APPENDIX U

Appendix U - REA Expansion Design, Rejects Disposal Options Study Technical Report

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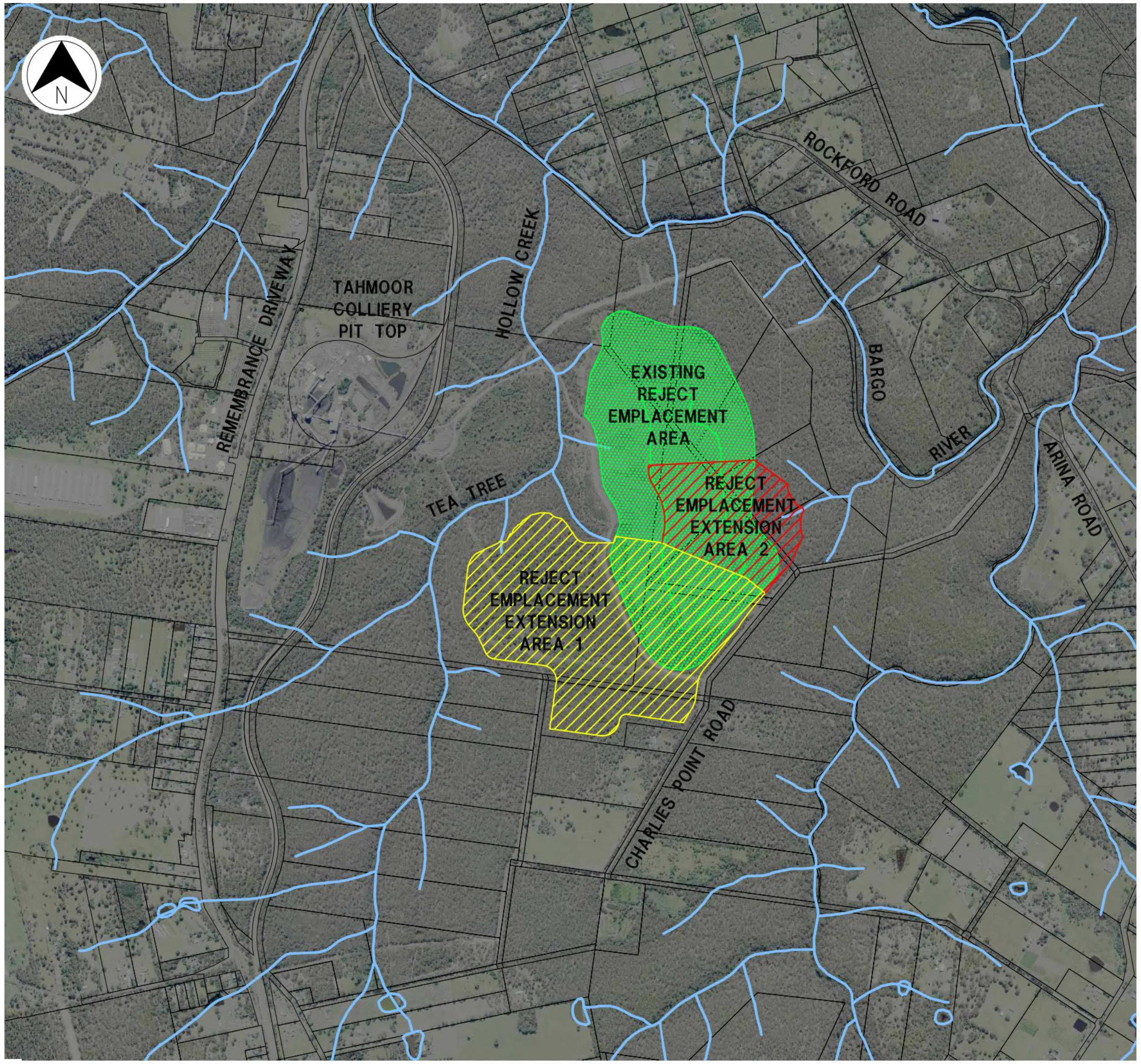
REA Expansion Design

TAHMOOR COAL
REJECTS EMPLACEMENT AREA



LOCALITY PLAN
SCALE 1:10000

DRAWING SCHEDULE

DRAWING No	DESCRIPTION
NW00243-ECC-DG-0001	LOCALITY PLAN AND DRAWING SCHEDULE
NW00243-ECC-DG-0002	NOTES
NW00243-ECC-DG-0003	OVERALL LAYOUT ROADS AND DRAINS
NW00243-ECC-DG-0004	OVERALL LAYOUT AND STAGING PLAN
NW00243-ECC-DG-0005	SITE SECTIONS SHEET 1 OF 2
NW00243-ECC-DG-0006	SITE SECTIONS SHEET 2 OF 2
NW00243-ECC-DG-0007	TYPICAL DETAILS SHEET 1 OF 6
NW00243-ECC-DG-0008	TYPICAL DETAILS SHEET 2 OF 6
NW00243-ECC-DG-0009	TYPICAL DETAILS SHEET 3 OF 6
NW00243-ECC-DG-0010	TYPICAL DETAILS SHEET 4 OF 6
NW00243-ECC-DG-0011	TYPICAL DETAILS SHEET 5 OF 6
NW00243-ECC-DG-0012	TYPICAL DETAILS SHEET 6 OF 6
NW00243-ECC-DG-0013	AREA 1 SHEET 1 OF 2
NW00243-ECC-DG-0014	AREA 1 SHEET 2 OF 2
NW00243-ECC-DG-0015	AREA 2 SHEET 1 OF 2
NW00243-ECC-DG-0016	AREA 2 SHEET 2 OF 2
~~NW00243-ECC-DG-0017~~	~~AREA 3~~ DELETED
NW00243-ECC-DG-0018	BASIN S11
NW00243-ECC-DG-0019	BASIN S12
NW00243-ECC-DG-0020	BASIN DETAILS SHEET 1 OF 3
NW00243-ECC-DG-0021	BASIN DETAILS SHEET 2 OF 3
NW00243-ECC-DG-0022	BASIN DETAILS SHEET 3 OF 3
NW00243-ECC-DG-0023	BASIN PIPES AND PUMPS
NW00243-ECC-DG-0024	BASIN PIPES AND PUMP DETAILS SHEET 1 OF 2
NW00243-ECC-DG-0025	BASIN PIPES AND PUMP DETAILS SHEET 2 OF 2
NW00243-ECC-DG-0026	DRAIN LONGITUDINAL SECTIONS SHEET 1 OF 6
NW00243-ECC-DG-0027	DRAIN LONGITUDINAL SECTIONS SHEET 2 OF 6
NW00243-ECC-DG-0028	DRAIN LONGITUDINAL SECTIONS SHEET 3 OF 6
NW00243-ECC-DG-0029	DRAIN LONGITUDINAL SECTIONS SHEET 4 OF 6
NW00243-ECC-DG-0030	DRAIN LONGITUDINAL SECTIONS SHEET 5 OF 6
NW00243-ECC-DG-0031	DRAIN LONGITUDINAL SECTIONS SHEET 6 OF 6
NW00243-ECC-DG-0032	HAUL ROAD MC01
NW00243-ECC-DG-0033	HAUL ROAD MC02
NW00243-ECC-DG-0034	HAUL ROAD DRAINAGE DETAILS SHEET 1 OF 2
NW00243-ECC-DG-0035	HAUL ROAD DRAINAGE DETAILS SHEET 2 OF 2
NW00243-ECC-DG-0036	HAUL ROAD LONGITUDINAL SECTIONS SHEET 1 OF 2
NW00243-ECC-DG-0037	HAUL ROAD LONGITUDINAL SECTIONS SHEET 2 OF 2
~~NW00243-ECC-DG-0038~~	~~HAUL ROAD LONGITUDINAL SECTIONS SHEET 3 OF 3~~ DELETED

SCALE 1:10000 (A1) 200 100 0 200 400 600 800 1000m

TENDER ISSUE

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REV	DATE	DRAWN	REVD	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	REJECTS EMPLACEMENT AREA REVISED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

GLENCORE

SKM
A.C.N 001 024 095
Sinclair Knight Merz
100 Christie Street
St Leonards, SYDNEY, NSW 2065
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CLIENT GLENCORE
PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED NG	DESIGN REVIEW TGMG	24/05/2013	24/05/2013

TITLE
LOCALITY PLAN AND DRAWING SCHEDULE

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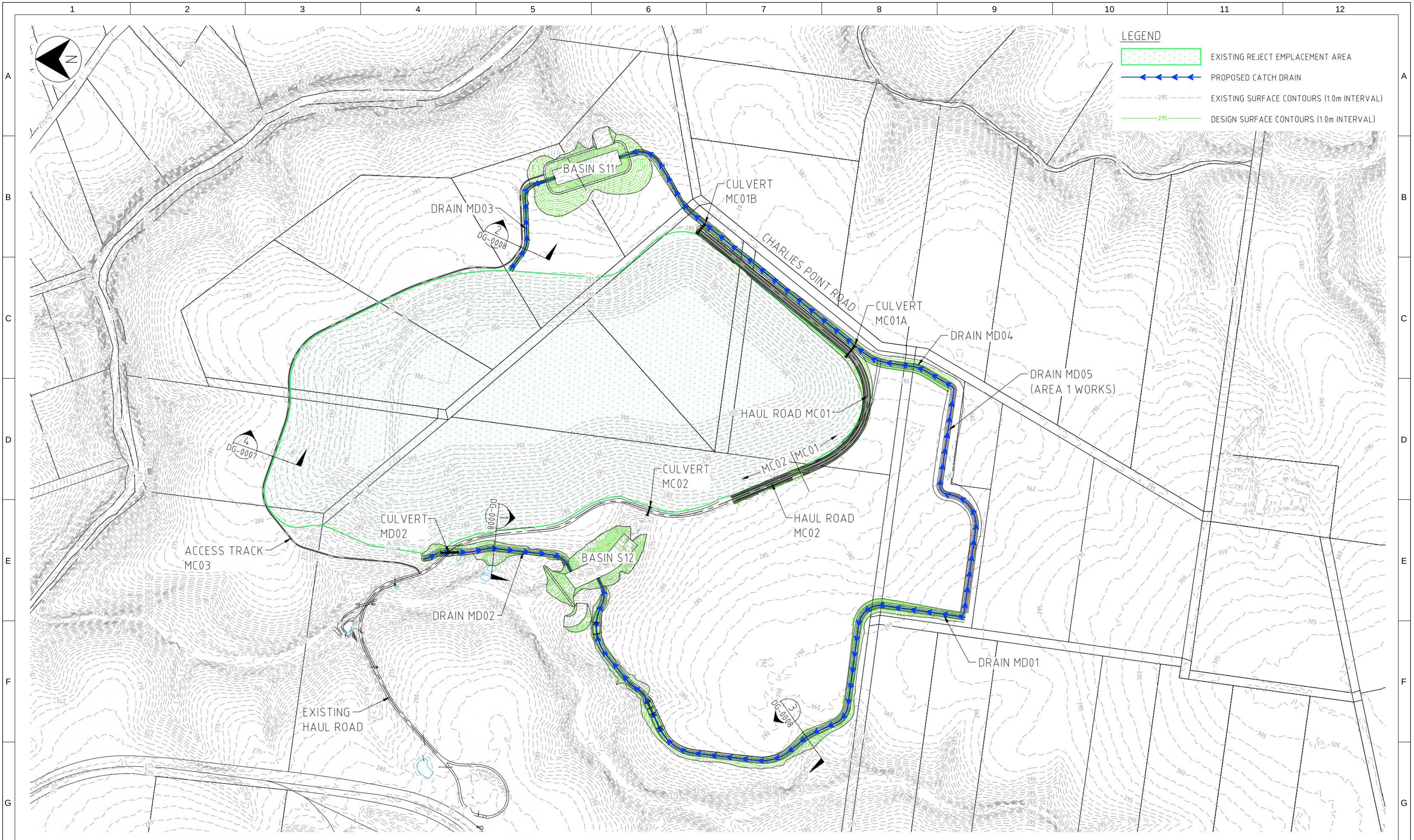

