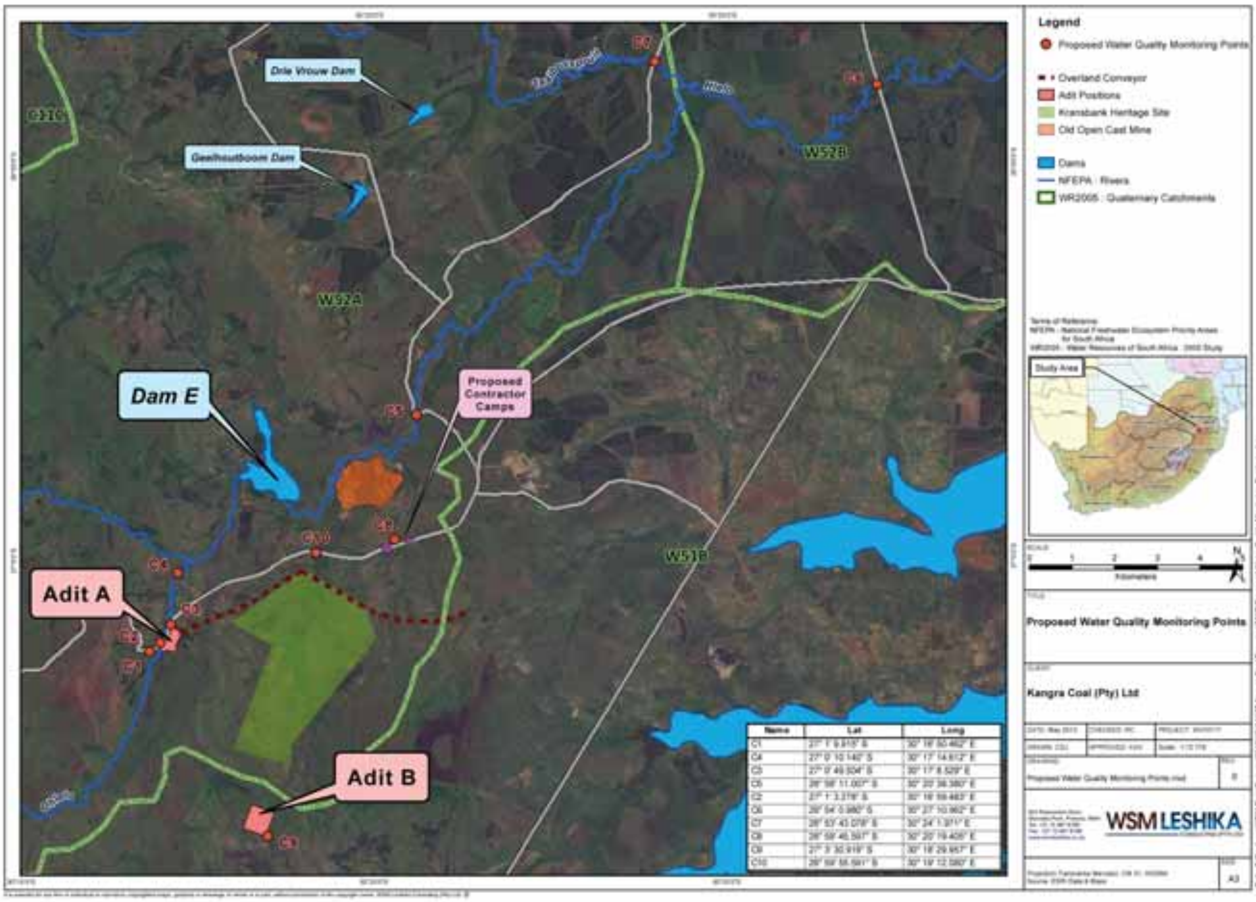
- Water quality results should be compared to the water quality screening levels developed as part of this ESIA process (refer to *Section 4.3.4* of *Chapter 4*) rather than to existing national screening levels. These screening levels are intended to be used to assess the quality of water in natural surface water systems.

- The screening levels are not discharge standards. In this regard, the General Authorisations in Terms of Section 39 of the National Water Act (1998) will apply for waste discharge into surface water systems. The monitoring of discharges in surface water systems is, however not included in the surface water monitoring plan, given Kangra Coal's commitment to a Zero Discharge Policy.

- All monitoring records should be stored in a database which is routinely updated, maintained, and should include all metadata associated with the monitoring activities.

- The monitoring programme and data should be reviewed annually and amended if necessary.

Figure 6.1 Surface water Monitoring Points for the Proposed Kusipongo Resource Expansion Project



Name	Lat	Long
C1	27° 1' 9.815" S	30° 16' 50.462" E
C4	27° 0' 10.140" S	30° 17' 14.612" E
C3	27° 0' 49.504" S	30° 17' 8.529" E
C5	26° 58' 11.007" S	30° 20' 38.380" E
C2	27° 1' 3.278" S	30° 16' 59.483" E
C6	26° 54' 0.980" S	30° 27' 10.962" E
C7	26° 53' 43.078" S	30° 24' 1.971" E
C8	26° 59' 45.597" S	30° 20' 19.405" E
C9	27° 3' 30.919" S	30° 18' 29.957" E
C10	26° 59' 55.591" S	30° 19' 12.080" E

7 CUMULATIVE IMPACTS

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This Section considers the cumulative impacts that would result from the combination of the proposed Kangra Coal Expansion Project and other actual or proposed future developments in the broader Study Area.

7.1 DEVELOPMENT CONTEXT

In addition to the proposed Kusipongo Resource Expansion Project, the Study Area may experience cumulative impacts as a result of existing and proposed developments in the broader Study Area. This section provides an overview of these developments.

Existing activities that could cumulatively impact on the social, physical and biophysical environment include:

- **Kangra Coal Current Mining Activities** – Kangra Coal has been extracting coal from the Savmore Colliery and operating the current washing plant neighbouring the Driefontein community since the late 1990's. The Savmore Colliery currently operates on the Maquasa East, Maquasa West and Maquasa West Extension properties. Current operations entail both underground and open pit mining methods, which produce less than five million tons per annum (Mpta) run-of-mine (ROM) of which 70% is product and 30% discard.

- **A Worked Out Mine** – the mine is situated on the banks the Hlelo River approximately 11km downstream of the proposed main mine adit site (26°58'26.34'' S 30°20'02.88'' E).

- **A Worked Out Mine** – the mine is located on the farm Taaiboschspruit on the northern border of the Hlelo River catchment, about 16.5km (along the length of the river) from the confluence with the Hlelo River (26°51'08.28'' S 30°20'28.75'' E).

Furthermore, the following **developments are proposed** in the Study Area:

- **Kangra Coal Maquasa Expansion** – Kangra Coal has plans to expand existing operations to include eight new opencast pits; the expansion of existing opencast pits; two new underground mining areas and expanded discard dumps. The new operations are planned to take place on Kangra Coal's Nooitgezien and Maquasa West farms, while extensions will happen on Maquasa and Roodekraal farms, which neighbour Driefontein.

- **New Storage Dam** – the construction of a new storage dam in the Hlelo River, capacity 4.2 million m^3, about 5km downstream of the site proposed for the main mine adit.

These cumulative factors may exacerbate the impacts identified in aforementioned section. Where these impacts may be intensified by these cumulative factors they are discussed in the following sections.

Given the limited detail available regarding such future developments, the assessment that follows is necessarily of a generic nature and focuses on key issues and sensitivities, and how these might be influenced by cumulative impacts with other planned development.

7.2 CUMULATIVE IMPACTS

The Ohlelo and Assegaai River Catchments have been identified by the Department of Water Affairs as being important catchments in the country, as they are a key source of water supply to industry, commercial agriculture and rural communities in the Study Area.

The surface water data for the Ohlelo Catchment show that surface water has been slightly affected by mine drainage in the Ohlelo River, but the water generally conforms to the derived RWQO. The surface water data for the Assegaai Catchment show that surface water has been impacted by neutral mine drainage, but the water generally conforms to the derived RWQO.

With further mining developments in the Study Area, these catchments are likely to come under increased pressure, not only in terms of water abstraction/discharge, but also in terms of the potential contamination of these rivers by diffuse sources of pollution.

On this basis, there is potentially significant cumulative surface water impacts associated with increased development in the Study Area.

8 CONCLUSION

The SWIA indicated that the proposed Main Mine Adit and overland conveyor route will have surface water related impacts; however, with suitable mitigation, residual impacts will be reduced. Impacts to the main mine adit as a result of stormwater runoff was major; however, if mine design ensures placement of infrastructure out of the 1:100 year floodline, suitable containment and management of dirty water and diversion of clean stormwater away from the main mine adit, the residual impact will be reduced to acceptable levels

The SWIA recommends that a surface water monitoring programme be established to monitor surface water quality and to assess the cumulative impacts on surface water quality from current operational and abandoned mines in the catchment area.

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Groundwater Consulting Services. (2009). *Maquasa West Amendment EMP Report*. Kangra Coal (Pty) Ltd.

Kangra Coal (Pty) Ltd. (2012) *Proposed Expansion of Mining Works to Include the Kusipongo Resource – Draft Scoping Report*.

Kangra Coal (Pty) Ltd (October 2012). *Groundwater Specialist Report: Kusipongo Expansion Project*. ERM.

Kovaćs Z.P. *et al* (1985). *Documentation of the 1984 Domoina Floods*. TR122. DWA.

Kotze, J. (September 2010). *Hydrogeological scoping report for the Kusipongo Reserve Coal Mine expansion area*. ERM.

Kruger, E (ed) (2006). *Drainage Manual*. SANRAL. Pretoria.

Kwezi V3 Engineers. (July 2009). *Water services development plan (WSDP) 2009-2013.* Mkhondo LM.

Left-Eye Productions. (2013). *Social Impact Assessment Report for the proposed Kangra Coal Kusipongo Resource Expansion Project.* ERM

Middleton, B.J.and A.K. Bailey. (2009). *Water Resources of South Africa, 2005 Study*. WRC Rep No TT381. Pretoria.

Midgley, D.C., Pitman W.V. and Middleton, B.J. (1994). *Surface Water Resources of South Africa 1990. (WR90 study)*. Vol V Appendices, WRC Report No 298/5.1/94. Pretoria.

Natural Scientific Services cc (August 2011). Report number 1639.

Oryx Environmental. (January 2006). *Maquasa West Amendment EMP Report.*

Venter, A. (October 2010). *Environmental site screening report for the proposed Kusipongo Reserve Coal Mine expansion area*. ERM.

Annex A

Curriculum Vitae

CURRICULUM VITAE – A.M. JANSEN VAN VUUREN

Name of Firm:	WSM Leshika Consulting (Pty) Ltd
Name of Staff:	Anna Maria Jansen van Vuuren
Profession:	Civil Engineer
Born:	13 May 1951
Years with Firm:	14
Nationality:	South African
Membership in Professional Societies:	Fellow of the South African Institution of Civil Engineering Registered Professional Engineer (ECSA No 770359)
Years experience:	36

Key Qualifications:

Anna van Vuuren is a water engineer working in the field of hydrology and specialised hydraulic designs, stormwater management and water supply, including water reticulation and pumping installation designs. While a lecturer in fluid mechanics and hydraulic engineering she carried out research into the scour characteristics at bridge piers. This research led to the award of a MEng degree in hydraulic engineering.

Expert in the analysis of flood lines, hydraulic characteristics related to bridge and large drainage structures, as well as urban flood studies and stormwater management. Recently involved in surface water assessments for coal mining projects, including floodline determination for the Limpopo and Mutamba Rivers, including smaller tributaries crossing the sites. Responsible for storm water management analysis for the proposed Neckartal Irrigation Scheme (Fish River, Keetmanshoop) and the Tandjieskoppe Irrigation Scheme (Orange River While with Africon (now Aurecon), she was responsible for the design of a 30 m drop structure for a bulk sewer, incorporating a vortex inlet and special energy dissipating chamber; hydrological calculations for the bridge at Mmadinare on the Motloutse River, just downstream of Letsibogo Dam; canalisation of Blesbokspruit and Wonderfonteinspruit over the Gemsbokfontein dolomite compartment; pump station and 30km rising main from Oshakati to Omakango, Namibia. For SRK, designed the canalised diversion of the Chingola River in Zambia. Her experience is wide-spread and includes planning, analysis, design and construction supervision of water supply schemes and in the field of hydrology, the calculation of main catchment area runoffs and routing of flows as well as assessment of spillway capacity for dam safety inspections. Countries of work experience include South Africa, Namibia, Botswana, Mozambique, Lesotho and Angola.

External Examiner for Final Year Hydraulics, University of Pretoria. Contributed to the 2006 SANRAL Drainage Manual (Chapter 8).

Education: M.Eng (Hydraulics), University of Pretoria, 1983
B.Eng (Hons)(Civil), University of Pretoria, 1977
B.Eng (Civil) University of Pretoria, 1972

Other Qualifications/Courses attended:
Course on Hydrology, Department of Water Affairs (RSA) and University of Pretoria, 1980.
Course on Flood Hydrology and SDF method, SAICE, 2002
Planning, design and management of dams, University of Stellenbosch, 2006
Drainage Manual course – presenter & attendee, 2007

Employment Record:

Date: April 1997 to date
Company: WSM Leshika Consulting (Pty) Ltd
Position: Director and Specialist engineer
Location: RSA

Specialist Engineer

Specialist Consultant for analyses and design of new inverted siphon of 1.8 m diameter (2012). Purpose of project was to remove bottleneck in system supplying irrigation water to Mhlume Irrigation Scheme, Swaziland. Client: Aurecon JV.

Floodlines of Limpopo River at Groblersbrug and Pafuri for upgrading of Border Posts (2010 to 2012). Client: Theo Pieterse &Ass for Dept of Public Works.

Contributor to Ed 7 of SANRAL's Drainage Manual (2012). Responsible for Chapter 8 on Bridge Sizing and Scour Protection measures. Client: Sinotech cc for SANRAL.

Stormwater system design, Neckartal Irrigation Scheme. (2009-2011). Responsible for hydrological analysis and system design for the stormwater drainage in the 5 000 ha new scheme being planned west of Keetmanshoop, Namibia. Client: Knight Piesold Consulting.

Surface water assessment input to EIA/EMP of Makhado Mine. (2007-2011). Complete assessment of surface water aspects for EIA and EMP, including floodlines (for site streams and the Mutamba River) and conceptual design of stormwater systems to divert clean water around pits and plant area. Client: Jacana Environmentals cc.

Surface water assessment input to EIA/EMP of Vele Mine. (2008-2010). Complete assessment of surface water aspects for EIA and EMP, including floodlines (for site streams and the Limpopo River) and conceptual design of stormwater systems to divert clean water around pits and plant area. Client: Jacana Environmentals cc.

Re-routing of stormwater in canal at Nestlé factory, Estcourt. (2008 and 2010). Analysed storm water inflows and designed diversion canal to accommodate new extensions to the factory. Client: Nestlé (South Africa) (Pty) Ltd.

Stormwater system design, Tandjieskoppe Irrigation Scheme. (2007-2008). Responsible for hydrological analysis and system design for the stormwater drainage in the 1 040 ha new scheme being planned at Noordoewer, Namibia. Client: Namibian Dept of Agriculture.

New Bridge on Road P166 : By-Pass to Mbombela Stadium. (2007-2008) Appointed to determine the 100-year and Probable Maximum flood peaks of the Crocodile River near Nelspruit and compile the pre-and post-development floodlines. Client: Madisha and Ass.

Laela-Sumbawanga Road, Tanzania. (2007). Specialist advice regarding flood hydrology along a number of river crossings. Client: Africon.

Mongu-Kalabo Bridge, Zambesi River, Zambia. (2005). Assessment of structural failure, responsible for hydrological assessment. Client: ZMCK.

Stormwater system at Soshanguve Plaza, Gauteng, RSA. (2004). Flood peaks and river diversion around shopping mall, including road crossings. Client: Hannes Hatting & Ass

Scour at road bridges, Tanzania. (2003). Scour depths were estimated seven new road bridges on major route to the south. Client: Kwezi V3.

Dam Safety and rehabilitation works, Glen Alpine Dam, Limpopo Province, RSA. (2001). Conducted second dam safety inspection of this Class 2 dam, including dam break analysis and designed rehabilitation works after 2000 flood damage. Client: DWAF

Grimman Weir, Lower Komati River. (2001) Determined flood peaks and levels to establish cause of failure and to assist in developing remedial measures. Client: Lower Komati Irrigation Board.

Lebombo Dam leakages, Lower Komati River (2004-2006). Investigated the cause of water logging of commercial sugarcane and banana plantations and prepared documentation for legal claim which was settled out of court in Client’s favour. Client: Nova Sun

Project Manager

Reconnaissance study of the Klein Letaba River to augment the water supply in the Middle Letaba Water Supply Scheme: (1997-2002) DWAF. Project leader for a multi disciplined team for quantifying the water requirements, identifiying possible dam sites, studying the hydrology of the catchments and determining dam yields, evaluating the environmental and socio-economic impacts and preparing conceptual designs and cost estimates to compare the most feasible options.

Water Resource Situation Assessment in Limpopo Province, including catchment areas of Limpopo, Letaba, Luvuvhu and Olifants Rivers (1997 to 2002). Client: DWAF

Loskop Dam canal study, (2001) Site survey to create drawing of the 1st section of left bank canal to the Moos River syphon, followed by hydraulic analysis. Client: Loskop Irrigation Board

Stormwater study: Sishen South Iron Ore Mine, Postmasburg, Northern Cape, RSA. (2003 – 2007). Complete assessment of surface water aspects for EIA, including floodlines and conceptual design of stormwater to divert clean water around pits and waste dumps, followed later by amendments for the changed mine layout and finally designing the structures for the surface water diversions, sizing the equipment required to dewater the pits and to pump rainwater from the pits. Client: Kumba Resources.

Rietvlei Dam and Fountains Valley dolomitic compartment boreholes, Tshwane (2003-2004). Project manager for the development of geohydrologic models to assess the impact of septic tanks and other possible pollution sources on the important potable water source. Client: City of Tshwane Metropolitan Council.

Nkwaleni Canal water loss assessment, Northern KZN. (2005). Project manager for geotechnical and hydraulic surveys, including flow measurements, to quantify water losses in the old unlined canal. Client: DWAF

Project Phoenix: Thabazimbi (2006). Project manager for the pre-feasibility study for bulk water supply and pit de-watering, including also cost estimates, a groundwater model and flood mitigation measures for the re-vitalised pit and new plant developments. Client: Kumba Resources.

Libya Roads Project (2008) Project manager for the hydrological and hydraulic assessment of drainage structures required along the 370 km section of coastal highway in Libya that forms part of the future Maghreb Motorway linking various countries along the Southern Mediterranean coastline. Client: BKS Global

Golf Estate development at Standerton (2008 – present) Responsible for stormwater issues and potable water supply to proposed new development at existing golf course. The project included flood studies, licensing and reticulation system designs for the layout which straddles the Vaal River. Client: Hayes Matkovich Developments (Pty) Ltd

Design Engineer

Stormwater system design in Gabon. (2002). Flood peak estimate and conceptual designs for housing development. Client: Selwyn Price.

Upgrading Tom Naude Detention Dam, Polokwane, Limpopo Provice, RSA. (1999). Floodpeak estimate, dam routing and design of new outlet works as well as embankment improvements. Client: Polokwane Local Municipality

Responsible Director/Study Leader

Wilgespruit Culvert, Tshwane, Gauteng, RSA. (2006) Design of energy dissipating structure. Client: D&M Consulting

Ngwenya Lodge, Mpumalanga, RSA. (2005). Floodlines in the Crocodile River. Client: C Greyling Consulting

Eiland Resort, Limpopo Province, RSA. (2003) Floodlines of the Great Letaba River were determined to establish potentail expansion of the resort. Client: Hans Merensky Game Reserve

Floodlines for Lephalale Municipality, Limpopo Province, RSA. (2002). Runoff calculations and floodlines in the Mokolo and Lephalale Rivers at urban development centres. Client: Lephalale Municipality.

Surface water assessment for EIA of the proposed Platreef Platinum Mine, near Mokopane (Potgietersrus), Limpopo Province, RSA. (2002). Client: African Minerals.

Water resources assessment for water supply to the Lephalala River communities, Limpopo Province, RSA. (2003). Client: Waterberg District Council.

Team Member

With C Sellick & Associates, responsible for technical coordination of seven consultancies to undertake Water Resource Situation Assessments in RSA, that will be used to develop National Water Resources Strategy. (1997 to 2001). Client: DWAF.

Member of a study team developing a water supply strategy for the "Eastern Limb" platinum and chrome mines in the eastern Olifants River catchment area, Limpopo Province, RSA. (2003) Responsible for surface water aspects. Client: Joint Development Forum

Task Leader

Rural Water Provisioning Project in southern Angola. (2000 to 2002). Responsible for water engineering input in developing strategies for water resource development and project implementation. Client: Agri Logic

Date: January 1994 to March 1997
Company: Africon International Ltd
Position: Associate
Location: RSA

Specialist Engineer

Sewerage treatment works. Specialist advice on hydraulics of sewerage treatment works, i.e. Olifantsvlei (Johannesburg), Northern Works (Johannesburg), Otjomuise (Windhoek), Walvis Bay(Namibia), Selosesha (Bloemfontein), Sasol II and III (Secunda)

Mmadinare Bridge, (Botswana). Responsible for all hydrological calculations to determine the size of the bridge. It involved flood routing analyses in the proposed Letsibogo Dam. Client: Botswana Roads Dept

Bonwapitse Bridge, Botswana. Responsible for hydrological (flood peak) analyses of failure flood and new design flood for the repairs to the structure. Client: Botswana Roads Dept.

Mozambique Roads. Responsible for analyses of Mozambique rainfall data in order to predict design rainfall intensity for upgrading of a number of bridges and culverts

Noordoewer/Vioolsdrift irrigation scheme Hydraulic analyses of complete system, including major Orange River siphons, and design of remedial works to some of the minor canals. Client: Namibian Dept of Agriculture

Design Engineer

Responsible for flood hydrology of river adjacent to the Maseru By-pass Road (Lesotho), for bridge design as well as flood line determination.

Team member

A Consortium investigated the pre-feasibility of transferring water from the Orange River to the Vaal River; involved in sediment management of the Caledon River Cascades Scheme and final production of reports. Involved mainly in a study to reverse the flow of the Caledon River by constructing a series of weirs and pumping the water upstream. Client: DWAF

Team member

Development of a Strategic Plan for bulk water supply in the Southern Drainage Basin of the Greater Johannesburg region. Involved in determining the required extensions and improvements of the reticulation system Client: Johannesburg City Council

Date: September 1991 to December 1993
Company: VWL Namibia Inc
Position: Senior Engineer
Location: Namibia

Project Leader

Design of 35 km rising main, pump station and village branch pipelines in Northern Namibia. (1992-1993) Client: Namibian Dept of Water Affairs

Design Engineer

Design of bulk supply pipeline,booster pumpstation and reticulation of raw water for irrigation in the town of Mariental (1993) Client: Namibian Dept of Rural Water Supply

Date: 1988 to 1991 (part-time)
Company: Hugo & Partners
Position: Associate
Location: RSA

Team member

Hydrological and spillway analyses of three municipal dams including the Saulspoort Dam (Class 3), Bethlehem, RSA for dam safety inspection reports. Study included flood routing and floodline determination along downstream river reach. (1990-1991) Client: Dr Kriel

Specialist Consultant

Various tasks, such as flood lines and stormwater dams for pollution control, Optima Coal Mine, and hydrology and hydraulics of Ngome Dam and Nooitgedacht Dam

Design and Site supervision

Replacement of hot water pipes and upgrading of fire reticulation at Tembisa Hospital. Client: Transvaal Provincial Administration

Date: 1987 to 1988
Company: SRK
Position: Senior Engineer
Location: RSA

Design Engineer
Designed the Chingola River diversion and canalisation in Zambia to convey 50m^3/sec. (1987) Client: ZCCM

Date: 1983 to 1987
Company: Van Wyk & Louw Consulting Engineers
Position: Design engineer
Location: RSA

Date: 1975 to 1983
Company: University of Pretoria
Position: Senior lecturer in Hydraulics
Location: RSA

Date: 1973 to 1975
Company: Department of Water Affairs and Forestry
Position: Assistant Engineer in Construction, Design and Planning Divisions
Location: RSA

Languages:	**Speak**	**Read**	**Write**
<u>First Language:</u>			
Afrikaans	Excellent	Excellent	Excellent
<u>Other Languages:</u>			
English	Good	Excellent	Good

Certification:

I the undersigned, certify that to the best of my knowledge and belief, the data above correctly describe my qualifications and my experience.