SCALE 1:4000 (A1)

TENDER ISSUE

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F	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
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B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

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DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
OVERALL LAYOUT ROADS AND DRAINS

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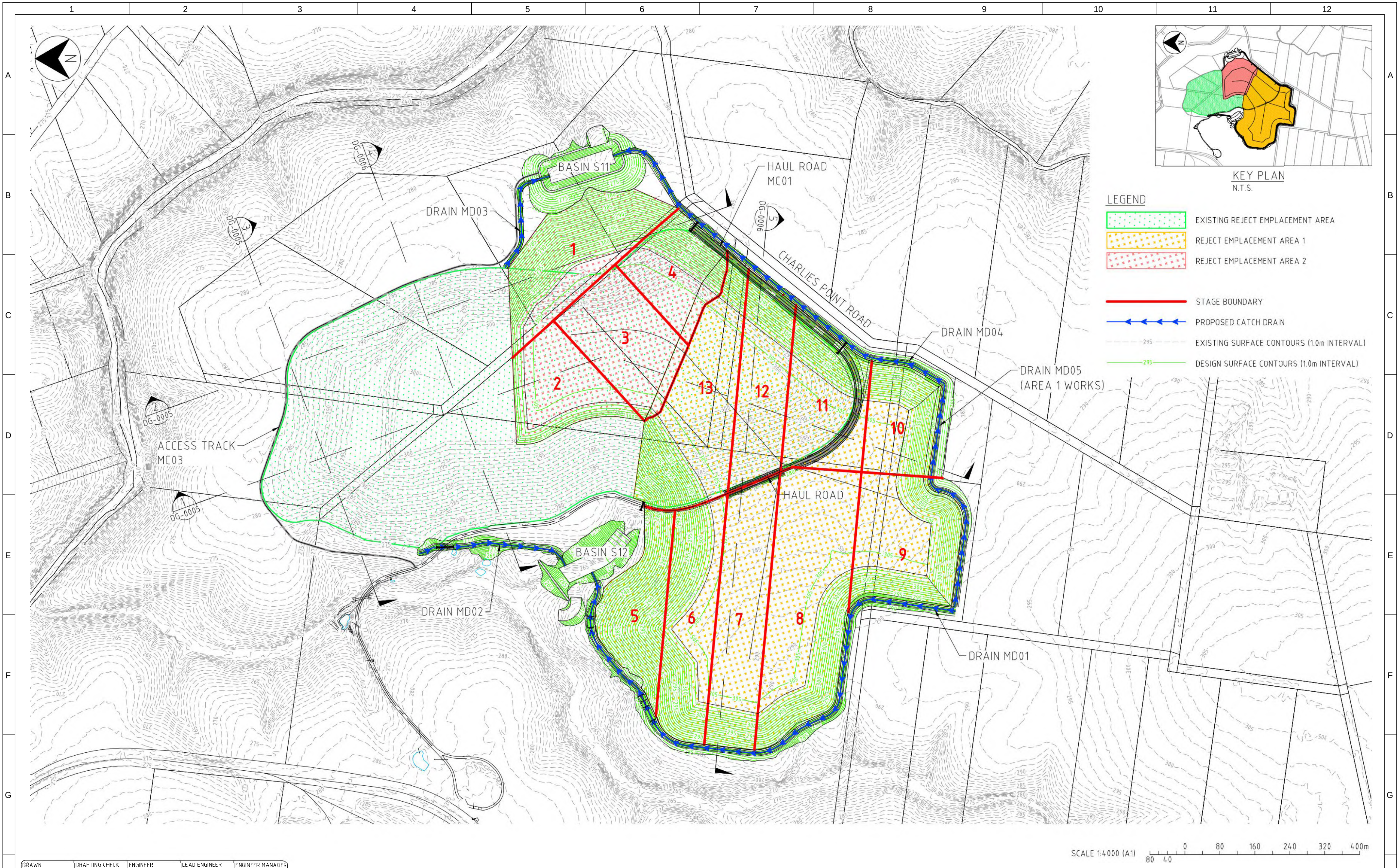

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REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis 24/05/2013	M. Curran 24/05/2013
DESIGNED NG	DESIGN REVIEW TGMG		

TITLE
OVERALL LAYOUT AND STAGING PLAN

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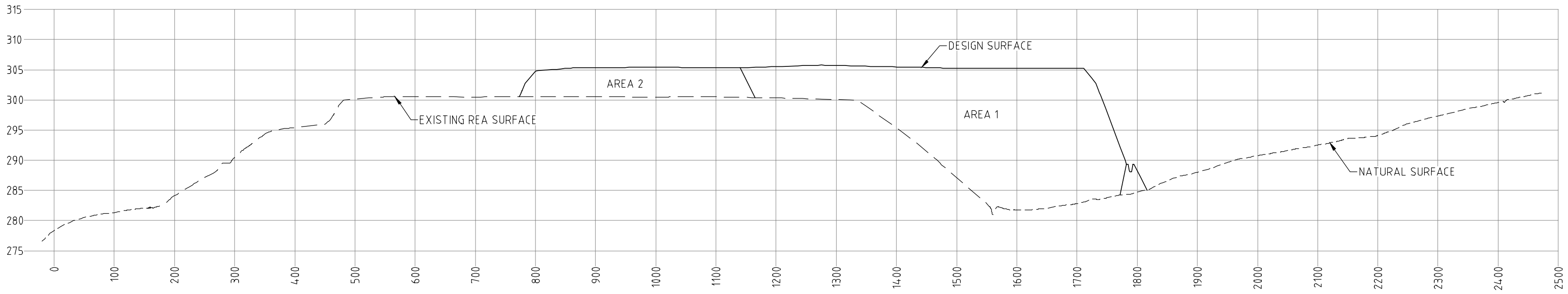

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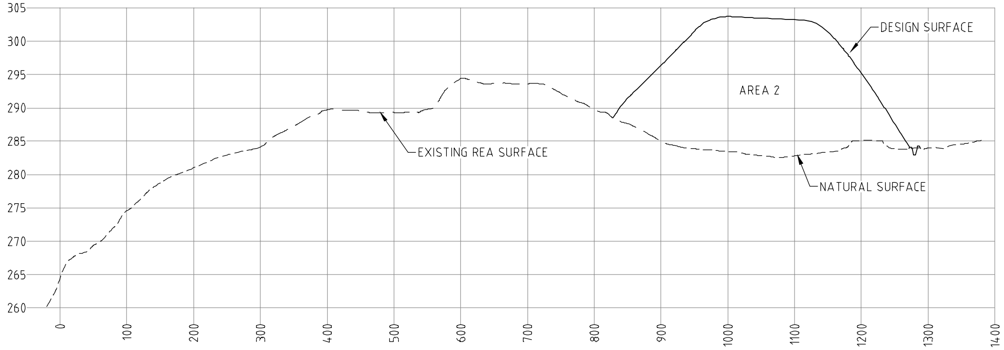

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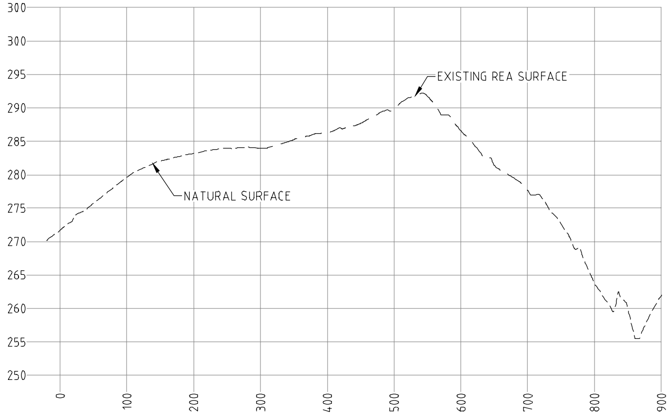

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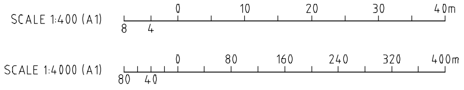

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

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D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
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CLIENT GLENCORE
PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
SITE SECTIONS
SHEET 1 OF 2

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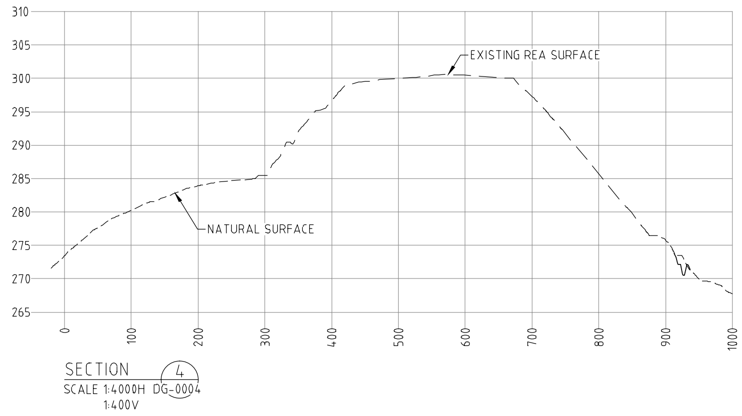

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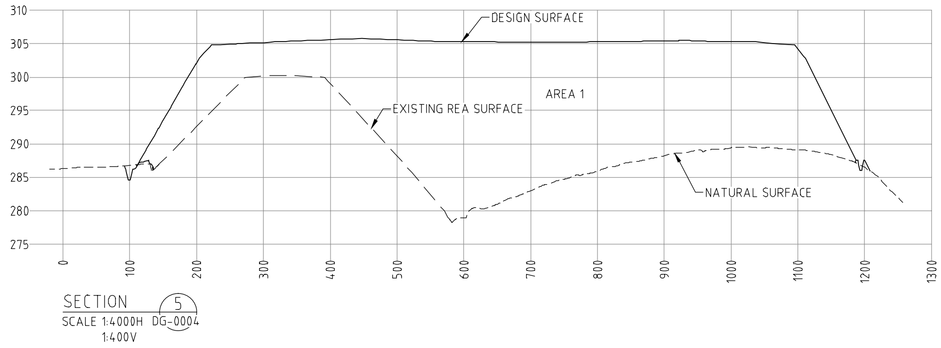

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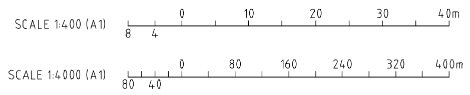

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

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REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED NG	DESIGN REVIEW TGMG	24/05/2013	24/05/2013

TITLE
SITE SECTIONS
SHEET 2 OF 2

SCALE AS SHOWN
DRAWING No NW00243-ECC-DG-0006
REV D

A1

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LEGEND

▨	EXISTING REJECT EMPLACEMENT AREA
▨	REJECT EMPLACEMENT AREA 1
—	STAGE BOUNDARY
◄◄◄	PROPOSED CATCH DRAIN
- - 295 - -	EXISTING SURFACE CONTOURS (1.0m INTERVAL)
— 295 —	DESIGN SURFACE CONTOURS (1.0m INTERVAL)
● 298.50	DESIGN SURFACE LEVELS

SCALE 1:2000 (A1) 40 20 0 40 80 120 160 200m

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

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REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
AREA 1
SHEET 1 OF 2

SCALE 1:2000 (A1)
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SCALE 1:2000 (A1)

40 20 0 40 80 120 160 200m

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REV'D	APP'D	REVISION
F	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
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B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

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CLIENT GLENCORE

PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
AREA 1
SHEET 2 OF 2

SCALE 1:2000 (A1)

DRAWING No NW00243-ECC-DG-0014

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TENDER ISSUE

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REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis 24/05/2013	M. Curran 24/05/2013
DESIGNED NG	DESIGN REVIEW TGMG		

TITLE
AREA 2
SHEET 1 OF 2

SCALE 1:2000 (A1)

DRAWING No NW00243-ECC-DG-0015

REV F

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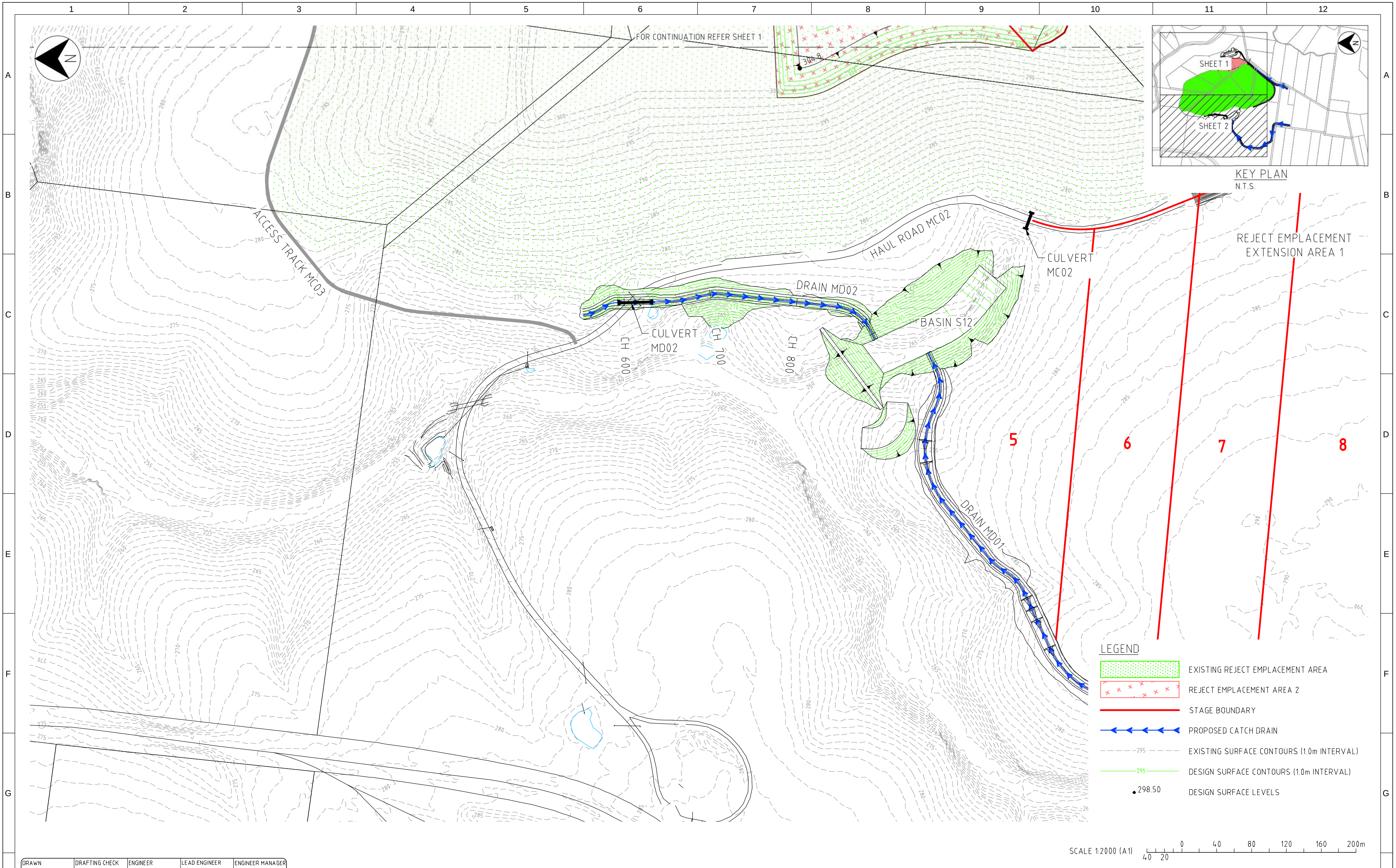

LEGEND

🟩	EXISTING REJECT EMPLACEMENT AREA
🟥	REJECT EMPLACEMENT AREA 2
━	STAGE BOUNDARY
◀◀◀	PROPOSED CATCH DRAIN
--295--	EXISTING SURFACE CONTOURS (1.0m INTERVAL)
—295—	DESIGN SURFACE CONTOURS (1.0m INTERVAL)
● 298.50	DESIGN SURFACE LEVELS

SCALE 1:2000 (A1)

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

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REJECTS EMPLACEMENT AREA

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SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
AREA 2
SHEET 2 OF 2

SCALE 1:2000 (A1)
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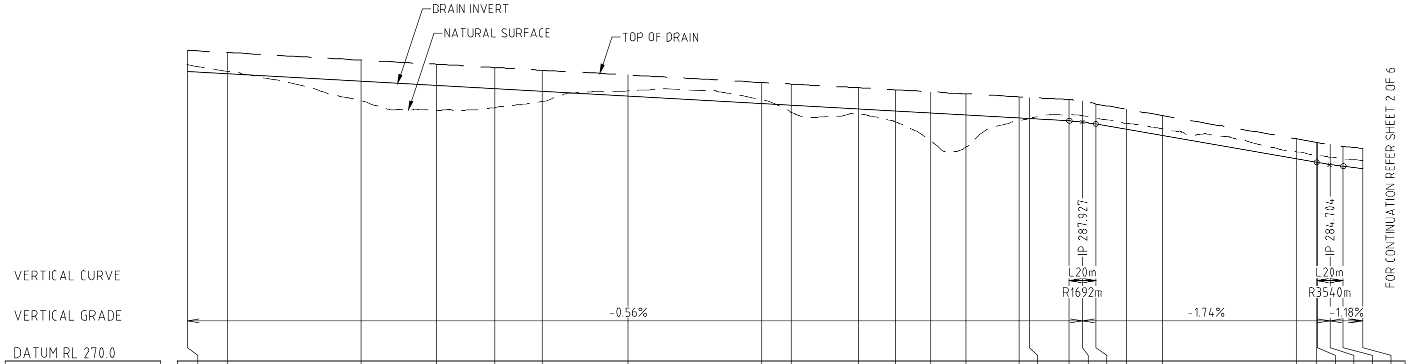
DRAIN MD01

CH	CH	DRAIN TYPE
470	1450	TYPE A
1450	1495	DROP STRUCTURE
1495	1690	TYPE A
1690	1725	DROP STRUCTURE
1725	1747	TYPE A
1747	1812	TYPE C

REFER TO DRAWINGS DG-0008-0010 FOR DETAILS.



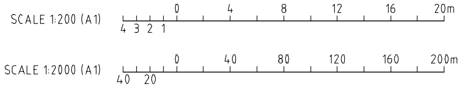
FOR CONTINUATION REFER SHEET 2 OF 6

DEPTH FROM EXISTING TO INVERT	-0.529	-0.197	1.454	1.868	1.402	0.744	-0.410	-0.297	0.514
DRAIN DEPTH	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600
DRAIN INVERT LEVEL	291.680	291.512	290.952	290.636	290.392	290.193	289.832	289.271	289.149
EXISTING SURFACE LEVEL	292.209	291.709	289.498	288.768	288.989	289.449	290.241	289.569	288.635
CHAINAGE	470.000	500.000	600.000	656.430	700.000	735.462	800.000	900.000	921.914
HORIZONTAL DATA				R-50m					R50m

DEPTH FROM EXISTING TO INVERT	0.352	0.791	2.085	2.397	0.159	-0.004	-0.464	-0.487	-0.457	-0.456	-0.511	-0.539	-0.501	-0.508	-0.563	-0.578	-0.629
DRAIN DEPTH	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.500	-1.500	-1.500	-1.500	-1.500	-1.500	-1.500	-1.500	-1.500
DRAIN INVERT LEVEL	288.866	288.711	288.563	288.416	288.195	288.151	287.983	287.897	287.753	287.350	286.882	285.140	284.879	284.865	284.719	284.587	284.410
EXISTING SURFACE LEVEL	288.515	287.921	286.479	286.019	288.035	288.155	288.447	288.384	288.210	287.805	287.392	285.679	285.380	285.374	285.282	285.165	285.039
CHAINAGE	972.358	1000.000	1026.384	1052.765	1092.245	1100.000	1130.000	1140.000	1150.000	1173.152	1200.000	1300.000	1315.000	1315.769	1325.000	1335.000	1350.000
HORIZONTAL DATA			R-100m		R100m									R100m			

LONGITUDINAL SECTION MD01

SCALE 1:2000H
1:200V



TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REV'D	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	CLIENT LOGO CHANGED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

GLENCORE

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CLIENT GLENCORE
PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

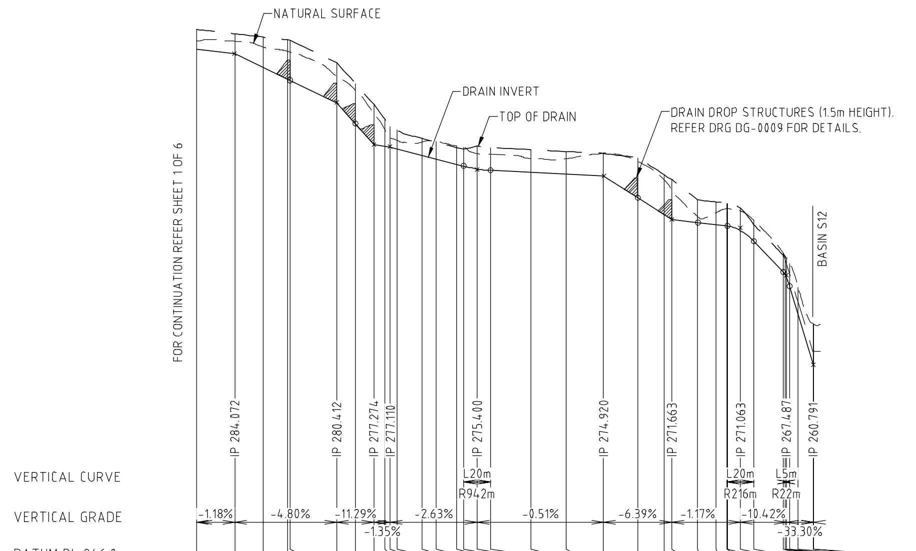
DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
DRAIN LONGITUDINAL SECTIONS
SHEET 1 OF 6

SCALE	DRAWING No	REV
AS SHOWN	NW00243-ECC-DG-0026	D

A1

DATE: 7/07/2014 2:26:21 PM LOGIN NAME: PARISI, ROBERT
LOCATION: I:\NWMM\Projects\NW00243\Deliverables\Drawings\Civil\Dwg\NW00243-ECC-DG-0026-0031-Drain Long Sects.dwg