______________________ Date: 24 May 2013

A.M. J. VAN VUUREN

Annex B

Monthly Naturalised Flow at the Main Mine Adit

RUNOFF AT ADIT (millions of cubic metre)

HYDRO YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL TOTAL	AVERAGE MONTHLY
1920	0.778	0.571	0.604	0.552	0.204	0.531	0.617	0.226	0.096	0.046	0.027	0.026	4.278	0.356
1921	0.085	1.205	1.730	0.776	0.280	0.132	0.076	0.036	0.029	0.027	0.034	0.042	4.453	0.371
1922	0.676	1.040	0.578	1.034	1.024	0.253	0.070	0.023	0.020	0.020	0.018	0.014	4.770	0.398
1923	0.015	0.023	0.067	0.118	0.130	0.170	0.162	0.079	0.036	0.021	0.017	0.039	0.876	0.073
1924	0.087	0.253	0.351	0.261	0.210	0.971	1.088	0.282	0.102	0.058	0.038	0.078	3.777	0.315
1925	0.113	0.115	0.105	0.101	0.152	0.193	0.156	0.077	0.046	0.040	0.028	0.061	1.187	0.099
1926	0.097	0.098	0.101	0.158	0.207	0.179	0.122	0.061	0.031	0.045	0.045	0.034	1.176	0.098
1927	0.125	0.176	0.235	0.344	0.249	0.137	0.102	0.064	0.036	0.024	0.021	0.026	1.540	0.128
1928	0.025	0.059	0.136	0.149	0.113	0.216	0.246	0.117	0.052	0.038	0.027	0.054	1.232	0.103
1929	0.500	0.976	0.682	0.363	0.307	0.171	0.072	0.033	0.023	0.031	0.037	0.029	3.224	0.269
1930	0.021	0.027	0.083	0.192	0.219	0.143	0.101	0.076	0.044	0.045	0.041	0.029	1.022	0.085
1931	0.021	0.070	0.128	0.115	0.091	0.128	0.126	0.089	0.076	0.054	0.032	0.020	0.951	0.079
1932	0.034	0.093	0.371	0.420	0.204	0.165	0.125	0.071	0.035	0.034	0.031	0.020	1.604	0.134
1933	0.020	0.243	0.893	2.230	1.894	0.435	0.177	0.114	0.071	0.070	0.096	0.076	6.321	0.527
1934	0.059	0.164	0.905	1.022	0.354	0.172	0.095	0.042	0.026	0.023	0.020	0.017	2.898	0.241
1935	0.027	0.028	0.089	0.412	0.470	0.234	0.152	0.148	0.162	0.097	0.047	0.029	1.896	0.158
1936	0.050	0.696	0.850	1.468	2.006	0.879	0.247	0.091	0.040	0.026	0.021	0.022	6.397	0.533
1937	0.039	0.042	0.276	0.404	0.259	0.190	0.213	0.216	0.121	0.071	0.051	0.036	1.918	0.160
1938	0.329	0.448	0.304	0.286	1.514	1.769	0.467	0.154	0.066	0.060	0.055	0.048	5.501	0.458
1939	0.089	0.869	1.095	0.418	0.215	0.135	0.097	0.086	0.135	0.125	0.081	0.056	3.400	0.283
1940	0.060	0.170	0.918	1.010	0.393	0.319	0.255	0.151	0.070	0.032	0.024	0.025	3.428	0.286
1941	0.041	0.069	0.171	0.316	0.268	0.204	0.180	0.087	0.069	0.058	0.042	0.041	1.547	0.129
1942	0.088	0.424	0.531	0.281	0.197	0.191	0.825	0.923	0.265	0.148	0.198	0.154	4.223	0.352
1943	0.152	0.200	0.223	0.301	1.349	1.418	0.320	0.082	0.043	0.047	0.031	0.034	4.201	0.350
1944	0.117	0.208	0.178	0.168	0.167	0.197	0.198	0.095	0.040	0.024	0.019	0.015	1.425	0.119
1945	0.024	0.036	0.034	0.583	0.808	0.545	0.414	0.135	0.046	0.027	0.021	0.017	2.689	0.224
1946	0.024	0.107	0.194	0.265	0.279	0.182	0.102	0.061	0.035	0.030	0.025	0.020	1.324	0.110
1947	0.039	0.174	0.629	0.714	0.406	0.345	0.264	0.137	0.061	0.029	0.022	0.025	2.844	0.237
1948	0.038	0.128	0.200	0.304	0.324	0.226	0.222	0.177	0.100	0.052	0.029	0.032	1.831	0.153
1949	0.052	0.082	0.272	0.382	0.262	0.183	0.139	0.095	0.064	0.040	0.036	0.028	1.637	0.136
1950	0.030	0.042	0.138	0.184	0.152	0.163	0.163	0.139	0.099	0.059	0.073	0.083	1.327	0.111
1951	0.113	0.123	0.174	0.198	0.109	0.070	0.069	0.066	0.052	0.051	0.046	0.031	1.101	0.092
1952	0.018	0.158	0.322	0.247	0.306	0.379	0.231	0.119	0.058	0.031	0.027	0.022	1.917	0.160
1953	0.026	0.232	0.318	0.227	0.620	0.650	0.247	0.133	0.075	0.040	0.026	0.035	2.629	0.219
1954	0.068	0.116	0.117	0.950	1.397	0.845	0.499	0.194	0.093	0.048	0.027	0.018	4.373	0.364
1955	0.050	0.125	0.684	0.748	0.333	0.335	0.211	0.115	0.085	0.056	0.033	0.037	2.813	0.234
1956	0.140	0.232	0.491	0.507	0.208	0.217	0.295	0.244	0.134	0.106	0.109	0.199	2.882	0.240
1957	0.270	0.209	0.131	0.271	0.319	0.143	0.105	0.106	0.063	0.033	0.022	0.036	1.706	0.142
1958	0.057	0.132	0.521	0.600	0.278	0.155	0.085	0.058	0.053	0.039	0.027	0.028	2.033	0.169
1959	0.046	0.137	0.247	0.199	0.164	0.182	0.184	0.164	0.087	0.040	0.032	0.030	1.512	0.126
1960	0.060	0.193	1.246	1.328	0.370	0.266	0.210	0.151	0.097	0.059	0.036	0.051	4.069	0.339
1961	0.083	0.137	0.453	0.747	0.516	0.213	0.125	0.084	0.048	0.028	0.027	0.035	2.498	0.208
1962	0.064	0.561	0.713	0.343	0.219	0.108	0.081	0.067	0.095	0.207	0.187	0.107	2.752	0.229
1963	0.087	0.255	0.279	0.281	0.287	0.125	0.058	0.038	0.026	0.023	0.021	0.015	1.496	0.125
1964	0.476	0.691	0.368	0.298	0.217	0.099	0.045	0.033	0.027	0.026	0.033	0.038	2.349	0.196
1965	0.044	0.081	0.211	0.302	0.244	0.140	0.052	0.022	0.029	0.031	0.024	0.023	1.204	0.100
1966	0.070	0.114	0.351	0.437	0.702	0.729	0.265	0.143	0.074	0.042	0.036	0.025	2.990	0.249
1967	0.049	0.366	0.535	0.320	0.162	0.226	0.266	0.131	0.056	0.031	0.034	0.026	2.201	0.183
1968	0.027	0.246	0.363	0.240	0.223	0.374	0.402	0.234	0.134	0.070	0.039	0.069	2.420	0.202
1969	0.219	0.280	0.314	0.353	0.326	0.249	0.116	0.062	0.047	0.037	0.033	0.034	2.070	0.172
1970	0.095	0.178	0.200	0.367	0.364	0.146	0.100	0.092	0.064	0.041	0.030	0.035	1.712	0.143
1971	0.096	0.579	0.983	1.082	0.822	0.314	0.139	0.091	0.080	0.056	0.034	0.027	4.304	0.359
1972	0.027	0.197	0.293	0.302	1.062	1.181	0.520	0.310	0.136	0.057	0.047	0.067	4.198	0.350
1973	0.079	0.185	0.384	0.595	0.528	0.265	0.168	0.135	0.082	0.056	0.043	0.027	2.547	0.212
1974	0.028	0.164	0.845	1.231	0.917	0.516	0.190	0.089	0.045	0.027	0.022	0.026	4.101	0.342
1975	0.045	0.470	1.399	1.376	0.597	0.291	0.205	0.149	0.101	0.058	0.032	0.020	4.743	0.395
1976	0.048	0.104	0.214	0.290	0.278	0.243	0.152	0.071	0.033	0.024	0.021	0.027	1.506	0.126
1977	0.032	0.135	0.242	0.882	0.991	0.357	0.231	0.172	0.100	0.054	0.041	0.046	3.284	0.274
1978	0.132	0.226	0.227	0.223	0.185	0.113	0.089	0.071	0.043	0.029	0.040	0.052	1.430	0.119
1979	0.094	0.234	0.276	0.302	0.689	0.627	0.175	0.058	0.028	0.024	0.022	0.036	2.565	0.214
1980	0.051	0.119	0.173	0.215	0.295	0.275	0.170	0.080	0.051	0.043	0.037	0.043	1.551	0.129
1981	0.065	0.104	0.156	0.243	0.211	0.095	0.052	0.030	0.019	0.018	0.015	0.013	1.021	0.085
1982	0.029	0.052	0.064	0.120	0.131	0.098	0.090	0.072	0.056	0.040	0.053	0.054	0.858	0.072
1983	0.050	0.972	1.255	2.363	2.454	0.518	0.191	0.076	0.041	0.069	0.080	0.064	8.132	0.678
1984	0.160	0.246	0.192	0.121	0.326	0.389	0.150	0.052	0.026	0.022	0.019	0.029	1.733	0.144
1985	0.127	0.227	0.266	0.332	0.311	0.218	0.152	0.099	0.053	0.034	0.026	0.021	1.866	0.156
1986	0.032	0.046	0.169	0.299	0.273	0.213	0.164	0.102	0.052	0.029	0.052	0.445	1.878	0.157
1987	1.141	1.229	0.646	0.271	0.247	0.192	0.109	0.060	0.037	0.041	0.035	0.030	4.037	0.336
1988	0.148	0.220	0.324	0.370	0.599	0.593	0.171	0.060	0.076	0.075	0.055	0.031	2.722	0.227
1989	0.058	0.381	0.528	0.278	0.212	0.234	0.182	0.116	0.059	0.029	0.024	0.018	2.120	0.177
1990	0.026	0.065	0.187	1.110	1.239	0.607	0.442	0.145	0.069	0.053	0.037	0.025	4.005	0.334
1991	0.033	0.075	0.159	0.193	0.147	0.082	0.039	0.021	0.015	0.015	0.014	0.014	0.806	0.067
1992	0.023	0.034	0.350	0.490	0.319	0.303	0.215	0.108	0.052	0.029	0.026	0.024	1.973	0.164
1993	0.095	0.233	0.503	0.569	0.338	0.259	0.204	0.092	0.037	0.025	0.022	0.020	2.397	0.200
1994	0.040	0.084	0.137	0.210	0.176	0.107	0.096	0.067	0.039	0.022	0.020	0.014	1.012	0.084
1995	0.053	0.174	1.012	1.339	1.540	1.567	0.627	0.229	0.099	0.052	0.042	0.026	6.762	0.563
1996	0.148	0.212	0.170	0.208	0.209	0.247	0.247	0.144	0.089	0.063	0.044	0.044	1.825	0.152
1997	0.144	0.399	0.390	0.250	0.236	0.155	0.086	0.046	0.026	0.022	0.021	0.028	1.803	0.150
1998	0.076	0.174	0.357	0.385	0.201	0.081	0.037	0.026	0.023	0.021	0.021	0.022	1.425	0.119
1999	0.073	0.145	1.812	2.474	1.410	0.887	0.329	0.193	0.123	0.072	0.041	0.030	7.590	0.632
2000	0.073	0.540	1.032	0.678	0.218	0.125	0.111	0.106	0.068	0.040	0.027	0.024	3.041	0.253
2001	0.080	0.422	0.485	0.286	0.260	0.158	0.082	0.047	0.030	0.034	0.048	0.045	1.978	0.165
2002	0.052	0.062	0.113	0.633	0.726	0.235	0.079	0.028	0.031	0.033	0.029	0.026	2.047	0.171
2003	0.033	0.154	0.235	0.224	0.287	0.383	0.309	0.125	0.056	0.056	0.052	0.037	1.951	0.163
2004	0.036	0.101	0.202	0.277	0.262	0.171	0.099	0.058	0.032	0.022	0.021	0.015	1.295	0.108
													Av Annual	Av monthly
AVERAGE	**0.110**	**0.261**	**0.434**	**0.524**	**0.480**	**0.340**	**0.206**	**0.115**	**0.064**	**0.046**	**0.039**	**0.042**	**2.660**	**0.222**

Annex C

DWA Strategy Document for Invasive Alien Plants in the Usutu – Mhlathuze WMA

Strategy No.: G6: WMA-LEVEL STRATEGY: INVASIVE ALIEN PLANTS

MANAGEMENT OBJECTIVE To make more efficient use of the existing available water resources to all water user sectors by reducing unproductive water use by Invasive Alien Plants.

SITUATION ANALYSIS/ MOTIVATION The situation with regard to invasive alien plants in the Mhlathuze catchment has been set out in the WMA report, as well as in more detailed reports such as the water conservation and demand management study carried out for the Mhlathuze catchment. The WC&DM study information available for the Mhlathuze catchment is based on detailed surveys and is probably fairly accurate, whilst the original estimates (Versfeld et al 1998) seem to have significantly over-estimated the problem. The information for the remainder of the WMA may be somewhat speculative. Other than in the Pongola River catchment, the impact of invasive alien plants appears to be relatively limited in the Usutu to Mhlathuze WMA, at least from a water resources perspective, and of no great concern. The impact in the Pongola River catchment is given in the WMA report (5), as 30 million m 3/annum. Large-scale and fast spreading infestations of Chromolaena are reported on the Zululand Coastal Plain (including Mkuze and Hluhluwe Game Reserves) with serious consequences for the biodiversity.

STRATEGY The strategy in the Usutu to Mhlathuze WMA should focus first on containment and secondly on eradication. The fact that infestation is, to date, relatively limited offers an opportunity for successful management but does not nullify the threat of future invasion. It is vitally important that this relatively favourable position of limited invasion be maintained. There are a number of possible approaches to the clearing of invasive alien plants.

- In the first instance landowners should be held responsible for invasions on their own land and should be strongly encouraged to see to their removal. Landowners should also be held fully accountable for all invasions after 1998. However it is also recognised that the task of clearing all land is not always either possible or economically feasible and that either incentives or intervention by Working for Water or others may be required.
- In all catchments that are stressed or likely to move into deficit in the foreseeable future to move into deficit the approach should, first and foremost, be to encourage and make full use of Working for Water in the clearing of invasives. These are catchments that cannot afford to lose any more water and any water that can be reclaimed through the clearing of invasives will be welcomed in providing for the Reserve and in reducing the pressure on reallocations through Compulsory Licensing.
- Where catchments are in surplus, investment in the clearing of invasive alien plant by individuals and organisations in exchange for a water use licence may be considered and even encouraged. This would need to be on the basis of the principles of Water Use Exchange, which are currently being developed within the Department.

MANAGEMENT ACTIONS RESPONSIBILITY/ PRIORITY

- Investigate the real extent of invasive alien plants in the WMA, determine their impact on the resource, and develop a programme for removal. Priorities for removal include: (i) The limited but dispersed invasions of Acacia mearnsii in the upper reaches of the Mhlathuze catchment. These must first be contained and ultimately eliminated. This should go hand in hand with the community afforestation strategy to ensure that valuable firewood resources (e.g. the invasive Acacia) are not eliminated without other woodlots being established. (ii) The clearing of the main stem of the Mhlathuze. The main objective here is riverbed and riverbank stabilisation.
- The impact of invasive alien plants in the Pongola River catchment needs to be investigated and a plan to address this put in place. In the Pongola, with its relative surplus, the approach of Water Use Exchanges could be considered.
- Prioritise further action based on the WMA survey

Volume III Annex C.9

Visual Impact Assessment Report

Version 5.0

May 2013

Document Ref.	Prepared By	Reviewed By	Date Submitted to Kangra Coal for Review
0120258_V5.0_VIA	Yonanda Martin – Newtown Landscape Architects cc	Dieter Rodewald	May 2013

CONTENTS

LIST OF ACRONYMS

Abbreviation	Full Definition
CSIR	Council for Scientific and Industrial Research
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
SEMP	Social and Environmental Management Programme
IFC	International Finance Corporation
NEMA	National Environmental Management Act (Act 107 of 1998)
NLA	Newtown Landscape Architects cc
VIA	Visual Impact Assessment

Aesthetic Value

Aesthetic value is the emotional response derived from the experience of the environment with its particular natural and cultural attributes. The response can be either to visual or non-visual elements and can embrace sound, smell and any other factor having a strong impact on human thoughts, feelings and attitudes (Ramsay, 1993). Thus aesthetic value encompasses more than the seen view, visual quality or scenery, and includes atmosphere, landscape character and sense of place (Schapper, 1993).

Aesthetically Significant Place

A formally designated place visited by recreationists and others for the express purpose of enjoying its beauty. For example, tens of thousands of people visit Table Mountain on an annual basis. They come from around the country and even from around the world. By these measurements, one can make the case that Table Mountain (a designated National Park) is an aesthetic resource of national significance. Similarly, a resource that is visited by large numbers who come from across the region probably has regional significance. A place visited primarily by people whose place of origin is local is generally of local significance. Unvisited places either have no significance or are "no trespass" places. (after New York, Department of Environment 2000).

Aesthetic Impact

Aesthetic impact occurs when there is a detrimental effect on the perceived beauty of a place or structure. Mere visibility, even startling visibility of a project proposal, should not be a threshold for decision making. Instead a project, by virtue of its visibility, must clearly interfere with or reduce (i.e. visual impact) the public's enjoyment and / or appreciation of the appearance of a valued resource e.g. cooling tower blocks a view from a National Park overlook (after New York, Department of Environment 2000).

Cumulative Effects

The summation of effects that result from changes caused by a development in conjunction with the other past, present or reasonably foreseeable actions.

Landscape Character

The individual elements that make up the landscape, including prominent or eye-catching features such as hills, valleys, woods, trees, water bodies, buildings and roads. They are generally quantifiable and can be easily described.

Landscape Impact

Landscape effects derive from changes in the physical landscape, which may give rise to changes in its character and how this is experienced (Institute of Environmental Assessment & The Landscape Institute, 1996).

Project Site

The proposed project site refers to the actual area where the Project infrastructure is proposed – the Project footprint.

Study Area

It is the actual areas where the Project infrastructure is proposed and the surrounding (receiving) social, physical and biophysical environment. For the purposes of this report the study area refers to the proposed site as well as the 'zone of potential influence' (the area defined as the radius about the centre point of the project beyond which the visual impact of the most visible features will be insignificant) which is a 10km radius surrounding Adit A site and 5km radius surrounding Adit B site.

Sense of Place (*genius loci*)

Sense of place is the unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer. *Genius loci* literally means 'spirit of the place'.

Sensitive Receptors

Sensitivity of visual receptors (viewers) to a proposed development.

Viewshed Analysis

The two dimensional spatial pattern created by an analysis that defines areas, which contain all possible observation sites from which an object would be visible. The basic assumption for preparing a viewshed analysis is that the observer eye height is 1,8m above ground level.

Visibility

The area from which project components would potentially be visible. Visibility depends upon general topography, aspect, tree cover or other visual obstruction, elevation and distance.

Visual Exposure

Visibility and visual intrusion qualified with a distance rating to indicate the degree of intrusion and visual acuity, which is also influenced by weather and light conditions.

Visual Impact

Visual effects relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity.

Visual Intrusion

The nature of intrusion of an object on the visual quality of the environment resulting in its compatibility (absorbed into the landscape elements) or discord (contrasts with the landscape elements) with the landscape and surrounding land uses.

Worst-case Scenario

Principle applied where the environmental effects may vary, for example, seasonally to ensure the most severe potential effect is assessed.

Zone of Potential Visual Influence

By determining the zone of potential visual influence it is possible to identify the extent of potential visibility and views which could be affected by the proposed development. Its maximum extent is the radius around an object beyond which the visual impact of its most visible features will be insignificant primarily due to distance.

1 INTRODUCTION

1.1 TERMS OF REFERENCE

Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) were appointed by Kangra Coal (Pty) Ltd. (Kangra Coal) to undertake the function of independent Environmental Assessment Practitioner (EAP) and undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Kusipongo Resource Expansion Project (the proposed Project) and compile an associated Environmental and Social Management Plan. The ESIA is been undertaken as the proposed Project requires the following environmental authorisations / licenses:

- **Mining Rights** from the Regional (Mpumalanga) Department of Minerals and Resources (DMR) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA).

- **Environmental Authorisation** from the Regional (Mpumalanga) Department of Economic Development, Environment and Tourism (DEDET) in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA).

- **Waste License** from the National Department of Environmental Affairs (DEA) in terms of the National Environmental Management Waste Act (No. 59 of 2008) (NEMWA).

- **Water Use Licenses** from the National Department of Water Affairs (DWA) in terms of the National Water Act (No. 36 of 1998) (NWA).

Newtown Landscape Architects cc (Newtown) was contracted by ERM to assess and evaluate the significance of potential visual impacts of the proposed Kusipongo Resource Expansion Project on the visual environment, and to develop a Visual Impact Assessment (VIA) Report (this report).

1.2 PROJECT BACKGROUND

Kangra Coal is considering expanding their coal mining operations at the Savmore Colliery, located within the Mkhondo and Dr. Pixley Kalsaka Seme Local Municipalities (which form part of the Gert Sibane District Municipality) in Mpumalanga, which is approximately 51km west-south-west from Piet Retief and 64km south east from Ermelo (refer to Figure *1.1*). This expansion is proposed to include the Kusipongo coal resource, situated to the west of existing operations. The proposed Project will be restricted to underground mining; however, surface infrastructure to support this underground expansion will include (*Figure 1.2*):

- **A Main Mine Adit (Adit A)** – entrance to the proposed underground mine which is inclined and through which people, equipment and coal will pass. The Adit A footprint will also include offices, workshops, stores, change house, silos, etc.

- **A Ventilation Shaft (Adit B)** – an adit used solely for ventilation intake. Adit B will include only a ventilation opening. Access to the underground working via this ventilation opening will be restricted by the installation of a metal grid that will prevent access by humans and animals. Adit B will require approximately 500m^2. Fresh air drawn in through this Adit will be returned directly to the main exhaust fans at Adit A.

- **An Overland Conveyor System** – this system will be approximately 8.4 km in length with a servitude width of 32m, and will be used to transport coal from the underground operations at the proposed Adit A to the existing Maquasa West Adit conveyor system. This in turn will transport mined coal to the existing wash plant facilities at the Savmore Colliery.

- **A Temporary Construction Camp** – to provide accommodation for semi-skilled and skilled workers and supervisory workers during the construction phase of the proposed Project, provisionally located 6 km away (towards the east) from the proposed site for the Main Mine Adit A along the extension of the D2548. This will be decommissioned at the end of the construction phase.