DATUM RL 246.0

DEPTH FROM EXISTING TO INVERT	DRAIN DEPTH	DRAIN INVERT LEVEL	EXISTING SURFACE LEVEL	CHAINAGE
-0.629	-1.500	284.410	285.039	1350.000
-0.957	-1.500	284.072	285.029	1378.700
-1.523	-2.274	283.051	284.573	1400.000
-2.079	-2.929	282.184	284.263	1418.055
-2.137	-3.000	282.086	284.224	1420.100
-1.967	-3.000	280.412	282.379	1455.000
-2.507	-3.000	278.832	281.339	1469.000
-2.377	-3.000	277.274	279.651	1482.800
-1.279	-2.013	277.166	278.445	1490.828
-0.710	-1.500	277.110	277.820	1495.000
-0.622	-1.375	276.978	277.600	1500.000
-0.988	-1.250	276.481	277.469	1518.888
-1.286	-1.250	276.204	277.490	1529.439
-1.354	-1.250	275.800	277.154	1544.786
-1.403	-1.250	275.663	277.066	1550.000
-1.152	-1.700	275.453	276.605	1560.000
-1.196	-1.700	275.349	276.545	1570.000
-1.032	-1.700	275.197	276.229	1600.000
-1.158	-1.700	275.062	276.220	1626.690
-1.716	-1.700	274.920	276.636	1654.600
-2.741	-3.000	273.292	276.033	1680.100
-2.613	-3.000	272.021	274.634	1700.000
-2.238	-3.000	271.663	273.901	1705.600
-0.436	-1.700	271.437	271.872	1725.000
-0.887	-1.700	271.280	272.166	1738.474
-1.282	-1.700	271.180	272.462	1747.000
-1.288	-1.700	271.176	272.464	1747.337
-1.483	-1.700	270.832	272.315	1757.000
-1.607	-1.250	270.021	271.628	1767.000
-1.425	-1.250	267.747	269.172	1788.826
-1.419		267.502	268.921	1790.533
-1.458		267.344	268.802	1791.326
-1.731		266.654	268.385	1793.826
-2.012		264.598	266.610	1800.000
-3.074		260.791	263.865	1811.434
-2.054		261.791	263.845	1811.767

HORIZONTAL DATA
R100m
R-50m
R50m
R100m
R-50m

LONGITUDINAL SECTION MD01

SCALE 1:2000H
1:200V

SCALE 1:200 (A1) 4 3 2 1 0 4 8 12 16 20m

SCALE 1:2000 (A1) 40 20 0 40 80 120 160 200m

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REVD	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	CLIENT LOGO CHANGED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

GLENCORE

SKM
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CLIENT GLENCORE
PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED NG	DESIGN REVIEW TGMG	24/05/2013	24/05/2013

TITLE
DRAIN LONGITUDINAL SECTIONS
SHEET 2 OF 6

SCALE AS SHOWN
DRAWING No NW00243-ECC-DG-0027
REV D

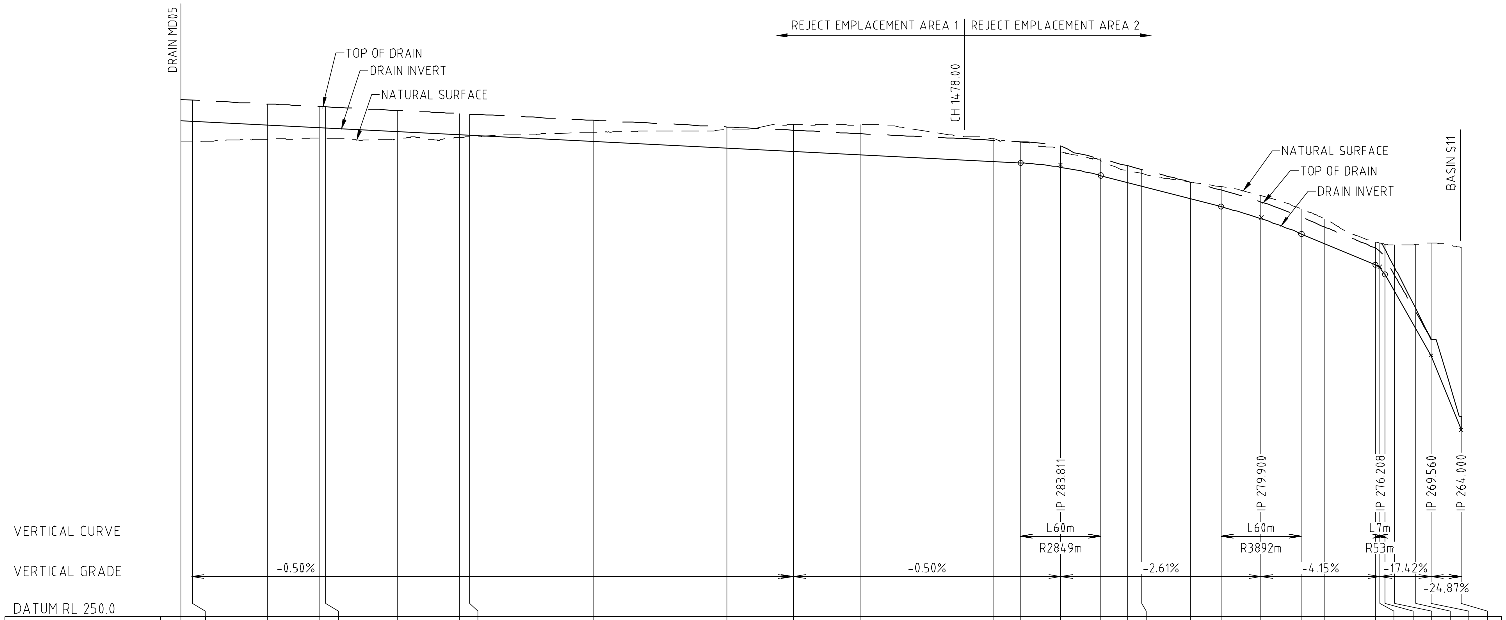
A1

DATE: 7/07/2014 2:27:30 PM LOGIN NAME: PARISI, ROBERT
LOCATION: I:\NWMM\Projects\NW00243\Deliverables\Drawings\Civil\Dwg\NW00243-ECC-DG-0026-0031-Drain Long Sects.dwg

DRAIN MD04

CH	CH	DRAIN TYPE
891.778	1520	TYPE A
1520	1785	TYPE B
1785	1850	TYPE C

REFER TO DRAWINGS DG-0008-0010 FOR DETAILS.



DEPTH FROM EXISTING TO INVERT	1.555	1.514	1.040	0.792	0.787	0.546	0.176	0.106	-0.691	-1.436	-2.003	-2.248
DRAIN DEPTH	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600	-1.600
DRAIN INVERT LEVEL	287.111	287.070	286.787	286.591	286.568	286.301	286.067	286.030	285.565	285.064	284.813	284.563
EXISTING SURFACE LEVEL	285.487	285.555	285.747	285.798	285.781	285.755	285.891	285.924	286.256	286.500	286.816	286.811
CHAINAGE	891.778	900.000	956.319	995.504	1000.000	1053.246	1100.000	1107.427	1200.000	1300.000	1350.000	1400.000
HORIZONTAL DATA				R-100m			R100m					

DEPTH FROM EXISTING TO INVERT	-1.700	-1.561	-1.184	-1.106	-0.892	-0.941	-1.265	-1.510	-1.720	-1.882	-1.823	-1.693	-1.876	-2.286	-3.519	-6.269	-8.416	-13.649
DRAIN DEPTH	-1.600	-1.600	-1.600	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.244	-1.250	-1.250	-1.250		
DRAIN INVERT LEVEL	284.061	283.961	283.653	283.029	282.507	282.224	281.278	280.682	279.784	278.655	277.918	276.353	276.091	275.598	274.291	271.590	269.560	264.000
EXISTING SURFACE LEVEL	285.762	285.522	284.837	284.135	283.399	283.165	282.543	282.192	281.505	280.537	279.741	278.046	277.967	277.884	277.811	277.859	277.976	277.649
CHAINAGE	1500.000	1520.000	1550.000	1580.000	1600.000	1610.860	1647.148	1670.000	1700.000	1730.000	1747.770	1785.500	1789.000	1792.500	1800.000	1815.507	1827.159	1849.517
HORIZONTAL DATA							R100m					R-50m						

LONGITUDINAL SECTION MD04

SCALE 1:2000H
1:200V

SCALE 1:200 (A1) 4 3 2 1 0 4 8 12 16 20m

SCALE 1:2000 (A1) 40 20 0 40 80 120 160 200m

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REV'D	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	REJECTS EMPLACEMENT AREA REVISED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

GLENCORE

SKM
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CLIENT GLENCORE
PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED NG	DESIGN REVIEW TGMG	24/05/2013	24/05/2013

TITLE
DRAIN LONGITUDINAL SECTIONS
SHEET 5 OF 6

SCALE AS SHOWN
DRAWING No NW00243-ECC-DG-0030
REV D

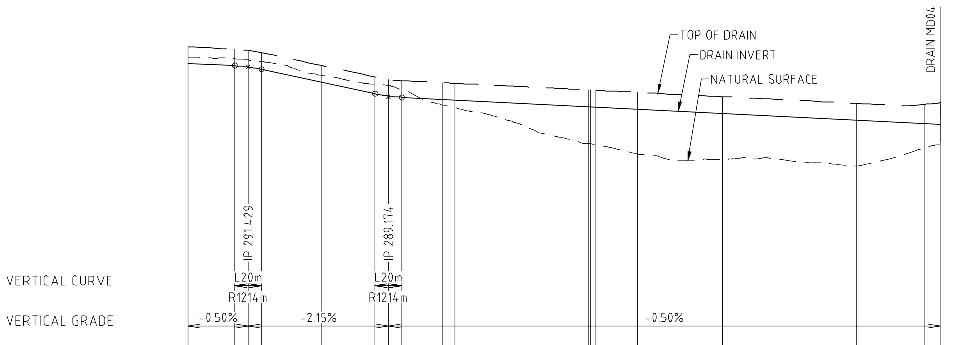
A1

DATE: 7/07/2014 2:28:37 PM LOGIN NAME: PARISI, ROBERT
LOCATION: I:\NWMM\Projects\NW00243\Deliverables\Drawings\Civil\Dwg\NW00243-ECC-DG-0026-0031-Drain Long Sects.dwg

DRAIN MD05

CH	CH	DRAIN TYPE
0	562.735	TYPE A

REFER TO DRAWINGS DG-0008-0010 FOR DETAILS.



DATUM RL 269.0

DEPTH FROM EXISTING TO INVERT	-0.491	-0.528	-0.541	-0.581	-0.531	-0.708	-0.804	-0.577	0.422	0.582	2.764	2.774	2.808	3.358	3.473	3.440	1.831	1.556
DRAIN DEPTH	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.250	-1.417	-1.600
DRAIN INVERT LEVEL	291.654	291.479	291.388	291.214	290.248	289.389	289.216	289.124	288.971	288.924	288.424	288.418	288.402	288.243	287.924	287.424	287.170	287.111
EXISTING SURFACE LEVEL	292.145	292.007	291.929	291.796	290.779	290.097	290.020	289.702	288.549	288.343	285.661	285.644	285.594	284.886	284.451	283.984	285.339	285.555
CHAINAGE	0.000	35.000	45.000	55.000	100.000	140.000	150.000	160.000	190.785	200.000	300.000	301.264	304.409	336.203	400.000	500.000	550.878	562.735
HORIZONTAL DATA										R-70m		R20m					R-10m	

LONGITUDINAL SECTION MD05

SCALE 1:2000H
1:200V

SCALE 1:200 (A1) 4 3 2 1 0 4 8 12 16 20m

SCALE 1:2000 (A1) 40 20 0 40 80 120 160 200m

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REV'D	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	REJECTS EMPLACEMENT AREA REVISED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

GLENCORE

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Web: www.globalskm.com

CLIENT GLENCORE
PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

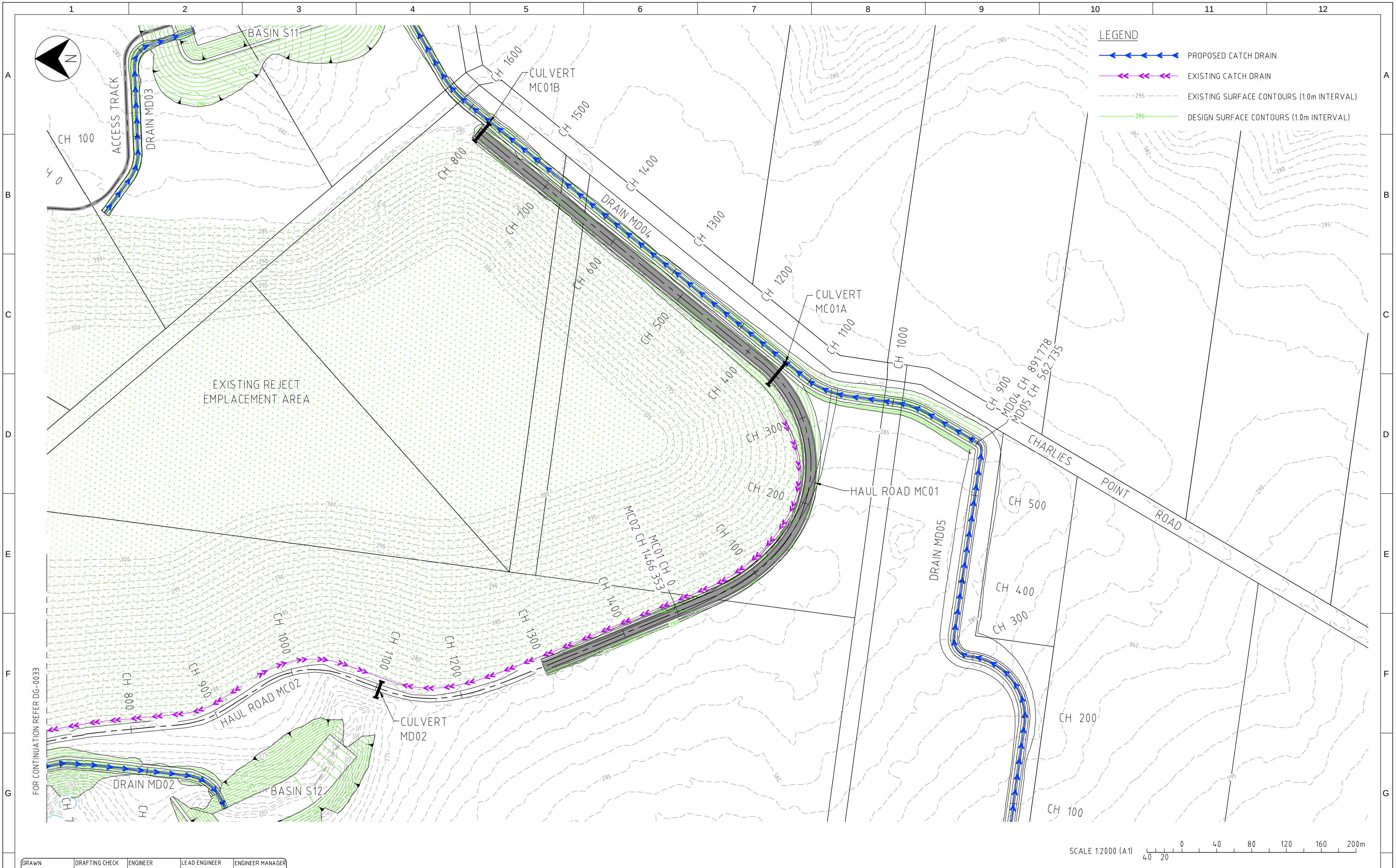
DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis 24/05/2013	M. Curran 24/05/2013
DESIGNED: NG	DESIGN REVIEW: TGMG		

TITLE
DRAIN LONGITUDINAL SECTIONS
SHEET 6 OF 6

SCALE AS SHOWN
DRAWING No NW00243-ECC-DG-0031
REV D

A1

DATE: 7/07/2014 2:29:50 PM LOGIN NAME: PARISI, ROBERT
LOCATION: I:\NWMM\Projects\NW00243\Deliverables\Drawings\Civil\Dwg\NW00243-ECC-DG-0026-0031-Drain Long Sects.dwg



TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REV'D	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	REJECTS EMPLACEMENT AREA REVISED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

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CLIENT GLENCORE

PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

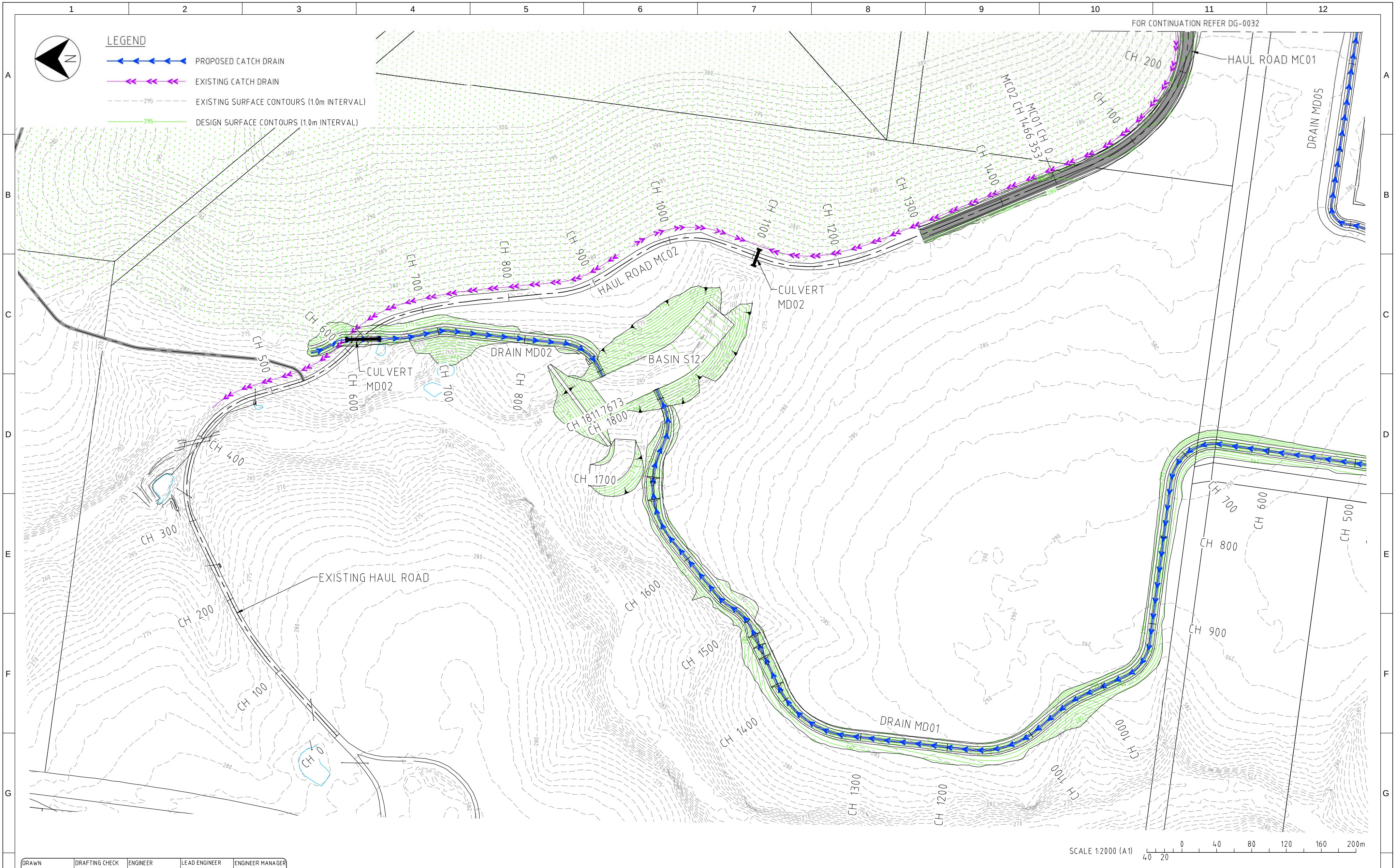
DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis 24/05/2013	M. Curran 24/05/2013
DESIGNED NG	DESIGN REVIEW TGMG		

TITLE
HAUL ROAD MC01

SCALE 1:2000(A1)
DRAWING No NW00243-ECC-DG-0032
REV D

A1

DATE: 7/07/2014 2:32:47 PM LOGIN NAME: PARISI, ROBERT
LOCATION: I:\NWMM\Projects\NW00243\Deliverables\Drawings\Civil\Dwg\NW00243-ECC-DG-0032-0033-Haul Roads.dwg



TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REV'D	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	REJECTS EMPLACEMENT AREA REVISED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

GLENCORE

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CLIENT GLENCORE

PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
HAUL ROAD MC02

SCALE	DRAWING No	REV
1:2000(A1)	NW00243-ECC-DG-0033	D

A1

DATE: 7/07/2014 2:34:10 PM LOGIN NAME: PARISI, ROBERT
LOCATION: I:\NWMM\Projects\NW00243\Deliverables\Drawings\Civil\Dwg\NW00243-ECC-DG-0032-0033-Haul Roads.dwg

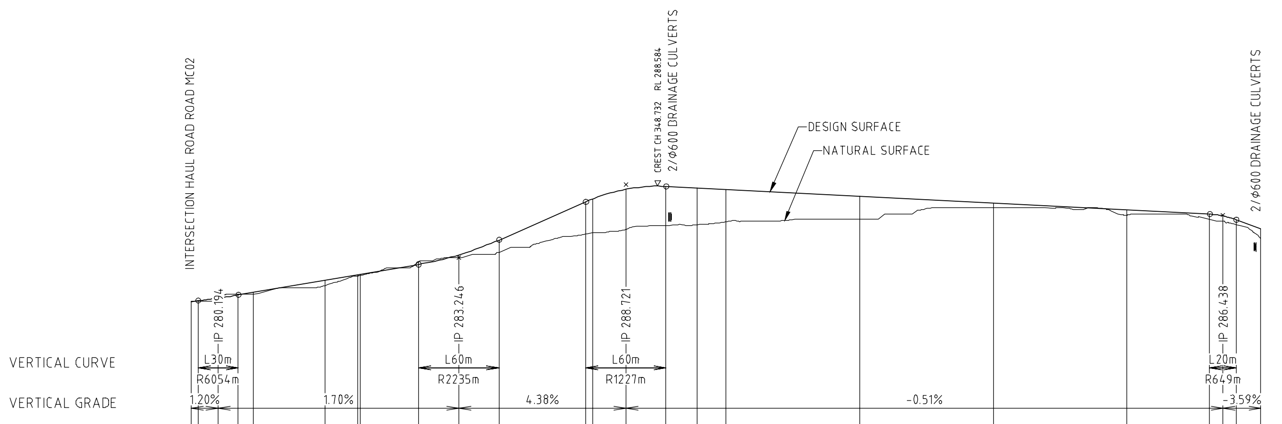
CONTROL LINE HAUL ROAD MC01 SETOUT

CHAINAGE	COORDINATES		BEARING DEG MIN SEC	RADIUS OF CURVATURE	TANGENT LENGTH	ARC LENGTH
	EASTING	NORTHING				
0.000	278190.223	6206524.252	157° 32' 45"	STRAIGHT		
46.560	278208.007	6206481.221	157° 32' 45"	-200.000		
IP 85.534	278223.084	6206444.740	-	-200.000	39.475	77.947
124.508	278250.891	6206416.722	135° 12' 56"	STRAIGHT		
126.503	278252.296	6206415.306	135° 12' 56"	-150.000		
IP 252.295	278369.853	6206296.861	-	-150.000	166.879	251.584
378.087	278475.139	6206426.335	39° 7' 3"	STRAIGHT		
800.000	278741.329	6206753.678	39° 7' 3"	STRAIGHT		