Figure 1.1 Project Locality

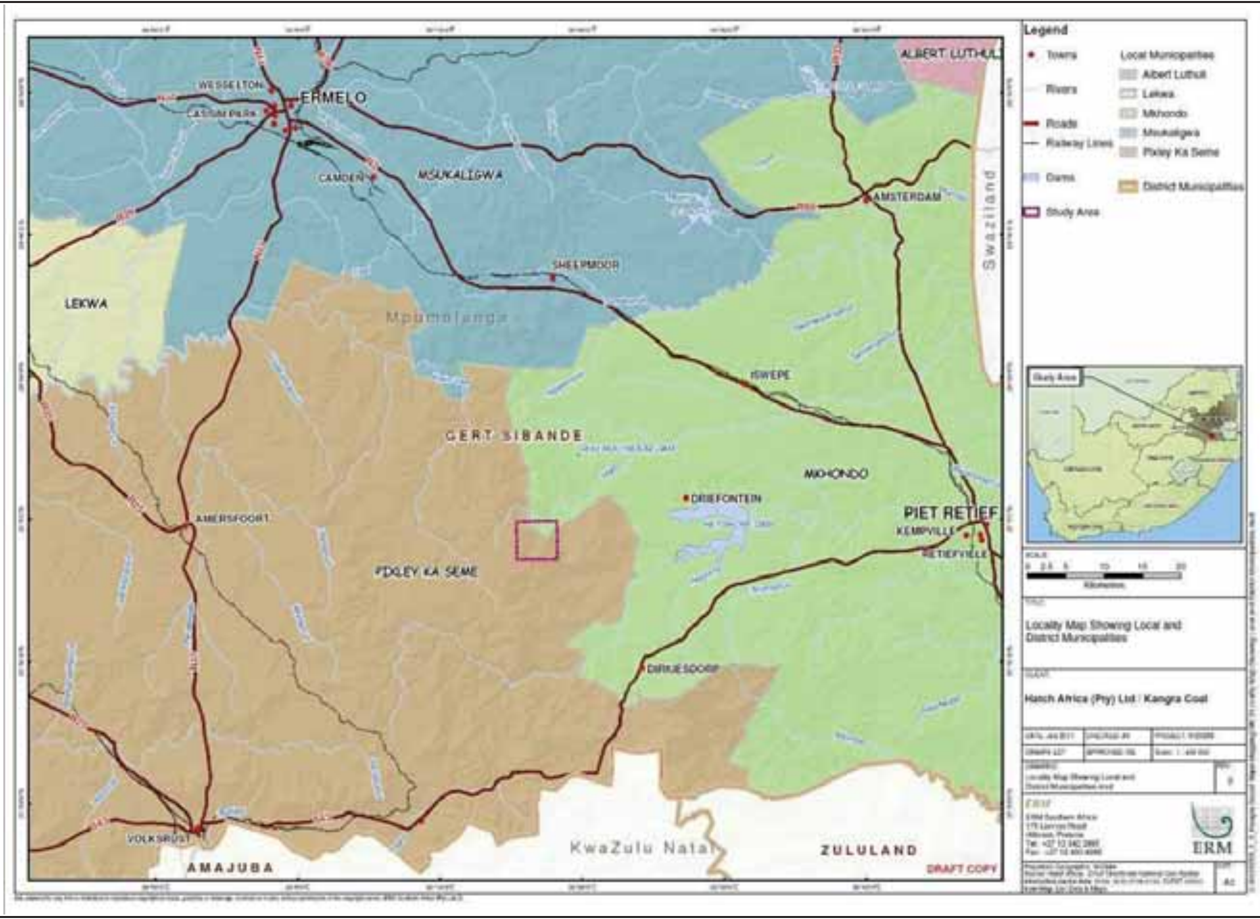
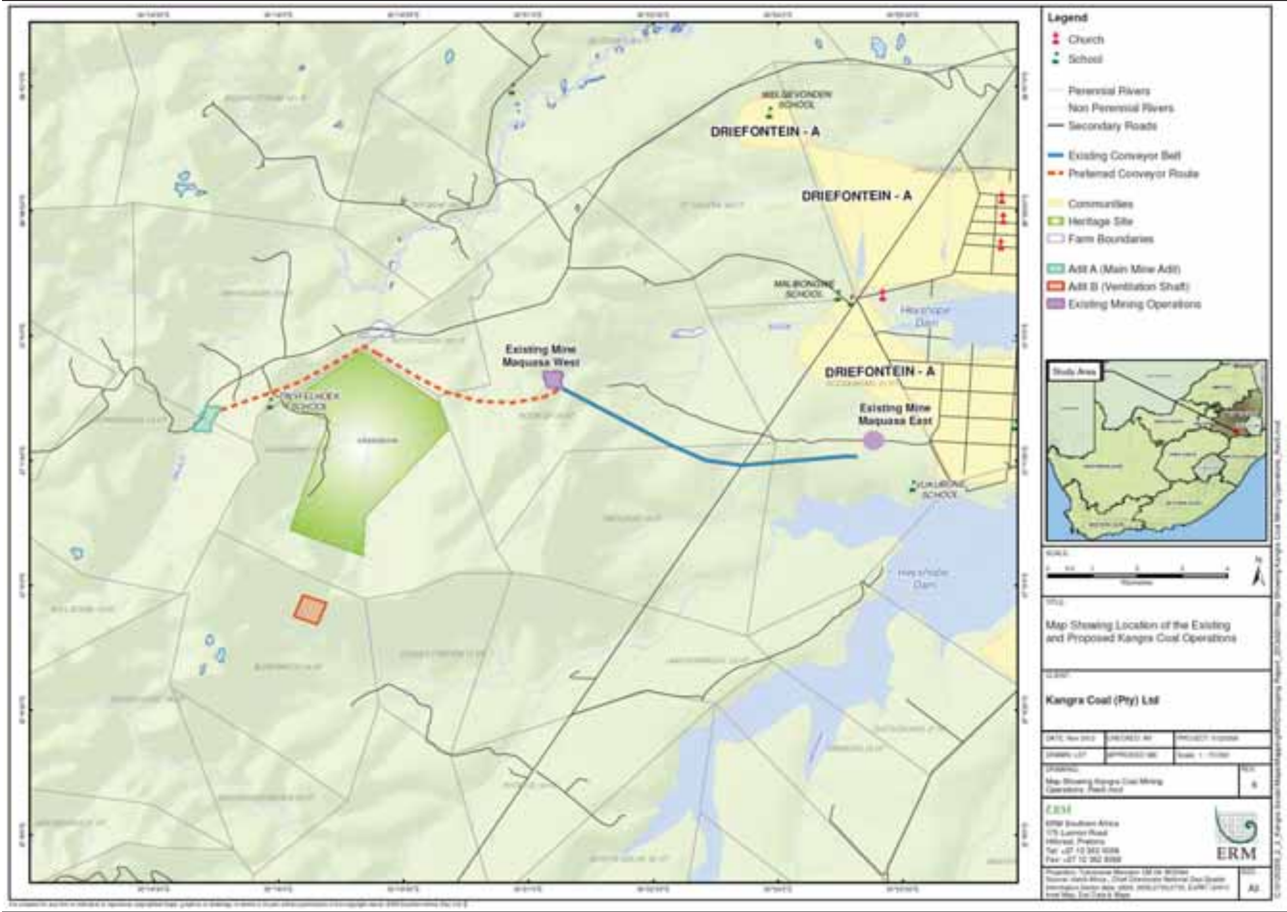


Figure 1.2 Location of Mine Site Infrastructure



1.3 SCOPE OF WORK

A specialist study is required to investigate the visual impact of the proposed Project. Based on the general requirements for a Visual Impact Assessment (VIA), this report sets out the following Scope of Work:

1.3.1 *Part 1: Baseline Study*

- **Site Visit:** A field survey was undertaken (8-9 November 2010) and the Study Area scrutinized to the extent that the receiving environment could be documented and adequately described.

- **Landscape Character:** The landscape character was determined by aerial photographic interpretation as well as the aforementioned field survey.

- **Scenic Value of the Landscape:** The scenic value (beauty) of the landscape was determined as a measurement of the union of ecological integrity (overall health of the landscape) and aesthetic appeal. Aesthetic appeal is described using contemporary research in perceptual psychology and the opinion of the specialist is used for determining the scenic value of the landscape.

- **Sense of Place:** The sense of place of the Study Area will be evaluated as to the uniqueness and distinctiveness of the landscape. The primary informants of these qualities are the spatial form, character and the natural landscape together with the cultural transformations and tradition associated with the historic and current use of the land of the Study Area.

- **Sensitive Viewers:** Sensitive viewers were determined by aerial photographic interpretation as well as the field survey.

1.3.2 *Part 2: Visual Impact Assessment*

The objectives of the VIA includes determination of the following:

- **Visual Intrusion:** Photographs taken from key viewing areas (adjacent landowner properties) were digitally manipulated to simulate the physical presence and nature of the visual intrusion of the proposed Project components.

- **Visibility and Visual Exposure:** Visibility of the proposed Project was determined by conducting a viewshed analysis. A Semi-quantitative digital terrain model (DTM) which consists of features that normally occur on 1 : 50 000 maps, such as roads and settlements, were "draped" over contours (derived from 1 : 50 000 maps) to generate an analysis that determines all potential observation sites (the viewshed) from which the proposed Project would be visible. Visual exposure is determined by the relative distance of the viewer from the proposed Project.

- **Impact on the Visual Environment and the Sense of Place of the Study Area:** Using visual intrusion, visibility and visual exposure criteria, along with criteria that determine the sense of place, the magnitude of the impact on the visual environment and sense of place were predicted. The significance of the impact was then qualified in terms of sensitivity (landscape and visual receptors), extent, duration and probability of the impact. The cumulative impact of visual impacts of the operational activities was also identified and rated.

- **Mitigation Measures:** Mitigation measures to reduce the visual impact and the impact on the sense of place are proposed for all three phases of the Project. A simulation of the proposed measures was produced to determine the effectiveness of the proposed mitigation action.

1.3.3 Author of the Visual Impact Assessment

Yonanda Martin has a B.Sc Degree in Environmental Science from the University of North West, Potchefstroom Campus (2003). M.Sc Degree in Ecological Remediation and Sustainable Utilization from the University of North West, Potchefstroom Campus (2007). She has 6 years' experience in Visual Impact Assessments and is currently employed by Newtown Landscape Architects. Her work experience includes the following projects:

- **Dorsfontein West Expansion**, Kriel
- **Mine Waste Solutions**, Stilfontein
- **Ferreira Coal Mining**, Ermelo
- **De Wittekrans Mining**, Hendrina
- **Grootvlei PV Development**, Grootvlei
- **Swakop Uranium Husab Project,** Namibia
- **Omitiomire Mine Project**, Namibia

2 LEGAL FRAMEWORK AND GOOD PRACTICE STANDARDS

This Section details the legal requirements that are relevant to the VIA.

2.1 NATIONAL REGULATORY FRAMEWORK

2.1.1 Constitution of the Republic of South Africa (No. 108 of 1996)

Summary of Constitution

The Constitution of the Republic of South Africa is the legal source for all law, including environmental law, in South Africa. The Bill of Rights is fundamental to the Constitution of the Republic of South Africa and in Section 24 states that:

Everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Applicability to Project

The residents of the immediate and surrounding area have the basic constitutional right to a protected environment that is not unnecessarily and / or irreparably damaged by any industrial or related development.

2.1.2 National Environmental Management Act (Act No. 107 of 1998)

Summary of Act

The National Environmental Management Act (NEMA) is a framework which provides guidance on environmental management in South Africa.

Applicability to Project

This VIA report is in accordance to the specification on conducting specialist studies and the mitigation measures as stipulated in the specialist report can be used as part of the Social and Environmental Management Programme (SEMPR).

2.1.3 The National Environmental Management: Protected Areas Act (Act No. 57 of 2003)

Summary of Act

The main aim of the Act is to identify and protect natural landscapes.

Applicability to Project

The proposed Project will need to ensure that the visual / landscape value of protected areas is protected.

2.1.4 The National Heritage Resources Act (Act No. 25 of 1999)

Summary of Act

The main aim of the Act is to protect the heritage resources of South Africa.

Applicability to Project

The Act is applicable to the protection of heritage resources and includes visual resources such as cultural landscapes, nature reserves, proclaimed scenic routes and urban conservation areas.

2.1.5 Western Cape Department of Environmental Affairs & Development Planning: Guideline for Involving Visual and Aesthetic Specialists in EIA Processes Edition 1 (CSIR, 2005)

Summary of Guidelines

Although the guidelines were specifically compiled for the Province of the Western Cape it provides guidance that will be appropriate for any VIA process. The Guideline document also seeks to clarify instances when a visual specialist should get involved in the EIA process.

Applicability to Project

The Guidelines provide guidance on how Visual Impact Assessments need to be conducted.

2.2 INTERNATIONAL GUIDELINES

2.2.1 World Bank IFC Standards

Summary of Standards

The World Bank International Financing Corporation (IFC) Standards provide a guideline for environmental management and impact assessments, specifically referring to the mining industry.

Applicability to Project

The World Bank's IFC Standards: Environmental, Health and Safety Guidelines for Mining refers to VIAs by stating that:

"Mining operations, and in particular surface mining activities, may result in negative visual impacts to resources associated with other landscape uses such as recreation or tourism. Potential contributors to visual impacts include high walls, erosion, discoloured water, haul roads, waste dumps, slurry ponds, abandoned mining equipment and structures, garbage and refuse dumps, open pits, and deforestation. Mining operations should prevent and minimize negative visual impacts through consultation with local communities about potential post-closure land use, incorporating visual impact assessment into the mine reclamation process. Reclaimed lands should, to the extent feasible, conform to the visual aspects of the surrounding landscape. The reclamation design and procedures should take into consideration the proximity to public viewpoints and the visual impact within the context of the viewing distance. Mitigation measures may include strategic placement of screening materials including trees and use of appropriate plant species in the reclamation phase as well as modification in the placement of ancillary facilities and access roads."

This VIA is in accordance with the IFC Performance Standards (Performance Standard 1: Social and Environmental Assessment and Management Systems) for the undertaking of Environmental Assessments and contributes to the ESIA for the proposed Project. These standards together with the National Regulations and Guidelines have been used to inform the standard of the Visual Impact Report as structured by Newtown Landscape Architects.

Kangra Coal will not seek international funding and therefore the Visual Impact Assessment does not have to be in conformance with the IFC Standards.

2.3 KANGRA COAL POLICIES

Kangra Coal is committed to responsible environmental stewardship and sustainable business practices; Kangra Coal pledges to improve their overall environmental performance across all their business activities. Kangra Coal encourages their business partners and members of the entire Kangra group to participate in this endeavour.

In accordance with this Environmental Policy (ENV-P-001), Kangra Coal strives for compliance with all environmental laws and commits to manage all of its activities in the environment. Of applicability to this study, Kangra Coal pledges to:

- Adopt the highest environmental standards in all areas of its operations, meeting and exceeding all relevant legislative requirements to which Kangra subscribes to.

- Regularly evaluating the existing and potential impact of its operations (including those relating to work undertaken by all staff) on the environment.

- Continuously improving on the overall company's environmental performance.

- Continuously conducting research to increase the knowledge on the environmental effects of Kangra Coal's relative activities and development or adoption of appropriate processes, technologies and equipment to meet anticipated environmental needs.

3 STUDY APPROACH AND IMPACT ASSESSMENT METHODOLOGY

3.1 STUDY APPROACH

The assessment of likely effects on a landscape resource and on visual amenity is complex, since it is determined through a combination of quantitative and qualitative evaluations (The Landscape Institute with the Institute of Environmental Management and Assessment, 2002). When assessing visual impacts the worst-case scenario is taken into account.

Although landscape and visual assessments are linked they are treated separately. The landscape, its analysis and the assessment of impacts on the landscape all contribute to the baseline for VIA studies. The assessment of potential impacts on the landscape is carried out as an impact on an environmental resource, i.e. the physical landscape. Visual impacts, on the other hand, are assessed as one of the interrelated effects on people (i.e. the viewers and the impact of an introduced object into a particular view or scene).

3.1.1 Visual Resource

Landscape character, landscape quality (Warnock, S. & Brown, N., 1998) and sense of place (Lynch, K., 1992) are used to evaluate the visual resource i.e. the receiving visual environment.

Aesthetic value is the emotional response derived from the experience of the environment with its particular natural and cultural attributes. The response is usually to both visual and non-visual elements and can embrace sound, smell and any other factor having a strong impact on human thoughts, feelings and attitudes (Ramsay, 1993). As a result, aesthetic value is more than the combined factors of the seen view, visual quality or scenery. It includes atmosphere, landscape character and sense of place (Schapper, 1993) (refer to Appendix B for further information). In this study, the aesthetic evaluation of the Study Area is determined by the professional opinion of the author (based on site observations) and the results of contemporary research in perceptual psychology.

Studies for perceptual psychology have shown human preference for landscapes with higher visual complexity, for instance scenes with water or topographic interest. On the basis of contemporary research, landscape quality increases where:

- Topographic ruggedness and relative relief increase;
- Water forms are present;
- Diverse patterns of grassland and trees occur;
- Natural landscape increases and man-made landscape decreases; and

- Where land use compatibility increases (Crawford, 1994).

Aesthetic appeal (value) is therefore considered **high** when the following are present (Ramsay, 1993):

- **Abstract Qualities –** such as the presence of vivid, distinguished, uncommon or rare features or abstract attributes;

- **Evocative Responses –** the ability of the landscape to evoke particularly strong responses in community members or visitors;

- **Meanings –** the existence of a long-standing special meaning to a particular group of people or the ability of the landscape to convey special meanings to viewers in general; and

- **Landmark Quality –** a particular feature that stands out and is recognized by the broader community.

And conversely, it would be **low** where (Crawford, 1994):

- Limited patterns of grasslands and trees occur;
- Natural landscape decreases and man-made landscape increases; and
- And where land use compatibility decreases.

In determining the quality of the visual resource, both the objective and the subjective (or aesthetic) factors associated with the landscape are considered. Many landscapes can be said to have a strong sense of place, regardless of whether they are considered to be scenically beautiful but where landscape quality, aesthetic value and a strong sense of place coincide - the visual resource or perceived value of the landscape is considered to be very high. The criteria given in Appendix B are used to assess landscape quality, sense of place and were used to determine the aesthetic value of the Study Area.

3.1.2 *Sensitivity of Visual Resource*

The sensitivity of a landscape or visual resource is the degree to which a particular landscape type or area can accommodate change arising from a particular development, without detrimental effects on its character. Its determination is based upon an evaluation of each key element or characteristic of the landscape likely to be affected. The evaluation will reflect such factors such as its quality, value, contribution to landscape character, and the degree to which the particular element or characteristic can be replaced or substituted (Institute of Environmental Assessment & The Landscape Institute, 1996:87).

3.1.3 *Sense of Place*

Central to the concept of sense of place is that the landscape requires uniqueness and distinctiveness. The primary informant of these qualities is the spatial form and character of the natural landscape taken together with the cultural transformations and traditions associated with the historic use and habitation of the area. According to Lynch (1992), sense of place is –

"*the extent to which a person can recognize or recall a place as being distinct from other places – as having a vivid, unique, or at least particular, character of its own*".

Sense of place is the unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer. In some cases these values allocated to the place are similar for a wide spectrum of users or viewers, giving the place a universally recognized and therefore, strong sense of place.

Because the sense of place of the Study Area is derived from the emotional, aesthetic and visual response to the environment, it cannot be experienced in isolation. The landscape context must be considered. With this in mind, the combination of the natural landscape (mountains, streams and the vegetation) together with the manmade structures (residential areas, roads, mining activities and power lines) contribute to the sense of place for the Study Area. It is these land-uses, which define the area and establish its identity.

3.1.4 Sensitive Viewer Locations

The sensitivity of visual receptors and views are dependent on the location and context of the viewpoint, the expectations and occupation or activity of the receptor or the importance of the view. This may be determined with respect to its popularity or numbers of people affected, its appearance in guidebooks, on tourist maps, and in the facilities provided for its enjoyment and references to it in literature or art.

The most sensitive receptors may include:

- Users of all outdoor recreational facilities including public rights of way, whose intention or interest may be focused on the landscape;
- Communities where development results in changes in the landscape setting or valued views enjoyed by the community; and
- Occupiers of residential properties with views affected by the development.

Other receptors include:

- People engaged in outdoor sport or recreation (other than appreciation of the landscape, as in landscapes of acknowledged importance or value);

- People traveling through or past the affected landscape in cars or other transport modes; and

- People at their place of work.

Views from residences and tourist facilities / routes are typically more sensitive, since views these are considered to be frequent and of long duration.

3.1.5 Landscape Impact

The landscape impact of a proposed development is measured as the change to the fabric, character and quality of the landscape caused by the physical presence of the proposed development. Identifying and describing the nature and intensity of change in the landscape brought about by the proposed new mine is based on the professional opinion of the author supported by photographic simulations. It is imperative to depict the change to the landscape in as realistic a manner as possible (Van Dortmont in Lange, 1994). In order to do this, photographic panoramas were taken from key viewpoints and altered using computer simulation techniques to illustrate the physical nature of the proposed Project in its final form within the context of the landscape setting. The resultant change to the landscape is then observable and an assessment of the anticipated visual intrusion can be made.

3.1.6 Visual Impact

Visual impacts are a subset of landscape impacts. Visual impacts relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effect with respect to visual amenity. Visual impact is therefore measured as the change to the existing visual environment (i.e. views) caused by the intervention and the extent to which that change compromises (negative impact) or enhances (positive impact) or maintains the visual quality of the scene as perceived by people visiting, working or living in the area. This approach reflects the layman's concerns, which normally are:

- Will I be able to see the new development?
- What will it look like?
- Will the development affect views in the area and if so how?

Landscape and visual impacts do not necessarily coincide. Landscape impacts can occur with the absence of visual impacts, for instance where a development is wholly screened from available public views, but nonetheless results in a loss of landscape elements and landscape character within a localized area (the site and its immediate surrounds).

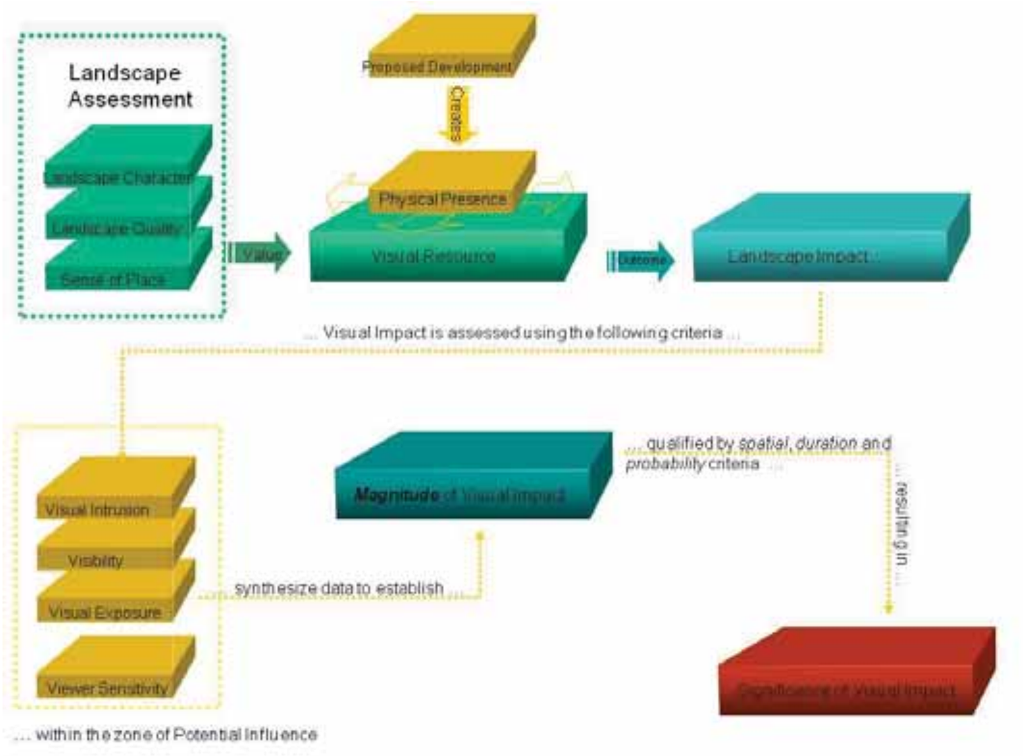
3.1.7 Severity of Visual Impact

The severity of visual impact is determined using visual intrusion, visibility and visual exposure criteria (Hull, R.B. and Bishop, I.E., 1988), qualified by the sensitivity of viewers (visual receptors) towards the proposed development. The severity of visual impact is therefore concerned with:

- The overall impact on the visual amenity, which can range from degradation through to enhancement;
- The direct impacts of the mine upon views of the landscape through intrusion or obstruction; and
- The reactions of viewers who may be affected.