CONTROL LINE ACCESS TRACK MC03 SETOUT

CHAINAGE	COORDINATES		BEARING DEG MIN SEC	RADIUS OF CURVATURE	TANGENT LENGTH	ARC LENGTH
	EASTING	NORTHING				
0.000	277959.140	6207387.008	68° 40' 19"	STRAIGHT		
3.718	277962.604	6207388.360	68° 40' 19"	-20.000		
IP 12.736	277971.624	6207391.882	-	-20.000	9.683	18.036
21.754	277974.456	6207401.142	17° 0' 13"	STRAIGHT		
42.468	277980.513	6207420.951	17° 0' 13"	-100.000		
IP 52.820	277983.551	6207430.885	-	-100.000	10.389	20.703
63.171	277984.482	6207441.232	5° 8' 30"	STRAIGHT		
191.585	277995.990	6207569.129	5° 8' 30"	100.000		
IP 201.881	277996.916	6207579.420	-	100.000	10.332	20.592
212.177	277999.927	6207589.304	16° 56' 23"	STRAIGHT		
276.766	278018.746	6207651.091	16° 56' 23"	50.000		
IP 291.602	278023.200	6207665.714	-	50.000	15.287	29.671
306.437	278035.070	6207675.347	50° 56' 26"	STRAIGHT		
383.746	278095.099	6207724.061	50° 56' 26"	80.000		
IP 424.588	278129.890	6207752.294	-	80.000	44.805	81.685
465.431	278172.139	6207737.380	109° 26' 35"	STRAIGHT		
596.776	278295.994	6207693.659	109° 26' 35"	-200.000		
IP 639.188	278336.598	6207679.325	-	-200.000	43.059	84.823
681.600	278379.502	6207682.971	85° 8' 35"	STRAIGHT		
684.188	278382.081	6207683.190	85° 8' 35"	130.000		
IP 761.858	278470.218	6207690.680	-	130.000	88.455	155.340
839.528	278509.538	6207611.445	153° 36' 26"	STRAIGHT		
1033.238	278595.646	6207437.926	63° 36' 26"	500.000		
IP 1069.086	278611.609	6207405.759	-	500.000	35.910	71.697
1104.935	278622.811	6207371.640	161° 49' 24"	STRAIGHT		
1182.048	278646.866	6207298.375	161° 49' 24"	150.000		
IP 1211.442	278656.155	6207270.086	-	150.000	29.776	58.787
1240.835	278653.933	6207240.393	184° 16' 42"	STRAIGHT		
1255.491	278652.840	6207225.778	184° 16' 42"	-60.000		
IP 1286.070	278650.339	6207192.338	-	-60.000	33.533	61.157
1316.648	278677.509	6207172.686	125° 52' 40"	STRAIGHT		
1334.396	278691.890	6207162.284	125° 52' 40"	-40.000		
IP 1347.729	278703.112	6207154.168	-	-40.000	13.849	26.664
1361.061	278716.949	6207154.727	87° 41' 3"	STRAIGHT		
1464.438	278820.242	6207158.905	87° 41' 3"	35.000		
IP 1487.225	278846.885	6207159.982	-	35.000	26.665	45.573
1510.011	278854.997	6207134.582	162° 17' 16"	STRAIGHT		
1540.755	278864.351	6207105.295	162° 17' 16"	STRAIGHT		

NOTE: FINAL LOCATION OF ACCESS TRACK TO BE DETERMINED ON SITE.



DATUM RL 269.0

CUT - FILL +	-0.046	0.014	-0.051	-0.052	0.144	0.391	0.100	0.086	-0.186	0.200	0.913	2.404
DESIGN SURFACE LEVEL	279.954	280.014	280.212	280.448	280.644	281.550	281.966	282.000	282.737	283.447	284.560	287.407
EXISTING SURFACE LEVEL	280.000	280.000	280.264	280.500	280.500	281.159	281.865	281.913	282.923	283.247	283.647	285.003
CHAINAGE	0.000	5.000	20.000	35.000	46.560	100.000	124.508	126.503	170.000	200.000	230.000	295.000
HORIZONTAL DATA						R-200m					R-150m	

CUT - FILL +	2.509	2.997	2.913	2.733	2.405	1.704	0.316	0.378	0.366	0.361	0.366	0.749
DESIGN SURFACE LEVEL	287.616	288.354	288.568	288.450	288.338	287.827	287.316	286.805	286.489	286.361	286.079	285.423
EXISTING SURFACE LEVEL	285.107	285.357	285.655	285.717	285.933	286.123	287.000	286.427	286.123	286.000	285.713	284.674
CHAINAGE	300.000	325.000	355.000	378.087	400.000	500.000	600.000	700.000	761.738	771.738	781.738	800.000
HORIZONTAL DATA												

LONGITUDINAL SECTION HAUL ROAD MC01

SCALE 1:2000H
1:200V

SCALE 1:200 (A1) 4 3 2 1 0 4 8 12 16 20m

SCALE 1:2000 (A1) 40 20 0 40 80 120 160 200m

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REVD	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	REJECTS EMPLACEMENT AREA REVISED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
A	20.05.13	RJB	TGMG	MAC	INTERNAL DISCIPLINE REVIEW

DRAWING NUMBER	REFERENCE DRAWING TITLE

GLENCORE

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PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis 24/05/2013	M. Curran 24/05/2013
DESIGNED	DESIGN REVIEW		
NG	TGMG		

TITLE
HAUL ROAD LONGITUDINAL SECTIONS
SHEET 1 OF 2

SCALE AS SHOWN
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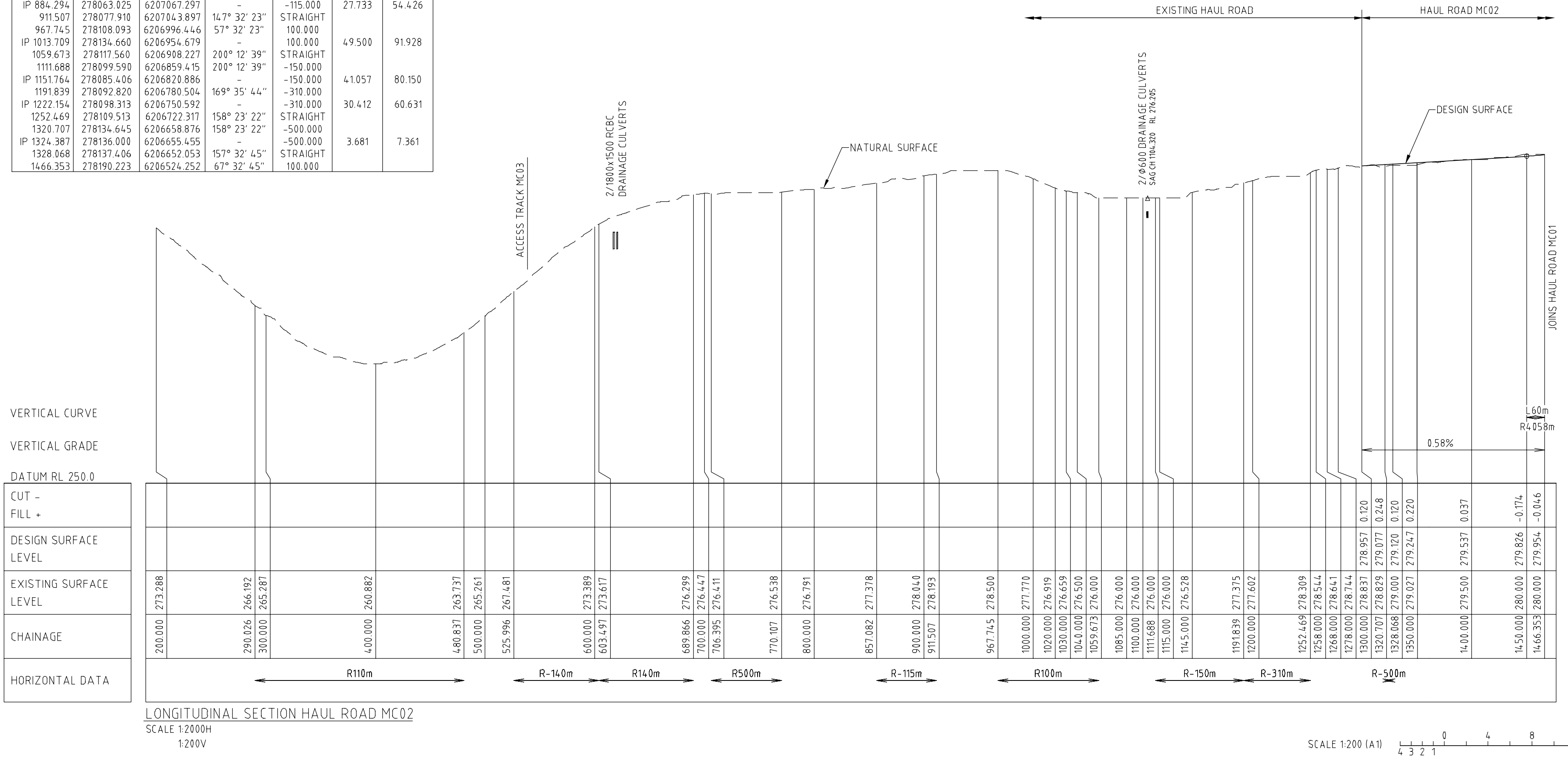
CONTROL LINE HAUL ROAD MC02 SETOUT

CHAINAGE	COORDINATES EASTING	COORDINATES NORTHING	BEARING DEG MIN SEC	RADIUS OF CURVATURE	TANGENT LENGTH	ARC LENGTH
0.000	277551.335	6207348.733	47° 47′ 10″	STRAIGHT		
103.160	277627.740	6207418.046	47° 47′ 10″	320.000		
IP 149.381	277662.213	6207449.320	-	320.000	46.545	92.442
195.602	277704.168	6207469.477	64° 20′ 16″	STRAIGHT		
290.026	277789.277	6207510.368	64° 20′ 16″	110.000		
IP 385.431	277906.166	6207566.528	-	110.000	129.680	190.812
480.837	277942.507	6207442.043	163° 43′ 34″	STRAIGHT		
525.996	277955.162	6207398.694	163° 43′ 34″	-140.000		
IP 564.746	277966.307	6207360.516	-	-140.000	39.771	77.501
603.497	277995.859	6207333.900	42° 0′ 30″	140.000		
IP 646.681	278029.005	6207304.046	-	140.000	44.608	86.369
689.866	278038.770	6207260.520	167° 21′ 19″	STRAIGHT		
706.395	278042.388	6207244.392	77° 21′ 19″	500.000		
IP 738.251	278049.371	6207213.266	-	500.000	31.899	63.712
770.107	278052.342	6207181.505	174° 39′ 22″	STRAIGHT		
857.082	278060.442	6207094.909	174° 39′ 22″	-115.000		
IP 884.294	278063.025	6207067.297	-	-115.000	27.733	54.426
911.507	278077.910	6207043.897	147° 32′ 23″	STRAIGHT		
967.745	278108.093	6206996.446	57° 32′ 23″	100.000		
IP 1013.709	278134.660	6206954.679	-	100.000	49.500	91.928
1059.673	278117.560	6206908.227	200° 12′ 39″	STRAIGHT		
1111.688	278099.590	6206859.415	200° 12′ 39″	-150.000		
IP 1151.764	278085.406	6206820.886	-	-150.000	41.057	80.150
1191.839	278092.820	6206780.504	169° 35′ 44″	-310.000		
IP 1222.154	278098.313	6206750.592	-	-310.000	30.412	60.631
1252.469	278109.513	6206722.317	158° 23′ 22″	STRAIGHT		
1320.707	278134.645	6206658.876	158° 23′ 22″	-500.000		
IP 1324.387	278136.000	6206655.455	-	-500.000	3.681	7.361
1328.068	278137.406	6206652.053	157° 32′ 45″	STRAIGHT		
1466.353	278190.223	6206524.252	67° 32′ 45″	100.000		