Refer to *Figure 3.1* below for the overview of the visual impact assessment process.

Figure 3.1 Visual Impact Process



3.2 *IMPACT ASSESSMENT*

The impact assessment stage comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors. The steps involved in the impact assessment stage are described in greater detail below.

The impact characteristic terminology to be used is summarised in *Table 3.1*.

Table 3.1 ***Impact Characteristic Terminology***

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value]

In the case of type, the designations are defined universally (i.e., the same definitions apply to all resources / receptors and associated impacts). For these universally-defined designations, the definitions are provided in *Table 3.2*.

Table 3.2 ***Designation Definitions***

Designation	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource / receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
Extent	
Local	Defined on a resource / receptor-specific basis.
Regional	
International	
Duration	
Temporary	Defined on a resource / receptor-specific basis.
Short-term	
Long-term	
Permanent	

In the case of *extent* and *duration*, the designations themselves (shown in *Table 3.1*) are universally consistent, but the definitions for these designations will vary on a resource / receptor basis (e.g., the definition of what constitutes a "short term" duration for a noise-related impact may differ from that of a "short term" duration for a habitat-related impact). This concept is discussed further below.

In the case of *scale* and *frequency*, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of acres affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

An additional characteristic that pertains only to unplanned events (e.g., traffic accident, operational release of toxic gas, community riot, etc.) is *likelihood*. The likelihood of an unplanned event occurring is designated using a qualitative (or semi-quantitative, where appropriate data are available) scale, as described in *Table 3.3*.

Table 3.3 Definitions for Likelihood Designations

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource/receptor sensitivity/vulnerability/importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (e.g., modelling, frequency charts) where available.

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. As in the case of extent and duration, the magnitude designations themselves (i.e., negligible, small, medium, large) are universally used and across resources/receptors, but the definitions for these designations will vary on a resource/receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *negligible* magnitude. In the case of positive impacts no magnitude will be assigned.

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource/receptor is biological or cultural (for example, the marine environment or a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact.

Impact significance is designated using the matrix shown in *Table 3.4*.

Table 3.4 Impact Significances

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box 3.1* provides a context for what the various impact significance ratings signify.

Box 3.1 Context of Impact Significances

An impact of ***negligible*** significance is one where a resource / receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of ***minor*** significance is one where a resource / receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and / or the resource / receptor is of low sensitivity / vulnerability / importance. In either case, the magnitude should be well within applicable standards.

An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and / or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of ***major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued / sensitive resource / receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

3.2.1 Mitigation of Impacts

Once the significance of a given impact has been characterised using the above matrix, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource / receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any impact assessment is to help our clients develop a consentable Project, and to help them achieve their business objectives in a responsible manner. Impact assessment is about identifying the aspects of a Project that need to be managed, and demonstrating how these have been appropriately dealt with and left a good quality and appropriate development. As key influencers in the decision making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an ALARP level.

Embedded controls (i.e., physical or procedural controls that are planned as part of the Project design and are not added in response to an impact significance assignment), are considered as part of the Project (prior to entering the impact assessment stage of the impact assessment process).

3.2.2 *Residual Impact*

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

3.2.3 *Cumulative Impacts/Effects*

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The impact assessment process should predict any cumulative impacts/effects to which the Project may contribute. The approach for assessing cumulative impacts and effects resulting from the Project and another activity affecting the same resource/receptor is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

4 RECEIVING ENVIRONMENT

This description of the baseline environment is essential in that it represents the conditions of the environment before the construction of the proposed Kusipongo Resource Expansion Project. The description of the baseline environment therefore provides a description of the current environment against which the impact of the proposed Project can be assessed and future changes monitored.

The information presented in this Section has been collected from desktop studies and supplemented with site visits to the Study Area.

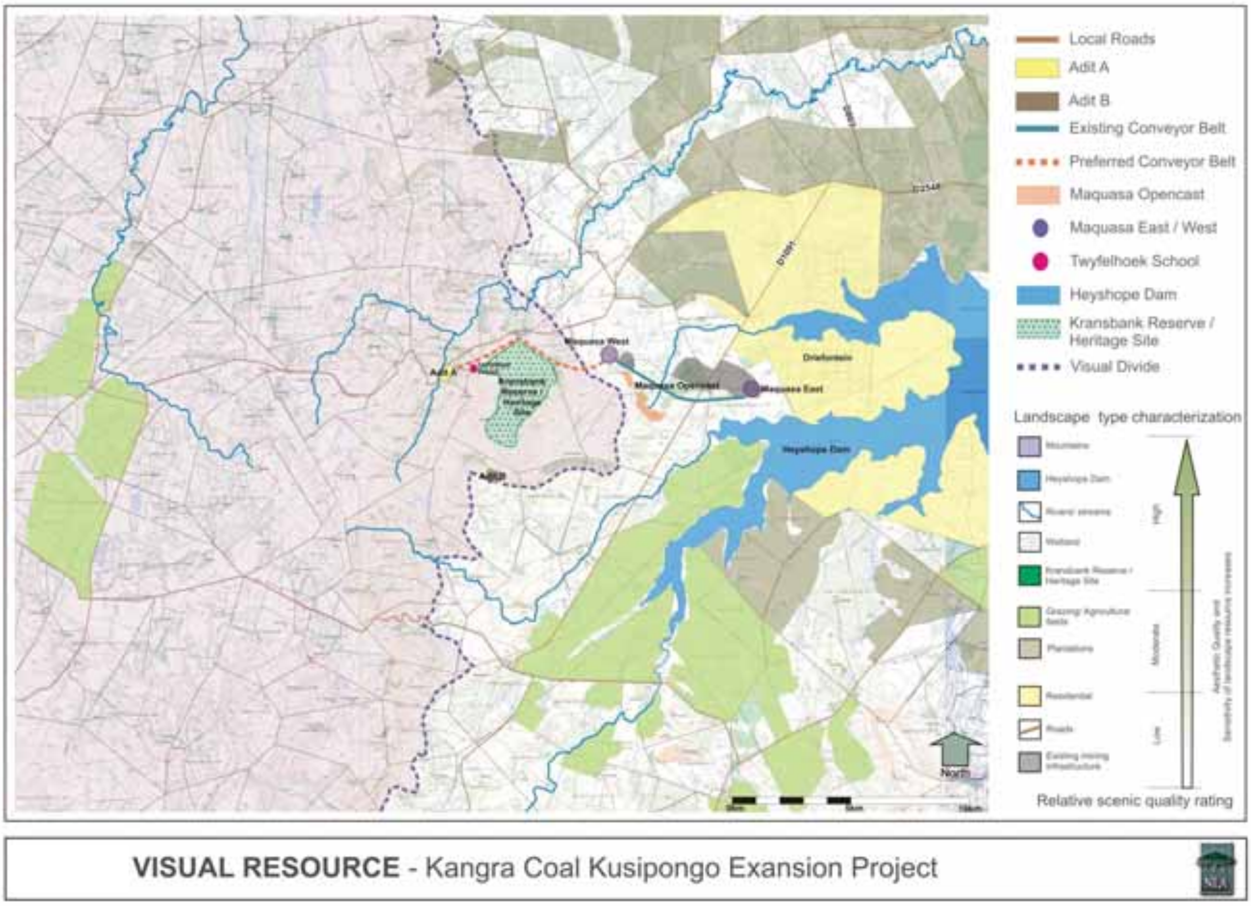
4.1 THE STUDY AREA

The proposed Project is located to the west and north-west of the town of Driefontein and the Heyshope dam respectively. The Study Area is mainly used as grazing fields with some scattered intensive agricultural activities and plantations. The Study Area can be characterised as having a rolling topography, which is mainly due to the Mantshangwe Mountain Range and the rivers / streams that cross the area. The Mantshangwe Mountain Range is currently utilised for underground mining activities. The existing Maquasa East Plant and open cast mining is located within the proposed Study Area. There are a couple of farmsteads and small villages scattered throughout the site (refer to *Figure 1.2*).

4.2 SURROUNDING LANDUSE

This Section details the varying land uses located within and surrounding the Study Area, and has reference to *Figure 4.1* overleaf.

Figure 4.1 Visual Resource



4.2.1 *Residential*

As previously stated the town of Driefontein is situated to the east of Project Site. Some rural residential dwellings, farmsteads and farm worker residences are scattered throughout the Study Area. The proposed Adit A site is located on the same farm as the Twyfelhoek School.

Kangra Coal, together with the Mkhondo Local Municipality, is currently investigating the provision of houses and associated bulk services in Driefontein. At this stage it is not clear as to the scale of this project; however, it will result in an increased footprint of Driefontein.

4.2.2 *Agriculture*

The agricultural land uses surrounding the Project Site predominantly comprise grazing fields with smaller sections of cultivated land (maize crops). The Study Area is also well known for its timber plantations which are located to the east of the Project Site.

4.2.3 *Tourism*

The only known area that could potentially be associated with is the Kransbank Private Reserve.

4.2.4 *Transportation Systems*

The N2 and the Driefontein road (D2548) provide the main access to the Study Area. The N2 passes the town of Driefontein approximately 16 kilometres to the northwest. The D1091 runs along the southern boundary of the Project Site in a north south direction. There is also an existing mine road that runs along the eastern boundary of the Project Site, along Adit A and the conveyor belt. Other roads include the local farm and mine roads.

4.2.5 *Mining*

As is previously mentioned, there are existing mining activities within the Study Area (Kangra Coal's Maquasa West, Maquasa West Extension and Maquasa East). As part of the future development, new open cast pits are proposed to be developed in the existing Kangra Coal mining concession area.

4.3 *LANDSCAPE CHARACTER*

Landscape character types are landscape units refined from the regional physiographic and cultural data derived from 1:50 000 maps, aerial photographs and information gathered on the site visit. Dominant landform / land use features (e.g., hills, rolling plains, valleys and urban areas) of similar physiographic and visual characteristics, typically define landscape character types. Refer to Landscape Character *Figure 4.2* to *Figure 4.8*.

The Study Area consists of four dominant **natural landscape types** – namely:

- Mountains and rolling hills, refer to (refer to *Figure 4.2 Figure 4.3; Figure 4.6; Figure 4.7* and *Figure 4.8*);

- Small rivers, streams and wetlands (refer to *Figure 4.6* and *Figure 4.8*);

- The Heyshope Dam to the east of the site (refer *Figure 4.4; Figure 4.5; Figure 4.6* and *Figure 4.8*); and

- The outstretched Eastern Highveld Grasslands (refer to *Figure 4.8*).

Three other types, mainly derived from **man-made intervention**, also occur within the Study Area – namely:

- Farmstead and rural residential dwellings with their related out buildings (refer to *Figure 4.2 Figure 4.3* and *Figure 4.7*);
- Structures and landforms directly related to mining activities (refer to *Figure 4.6*); and
- Linear infrastructure such as the D1091, D2458, D803 and other local roads (refer to *Figure 4.4* and *Figure 4.7*).

Figure 4.1 above illustrates the spatial distribution of the various landscape character types.

Figure 4.2 Landscape Character – Image 1

View 1: From the Poortjie Residential Settlement (workers residential area) towards Adit B

View 2: From local farm road on the farm Poortjie towards the proposed Adit B

Refer to Figure 1 for the location of respective views

LANDSCAPE CHARACTER - Kangra Coal Kusipongo Expansion Project

Figure 4.3 Landscape Character – Image 2

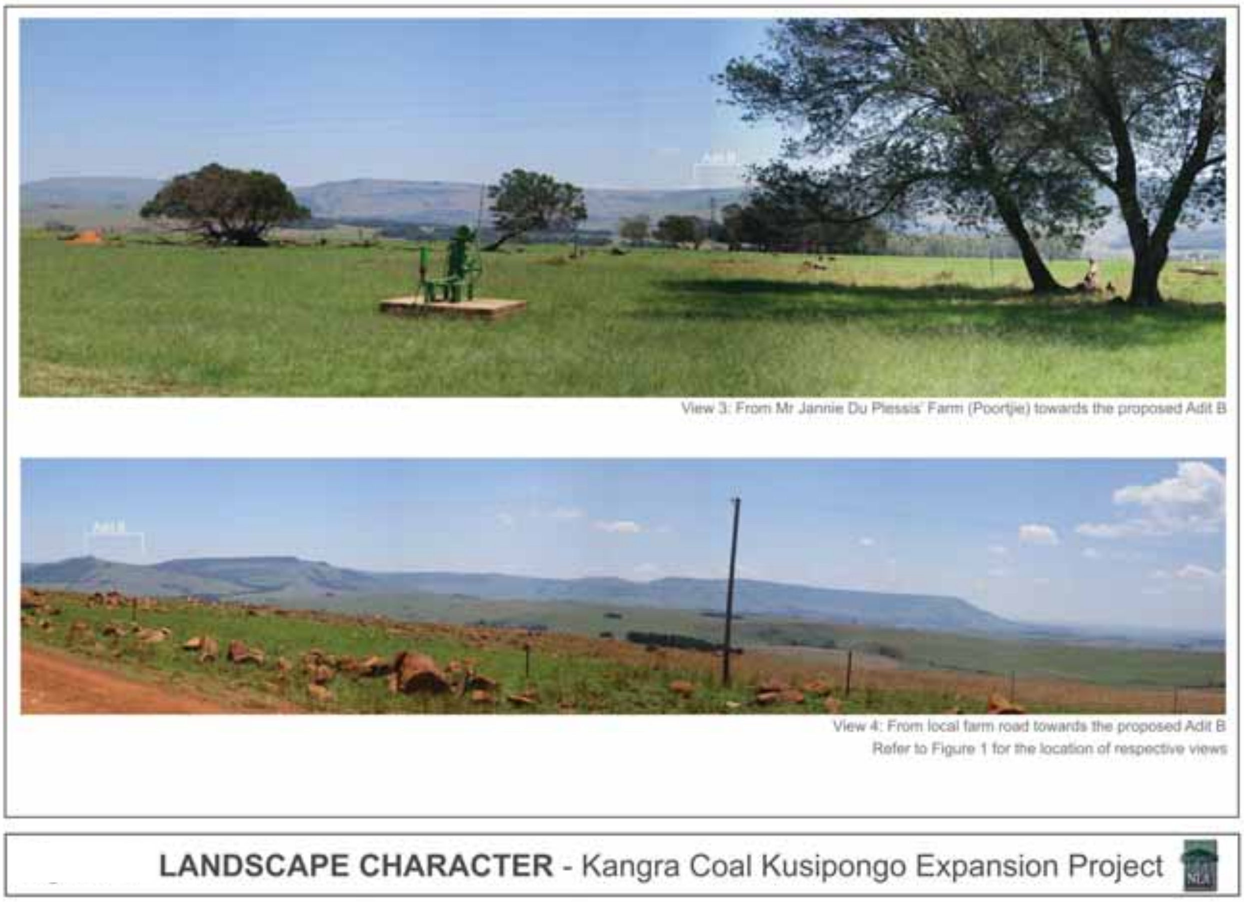


Figure 4.4 Landscape Character – Image 3

View 5: From the entrance road to Bovenvalei Farm towards the proposed Expansion Project site

View 6: From De Paarl turnoff towards the proposed Expansion Project site

Refer to Figure 1 for the location of respective views

LANDSCAPE CHARACTER - Kangra Coal Kusipongo Expansion Project

Figure 4.5 Landscape Character – Image 4

View 7: From local farm road towards the proposed Expansion Project site

View 8: From Mooihoek farm road towards the proposed Expansion Project site

Refer to Figure 1 for the location of respective views

LANDSCAPE CHARACTER - Kangra Coal Kusipongo Expansion Project

Figure 4.6 Landscape Character – Image 5

View 9: From local road towards the proposed Expansion Project site

View 10: From local road towards the proposed Adit A

Refer to Figure 1 for the location of respective views

LANDSCAPE CHARACTER - Kangra Coal Kusipongo Expansion Project

Figure 4.7 Landscape Character – Image 6

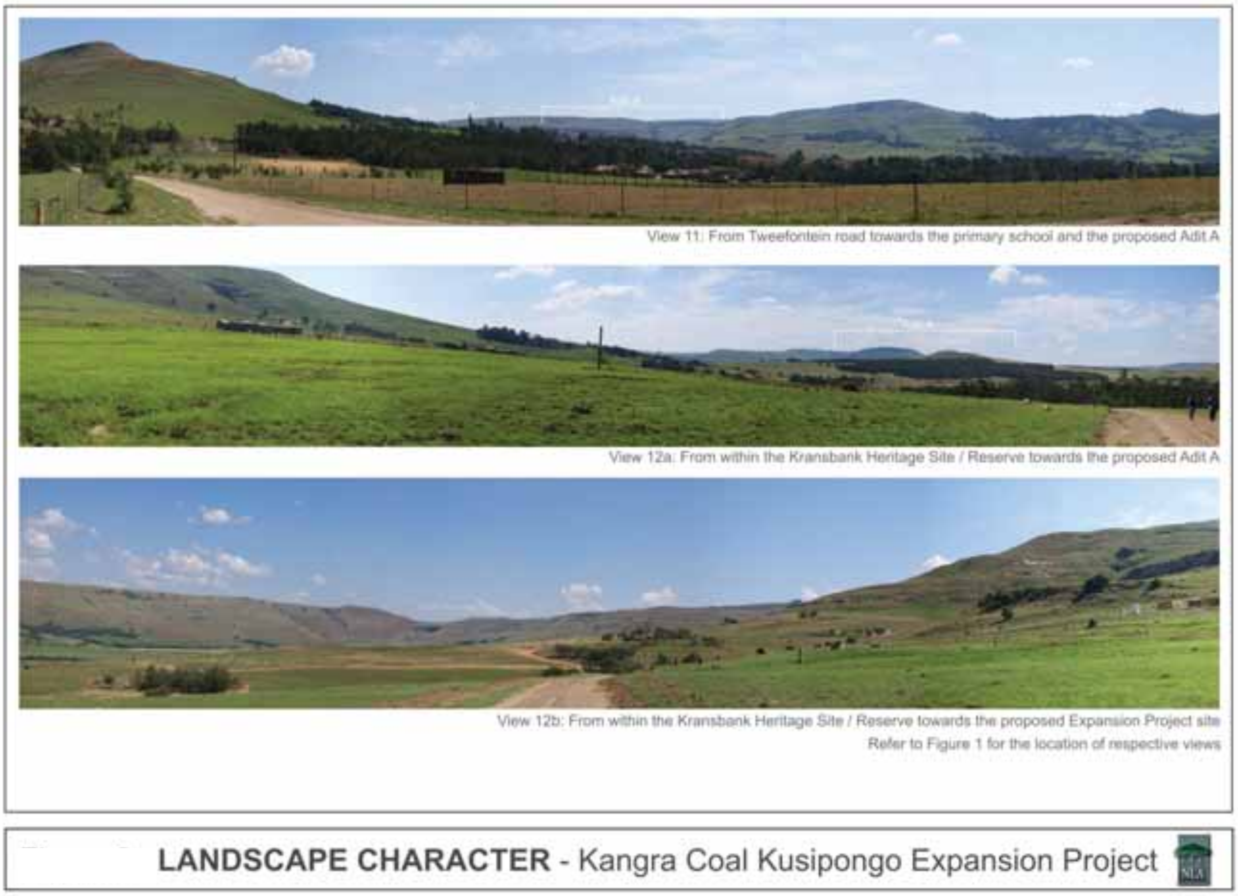


Figure 4.8 Landscape Character – Image 7

View 13: From local road towards Kransbank and Tweefontein Primary School with the proposed Adit A in the background

View 14: From local farm road, opposite of Heyshope Dam, towards the proposed Adit B

Refer to Figure 1 for the location of respective views

LANDSCAPE CHARACTER - Kangra Coal Project

The Mantshangwe Mountains are more or less in the middle of the Study Area and to the west is the Heyshope Dam. The Ohlelo River stretches in a north to south easterly direction and passes through the Study Area alongside the site proposed for Adit A (the Main Mine Adit). In addition to the Ohlelo River, there are a number of other small rivers / streams that traverse the Project Site. The grassland is classified as Eastern Highveld Grassland (Mucina & Rutherford, 2006) with slight to moderately undulating plains, including some low hills and pan depressions. The vegetation is short dense grassland dominated by the usual highveld grass composition (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya*) with small, scattered rocky outcrops with wiry sour grasses and some woody species such as *Acacia caffra, Celtis Africana* and *Diospyros lycioides* subsp *lycioides*. As previously mentioned parts of the Study Area are predominantly used as grazing fields, with clusters of exotic trees scattered throughout the area. There are also cultivated land and plantations.

As is mentioned earlier in this report, to the east of the Study Area is the town of Driefontein. The town is a small densely populated area.

As previously mentioned there are existing mining activities to the east of the site.

5 *VISUAL RESOURCE*

5.1 *VISUAL RESOURCE / SCENIC QUALITY*

In determining the quality of the visual resource, both the objective and the subjective or aesthetic factors associated with the landscape are considered. Many landscapes can be said to have a strong sense of place, regardless of whether they are considered to be scenically beautiful but where landscape quality, aesthetic value and a strong sense of place coincide – the visual resource or perceived value of the landscape is considered to be very high.

The landscape as described in *Section 4.3* can be divided into basic landscape character types, each with its own set of physical, visual and aesthetic characteristics. The spatial distribution of these landscape types is illustrated in *Figure 4.1*, and is a graphic illustration of the various elements contributing to the value of the visual resource.

Scenic quality ratings (using the scenic quality rating criteria described in *Appendix A*) were assigned to each of the landscape units defined in *Figure 4.1*. The highest value is assigned to the Mantshangwe Mountains that runs through the middle of the Study Area and the Heyshope Dam to the east. The Ohlelo River, smaller streams, the wetlands and the Kransbank Private Reserve are also rated high. The outstretched grasslands have a moderate visual value. The combination of natural features characteristic of these areas, stand out within the context of the region and evoke distinct and unique images to produce a strong sense of place.

The landscape types with the lowest scenic quality rating are the plantations, residential areas, roads and other infrastructures as well as the mining areas.

Based on the above findings and the criteria in *Appendix B*, scenic quality values for the various landscape types within the Study Area vary from high to moderate. This is due to the fact that landscape types with a high scenic quality (mountains, river, streams and wetlands) are mixed with those with a lower scenic quality (residential, roads, infrastructure and mining areas). This is tabulated in *Table 5.1* overleaf.

Table 5.1 Value of the Visual Resource - Scenic Quality

HIGH	MODERATE	LOW
Mantshangwe Mountains, Heyshope Dam, Ohlelo River, streams, wetlands and Kransbank Private Reserve	Grasslands and agricultural fields	Built up / Infrastructure / Mining
This landscape type is considered to have a *high* value because it is a: • Distinct landscape that exhibits a very positive character with valued features that combine to give the experience of unity, richness and harmony. It is a landscape that may be considered to be of particular importance to conserve and which has a strong sense of place. It may be sensitive to change in general and may be detrimentally affected if change is inappropriately dealt with.	This landscape type is considered to have a *moderate* value because it is a: • Common landscape that exhibits some positive character but which has evidence of alteration / degradation / erosion of features resulting in areas of more mixed character. It is potentially sensitive to change in general and change may be detrimental if inappropriately dealt with but change may not require special or particular attention to detail.	This landscape type is considered to have a *low* value because it is a: • Minimal landscape generally negative in character with few, if any, valued features. Scope for positive enhancement could occur.

Reference: The Landscape Institute with the Institute of Environmental Management and Assessment (2002)

5.2 SENSITIVITY OF VISUAL RESOURCES

The landscape types with the highest visual resource value, as discussed in Section 6.1 above, present the highest sensitivity to change.

5.3 SENSE OF PLACE

The sense of place for the Study Area cannot be assessed in isolation, as it is derived from the emotional, aesthetic and visual response to the environment – as such, the landscape context must also be considered. With this in mind, the mountains, dam, river, streams, wetland, roads, conveyor, the mining activities and residential landscape types contribute to the sense of place for the Study Area. It is these land-uses, which define the Study Area and establish its identity.

The sense of place can be divided into two different environments, the area to the east of the Mantshangwe Mountains and the area to the west of the mountains. The area to the west of the Mantshangwe Mountains have a rolling topography with the hills and mountains, the oHlelo River and associated streams, outstretched grassland and cultivated land. This environment emphasises the peaceful nature of the Study Area and evokes a calm and pastoral sense of place.

This scene however changes once you move to the east of the Mantshangwe Mountains and enter into an environment that's been interrupted by the presence of manmade structures such as the residential area of Driefontein, roads and existing mining activities as well as the agricultural timber plantations.

Refer to *Figure 4.1* on *Page 4-2* for the spatial divide in the sense of place of the Study Area.

6 VISUAL RECEPTORS

6.1 VIEWS

Potential views towards the proposed Project sites will be from the Driefontein Town, rural villages / residential areas scattered throughout the site, farmsteads, and local roads as well as from similar mining activities. The Mantshangwe Mountains forms a visual screen between the proposed Main Mine Adit on the eastern and the visual sensitive receptors on the western side of the mountains.

6.2 SENSITIVE VIEWER LOCATIONS

Potential sensitive viewers include those residing in Driefontein Town, rural villages and farmsteads. The residents (farmers, rural villages, etc.) located to the west of the Mantshangwe Mountains will be more sensitive to the proposed Project as there are no similar activities within this portion of the Study Area. Residents (Driefontein and rural villages) on the eastern side of the Mantshangwe Mountains will be less sensitive as these areas already have mining activities within their views.

Other sensitive visual receptors include potential visitors to the Kransbank Private Reserve. Furthermore, individuals using local farm roads, the Twyfelhoek School as well as recreational users of the Heyshope Dam will also be visually affected by the proposed Project. Although the Twyfelhoek School is closed at this stage it will still be included as a sensitive viewer. It should however be noted that haze plays a major role in the Study Area and will decrease the visibility of the mining activities from the Heyshope Dam. This is tabulated in *Table 6.1* overleaf.

Table 6.1 Potential Sensitivity of Visual Receptors

HIGH	MODERATE	LOW
Mantshangwe Mountains, farmsteads, rural villages / residential areas, especially the ones located on the western side of the Mantshangwe Mountains	Local farm roads, Driefontein town, Twyfelhoek School, Heyshope Dam	Existing mining areas and mining roads
This potential sensitivity of visual receptors is considered to be *high* because it includes: • Users of all outdoor recreational facilities including public rights of way (tourist routes), whose intention or interest may be focused on the landscape; • Communities where the development results in changes in the landscape setting or valued views enjoyed by the community; and • Occupiers of residential properties with views affected by the development.	This potential sensitivity of visual receptors is considered to be *moderate* because it includes: • People engaged in outdoor sport or recreation (other than appreciation of the landscape, as in landscapes of acknowledged importance or value); and • People travelling through or past the affected landscape in cars, on trains or other transport routes.	This potential sensitivity of visual receptors is considered to be *low* because it includes: • The least sensitive receptors are likely to be people at their place of work, or engaged in similar activities, whose attention may be focused on their work or activity and who therefore may be potentially less susceptible to changes in the view (i.e. office and industrial areas); and • Roads going through urban and industrial areas.

7 QUALIFICATION OF LANDSCAPE AND VISUAL IMPACT

The *landscape* impact (i.e. the change to the fabric and character of the landscape caused by the physical presence of a development) of the proposed Project will be ***moderate*** as the physical impact of the construction, operation, decommissioning and closure of the mining activities will disturb a reasonable percentage of the landscape associated with the proposed Project Site.

However, as stated in the approach, the physical change to the landscape should be understood in visibility and aesthetic terms within the context of the Study Area. This Section discusses the effect that the proposed Project activities will have on the visual and aesthetic environment.

7.1 SEVERITY OF VISUAL IMPACT

The severity of visual impact is determined by assessing / using the following:

- Visibility;
- Visual intrusion;
- Visual exposure; and
- Viewer sensitivity criteria.

When the severity of the visual impact is qualified with spatial, duration and probability criteria the significance of the impact can be predicted (refer to *Appendix D*).

7.1.1 Visual Intrusion

Visual intrusion deals with the notion of contextualism – i.e. how well a project fits into the cultural aesthetic of the landscape.

Due to the moderate to high scenic quality of the Study Area, the visual intrusion of the proposed Project will be high. Although there are existing mining activities within the Study Area, the proposed infrastructure will be located within visual sensitive areas / high scenic quality areas and will therefore be intrusive to the area as a whole.

The proposed site for the Main Mine Adit (Adit A) and the overland conveyor system will be located in close proximity to the Kransbank Private Reserve and will be in contrast to the existing land use, refer to *Figure 7.1* and *Figure 7.2*. Adit B is located within an area characterised as rural and will contrast highly with the existing land-use activities. The Adits will not only be in contrast with the landscape character of the Study Area but will also be in contrast to the sense of place of the Study Area and will therefore contribute to a high visual intrusiveness.

Figure 7.1 Simulations - Image 1

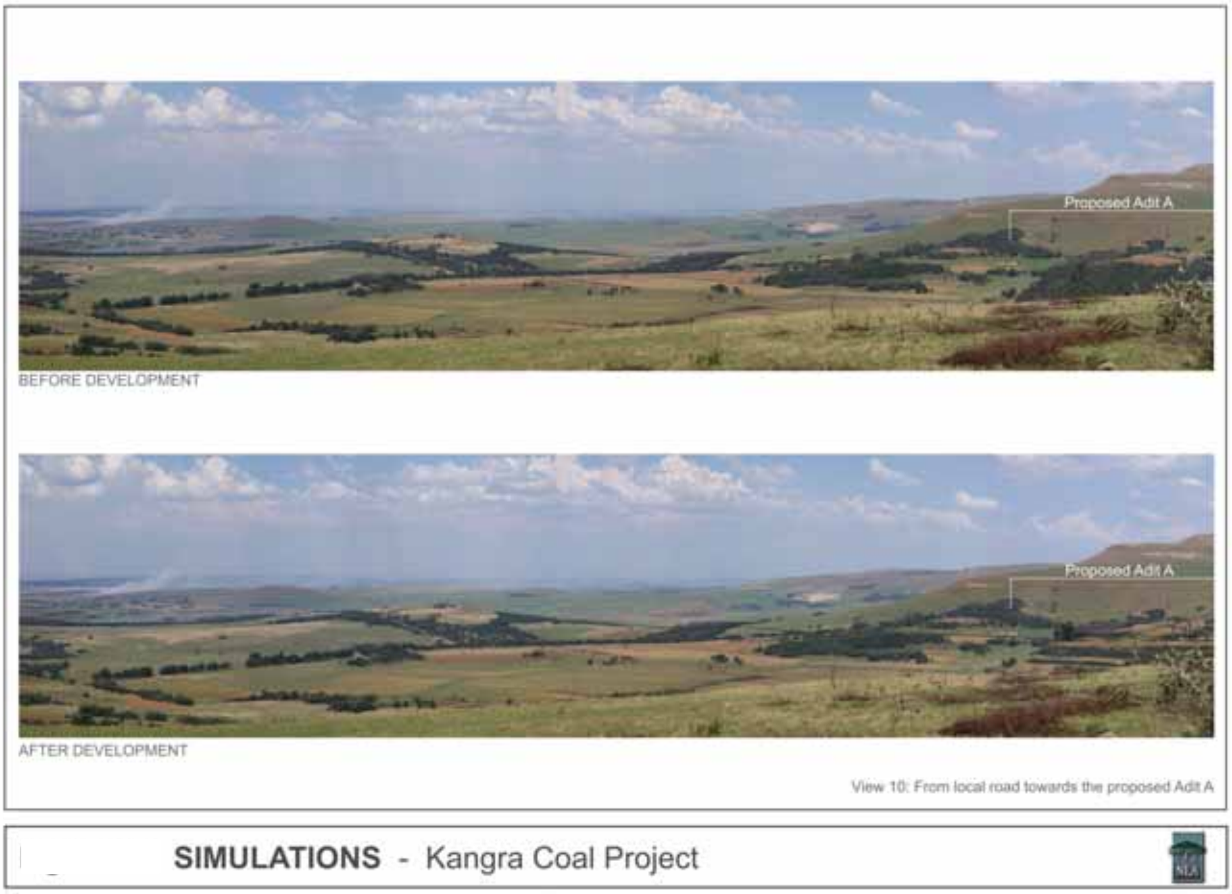
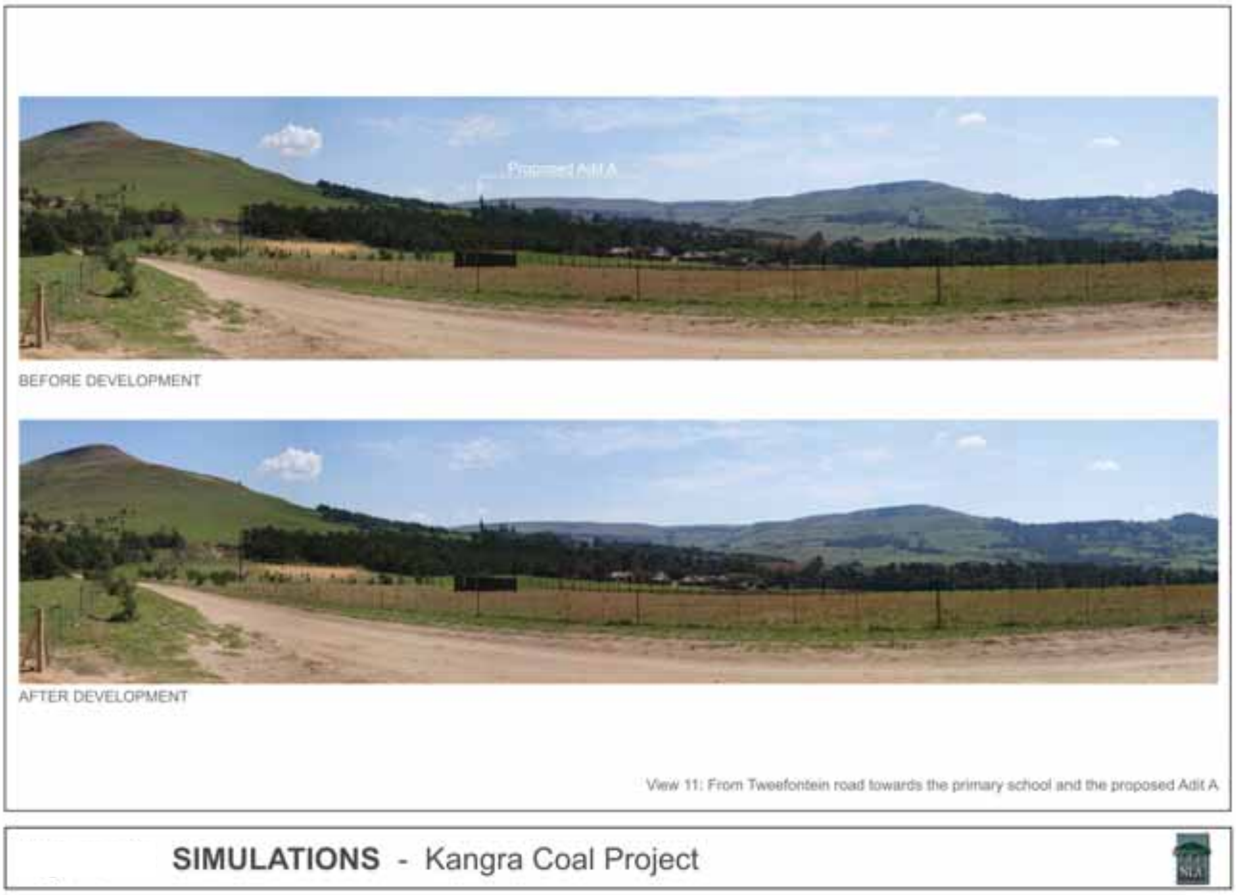


Figure 7.2 Simulations - Image 2



The visual intrusion of the proposed Adit A after sunset will be high. Adit A will be located within an area that is not exposed to a lot of light and the lights associated with mining activities will brighten the area. Adit B and the conveyor belt will have a high visual intrusion after sunset.

Table 7.1 overleaf rates and summarises visual intrusion of the Project components when the worst case scenario (no mitigation) is taken into account.

Table 7.1 Visual Intrusion of the Proposed Project

HIGH	MODERATE	**LOW**	POSITIVE
Adit A, B and the conveyor belt. Construction and Operational phases. Closure phase – if all structures are not removed and if the area is not rehabilitated successfully **Adit A - After sunset**	N / A	**Adit B and the Conveyor belt after sunset**	N / A
Because the proposed Project: • **Has a substantial negative effect on the visual quality of the landscape;** • **Contrasts dramatically with the patterns or elements that define the structure of the immediate landscape;** • **Contrasts with land use, settlement or enclosure patterns of the immediate environment; and** • **Cannot be 'absorbed' into the landscape from key viewing areas.**	Because the proposed project: • Has a moderate negative effect on the visual quality of the landscape; • Contrasts with the patterns or elements that define the structure of the landscape; • Is partially compatible with land use (utilities) patterns of the general area; and • Is partially 'absorbed' into the landscape from key viewing areas.	**Because the proposed project:** • **Contrasts minimally with the patterns or elements that define the structure of the landscape;** • **Is mostly compatible with land use, (utility) patterns; and** • **Is 'absorbed' into the landscape from key viewing areas.**	The proposed project: • Has a beneficial effect on the visual quality of the landscape; • Enhances the patterns or elements that define the structure of the landscape; and • Is compatible with land use, settlement or enclosure patterns.
***Result*:** **Notable change in landscape characteristics over an extensive area and/or intensive change over a localized area resulting in major changes to key views.**	*Result*: Moderate change in landscape characteristics over localized area, resulting in a moderate change to key views.	***Result*:** **Moderate change in landscape characteristics over localized area resulting in a minor change to a few key views.**	*Result*: Positive change in key views.

Please Note – Sections that are **BOLD** are applicable to the proposed Kangra Kusipongo Resource Coal Mine Kusipongo Expansion Project.

7.1.2 *Visibility and Visual Exposure*

In determining the visibility of the proposed Project the 'zone of potential influence' was established and is regarded to be 10km for Adit A and 5km for Adit B and the conveyor belt. Over 10km the impact of the proposed activities would have diminished due to the diminishing effect of distance (the proposed Project recedes into the background) and atmospheric conditions (haze) decrease visibility. Also, at a distance greater than 10km the features would appear in the background of a view and thus begin to be 'absorbed' into the landscape setting.

Visual exposure of the proposed Project is determined by the proximity of the viewer to the Project Site. The impact of an object in the foreground (0 to 0.8km) is greater than the impact of that same object in the middle ground (0.8km to 3km), which in turn is greater than the impact of the object in the background (greater than 3km) of a particular scene. Therefore the visibility and visual exposure for viewers is as follows:

- **High** – within 0.8km of the proposed Project Site;
- **Moderate** – within 0.8km and 3km of the proposed Project Site; and
- **Low** – with distances greater than 3km.

Day Time

The proposed Project will be visible from approximately 25% of the 'zone of potential influence'. It is clear from the viewshed analysis (*Figure 7.3* to *Figure 7.5*) that the rolling topography of the proposed Study Area is screening the view from areas within the 'zone of potential influence'.

- **Main Mine Adit (Adit A)** – will be ***highly visible*** for all views located within the immediate vicinity (0 to 0.8km) of the Project Site. Views from the west, south, east and the sections to the north will be screened as a result of the rolling topography of the Study Area. Although the proposed Adit A will not be visible from the Kransbank Private Reserve it will be visible from the roads leading to the Reserve. The proposed Adit A will be visible from the Twyfelhoek School and from residents staying within the area directly adjacent to the site proposed for Adit A. It should be noted that although Adit A is located between highly dense vegetated areas the structures are higher than the surrounding trees and is therefore visible above the tree canopy height. The views are therefore partially obstructed but unfortunately still visible (refer to *Figure 7.3*).

- **Adit B** – will be ***highly visible*** for viewers located directly next to the ventilation shafts and within 0.8km from the site. Although Adit B is located on the plateau / edge of the mountains most of the views towards Adit B is screened or partially screened by the rolling topography. Adit B will be visible from the north and from sections towards the east and the west (refer to *Figure 7.4*).

- **Overland Conveyor System** – will have a ***low visibility*** and will mostly be seen by people travelling along the conveyor route or when the conveyor belt crosses roads.

Night Time

It is anticipated that the proposed Adit A will have an impact after sunset as it will light up the receiving area. It is not anticipated that there will be any impacts from Adit B as there will be no lighting.

Table 7.2 below is based on the worst-case scenario (no mitigation).

Table 7.2 Visibility of the Proposed Project

HIGH VISIBILITY Main Mine Adit A and Adit B	MODERATE VISIBILITY N / A	LOW VISIBILITY Overland Conveyor System
The potential sensitivity to visual receptors is considered to be *high* if - • **The project is visible from over half the zone of potential influence, and/or views are mostly unobstructed and / or the majority of viewers are affected.**	The potential sensitivity to visual receptors is considered to be *moderate* if - • The project is visible from less than half the zone of potential influence, and / or views are partially obstructed and or many viewers are affected	**The potential sensitivity to visual receptors is considered to be *low* if -** • **The project is visible from less than a quarter of the zone of potential influence, and / or views are mostly obstructed and or few viewers are affected.**

Please Note – Sections that are **highlighted** are applicable to the proposed Kangra Kusipongo Resource Coal Mine Kusipongo Expansion Project.

Figure 7.3 Viewshed - Main Mine Adit (Adit A)