CHAINAGE	EXISTING SURFACE LEVEL	DESIGN SURFACE LEVEL	CUT - FILL +
200.000	273.288		
290.026	266.192		
300.000	265.287		
400.000	260.882		
480.837	263.737		
500.000	265.261		
525.996	267.481		
600.000	273.389		
603.497	273.617		
689.866	276.299		
700.000	276.447		
706.395	276.411		
770.107	276.538		
800.000	276.791		
857.082	277.378		
900.000	278.040		
911.507	278.193		
967.745	278.500		
1000.000	277.770		
1020.000	276.919		
1030.000	276.659		
1040.000	276.500		
1059.673	276.000		
1085.000	276.000		
1100.000	276.000		
1111.688	276.000		
1115.000	276.000		
1145.000	276.528		
1191.839	277.375		
1200.000	277.602		
1252.469	278.309		
1258.000	278.544		
1268.000	278.641		
1278.000	278.744		
1300.000	278.837	278.957	0.120
1320.707	278.829	279.077	0.248
1328.068	279.000	279.120	0.120
1350.000	279.027	279.247	0.220
1400.000	279.500	279.537	0.037
1450.000	280.000	279.826	-0.174
1466.353	280.000	279.954	-0.046

LONGITUDINAL SECTION HAUL ROAD MC02

SCALE 1:2000H
1:200V

SCALE 1:200 (A1) 4 3 2 1 0 4 8 12 16 20m

SCALE 1:2000 (A1) 40 20 0 40 80 120 160 200m

TENDER ISSUE

DRAWN	DRAFTING CHECK	ENGINEER	LEAD ENGINEER	ENGINEER MANAGER

REV	DATE	DRAWN	REV'D	APP'D	REVISION
D	07.07.14	DA	SRP	TG	REJECTS EMPLACEMENT AREA REVISED
C	06.11.13	RJB	TGMG	-	REJECTS EMPLACEMENT AREA REVISED
B	24.05.13	RJB	TGMG	MAC	TENDER ISSUE
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CLIENT GLENCORE
PROJECT TAHMOOR COAL
REJECTS EMPLACEMENT AREA

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SAB	RJB	T. Geertshuis	M. Curran
DESIGNED	DESIGN REVIEW		
NG	TGMG	24/05/2013	24/05/2013

TITLE
HAUL ROAD LONGITUDINAL SECTIONS
SHEET 2 OF 2

SCALE AS SHOWN
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Rejects Disposal Options Study Technical Report

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31 July 2017

Attention: Ben Streckeisen
Coal Assets Australia, Glencore
ben.streckeisen@glencore.com.au

Project Name: Tahmoor South Project - Rejects Disposal Options Study
Project Number: QN10312

Subject: Review of 2017 Secretary's Environmental Assessment Requirements

Dear Ben

As you are aware, in 2013 Jacobs (SKM at the time) was engaged by Glencore to undertake an assessment of Rejects Disposal options for the Tahmoor South Project. The purpose of the assessment was to address the 2012 Director General's Environmental Assessment Requirements (GDRs) for input into the Project's Environmental Impact Statement (EIS). In 2013/14, two reports were prepared; a Technical Report for internal Glencore use (refer QN10312-EAM-RP-E4-0001) and a Strategy Report for inclusion in the EIS (refer QN10312-EAM-RP-E4-0002).

It is understood that approvals for the Tahmoor South Project are progressing and recently the 2017 Secretary's Environmental Assessment Requirements (SEARs) have been issued, superseding the 2012 DGRs.

As requested, we have undertaken a review of the 2017 SEARs against the 2012 GDRs to assess whether the previously issued Rejects Disposal reports remain valid, or whether an update to the reports are required.

Based on our review, it is our opinion that the key requirements are those listed in Table 1 below.

Table 1 Summary of 2012 DGRs vs 2017 SEARs

2012 Director General's Environmental Assessment Requirements (GDRs)	2017 Secretary's Environmental Assessment Requirements (SEARs)
General Requirements The EIS must include: • Detailed assessment of the key issues specified below and any other significant issued identified in this risk assessment, which includes: - A description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of	General Requirements The EIS must include: • An assessment of the likely impacts of the development on the environment, focusing on the specific issued identified below, and including: - Whether these measures are consistent with industry best practice and represent the full range of reasonable and feasible

2012 Director General's Environmental Assessment Requirements (GDRs)	2017 Secretary's Environmental Assessment Requirements (SEARs)
the development, including proposals for the adaptive management and/or contingency plans to manage any significant risk to the environment	mitigation measures that could be implemented - The likely effectiveness of these measures, including performance measures, where relevant • Consideration of alternatives, including the development of a mine plan which avoids key sensitive surface features
Key issues – Waste - A tailings and course reject disposal strategy - Investigate alternative methods for the disposal and use of coal wash reject, including underground emplacement	Specific Issues – Waste Including a waste management strategy
EPA Section 6.1 Coal Wash Reject Emplacement Area The proponent should document in the EA a range of options to extend the life of the existing emplacement. This should include active programs for coal wash reuse, investigating options to extend the height of the existing emplacement and underground disposal options. Based on the outcomes of these investigations justification should be documented on the need for any extension in coal wash emplacement that avoids the clearing of native vegetation and impacts on significant natural features (OEH is the appropriate authority on this matter). However, this should only be based as a contingency in the event that alternative options cannot be found. For your information as part of the Project Approval requirements for the Metropolitan Coal Project the company trialled a pilot pasting plant… All coal wash generated by the Metropolitan Coal operation is now emplaced underground.	EPA – Coal Washery Reject Emplacement The EIS should outline advancements in underground emplacement of coal wash – including developments at Metropolitan and the proposed Hume Coal Mine. This should include an assessment of technical and economic feasibility of implementing integrated high pressure coal wash paste injection into the longwall goaf in order to reduce the need to extend the emplacement area.
OEH Attachment A Section 2 Coal Wash Reject Emplacement Area OEH recommends the EIS provide alternative solutions for disposal and use of coal wash reject rather than emplacement into areas supporting significant biodiversity and cultural heritage. Studies have demonstrated that with a certain amount of treatment, coal wash can be emplaced underground which may have the added benefit of subsidence amelioration amongst other things or used as a construction material.	OEH Attachment A Historic Heritage 5. The EIS must provide a heritage assessment including but not limited to an assessment of impacts to state and local heritage including conservation areas, natural heritage areas, places of Aboriginal heritage value, building, works, relics, gardens, landscapes, views, trees should be assessed. Where impacts to State or locally significant heritage items are identified the assessment shall: a. Outline the proposed mitigation and management measures (including

2012 Director General's Environmental Assessment Requirements (GDRs)	2017 Secretary's Environmental Assessment Requirements (SEARs)
	measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures)…

It is our opinion that the previously issued reports, particularly the Strategy Report (QN10312-EAM-RP-E4-0002) for inclusion in the EIS, generally address the 2017 SEARs. However it is noted that the reports only consider the technologies available at the time of the Study (2013/14). Any advancement in technologies during the course of the past 4 years may need to be specifically addressed. Review and updating Section 3 of the Technical Report (QN10312-EAM-RP-E4-0001) may be worthwhile and would provide an understanding as to the validity of the Strategy Report.

We note that the 2017 SEARs specifically references the Metropolitan Mine. At the time of writing our Disposal Options reports, the Metropolitan Mine had only conducted a pilot trial and only approximately 15,000 tonnes of rejects had been disposed underground. I am unsure whether underground disposal is being more extensively used at Metropolitan and perhaps this needs to be ascertained. Nonetheless, the technology employed at Metropolitan was addressed by our previously issued reports, and incorporated as the “co-disposal” option.

The 2017 SEARs also specifically references the Hume Coal Mine. That particular project is still going through the approval process, however they have proposed that all coal rejects will be disposed of underground. The Hume Coal Mine is proposing to use a “first workings mining system” that will leave pillars in place (to be used for future rejects backfilling) rather than the longwall mining technique as employed at Tahmoor. The option of returning rejects (either as a dry material or paste) to disused mine workings was also addressed by our previously issued reports.

Yours sincerely

Jonathan Magin
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Tahmoor Coal

Tahmoor South Project

Rejects Disposal Options Study

TECHNICAL REPORT

QN10312-EAM-RP-E4-0001 | Revision F

SINCLAIR KNIGHT MERZ

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	03.07.2013	N. September H. Simpson	D. Jolly	03.07.2013	Issued for Client Review
B	06.09.2013	J. Magin	D. Jolly	06.09.2013	Re-issued for Client Review
C	04.12.2013	J. Magin	P. Raymond	03.12.2013	Final Draft
D	22.01.2014	J. Magin	P. Raymond	22.01.2014	Final
E	11.07.2014	J. Magin	P. Raymond	10.07.2014	Expansion Area 3 removed
F	24.07.2014	J. Magin	J. Magin	22.07.2014	Table 7-2 amended

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Revision	Copy no	Quantity	Issued to
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Project Manager:	Jon Magin
Name of organisation:	Tahmoor Coal
Name of project:	Tahmoor South Project – Rejects Disposal Options Study
Name of document:	Technical Report
Document version:	Revised Final
Project number:	QN10312

Contents

Executive summary

Tahmoor Coal Pty Ltd (Tahmoor Coal) engaged Sinclair Knight Merz (SKM) to undertake a study of coal washery reject disposal options in support of their Environmental Impact Statement (EIS) and approval submission for the Tahmoor South Project. Tahmoor Coal is a wholly owned entity of Glencore's coal business (Glencore Xstrata plc.)

A Preliminary Environmental Assessment report, undertaken in August 2012, refers to the expanded rejects emplacement area (REA) as the preferred option for rejects disposal. Responses received by Tahmoor Coal from approving authorities indicated that other methods of disposal should be investigated, including underground disposal and beneficial reuse. Therefore, the purpose of this study was to review alternate disposal options considering technical issues, risks and economics of the various options, as identified in collaboration with Tahmoor Coal.

Nine disposal options were initially considered, incorporating both underground and surface disposal areas. A multi criteria analysis approach was adopted to determine the relative merit of each option and to shortlist options for further detailed assessment. Key considerations in the shortlisting of options included insufficient volume for storing of rejects in old workings or former goaf areas, the velocity required to move slurry (rather than paste) through a pipeline and the resulting excessive pipe wear, impact to operations and consequential reduced productivity, excessive capital and operating costs. The options that were identified for further detailed investigation were:

- Surface disposal at an expanded existing reject emplacement area
- Underground disposal as paste material (active goafs via a trailing pipe)

The surface disposal option is a continuation of the current rejects disposal method. The technical risks are therefore known and the operation is well established. As this operation is undertaken completely on the surface, the number of personnel exposed to the hazards of the underground environment is not increased by the option and it is therefore considered to be safer than underground alternatives. Although there is sufficient space to expand the existing rejects emplacement area on the surface, the expansion would require clearing of native vegetation. The surface disposal option may also have noise and dust impacts which require appropriate management.

The option to dispose of the rejects as paste material into the active goaf is technically complex. Careful consideration would need to be given to the design of the system with regards to extreme transients such as water hammer, stored energy, and paste properties to minimise pipe blockages. Further investigative work would also need to be undertaken with regards to the risk of liquefaction due to shocks and vibration, amount of water required to flush the pipeline and avoiding the ingress of paste material into the longwall working area. As the trailing pipes would be integral with the longwall, any maintenance or malfunction of the rejects system would most likely cause operational delays to the longwall. Notwithstanding these risks, it is believed that control mechanisms can be designed to be sufficiently robust to ensure reliable operation of the system and safe operation (although lower in the hierarchy of risk control than surface disposal).