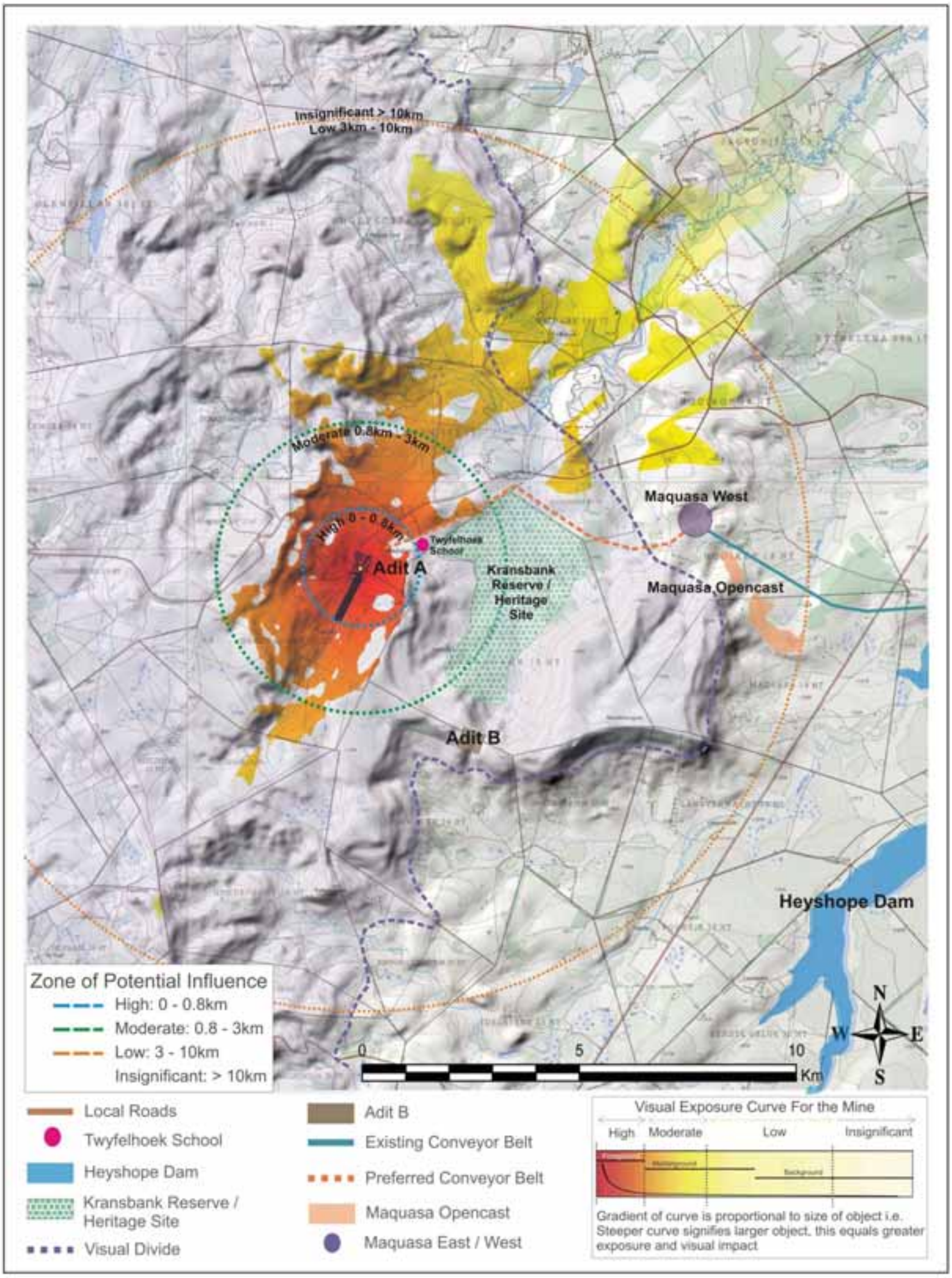


Figure 12: **VIEWSHED** - Kangra Coal Kusipongo Expansion Project: Adit A

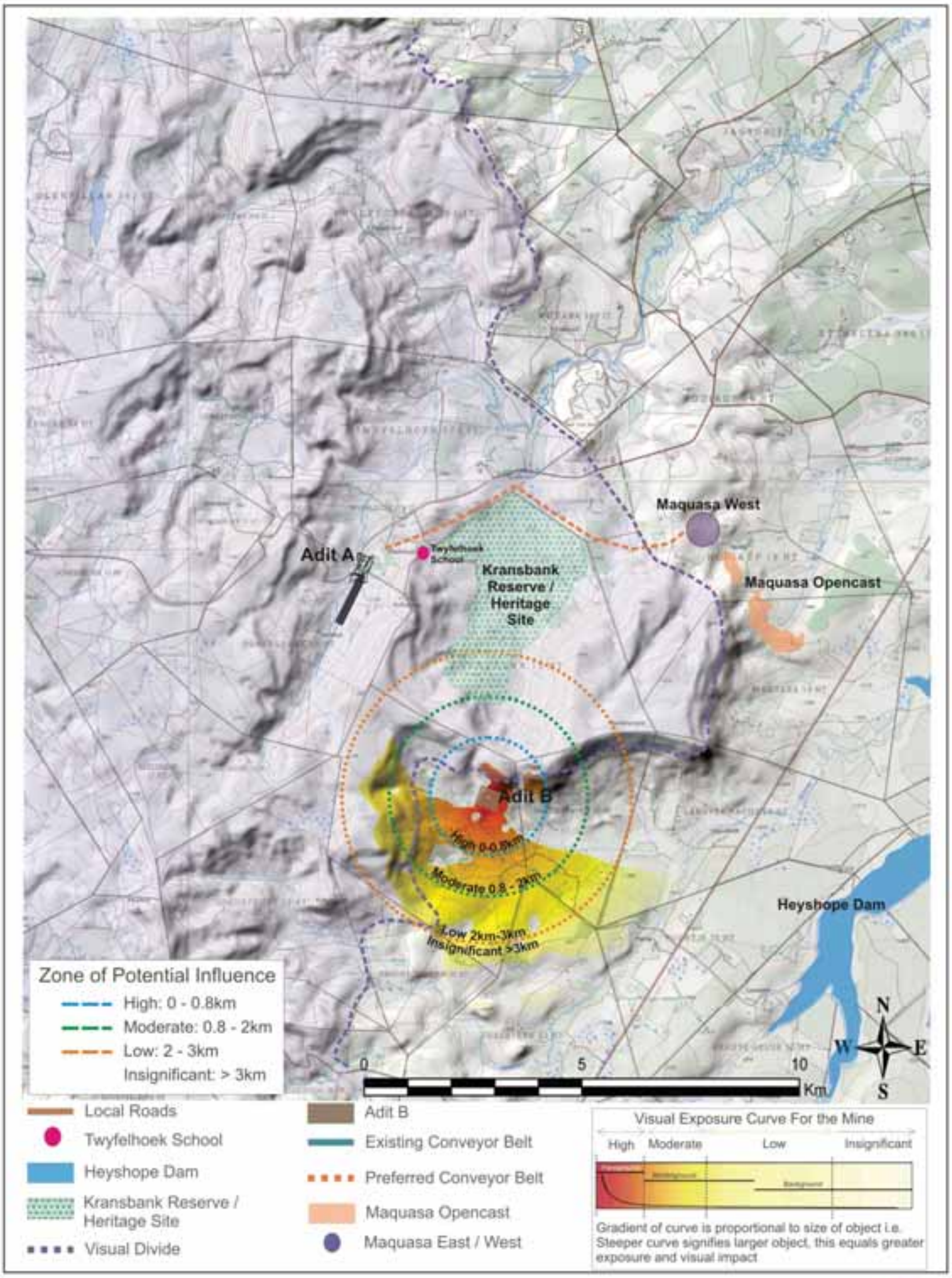


Figure 13: **VIEWSHED** - Kangra Coal Kusipongo Expansion Project: Adit B

Figure 7.5 Viewshed - Adit A and Adit B Combined

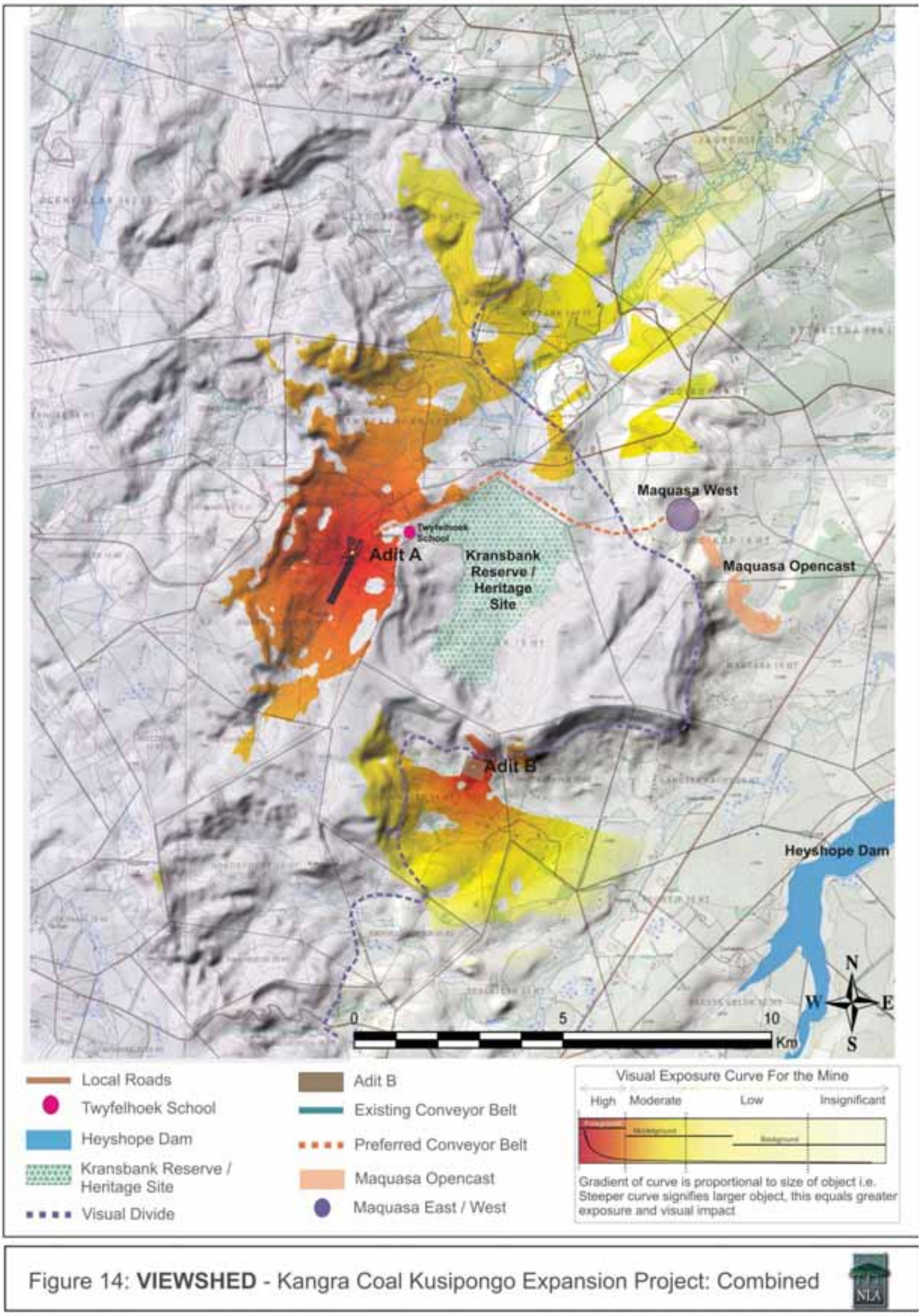


Figure 14: **VIEWSHED** - Kangra Coal Kusipongo Expansion Project: Combined

The visual exposure for the Project will be as follow:

- **<u>Proposed Mine Main Adit (Adit A)</u>** – will result in a ***<u>high</u>*** visual exposure for people / pupils from the Twyfelhoek School, residents in the immediate vicinity as well as for motorists/pedestrians travelling along the local road (refer to *Table 7.3*).

- **<u>Proposed Adit B</u>** – will result in a ***<u>low</u>*** visual exposure for residents in the area, as the distance between the Adit and residents is approximately 9km (refer to *Table 7.4*), and the visual impact of an object reduces at an exponential rate as the distance between the observer and the object increases.

- **<u>Overland Conveyor System</u>** – would result in a high visual exposure (refer to *Table 7.5*); however, although the conveyor borders some sensitive viewer locations (Twyfelhoek School and the Kransbank Private Reserve) it will not be fully visible due to the height of the belt, screening from vegetation and the topography of the Study Area. As such, the overland conveyor system will also result in a ***<u>low</u>*** visual exposure.

Table 7.3 Visual Exposure of the Proposed Main Mine Adit (Adit A)

	HIGH EXPOSURE (significant contribution to visual impact)	**MODERATE EXPOSURE** (moderate contribution to visual impact)	**LOW EXPOSURE** (minimal influence on visual impact)	**INSIGNIFICANT EXPOSURE** (negligible influence on visual impact)
Local roads	**0 – 0.8 km**	**0.8 – 3.0 km**	**3.0 – 10.0 km**	**Over 10.0 km**
Farmsteads	0 – 0.8 km	**0.8 – 3.0 km**	**3.0 – 10.0 km**	**Over 10.0 km**
Villages / residents	0 – 0.8 km	**0.8 – 3.0 km**	**3.0 – 10.0 km**	**Over 10.0 km**
Kransbank Private Reserve	0 – 0.8 km	**0.8 – 3.0 km**	**3.0 – 10.0 km**	**Over 10.0 km**
Twyfelhoek School	**0 – 0.8 km**	0.8 – 3.0 km	3.0 – 10.0 km	Over 10.0 km

<u>Please Note</u> – Sections that are **BOLD** are applicable to the proposed Kangra Kusipongo Resource Coal Mine Kusipongo Expansion Project.

Table 7.4 Visual Exposure of the Proposed Adit B

	HIGH EXPOSURE (significant contribution to visual impact)	MODERATE EXPOSURE (moderate contribution to visual impact)	LOW EXPOSURE (minimal influence on visual impact)	INSIGNIFICANT EXPOSURE (negligible influence on visual impact)
Local roads	0 – 0.8 km	0.8 – 3.0 km	**3.0 – 10.0 km**	Over 10.0 km
Farmsteads	0 – 0.8 km	0.8 – 3.0 km	**3.0 – 10.0 km**	Over 10.0 km

Please Note – Sections that are **BOLD** are applicable to the proposed Kangra Kusipongo Resource Coal Mine Kusipongo Expansion Project.

Table 7.5 Visual Exposure of the Proposed Conveyor Belt

	HIGH EXPOSURE (significant contribution to visual impact)	MODERATE EXPOSURE (moderate contribution to visual impact)	LOW EXPOSURE (minimal influence on visual impact)	INSIGNIFICANT EXPOSURE (negligible influence on visual impact)
Local roads	0 – 0.8 km	**0.8 – 3.0 km**	**3.0 – 10.0 km**	**Over 10.0 km**
Farmsteads	0 – 0.8 km	0.8 – 3.0 km	**3.0 – 10.0 km**	**Over 10.0 km**
Kransbank Private Reserve	**0 – 0.8 km**	**0.8 – 3.0 km**	**3.0 – 10.0 km**	**Over 10.0 km**
Twyfelhoek School	**0 – 0.8 km**	0.8 – 3.0 km	3.0 – 10.0 km	Over 10.0 km

Please Note – Sections that are **BOLD** are applicable to the proposed Kangra Kusipongo Resource Coal Mine Kusipongo Expansion Project.

7.1.3 Sensitivity of Visual Receptors

When visual intrusion, visibility and visual exposure are incorporated, and qualified by sensitivity (visual receptors) criteria, the intensity of the visual impact of the proposed Project can be determined.

The sensitivity of the visual receptors will be ***high***, refer to *Table 7.6*, for the proposed Kusipongo Resource Expansion Project, as the proposed Project will bring change to the landscape character and views from sensitive viewing areas.

Table 7.6 Sensitivity of Receptors for the Proposed Project

HIGH RECEPTOR SENSITIVITY **Twyfelhoek School, residents / villages Kransbank Private Reserve**	**MODERATE RECEPTOR SENSITIVITY** **Motorist (residents and tourists) travelling on local roads**	LOW RECEPTOR SENSITIVITY
• **Users of all outdoor recreational facilities including public rights of way (tourist routes), whose intention or interest may be focused on the landscape;** • **Communities where the development results in changes in the landscape setting or valued views enjoyed by the community; and** • **Occupiers of residential properties with views affected by the development.**	• People engaged in outdoor sport or recreation (other than appreciation of the landscape, as in landscapes of acknowledged importance or value); and • **People travelling through or past the affected landscape in cars.**	• The least sensitive receptors are likely to be people at their place of work, or engaged in similar activities, whose attention may be focused on their work or activity and who therefore may be potentially less susceptible to changes in the view (i.e. office and industrial areas); and • Roads going through urban and industrial areas.

Please Note – Sections that are **BOLD** are applicable to the proposed Kangra Kusipongo Resource Coal Mine Kusipongo Expansion Project.

7.1.4 *Severity of Visual Impact*

In qualifying the criteria used to establish the severity of visual impact, a numerical or weighting system is avoided. The reason for this is that attempting to attach a precise numerical value to qualitative resources is rarely successful, and should not be used as a substitute for reasoned professional judgement (Institute of Environmental Assessment and The Landscape Institute, 1996). The results, as tabulated in *Table 7.7* overleaf, are based on *worst-case scenarios* when the impact of all aspects is taken together and when viewed from the various sensitive viewing points.

According to the results tabulated in *Table 7.7* below, the *severity* of visual impact will be ***high*** as the proposed Project is situated in a natural environment. The visual intrusion will also be high as this proposed Project will be introduced into an area that has a high scenic quality.

Although the proposed Project will result in the loss or alteration of the baseline characteristics, as described in *Section* 4, of the Study Area, it will be partially screened / obstructed from sensitive viewers as a result of the receiving topography. The visibility of the proposed Project is rated as being moderate for most sensitive viewers, as it will fall within either the middle-ground or background view of the viewer.

Table 7.7 Severity of Impact of the Proposed Project

HIGH SEVERITY	MODERATE SEVERITY	LOW SEVERITY	NEGLIGIBLE SEVERITY
• **Total loss of or major alteration to key elements / features / characteristics of the baseline.** **i.e. Pre-development landscape or view and / or introduction of elements considered to be totally uncharacteristic when set within the attributes of the receiving landscape.** • **High scenic quality impacts would result.**	• Partial loss of or alteration to key elements / features / characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements that may be prominent but may not necessarily be considered to be substantially uncharacteristic when set within the attributes of the receiving landscape. • Moderate scenic quality impacts would result.	• Minor loss of or alteration to key elements / features / characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements that may not be uncharacteristic when set within the attributes of the receiving landscape. • Low scenic quality impacts would result.	• Very minor loss or alteration to key elements / features / characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements that is not uncharacteristic with the surrounding landscape – approximating the 'no change' situation. • Negligible scenic quality impacts would result.

Please Note – Sections that are **BOLD** are applicable to the proposed Kangra Kusipongo Resource Coal Mine Kusipongo Expansion Project.

8 IMPACT ASSESSMENT

The predicted impacts to the landscape and visual environment of the Study Area as a result of the proposed Kusipongo Resource Expansion Project are described in this Section.

8.1 IMPACTS TO THE LANDSCAPE AND VISUAL ENVIRONMENT DURING THE CONSTRUCTION PHASE OF THE PROPOSED PROJECT

8.1.1 Description of the Baseline Environment

The baseline landscape and visual environment is described in *Sections* 4 and 5.

The receiving environment is characterised by a rolling topography, which is created by the combination of mountains and rolling hills, small rivers, streams and wetlands. The Heyshope Dam is located to the east of the site. Man-made interventions include the farmsteads and rural residential dwellings with their related out buildings, structures and landforms directly related to the mining activities as well as infrastructure such as the Driefontein Road and other local roads (D1901 and D2548).

8.1.2 Proposed Project Activities

Landscape and visual changes resulting from the construction phase include:

- The removal of vegetation;
- The establishment of the site construction camp, including the material for construction;
- The construction and installation of the different mining elements, workshops, offices etc.;
- The movement of heavy and light construction vehicles;
- Dust created by construction activities and the movement of vehicles; and
- Lighting provided during the construction period, especially security lighting.

8.1.3 Sensitive Receptors

During the construction period construction activities will cause a major change in landscape characteristics over a localized area. The change will be from a natural environment to an area characterised by mining infrastructure, which results in a high change in the key views. This will have a high negative effect on the landscape character and the visual quality of the Study Area. Construction activities will also add to the cumulative negative effect the mining industry currently has on the visual quality of the landscape.

The main visual receptors will include the farmsteads and rural villages located close to the Project Site, Twyfelhoek School and local roads passing the site as well as visitors to the Kransbank Reserve / Heritage Site.

8.1.4 *Significance of Impact (Pre-mitigation)*

This impact has been assessed as a '**Major Negative Impact**' prior to mitigation (refer to *Table 9.8.1*). The reason for this is due to the change the proposed Project will bring to the natural environment and the impact it will have on sensitive viewers located around the Project Site. The Project will be intrusive to the environment and will not just be visible to the communities staying in the area but will also change the sense of place of the area surrounding the Project Site.

This negative impact is likely to be experienced by the farmsteads and rural villages located within close proximity to the Project Site.

The visual impact of the proposed temporary construction camp (staff accommodation during construction) will be high as it will be located directly next to the local roads. Since the accommodation is only temporary the impact will be high for the construction period and will only be low if all structures are removed and the area is successfully rehabilitated.

Table 9.8.1 Rating of Impacts Related to Landscape and Visual Environment during Construction (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is likely to be experienced by farmsteads / villages located close to the proposed Project Site, especially the villages located around the proposed site for the Main Mine Adit (Adit A). Communities (Driefontein) located further away are unlikely to be significantly disturbed due to their distance from the proposed Project Site.
Duration	Temporary and Short Term	The construction period is only temporary (18 to 24 months in duration) and this includes the establishment of a temporary Construction Site Camp, which will be decommissioned at the end of the construction phase.
Scale	Limited to within the Study Area	The change in landscape will occur within the Study Area and will be limited to a 10km zone of potential influence for Adit A and a 3km zone of potential influence for Adit B.
Frequency	NA	For unplanned events only.
Likelihood	NA	For unplanned events only.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
High sensitivity of the receiving landscape and visual receptors due to the visual intrusion, change in the sense of place of the area and the visibility of the proposed Project.		

Significant Rating Before Mitigation
Major Negative Impact

8.1.5 *Recommendations and Mitigation/Management Measures*

The following mitigation measures should be used to reduce the significance of the impact:

- Dust suppression techniques, as per the specifications of the Air Quality Impact Assessment Report (2013), should be in place at all times during the construction phase of the proposed Project. This is specific to areas where vegetation has been removed, soil stockpiles, on temporary / permanent unpaved road and any other areas where soil will be exposed.

- As much vegetation as possible should be kept during site clearance. The trees that are currently located around the Main Mine Adit (Adit A) site form a vegetation screen that could partially screen views towards the mine infrastructure and even the temporary construction camp. It is therefore recommended that these trees be kept in order to minimise the visual impact of the Main Mine Adit (Adit A).

- Buildings and structures constructed during the construction phase should be painted with colours that reflect and complement the natural browns and greens of the surrounding landscape. Pure light colours and pure blacks should be avoided.

- To reduce the potential of glare, external surfaces of buildings and structures should be articulated or textured to create interplay of light and shade.

- Avoid high pole top security lighting along the periphery of the Main Mine Adit and, as far as possible.

- Worker/security movement areas (pathways and roads) should be lit with low level 'bollard' type lighting and post top lighting should be avoided.

- The temporary contractors camp and construction sites should be kept neat / tidy at all times.

- Exposed areas should be restored / rehabilitated as soon as possible after decommissioning of the Temporary Construction Camp site.

- Fires should not be permitted so as to avoid veld fires.

- Construction material should be stored neatly in a designated area.

- Construction vehicles should keep to speed limits (45km/h is recommended in the air quality impact assessment) so to avoid excessive dust generation.

- *Ad hoc* monitoring should be implemented so as to ensure that visual screening and dust control measures during the construction phase of the proposed Project are implemented effectively.

- Progressive rehabilitation measures should be implemented during the early stages of the proposed Project, beginning during the construction phase if possible.

8.1.6 *Residual Impact (Post-mitigation)*

Should mitigation measures be implemented successfully the significance of the impact could be reduced to '**Moderate Negative Impact**' (*Table 9.8.2*). The main reason for this is the visibility of the proposed Project will be reduced, which could result in a reduction in the magnitude of the impact, as less sensitive viewers will be able to see the Project.

Table 9.8.2 Rating of Residual Impacts Related to Landscape and Visual Environment during Construction Post-Mitigation

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is likely to be experienced by farmsteads / villages located close to the proposed Project Site, especially the villages located around the proposed site for the Main Mine Adit (Adit A). Communities (Driefontein) located further away are unlikely to be significantly disturbed due to their distance from the proposed Project Site.
Duration	Temporary and Short Term	The construction period is only temporary (18 to 24 months in duration) and this includes the establishment of a temporary Construction Site Camp, which will be decommissioned at the end of the construction phase.
Scale	Limited within the Project Site	The change in landscape will occur within the study area but will be limited to the Project Site and directly surrounding areas, should mitigation measures be implemented.
Frequency	NA	For unplanned events only.
Likelihood	NA	For unplanned events only.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Moderate Negative Impact		

8.2 IMPACT TO THE LANDSCAPE AND VISUAL ENVIRONMENT DURING THE OPERATIONAL PHASE OF THE PROPOSED PROJECT

8.2.1 *Description of the Baseline Environment*

The baseline landscape and visual environment is described in *Sections* 4 and 5.

The receiving environment is characterised by a rolling topography which is created by the combination of mountains and rolling hills, small rivers, streams and wetlands. The Heyshope Dam is located to the east of the site. Man-made interventions include the farmsteads and rural residential dwellings with their related out buildings, structures and landforms directly related to the mining activities as well as infrastructure such as the Driefontein Road and other local roads (D1901 and D2548).

8.2.2 Proposed Project Activities

Landscape and visual changes resulting from operational phase activities include:

- The Main Mine Adit (Adit A) and Ventilation Adit (Adit B) and associated infrastructure;
- Overland conveyor system;
- Rock Dump in the footprint of Adit A;
- The movement of heavy and light vehicles;
- Dust created by the movement of vehicles; and
- Lighting of operational workings at the Main Mine Adit during the night time.

8.2.3 Sensitive Receptors

The main visual receptors which will be impacted upon during the operational phase of the proposed Project will include farmsteads and rural villages located close to the Project Site, Twyfelhoek School and local roads passing the site and visitors to the Kransbank Private Reserve. Communities such as Driefontein, which is located further away from the Project Site, are unlikely to be significantly disturbed due to their distance from the proposed Project Site.

During the operational period the structures and infrastructure associated with Adit A, B and the overland conveyor system will be more prominent than during the construction phase, and will result in a major change in landscape characteristics over a localized area resulting in a high change in key views. As indicated in *Section 7.1.2* and as illustrated in *Figure 7.3* to *Figure 7.5*, Adit A will be visible for residents directly surrounding the proposed Project Site, as well as residents located to the north and the north-east of the Project Site. Visitors to the Kransbank Private Reserve might not have a clear view of the proposed Project, but will have a view of the Project when travelling to the Project Site. Viewers from Twyfelhoek School will have an obstructed view towards the Project Site due to the rolling topography and vegetation that screens the view. Adit B will be mainly visible from farmsteads located within a 3km zone of potential influence surrounding the Project Site.

The operational phase will add to the cumulative effect that existing mining activities have on the visual quality of the landscape. In addition day-time impacts, the proposed Project will have a visual impact at night, as lighting will affect the residents staying in the Study area. This impact will however be limited to viewers surrounding Adit A since there will be no lighting at Adit B.

8.2.4 *Significance of Impact (Pre-mitigation)*

This impact has been assessed as a '**Major Negative Impact'** prior to mitigation (refer to *Table 8.3*). The reason for this is due to the change that the proposed Project will bring a change to the natural environment and the impact it will have on sensitive viewers located around the Project Site. The Project will be intrusive to the environment and will not just be visible to the communities staying in the area but will also change the sense of place of the area surrounding the Project Site.

This negative impact is likely to be experienced by the farmsteads and rural villages located within close proximity to the Project Site (located within 3km and located to the north and north-east of Adit A) as well as visitors to the Kransbank Private Reserve.

Table 8.3 Rating of Impacts Related to Landscape and Visual Environment during Operation (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is likely to be experienced by farmsteads / villages located in close proximity to the site, especially the villages located around the Main Mine Adit (Adit A). Communities (Driefontein) located further away are unlikely to be significantly disturbed due to their distance from the proposed Project Site.
Duration	Long Term. Duration of the Life of Mine.	The operation period is a long term period (10 to 20 years) but not a permanent period and structures will be removed during the decommissioning period.
Scale	Limited within 3km from the Project site	The change in landscape will occur within the Project Site. For the proposed Adit A, it will be limited to the area directly surrounding the site (within 3km) as well as areas located to the north and the north-east of the site. The area for Adit B is limited to the west, south-west, south and the south-east.
Frequency	NA	For unplanned events only.
Likelihood	NA	For unplanned events only.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
High sensitivity of the receiving landscape and visual receptors due to the visual intrusion, change in the sense of place of the area and the visibility of the proposed Project.		
Significant Rating Before Mitigation		
Major Negative Impact		

8.2.5 *Recommendations and Mitigation/Management Measures*

The following mitigation measures should be used to reduce the significance of the impact:

- Dust suppression techniques, as per the specifications of the Air Quality Report (2013), should be in place at all times during the operational phase of the proposed Project. This is specific to areas where vegetation was removed, soil stockpiles, on temporary / permanent unpaved road and any other areas where soil will be exposed.

- Vegetation screens (combination of indigenous trees and shrubs) should be planted along the boundaries of sensitive viewing areas surrounding Adit A (farmsteads, villages, Twyfelhoek School, Kransbank Private Reserve) (refer to *Figure 7.5*). Please note that when planting a vegetation screen the screen should be as close as possible to the sensitive viewer.

- Adit B is situated on a plateau / mountain and there are currently no trees surrounding the immediate site; however, there are groups of trees in the nearer vicinity. As such, a vegetation screen could be planted along the boundary of Adit B and will not look out of place.

- It is however suggested that a Professional Landscape Architect in conjunction with an Ecologist be appointed to advise on the establishment of these natural screens, so as to avoid having unnatural look and to avoid the introduction of unwanted species into the Study Area.

- The negative impact of night lighting, glare and spotlight effects, can be mitigated by using the following methods:

  - Install light fixtures that provide precisely directed illumination, so as to reduce light "spillage" beyond the immediate surrounds of the immediate Project Site.
  - Avoid high pole top security lighting along the periphery of the Project Site.
  - Use security lighting at the periphery of the site that is activated by movement and are not permanently switched on.

- *Ad hoc* monitoring should be implemented to ensure that visual screening and dust control measures for the proposed Project are implemented effectively during the operational phase.

- Operational vehicles should keep to speed limits (45km/h is recommended in the air quality impact assessment) so to avoid excessive dust generation.

8.2.6 Residual Impact (Post-mitigation)

The mitigation measures above will reduce the significance of the impact to a '**Moderate Negative Impact'** (*Table 8.4*). Should mitigation measures be implemented successfully the scale of the impact will be reduced to a much smaller area surrounding Adit A and Adit B. It should however be noted that vegetation screening might take a few years before they completely screen views and therefore the impact might start out as a "Major Negative Impact" but overtime will become a "Moderate Negative Impact".

Table 8.4 Rating of Residual Impacts Related to Landscape and Visual Environment during Operation (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is likely to be experienced by farmsteads / villages located in close proximity to the site, especially the villages located around the Main Mine Adit (Adit A). Communities (Driefontein) located further away are unlikely to be significantly disturbed due to their distance from the proposed Project Site.
Duration	Long Term. Duration of the Life of Mine operations.	The operation period is a long term period (10 to 20 years) but not a permanent period and structures will be removed during the decommissioning period.
Scale	Limited within the immediate Project Site	The change in landscape will occur within the Project Site and will be limited to the directly surrounding viewers, viewers travelling past the Project Site or viewers that are on elevated areas. The mitigation measure will reduce the scale but it should be noted that this will only happen if the mitigations are implemented successfully.
Frequency	NA	For unplanned events only.
Likelihood	NA	For unplanned events only.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Moderate Negative Impact		

8.3 IMPACTS TO THE LANDSCAPE AND VISUAL ENVIRONMENT DURING THE DECOMMISSIONING PHASE OF THE PROPOSED PROJECT

8.3.1 Description of the Baseline Environment

The baseline landscape and visual environment is described in *Sections* 4 and 5.

The receiving environment is characterised by a rolling topography which is created by the combination of mountains and rolling hills, small rivers, streams and wetlands. The Heyshope Dam is located to the east of the site. Man-made interventions include the farmsteads and rural residential dwellings with their related out buildings, structures and landforms directly related to the mining activities as well as infrastructure such as the Driefontein Road and other local roads (D1901 and D2548).

8.3.2 Proposed Project Activities

Landscape and visual changes resulting from decommissioning activities include:

- Decommissioning of the Main Mine Adit (Adit A) and the Ventilation Adit (Adit B) structures and associated infrastructure, including the overland conveyor system;

- The replacement of overburden (waste rock) into adit entrances;
- The movement of heavy and light vehicles when moving material from the site;
- Dust created by the movement of vehicles and the decommissioning and removal of structures and infrastructure;
- Lighting provided during the decommissioning period, specifically security lighting; and
- Rehabilitation activities.

8.3.3 Sensitive Receptors

During the decommissioning period it is assumed that all structures and infrastructure will be removed and that the area will be rehabilitated. These activities will create dust and may result in untidy / messy working areas.

The main visual receptors will include the farmsteads and rural villages located close to the Project Site, Twyfelhoek School and local roads passing the site as well as visitors to the Kransbank Private Reserve. Communities such as Driefontein, located further away from the Project Site, are unlikely to be significantly disturbed due to their distance from the proposed Project Site.

8.3.4 Significance of Impact (Pre-mitigation)

This impact has been assessed as a '**Major Negative Impact**' prior to mitigation (refer to *Table 8.5* below). The reason for this is that decommissioning activities are characterised as being untidy and create dust. As such, decommissioning activities will likely be intrusive to the environment and will be visible to the communities (villages and farmsteads) staying in the area.

This negative impact is likely to be experienced by the farmsteads and villages located within close proximity to the Project Site (located within 3km of Adit A and B and located to the north and north-east of Adit A) as well as visitors to the Kransbank Private Reserve.

Table 8.5 Rating of Impacts Related to Landscape and Visual Environment during Decommissioning Pre-Mitigation

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is likely to be experienced by farmsteads / rural villages located close to the Project Site, specifically villages located around Adit A. Communities (Driefontein) located further away are unlikely to be significantly disturbed due to their distance from the proposed Project Site.
Duration	Temporary and Short Term	The decommissioning period is only temporary but the outcomes of rehabilitation are permanent.

Scale	Limited to within the Study Area	The change in landscape will occur within the Study Area and will be limited to a 10km zone of potential influence for Adit A and a 3km zone of potential influence for Adit B.
Frequency	NA	For unplanned events only.
Likelihood	NA	For unplanned events only.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Magnitude		
High sensitivity of the receiving landscape and visual receptors due to the visibility and the visual intrusion of the proposed Project during the decommissioning phase.		
Significant Rating Before Mitigation		
Major Negative Impact		

8.3.5 Recommendations and Mitigation/Management Measures

The following mitigation measures should be used to reduce the significance of the impact:

- Dust suppression techniques, as per the specifications of the Air Quality Report (2013), should be in place at all times during the decommissioning phase of the proposed Project. This is specific to areas where vegetation was removed, soil stockpiles, on temporary / permanent unpaved road and any other areas where soil will be exposed.

- During this phase it will not be necessary to remove the vegetation screens as it will form part of the natural environment.

- The Project Site should be rehabilitated / restored to as close as the pre-mining environment as possible.

- High pole top security lighting along the periphery of the Project Site should be avoided.

- Use security lighting at the periphery of the site that is activated by movement and are not permanently switched on.

- Worker movement areas (pathways and roads) should be lit with low level 'bollard' type lights and post top lighting should be avoided.

- All material should be stored neatly in a designated area until it can be removed.

- Vehicles used during the decommissioning phase should keep to speed limits (45km/h is recommended in the air quality impact assessment) so to avoid excessive dust generation.

- *Ad hoc* monitoring should be implemented to ensure that visual impact management measures for the decommissioning phase of the proposed Project are implemented effectively.

8.3.6 Residual Impact (Post-mitigation)

The mitigation measures above will reduce the significance of the impact to a '**Minor to Moderate Negative Impact**' (*Table 8.6*). Should mitigation measures be implemented successfully the scale of the impact will be reduced to a much smaller area surrounding Adit A and Adit B. By the time the proposed Project is decommissioned vegetation screens should be suitably established and as a result will screen views from sensitive viewer locations and also assist with dust suppression. The decommissioning phase (post-mitigation) will therefore be less intrusive and visible for viewers than the construction and operational phases.

Table 8.6 Rating of Residual Impacts Related to Landscape and Visual Environment during Decommissioning (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is likely to be experienced by farmsteads / rural villages located close to the Project Site, specifically villages located around Adit A. Communities (Driefontein) located further away are unlikely to be significantly disturbed due to their distance from the proposed Project Site.
Duration	Temporary and Short Term	The decommissioning period is only temporary but the outcomes of rehabilitation are permanent.
Scale	Limited to immediately adjacent to the Project Site	The change in landscape will occur within the Project Site and will be limited to site specific and directly adjacent areas since the mitigation measures such as vegetation screening will be suitably established.
Frequency	NA	For unplanned events only.
Likelihood	NA	For unplanned events only.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor to Moderate Negative Impact		

9 CUMULATIVE IMPACTS AND MITIGATION

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This Chapter considers the cumulative impacts that would result from the combination of the proposed Kangra Coal Expansion Project and other actual or proposed future developments in the broader Study Area.

9.1 CUMULATIVE IMPACTS TO THE LANDSCAPE AND VISUAL ENVIRONMENT

As mentioned in *Chapter 4* there are existing mining activities taking place within the Study Area, these activities include the existing Maquasa East and Maquasa West Projects. Furthermore, possible future development within the Study Area includes the expansion of Driefontein (through a potential housing project between Kangra Coal and the district municipality) as well as the expansion of mining activities within the existing Kangra Coal Mining lease area.

The cumulative impacts that would result from a combination of the proposed Project and other actual or proposed future developments in the broader Study Area include:

- Additional change in the character and the visual resource value of the landscape, since more man-made structures will be introduced into the Study Area;
- A change in the sense of place of the Study Area as the area will become more urbanised;
- Increased visual impact at night caused by the combination of the different light sources, especially referring to the glow created by the mining activities as well as the surrounding communities such as Driefontein; and
- Increased development in the Study Area will result in excessive dust emissions, since more vehicles will be driving on unpaved roads, larger areas will be cleared of vegetation and the creation of more (potentially exposed) stockpiles.

10 CONCLUSION

Newtown Landscape Architects (NLA) was appointed by Environmental Resource Management (South Africa) Pty Ltd as a sub-consultant to provide input on the visual impact associated with the proposed Kangra Coal Kusipongo Resource Expansion Project.

This study has taken the following laws and guidelines into consideration:

- National Environmental Management Act (Act No. 107 of 1998) EIA Regulations;
- The NEMA Protected Areas Act (Act No. 57 of 2003);
- The National Heritage Resources Act (Act No. 25 of 1999);
- Western Cape Department of Environmental Affairs & Development Planning: Guideline for Involving Visual and Aesthetic Specialists in EIA Processes Edition 1 (CSIR, 2005); and
- World Bank's IFC Standards.

To evaluate the visual and landscape impacts of the proposed Project, the visual condition of the existing landscape was assessed by determining the value of the visual resource, assessing landscape quality and characteristics and the sense of place in the Study Area. The sensitivity of receptors was determined, following which the intrusiveness, visibility and visual exposure were determined. It was anticipated that visual impacts would result during the construction, operation and the decommissioning phases of the proposed Project, and more specifically from being seen from sensitive viewpoints and the effects it would have on the scenic value of the landscape.

During the baseline assessment it was established that the proposed Project Area has a ***high*** visual resource value and the following sensitive viewers were noted:

- Farmsteads and rural villages / residential areas;
- Twyfelhoek School;
- Kransbank Private Reserve;
- Motorist using the local farm roads; and
- Driefontein Community.

Other viewpoints, such as views from the mine roads and the existing mining activities are considered ***low*** sensitivity viewpoints.

10.1 VISUAL INTRUSION AND VISIBILITY

During the impact assessment it was determined that the visual intrusion of the proposed Project is ***high***, as there are no other similar activities located with the direct vicinity of the proposed Project Sites. The visibility of the proposed Adit A is also ***high*** for motorist travelling along the local roads as well as for tourist visiting the Kransbank Reserve / Heritage Site. For people staying in the vicinity of the site proposed for Adit A, as well as pupils attending the Twyfelhoek School the visibility will be high. It is recommended that as much of the vegetation as possible should be kept in order to screen the proposed Adit A from sensitive viewers.

The visibility of Adit B is ***moderate*** as most of the views towards the proposed sites will be in the middle-ground or background. The visibility of the overland conveyor system will be ***low*** as the structure is low and the topography of the area as well as the vegetation will partially screen the belt.

It should be noted that even though there are similar mining activities in the greater extent of the Study Area the proposed Kusipongo Resource Expansion Project is shielded / screened from these activities by a visual divide, namely the Mantshangwe Mountain Range. The proposed Project will however contribute to the cumulative visual impact associated with other mining activities in the greater Study Area.

10.2 SIGNIFICANCE OF IMPACTS RELATED TO LANDSCAPE AND VISUAL ENVIRONMENT

The significance of impacts related to the landscape and visual environment will be as follow:

- **Construction Phase** – the construction phase will result in a ***high*** visual impact before mitigation but ***moderate*** if mitigation measures are implemented successfully. Typical mitigation measures during this phase will include dust suppression techniques, lighting measurements, planting of a vegetation screen and good housekeeping. The visual impact of the proposed temporary construction camp (staff accommodation during construction) will be high as it will be located directly next to a local road. Since the construction camp is only temporary the impact will be high for the construction period and will only be low if all structures are removed and the area is successfully rehabilitated. Unfortunately there are limited mitigation / management measures associated with managing the visual impact of the construction camp, as it will be temporary; however it is suggested that good housekeeping rules should be applied.

- **Operational Phase** – the visual impact will be ***high*** before mitigation but ***moderate*** post-mitigation. During the operational phase proposed Project infrastructure will become more visible and intrusive and good mitigation measures are essential to screen views from sensitive viewers such as the surrounding farmsteads, villages, Twyfelhoek School and the Kransbank Private Reserve. It should be noted that vegetation screening will take a few years before it is successful (as plants need to establish) and should be adequately maintained in order to ensure its success.

- **Decommissioning Phase** – the decommissioning phase will result in a ***high*** negative visual impact before mitigation but ***minor to moderate*** negative visual impact if mitigation measures are implemented successfully. The vegetation screening as implemented during the previous phases should be suitably established and therefore the mitigation measures will result in a lower visual impact than for the construction phase.

The overall Project proposed will therefore have a high visual impact that could become moderate should the recommended mitigation / management measure be successfully implemented.

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Appendix A

Determining a Landscape and the Value of the Visual Resource

In order to reach an understanding of the effect of development on a landscape resource, it is necessary to consider the different aspects of the landscape as follows:

Landscape Elements and Character

The individual elements that make up the landscape, including prominent or eye-catching features such as hills, valleys, savannah, trees, water bodies, buildings and roads are generally quantifiable and can be easily described.

Landscape character is therefore the description of pattern, resulting from particular combinations of natural (physical and biological) and cultural (land use) factors and how people perceive these. The visual dimension of the landscape is a reflection of the way in which these factors create repetitive groupings and interact to create areas that have a specific visual identity. The process of landscape character assessment can increase appreciation of what makes the landscape distinctive and what is important about an area. The description of landscape character thus focuses on the nature of the land, rather than the response of a viewer.

Landscape Value – all encompassing (Aesthetic Value)

Aesthetic value is the emotional response derived from the experience of the environment with its particular natural and cultural attributes. The response can be either to visual or non-visual elements and can embrace sound, smell and any other factor having a strong impact on human thoughts, feelings and attitudes (Ramsay 1993). Thus aesthetic value encompasses more than the seen view, visual quality or scenery, and includes atmosphere, landscape character and sense of place (Schapper 1993).

Aesthetic appeal (value) is considered high when the following are present (Ramsay 1993):

- **Abstract Qualities** – such as the presence of vivid, distinguished, uncommon or rare features or abstract attributes;
- **Evocative Responses** – the ability of the landscape to evoke particularly strong responses in community members or visitors;
- **Meanings** – the existence of a long-standing special meaning to a particular group of people or the ability of the landscape to convey special meanings to viewers in general; and
- **Landmark Quality** – a particular feature that stands out and is recognised by the broader community.

Sense of Place

Central to the concept of a sense of place is that the place requires uniqueness and distinctiveness. The primary informant of these qualities is the spatial form and character of the natural landscape together with the cultural transformations and traditions associated with historic use and habitation.

According to Lynch (1992) sense of place "is the extent to which a person can recognize or recall a place as being distinct from other places – as having a vivid, or unique, or at least particular, character of its own". Sense of place is the unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer. In some cases these values allocated to the place are similar for a wide spectrum of users or viewers, giving the place a universally recognized and therefore, strong sense of place.

Scenic Quality

Assigning values to visual resources is a subjective process. The phrase, "beauty is in the eye of the beholder," is often quoted to emphasize the subjectivity in determining scenic values. Yet, researchers have found consistent levels of agreement among individuals asked to evaluate visual quality.

Studies for perceptual psychology have shown human preference for landscapes with a higher visual complexity particularly in scenes with water, over homogeneous areas. On the basis of contemporary research landscape quality increases when:

- Topographic ruggedness and relative relief increase;
- Where water forms are present;
- Where diverse patterns of grasslands and trees occur;
- Where natural landscape increases and man-made landscape decreases; and
- And where land use compatibility increases and land use edge diversity decreases (Crawford 1994).

Scenic Quality – Explanation of Rating Criteria

The following details explanations of the rating criteria for scenic quality, taken from *The Visual Resource Management System* (Department of the Interior of the USA Government, Bureau of Land Management):

- **Landform –** topography becomes more interesting as it gets steeper or more massive, or more severely or universally sculptured. Outstanding landforms may be monumental, as the Fish River or Blyde River Canyon, the Drakensberg or other mountain ranges, or they may be exceedingly artistic and subtle as certain badlands, pinnacles, arches, and other extraordinary formations.

- **Vegetation** – give primary consideration to the variety of patterns, forms, and textures created by plant life. Consider short-lived displays when they are known to be recurring or spectacular (wildflower displays in the Karoo regions). Consider also smaller scale vegetational features, which add striking and intriguing detail elements to the landscape (e.g., gnarled or wind beaten trees, and baobab trees).

- **Water** – that ingredient which adds movement or serenity to a scene. The degree to which water dominates the scene is the primary consideration in selecting the rating score.

- **<u>Colour</u>** – consider the overall colour(s) of the basic components of the landscape (e.g., soil, rock, vegetation, etc.) as they appear during seasons or periods of high use. Key factors to use when rating "colour" are variety, contrast, and harmony.

- **<u>Adjacent Scenery</u>** – degree to which scenery outside the scenery unit being rated enhances the overall impression of the scenery within the rating unit. The distance which adjacent scenery will influence scenery within the rating unit will normally range from 0 to 8 kilometres, depending upon the characteristics of the topography, the vegetative cover, and other such factors. This factor is generally applied to units which would normally rate very low in score, but the influence of the adjacent unit would enhance the visual quality and raise the score.

- **<u>Scarcity</u>** – this factor provides an opportunity to give added importance to one or all of the scenic features that appear to be relatively unique or rare within one physiographic region. There may also be cases where a separate evaluation of each of the key factors does not give a true picture of the overall scenic quality of an area. Often it is a number of not so spectacular elements in the proper combination that produces the most pleasing and memorable scenery - the scarcity factor can be used to recognize this type of area and give it the added emphasis it needs.

- **<u>Cultural Modifications</u>** – cultural modifications in the landform / water, vegetation, and addition of structures should be considered and may detract from the scenery in the form of a negative intrusion or complement or improve the scenic quality of a unit.

The above culminates into the following Scenic Quality Inventory and Evaluation Chart - (*The Visual Resource Management System*, Department of the Interior of the USA Government, Bureau of Land Management):

Key factors	**Rating Criteria and Score**		
Landform	High vertical relief as expressed in prominent cliffs, spires, or massive rock outcrops, or severe surface variation or highly eroded formations including major badlands or dune systems; or detail features dominant and exceptionally striking and intriguing such as glaciers. **5**	Steep canyons, mesas, buttes, cinder cones, and drumlins; or interesting erosional patterns or variety in size and shape of landforms; or detail features which are interesting though not dominant or exceptional. **3**	Low rolling hills, foothills, or flat valley bottoms; or few or no interesting landscape features. **1**
Vegetation and land cover	A variety of vegetative types as expressed in interesting forms, textures, and patterns. **5**	Some variety of vegetation, but only one or two major types. **3**	Little or no variety or contrast in vegetation. **1**

Water	Clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. **5**	Flowing, or still, but not dominant in the landscape. **3**	Absent, or present, but not noticeable. **0**
Colour	Rich colour combinations, variety or vivid colour; or pleasing contrasts in the soil, rock, vegetation, water or snow fields. **5**	Some intensity or variety in colours and contrast of the soil, rock and vegetation, but not a dominant scenic element. **3**	Subtle colour variations, contrast, or interest; generally mute tones. **1**
Influence of adjacent scenery	Adjacent scenery greatly enhances visual quality. **5**	Adjacent scenery moderately enhances overall visual quality. **3**	Adjacent scenery has little or no influence on overall visual quality. **0**
Scarcity	One of a kind; or unusually memorable, or very rare within region. Consistent chance for exceptional wildlife or wildflower viewing, etc. National and provincial parks and conservation areas *** 5+**	Distinctive, though somewhat similar to others within the region. **3**	Interesting within its setting, but fairly common within the region. **1**
Cultural modifications	Modifications add favourably to visual variety while promoting visual harmony. 2	Modifications add little or no visual variety to the area, and introduce no discordant elements. 0	Modifications add variety but are very discordant and promote strong disharmony. -4

Scenic Quality (i.e. value of the visual resource)

In determining the quality of the visual resource both the objective and the subjective or aesthetic factors associated with the landscape are considered. Many landscapes can be said to have a strong sense of place, regardless of whether they are considered to be scenically beautiful but where landscape quality, aesthetic value and a strong sense of place coincide – the visual resource or perceived value of the landscape is considered to be very high.
When considering both objective and subjective factors associated with the landscape there is a balance between landscape character and individual landscape features and elements, which would result in the values as follows:

Value of Visual Resource – Expresses as Scenic Quality

The value of the visual resource (expressed as scenic quality) is presented below:

HIGH	MODERATE	LOW
Areas that exhibit a very positive character with valued features that combine to give the experience of unity, richness and harmony. These are landscapes that may be considered to be of particular importance to conserve and which may be sensitive change in general and which may be detrimental if change is inappropriately dealt with.	Areas that exhibit positive character but which may have evidence of alteration to / degradation / erosion of features resulting in areas of more mixed character. Potentially sensitive to change in general; again change may be detrimental if inappropriately dealt with but it may not require special or particular attention to detail.	Areas generally negative in character with few, if any, valued features. Scope for positive enhancement frequently occurs.

Appendix B

Method for Determining the Magnitude (Severity / Intensity) of Landscape and a Visual Impact

A visual impact study analysis addresses the importance of the inherent aesthetics of the landscape, the public value of viewing the natural landscape, and the contrast or change in the landscape from the project.

For some topics, such as water or air quality, it is possible to use measurable, technical international or national guidelines or legislative standards, against which potential effects can be assessed. The assessment of likely effects on a landscape resource and on visual amenity is more complex, since it is determined through a combination of quantitative and qualitative evaluations. (The Landscape Institute with the Institute of Environmental Management and Assessment, 2002).

Landscape impact assessment includes a combination of objective and subjective judgments, and it is therefore important that a structured and consistent approach is used. It is necessary to differentiate between judgments that involve a degree of subjective opinion (as in the assessment of landscape value) from those that are normally more objective and quantifiable (as in the determination of magnitude of change). Judgment should always be based on training and experience and be supported by clear evidence and reasoned argument. Accordingly, suitably qualified and experienced landscape professionals carry out landscape and visual impact assessments (The Landscape Institute with the Institute of Environmental Management and Assessment (2002).

Landscape and visual assessments are separate, although linked, procedures. The landscape baseline, its analysis and the assessment of landscape effects all contribute to the baseline for visual assessment studies. The assessment of the potential effect on the landscape is carried out as an effect on an environmental resource, i.e. the landscape. Visual effects are assessed as one of the interrelated effects on populations.

Landscape Impact

Landscape impacts derive from changes in the physical landscape, which may give rise to changes in its character and from effects to the scenic values of the landscape. This may in turn affect the perceived value ascribed to the landscape. The description and analysis of effects on a landscape resource relies on the adoption of certain basic principles about the positive (or beneficial) and negative (or adverse) effects of change in the landscape. Due to the inherently dynamic nature of the landscape, change arising from a development may not necessarily be significant (Institute of Environmental Assessment & The Landscape Institute, 2002).

Visual Impact

Visual impacts relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity. Visual impact is therefore measured as the change to the existing visual environment (caused by the physical presence of a new development) and the extent to which that change compromises (negative impact) or enhances (positive impact) or maintains the visual quality of the area.

To assess the magnitude of visual impact four main factors are considered.

1. **Visual Intrusion – t**he nature of intrusion or contrast (physical characteristics) of a project component on the visual quality of the surrounding environment and its compatibility / discord with the landscape and surrounding land use.

2. **Visibility –** the area / points from which project components will be visible.

3. **Visual Exposure –** visibility and visual intrusion qualified with a distance rating to indicate the degree of intrusion.

4. **Sensitivity –** sensitivity of visual receptors to the proposed development.

Visual Intrusion / Contrast

Visual intrusion deals with the notion of contextualism i.e. how well does a project component fit into the ecological and cultural aesthetic of the landscape as a whole. Or conversely what is its contrast with the receiving environment. Combining landform / vegetation contrast with structure contrast derives overall visual intrusion / contrast levels of high, moderate, and low.

Landform / vegetation contrast is the change in vegetation cover and patterns that would result from construction activities. Landform contrast is the change in landforms, exposure of soils, potential for erosion scars, slumping, and other physical disturbances that would be noticed as uncharacteristic in the natural landscape. Structure contrast examines the compatibility of the proposed development with other structures in the landscape and the existing natural landscape. Structure contrast is typically strongest where there are no other structures (e.g., buildings, existing utilities) in the landscape setting.

Photographic panoramas from key viewpoints before and after development are presented to illustrate the nature and change (contrast) to the landscape created by the proposed development. A computer simulation technique is employed to superimpose a graphic of the development onto the panorama. The extent to which the component fits or contrasts with the landscape setting can then be assessed using the following criteria:

- Does the physical development concept have a negative, positive or neutral effect on the quality of the landscape?

- Does the development enhance or contrast with the patterns or elements that define the structure of the landscape?

- Does the design of the project enhance and promote cultural continuity or does it disrupt it?

The consequence of the intrusion / contrast can then be measured in terms of the sensitivity of the affected landscape and visual resource given the criteria listed below. For instance, within an industrial area, a new sewage treatment works may have an insignificant landscape and visual impact; whereas in a valued landscape it might be considered to be an intrusive element. (Institute of Environmental Assessment & The landscape Institute, 1996).

Visual Intrusion

HIGH	MODERATE	LOW	POSITIVE
If the project: - Has a substantial negative effect on the visual quality of the landscape; - Contrasts dramatically with the patterns or elements that define the structure of the landscape; - Contrasts dramatically with land use, settlement or enclosure patterns; - Is unable to be 'absorbed' into the landscape.	If the project: - Has a moderate negative effect on the visual quality of the landscape; - Contrasts moderately with the patterns or elements that define the structure of the landscape; - Is partially compatible with land use, settlement or enclosure patterns. - Is partially 'absorbed' into the landscape.	If the project: - Has a minimal effect on the visual quality of the landscape; - Contrasts minimally with the patterns or elements that define the structure of the landscape; - Is mostly compatible with land use, settlement or enclosure patterns. - Is 'absorbed' into the landscape.	If the project: - Has a beneficial effect on the visual quality of the landscape; - Enhances the patterns or elements that define the structure of the landscape; - Is compatible with land use, settlement or enclosure patterns.
Result Notable change in landscape characteristics over an extensive area and / or intensive change over a localized area resulting in major changes in key views.	*Result* Moderate change in landscape characteristics over localized area resulting in a moderate change to key views.	*Result* Imperceptible change resulting in a minor change to key views.	*Result* Positive change in key views.

Visual intrusion also diminishes with scenes of higher complexity, as distance increases, the object becomes less of a focal point (more visual distraction), and the observer's attention is diverted by the complexity of the scene (Hull and Bishop, 1988).

Visibility

A viewshed analysis was carried out to define areas, which contain all possible observation sites from which the development would be visible. The basic assumption for preparing a viewshed analysis is that the observer eye height is 1.8m above ground level. Topographic data was captured for the site and its environs at 10m contour intervals to create the Digital Terrain Model (DTM). The DTM includes features such as vegetation, rivers, roads and nearby urban areas. These features were 'draped' over the topographic data to complete the model used to generate the viewshed analysis. It should be noted that viewshed analyses are not absolute indicators of the level of significance (magnitude) of the impact in the view, but merely a statement of the fact of potential visibility. The visibility of a development and its contribution to visual impact is predicted using the criteria listed below:

Visibility

HIGH	**MODERATE**	**LOW**
Visual Receptors If the development is visible from over half the zone of potential influence, and / or views are mostly unobstructed and / or the majority of viewers are affected.	*Visual Receptors* If the development is visible from less than half the zone of potential influence, and / or views are partially obstructed and or many viewers are affected	*Visual Receptors* If the development is visible from less than a quarter of the zone of potential influence, and / or views are mostly obstructed and / or few viewers are affected.

Visual Exposure

Visual exposure relates directly to the distance of the view. It is a criterion used to account for the limiting effect of increased distance on visual impact. The impact of an object in the foreground (0 – 800m) is greater than the impact of that same object in the middle ground (800m – 5.0km) which, in turn is greater than the impact of the object in the background (greater than 5.0km) of a particular scene.

Distance from a viewer to a viewed object or area of the landscape influences how visual changes are perceived in the landscape. Generally, changes in form, line, colour, and texture in the landscape become less perceptible with increasing distance.

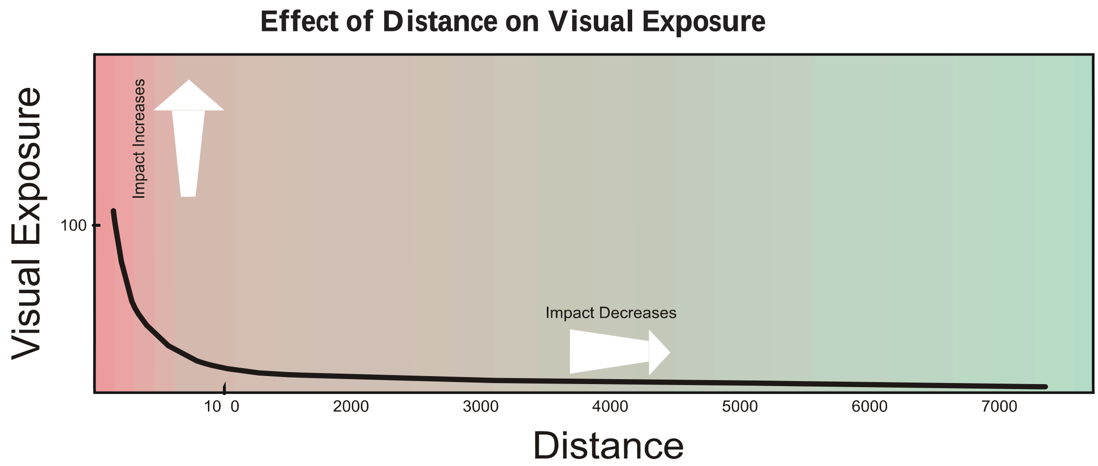
Areas seen from 0 to 800m are considered foreground; foliage and fine textural details of vegetation are normally perceptible within this zone.

Areas seen from 800m to 5.0km are considered middle ground; vegetation appears as outlines or patterns. Depending on topography and vegetation, middle ground is sometimes considered to be up to 8.0km.

Areas seen from 5.0km to 8.0km and sometimes up to 16km and beyond are considered background. Landforms become the most dominant element at these distances.

Seldom seen areas are those portions of the landscape that, due to topographic relief or vegetation, are screened from the viewpoint or are beyond 16km from the viewpoint. Landforms become the most dominant element at these distances.

The impact of an object diminishes at an exponential rate as the distance between the observer and the object increases. Thus, the visual impact at 1000m would be 25% of the impact as viewed from 500m. At 2000 m it would be 10% of the impact at 500m. The inverse relationship of distance and visual impact is well recognised in visual analysis literature (e.g. Hull and Bishop (1988)) and is used as important criteria for the study. This principle is illustrated in the figure below.



Sensitivity of Visual Receptors

When visual intrusion, visibility and visual exposure are incorporated, and qualified by sensitivity criteria (visual receptors) the magnitude of the impact of the development can be determined.

The sensitivity of visual receptors and views will be depended on:

- The location and context of the viewpoint;
- The expectations and occupation or activity of the receptor; and
- The importance of the view (which may be determined with respect to its popularity or numbers of people affected, its appearance in guidebooks, on tourist maps, and in the facilities provided for its enjoyment and references to it in literature or art).

The most sensitive receptors may include:

- Users of all outdoor recreational facilities including public rights of way, whose intention or interest may be focused on the landscape;
- Communities where the development results in changes in the landscape setting or valued views enjoyed by the community;
- Occupiers of residential properties with views affected by the development; and
- These would all be high (5).

Other receptors include:

- People engaged in outdoor sport or recreation (other than appreciation of the landscape, as in landscapes of acknowledged importance or value); (3)

- People travelling through or past the affected landscape in cars, on trains or using other transport modes; and (0)
- People at their place of work. (0)

The least sensitive receptors are likely to be people at their place of work, or engaged in similar activities, whose attention may be focused on their work or activity and who therefore may be potentially less susceptible to changes in the view.

In this process more weight is usually given to changes in the view or visual amenity which are greater in scale and visible over a wide area. In assessing the effect on views, consideration should be given to the effectiveness of mitigation measures, particularly where planting is proposed for screening purposes (Institute of Environmental Assessment & The Landscape Institute (1996).

Sensitivity of Visual Receptors

HIGH (5)	MODERATE (3)	LOW (0)
Users of all outdoor recreational facilities including public rights of way, whose intention or interest may be focused on the landscape; Communities where the development results in changes in the landscape setting or valued views enjoyed by the community; Occupiers of residential properties with views affected by the development.	People engaged in outdoor sport or recreation (other than appreciation of the landscape, as in landscapes of acknowledged importance or value); People travelling through or past the affected landscape in cars, on trains or other transport routes;	The least sensitive receptors are likely to be people at their place of work, or engaged in similar activities, whose attention may be focused on their work or activity and who therefore may be potentially less susceptible to changes in the view (i.e. office and industrial areas). Roads going through urban and industrial areas

Magnitude (Severity / Intensity) of the Visual Impact

Potential visual impacts are determined by analysing how the physical change in the landscape, resulting from the introduction of a project, are viewed and perceived from sensitive viewpoints. Impacts to views are the highest when viewers are identified as being sensitive to change in the landscape, and their views are focused on and dominated by the change. Visual impacts occur when changes in the landscape are noticeable to viewers looking at the landscape from their homes or from parks, and conservation areas, highways and travel routes, and important cultural features and historic sites, especially in foreground views.

The magnitude of impact is assessed through a synthesis of visual intrusion, visibility, visual exposure and viewer sensitivity criteria. Once the magnitude of impact has been established this value is further qualified with spatial, duration and probability criteria to determine the significance of the visual impact.

For instance, the fact that visual intrusion and exposure diminishes significantly with distance does not necessarily imply that the relatively small impact that exists at greater distances is unimportant. The level of impact that people consider acceptable may be dependent upon the purpose they have in viewing the landscape. A particular development may be unacceptable to a hiker seeking a natural experience, or a household whose view is impaired, but may be barely noticed by a golfer concentrating on his game or a commuter trying to get to work on time (Ittleson et al., 1974).

In synthesising these criteria a numerical or weighting system is avoided. Attempting to attach a precise numerical value to qualitative resources is rarely successful, and should not be used as a substitute for reasoned professional judgment. (Institute of Environmental Assessment and The Landscape Institute, 1996).

Magnitude (Severity / Intensity) of Visual Impact

HIGH	MODERATE	LOW	NEGLIGIBLE
Total loss of or major alteration to key elements / features / characteristics of the baseline. I.e. Pre-development landscape or view and / or introduction of elements considered to be totally uncharacteristic when set within the attributes of the receiving landscape. High scenic quality impacts would result.	Partial loss of or alteration to key elements / features / characteristics of the baseline. I.e. Pre-development landscape or view and / or introduction of elements that may be prominent but may not necessarily be considered to be substantially uncharacteristic when set within the attributes of the receiving landscape. Moderate scenic quality impacts would result	Minor loss of or alteration to key elements / features / characteristics of the baseline. I.e. Pre-development landscape or view and / or introduction of elements that may not be uncharacteristic when set within the attributes of the receiving landscape. Low scenic quality impacts would result.	Very minor loss or alteration to key elements / features / characteristics of the baseline. I.e. Pre-development landscape or view and / or introduction of elements that are not uncharacteristic with the surrounding landscape – approximating the 'no change' situation. Negligible scenic quality impacts would result.

Cumulative Effects

Cumulative landscape and visual effects (impacts) result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments (associated with or separate to it), or actions that occurred in the past, present or are likely to occur in the foreseeable future. They may also affect the way in which the landscape is experienced. Cumulative effects may be positive or negative. Where they comprise a range of benefits, they may be considered to form part of the mitigation measures.

Cumulative effects can also arise from the intervisibility (visibility) of a range of developments and / or the combined effects of individual components of the proposed development occurring in different locations or over a period of time. The separate effects of such individual components or developments may not be significant, but together they may create an unacceptable degree of adverse effect on visual receptors within their combined visual envelopes. Intervisibility depends upon general topography, aspect, tree cover or other visual obstruction, elevation and distance, as this affects visual acuity, which is also influenced by weather and light conditions. (Institute of Environmental Assessment and The Landscape Institute, 1996).

Appendix C

Criteria for Significance of Impact Assessment

The significance of impact was determined based on the methodology as provided by Environmental Resources Management (Pty) Ltd. The methodology states that the significance of the impact is a function of the magnitude of the impact and the likelihood of the impact occurring. The impact magnitude (severity) is a function of the extent, duration and intensity of the impact.

Impact magnitude – the degree of change brought about in the environment	
Extent	**On-site** – impacts that are limited to the site boundaries. **Local** – impacts that affect the area in close proximity to the site **Regional** – impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type / ecosystem. **National** – impacts that affect nationally important environmental resources or affect an area that is nationally important / or have macro-economic consequences. **Trans-boundary/International** – impacts that affect internationally important resources such as areas protected by international conventions.
Duration	**Temporary** – impacts are predicted to be of short duration and intermittent / occasional. **Short-term** – impacts that are predicted to last only for the duration of the construction period. **Long-term** – impacts that will continue for the life of the Project, but ceases when the Project stops operating. **Permanent** – impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.
Intensity (1)	BIOPHYSICAL ENVIRONMENT: *Intensity can be considered in terms of the sensitivity of the biodiversity receptor (i.e. habitats, species or communities).* **Negligible** – the impact on the environment is not detectable. **Low** – the impact affects the environment in such a way that natural functions and processes are not affected. **Medium** – where the affected environment is altered but natural functions and processes continue, albeit in a modified way. **High** – where natural functions or processes are altered to the extent that it will temporarily or permanently cease. ***Where appropriate, national and/or international standards are to be used as a measure of the impact.*** *Specialist studies should attempt to quantify the magnitude of impacts and outline the rationale used.*
	SOCIO-ECONOMIC ENVIRONMENT: *Intensity can be considered in terms of the ability of project affected people/communities to adapt to changes brought about by the Project.* **Negligible** – there is no perceptible change to people's livelihood **Low** – People / communities are able to adapt with relative ease and maintain pre-impact livelihoods. **Medium** – Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.

(1) The frequency of the activity causing the impact also has a bearing on the intensity of the impact, ie. the more frequent the activity, the higher the intensity.

	High – Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods.
Impact likelihood – the likelihood that an impact will occur	
Unlikely	The impact is unlikely to occur.
Likely	The impact is likely to occur under most conditions.
Definite	The impact will occur.

Appendix D

Criteria for Photo / Computer Simulation

To characterize the nature and magnitude of visual intrusion of the proposed project, a photographic simulation technique was used. This method was used according to Sheppard (in Lange 1994), where a visual simulation is good quality when the following five criteria are met.

Representativeness: A simulation should represent important and typical views of a project.

Accuracy: The similarity between a simulation and the reality after the project has been realized.

Visual clarity: Detail, parts and overall contents have to be clearly recognizable.

Interest: A simulation should hold the attention of the viewer.

Legitimacy: A simulation is defensible if it can be shown how it was produced and to what degree it is accurate.

To comply with this standard it was decided to produce a stationary or static simulation (Van Dortmont in Lange, 1994), which shows the proposed development from a typical static observation points (Critical View Points).

Photographs are taken on site during a site visit with a manual focus, 50mm focal depth digital camera. All camera settings are recorded and the position of each panoramic view is recorded by means of a GPS. These positions, coordinates are then placed on the virtual landscape (see below).

A scale model of the proposal is built in virtual space, scale 1:1, based on CAD (vector) information as supplied by the architect / designers. This model is then placed on a virtual landscape, scale 1:1, as produced by means of GIS software. The accuracy of this depends on the contour intervals.

The camera views are placed on the points as recorded on the virtual landscape. The respective photographs are overlaid onto the camera views, and the orientation of the cameras adjusted accordingly. The light source is adjusted to suit the view. Each view is then rendered as per the process above.

Appendix E

Declaration of Independence

Declaration of Independence

I, Graham A Young hereby declare that Newtown Landscape Architects cc, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service.
Consultant name: Graham Young

Signature:

Date: 11 October 2010

Appendix F

Curriculum Vitae of Specialists

Since 1994

Graham Young PrLArch

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Graham is a landscape architect with thirty years experience. He has worked in Southern Africa and Canada and has valuable expertise in the practice of landscape architecture, urban design and environmental planning. He is also a senior lecturer, teaching urban design and landscape architecture at post and under graduate levels at the University of Pretoria. He also specializes in Visual Impact Assessments.

EXPERIENCE:	**NEWTOWN LANDSCAPE ARCHITECTS cc.** ***Member***
Current	Responsible for project management, landscape design, urban design, and visual impact assessment. *Senior Lecturer*: Department of Architecture, University of Pretoria.
1991 - 1994	**GRAHAM A YOUNG LANDSCAPE ARCHITECT** - ***Sole proprietor***
1988 - 1989	Designed major transit and CBD based urban design schemes; designed commercial and recreational landscapes and a regional urban park; participated in inter-disciplinary consulting teams that produced master plans for various beachfront areas in KwaZulu Natal and a mountain resort in the Drakensberg.
1989 - 1991	**CANADA** - ***Free Lance*** Designed golf courses and carried out golf course feasibility studies (Robert Heaslip and Associates); developed landscape site plans and an end-use plan for an abandoned mine (du Toit, Allsopp and Hillier); conducted a visual analysis of a proposed landfill site. .
1980 - 1988	**KDM (FORMERLY DAMES AND MOORE)** - *Started as a Senior Landscape Architect and was appointed Partner in charge of Landscape Architecture and Environmental Planning in 1984*. Designed commercial, corporate and urban landscapes; completed landscape site plans; developed end-use master plans for urban parks, college and technikon sites; carried out ecological planning studies for factories, motorways and a railway line.
1978 - 1980	**DAYSON & DE VILLIERS** - ***Staff Landscape Architect*** Designed various caravan parks; designed a recreation complex for a public resort; conducted a visual analysis for the recreation

planning of Pilgrims Rest; and designed and supervised the installation of various private gardens.

EDUCATION:

Bachelor of Landscape Architecture, 1978, (BLArch), University of Toronto, Canada;

Completing a master's degree in Landscape Architecture, University of Pretoria; Thesis: Visual Impact Assessment;

Senior Lecturer - Department of Architecture, University of Pretoria.

PROFESSIONAL:

Registered Landscape Architect – South African Council for Landscape Architectural Profession (2001);

Board of Control for Landscape Architects of South Africa (1987) – Vice Chairman 1988 to 1989;

Professional Member - Institute of Landscape Architects Southern Africa (1982) – President 1986 - 1988;

Member Planning Professions Board 1987 to 1989;

Member International Association of Impact Assessment;

AWARDS:

Torsanlorenzo International Prize, Landscape design and protection 2nd Prize Section B: Urban Green Spaces, for Intermediate Phase Freedom Park (2009)

Phase 1 and Intermediate Phase Freedom Park: Special Mention World Architecture Festival, Nature Category (2008)

Moroka Park Precinct, Soweto: ILASA Merit Award for Design (2005) and Gold Medal United Nations Liveable Communities (LivCom) Award (2007)

Isivivane, Freedom Park: ILASA Presidential Award of Excellence Design (2005)

Information Kiosk, Freedom Park: ILASA Merit Award for Design (2005)

Moroka – Mofola Open Space Framework, Soweto: ILASA Merit Award for Planning (2005)

Mpumalanga Provincial Government Complex: ILASA Presidential Award of Excellence (with KWP Landscape Architects for Design (2003)

Specialist Impact Report: Visual Environment, Sibaya Resort and Entertainment World: ILASA Merit Award for Environmental Planning (1999);

Gillooly's Farm, Bedfordview (with Dayson and DeVilliers): ILASA Merit Award for Design;

COMPETITIONS:

Pan African Parliament International Design competition – with MMA architects (2007) Finalist

Leeuwpan Regional Wetland Park for the Ekurhuleni Metro Municipality (2004) Landscape Architectural Consultant on Department of Trade and Industries Building (2002) – Finalist

Landscape Architecture Consultant on Project Phoenix Architectural Competition, Pretoria (1999): Winner;

Mpumalanga Legislature Buildings (1998): Commissioned;

Toyota Fountain (1985): First Prize - commissioned;

Bedfordview Bike / Walkway System - Van Buuren Road (1982): First Prize -commissioned;
Portland Cement Institute Display Park (1982): Second Prize

CONTRIBUTOR:

Joubert, O, 10 Years + *100 Buildings – Architecture in a Democratic South Africa Bell-Roberts Gallery and Publishing*, South Africa (2009)

- Freedom Park Phase 1 and Intermediate Phase (NBGM), Pretoria, Gauteng

Galindo, M, *Collection Landscape Architecture*, Braun, Switzerland (2009)

- Freedom Park Phase Intermediate Phase (NBGM), Pretoria, Gauteng

In *1000 X Landscapes*, Verlagshaus Braun, Germany (2008)

- Freedom Park Phase 1 and Intermediate Phase (NBGM), Pretoria, Gauteng
- Riverside Government Complex (NLAKWP), Nelspruit, Mpumalanga;
- Moroka Dam Parks Precinct, Soweto, Gauteng.

In *Johannesburg: Emerging/Diverging Metropolis*, Mendrision Academy Press, Italy (2007)

- Moroka Dam Parks Precinct, Soweto, Gauteng.

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B.Sc Degree in Environmental Science from the University of North West, Potchefstroom Campus (2003). M.Sc Degree in Ecological Remediation and Sustainable Utilization from the University of North West, Potchefstroom Campus (2007). She is currently employed by Newtown Landscape Architects working on the following projects.

EXPERIENCE:

Environmentalist: Newtown Landscape Architects

Responsible for the environmental work, which includes Basic Assessments, Environmental Impact Assessments (Scoping & EIA), Environmental Management Plans (EMP), Environmental Auditing as well as Visual Impact Assessments.

Current Projects:

- **Orchards Extension 49-53,** Pretoria - Environmental Impact Assessment and Environmental Management Plan
- **Tangananı Ext 8,** Johannesburg - Environmental Impact Assessment and Environmental Management Plan
- **Diepsloot East Development,** Diepsloot - Environmental Impact Assessment and Environmental Management Plan
- **Klerksoord Ext 25 & 26,** Pretoria – Environmental Impact Assessment
- **Ennerdale Ext 16,** Johannesburg - Environmental Impact Assessment and Environmental Management Plan

- **Glen Marais Ext 102 & 103,** Kempton Park - Basic Assessment and Environmental Management Plan
- **Princess Plot 229,** Princess - Environmental Assessment (S24G Application)
- **Uthlanong Drive Upgrade** – Mogale City Local Municipalty project in Kagiso, Basic Assessment for the upgrade of the stormwater and the roads
- **Luipaardsvlei Landfill Site** – Mogale City Local Municipalty project in Krugersdorp, the expansion of the existing landfill site.
- **MCLM Waste Water Treatment Works** – Mogale City Local Municipalty project in Magaliesburg, the expansion of the existing facility.
- **Rand Uranium** (Golder Associates Africa (Pty) Ltd), Randfontein – VIA
- **Dorsfontein West Expansion** (GCS (Pty) Ltd), Kriel – VIA
- **Mine Waste Solutions** (GCS (Pty) Ltd), Stilfontein – VIA
- **Ferreira Coal Mining** (GCS (Pty) Ltd), Ermelo – VIA
- **De Wittekrans Mining** (GCS (Pty) Ltd), Hendrina – VIA

EDUCATION:

May 2009	Public Participation Course, International Association for Public Participation, Golder Midrand
May 2008	Wetland Training Course on Delineation, Legislation and Rehabilitation, University of Pretoria.
April 2008	Environmental Impact Assessment: NEMA Regulations – A practical approach, Centre for Environmental Management: University of North West.
Feb 2008	Effective Business Writing Skills, ISIMBI
Oct 2007	Short course in Geographic Information Systems (GIS), Planet GIS
Jan 2004 – April 2007	M.Sc Degree in Ecological Remediation and Sustainable Utilization, University of North West, Potchefstroom Campus. Thesis: Tree vitality along the urbanization gradient in Potchefstroom, South Africa.
Jan 2001 – Dec 2003	B.Sc Degree in Environmental Science, University of Potchefstroom

PROFESSIONAL REGISTRATION:

Sep 2009 Professional National Scientist – 400204/09