An options workshop was held in conjunction with Tahmoor Coal personnel to further analyse the shortlisted options. This subsequent examination of the two remaining options involved subjecting them to a series of criteria and scoring their suitability against each. During the workshop it was identified due to the availability of the paste plant, disposal underground into active goaf would still require a proportion of the rejects to be disposed within an expanded REA. Consequently, this option developed into and was evaluated as a co-disposal option with approximately 70 per cent of material to be disposed underground and 30 per cent to be disposed on the surface at an expanded REA. Adopting 70 per cent disposal underground, based on the current mine plan there is insufficient volume available and as such either the mine plan may need to be revised to maximise underground reject disposal (which in itself may be unfeasible), or other underground disposal locations (such as disused workings) adopted in conjunction with the trailing pipe.

The two options assessed during the options workshop were:

- Surface disposal – Expanded rejects emplacement area, modified EPL boundary
- Co-disposal – Underground paste material (active goaf via trailing pipe) and surface rejects emplacement area

A further option, “Option 1A – Surface disposal at REA, existing EPL boundary” has been considered to provide Tahmoor Coal with potential costs and benefits should the EPL boundary modification not be approved.

SKM’s scope included a cost benefit analysis to assess the net economic benefit associated with the rejects disposal options. The cost benefit analysis method was preferred over a financial analysis to account for the other economic, social, or environmental costs that may be occurring as a result of coal rejects disposal. Based on information provided by Tahmoor Coal, SKM has quantified the costs and benefits of the two preferred options and monetised these wherever possible to reflect impacts in dollar terms. A summary of the cost benefit analysis results is presented in Table 0-1 and indicates that both options are economically viable when assessed against a base case of disposing of reject material off site. The base case considered no further approvals relating to the disposal of rejects, therefore requiring disposal off site.

Table 0-1 Cost benefit analysis results

Decision criteria	**Option 1 –** Surface disposal at REA, modified EPL boundary (A$ millions)	**Option 1A –** Surface disposal at REA, existing EPL boundary (A$ millions)	**Option 2 –** Co-disposal, Surface rejects emplacement and underground paste material (A$ millions)
PV Costs	-$17.6	-$17.6	-$63.1
PV Benefits	$139.6	$135.7	$114.3
NPV	$121.9	$118.0	$51.3
BCR	7.91	7.69	1.81
IRR	58%	58%	9%

The results of the options analysis are summarised within Table 0-2.

Table 0-2 Options analysis results

Primary options	Compatibility against criteria	Option Score	Preferred Option	Viable Option
Option 1 Expanded Surface Rejects Emplacement Area (REA)	Compatible	1880	Preferred	Yes
Option 2 Co-disposal Paste Disposal Underground into Active Goaf and Expanded Surface REA	Not Suitable	1005	Not preferred	No

It was therefore determined that when considered against a number of criteria, including economic, environmental, social, technical and safety, that the surface disposal at an expanded REA is the preferred strategy for disposing of reject material associated with the Tahmoor South project. This conclusion is supported by a cost benefit analysis which monetised the benefits and dis-benefits associated with each option and concluded that the surface disposal at an expanded REA far exceeds the underground disposal option and is therefore the preferred option.

Limitation statement

The sole purpose of this report and the associated services performed by Sinclair Knight Merz (“SKM”) is to review reject disposal options for the Tahmoor South Project in accordance with the scope of services set out in the contract between SKM and Tahmoor Coal Pty Limited (“Tahmoor Coal”). That scope of services, as described in this report, was developed with Tahmoor Coal.

In preparing this report, SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Tahmoor Coal and/or from other sources. Except as otherwise stated in the report, SKM has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

SKM derived the data in this report from information sourced from Tahmoor Coal and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. SKM has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SKM for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of Tahmoor Coal and is subject to, and issued in accordance with, the provisions of the contract between SKM and Tahmoor Coal. SKM accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Abbreviations

Table 0-3 contains a listing of acronyms and abbreviations that are used throughout this report.

Table 0-3 Acronyms and abbreviations

Abbreviation	Description
ACARP	Australian Coal Association Research Program
BCR	Benefit Cost Ratio
CAPEX	Capital expenditure
CBA	Cost benefit analysis
CBR	California bearing ratio
CHPP	Coal handling and preparation plant
CPP	Coal processing plant
CWR	Coal washery rejects
DCT	Deep cone thickener
DoPI	Department of Planning and Infrastructure
EPA	Environmental Protection Agency
EPCM	Engineering, procurement and construction management
EPL	Environmental Protection License
HSI	Horizontal shaft impact
IRR	Internal Rate of Return
LHD	Load-haul-dump
MCA	Multi criteria assessment
MCPL	Metropolitan Collieries Pty Ltd
Mtpa	Million tonnes per annum
NOW	NSW Office of Water
NPV	Net Present Value
OEH	Office of Environment and Heritage
OPEX	Operating expenditure
PSD	Particle size distribution
REA	Rejects emplacement area
RMS	Road and Maritime Services
SCA	Sydney Catchment Authority
SSTF	Shale sandstone transition forest
SWOT	Strengths, weaknesses, opportunity and threats
TBS	Teeter bed separator
tph	Tonnes per hour

Abbreviation	Description
UCS	Unconfined compressive strength
UG	Underground
UoM	Unit of measure
VSI	Vertical shaft impact
w/w%	Weight / weight percentage

1. Introduction

1.1 Project appreciation

1.1.1 Location

Tahmoor Coal Pty Ltd (Tahmoor Coal) operates the Tahmoor Mine, located approximately 75 kilometres south-west of Sydney, New South Wales. Tahmoor Coal is a wholly owned business unit within Glencore's coal business (Glencore Xstrata plc.). Tahmoor Mine is an underground mining operation, with a run of mine production of up to three (3) million tonnes per annum (Mtpa), and product output of up to approximately two (2) Mtpa.

1.1.2 Ownership

The Tahmoor Mine was initially owned by Clutha Development Pty Ltd, who commenced production in 1979, under an approval granted in 1975. Since 1975, Tahmoor Mine has been owned by a number of companies, as follows:

- 1975 – Clutha Development Pty Ltd
- 1985 – BP Coal
- 1989 – Kembla Coal and Coke Pty Ltd
- 1997 – Austral Coal Ltd
- 2005 – Centennial Coal Pty Ltd
- 2007 – Tahmoor Coal, Coal Assets Australia, Glencore (formerly Xstrata)

1.1.3 Overview of operations

The initial Tahmoor Mine workings in the mid to late 1970s were bord and pillar, with long wall operations commencing in 1987. The current mining operations in Tahmoor North are forecast to complete in 2023. Currently, mining is taking place in longwall 27, with current approvals up to longwall 36. Only one seam is mined at Tahmoor Mine, namely the Bulli seam.

Raw coal is washed at the on-site CHPP, producing washed product at a yield of between 70 to 80 per cent. However product yield can be as low as mid 60 per cent, under certain geological conditions, as reported from 2012. Washery rejects consist of coarse and fine materials, predominantly shale, with some sandstone and a small percentage of low grade coal. The source of the reject is from over cutting of the roof by up to 400mm, floor heave material associated with abutment stresses and intra seam parting bands accounting for approximately 10 per cent of the reject tonnages. The current reject disposal method utilises a surface reject emplacement area (REA), which is contractor operated. Haul trucks cart the reject material from the existing rejects bin at the head end of 3R conveyor to the REA, where the material is dumped and shaped to the planned landform, before being re-vegetated. The current REA operates under the 1979 NSW Planning and Environment Commission development consent.

1.1.4 Tahmoor South Project

The Tahmoor South Project is a continuation of mining project to extend the life of mine through to nominally 2040. Development of Tahmoor South is currently scheduled to commence in 2016, although production is not forecast to commence until completion of Tahmoor North in 2023. Currently, it is proposed that the Tahmoor South operation will utilise the existing mine infrastructure, including mine access, coal clearance and surface infrastructure.

1.1.5 Purpose of this study

The volume of washery reject material produced from the Tahmoor Mine operations (including the forecast yield from the Tahmoor South Project) will exceed the current storage capacity of the existing REA. As such, to continue the current reject disposal method, the REA will need to be expanded to accommodate the surplus volume. The Preliminary Environmental Assessment report from August 2012 makes reference to the expanded REA as the preferred reject disposal option. The Director General's Requirements (DGRs) and correspondence from the Department of Planning and Infrastructure (DoPI), Environmental Protection Agency (EPA), and Office of Environment and Heritage (OEH) identified that other methods of reject disposal should be investigated, including underground disposal.

The purpose of this study is to undertake a literature review of coal mining reject disposal methods, review the alternate disposal options, and review technical issues, risks and economics of the disposal options.

1.2 Reference data

The following documents have been provided by Tahmoor Coal as reference documents for the project:

1) ACARP reports (C1014 and C16023)

2) CHPP flow sheet (TCC-1310)

3) Tarrant G., Gilroy T., Sich G., Nielsen D. (2012), Metropolitan Mine Underground Emplacement of Coal Rejects. University of Wollongong.

4) AECOM Preliminary Environmental Assessment report (Ref 60267390) and responses from EPA, NSW Office of Water, Office of Environment and Heritage, Resources and Energy, Roads and Maritime Services, Sydney Catchment Authority, Wollondilly Shire Council and Director General Requirements

5) Bureau Veritas (2011), Tahmoor Weekly Reject Samples - Reject material test data 85007431

6) Glencore (2011), Tahmoor Backfilling Concept.

7) Engenicom (2011), Pre-feasibility report

8) Tahmoor Coal (2008), Coal Preparation Plant Process Flowsheet 650tph.

9) Engenicom (2011), Glencore Tahmoor Evaluation of Rejects Disposal Options

10) Weir Minerals (2009), Technical Bulletin Nº 14: Pumping Non-Newtonian Slurries

11) Prof Dr. Carsten Drebenstedt, Freiberg, Prof.Dr. -Ing. Thomas A. Bier, Freiberg, Prof.Dr. Pitsanu Bunnaul, Songkhla (2009) Systematic Selection and Application of Backfill in Underground Mines

12) Douglas Partners (2013), Report on Geotechnical Investigation, Density Assessment Tahmoor Colliery Reject Area Remembrance Drive Tahmoor

2. Methodology

2.1 Scope of services

To complete the study as outlined in Section 1.1.5, the scope of services undertaken is generally described as follows:

- Review existing fine and coarse reject material stream, including review of reject waste plant processes, reject material plant flow, material properties and projected reject quantities (based on volumes provided by Tahmoor Coal).
- Undertake a literature review of coal washery reject disposal and reuse, using both published and non-published sources (provided by Tahmoor Coal).
- Undertake an audit of underground disposal areas available and potentially available with an estimation of the volumes.
- Review existing rejects disposal method within emplacement area and management plans.
- Review the proposed emplacement area expansion, as detailed within the REA design report and drawings.
- Provide a summary technical review of each option considered including details and assessment of:
    - Operational issues
    - Technical issues
    - Risks
    - Advantages and dis-advantages
    - Capital and operational costs ($/t), including external costs such as cost of environmental offsets
    - Environmental issues
- Review possible reject reuse options to beneficially use or partly use reject volumes generated, such as road construction sub-base material or select fill for construction, assess rejects against relevant product specifications to confirm suitability, review potential reuse market within region and close proximity to Tahmoor, potential environmental issue within reuse options and ease of access to market and reuse location.
- Prepare a cost benefit analysis, including NPV analysis.

2.2 Design criteria

A high level design criteria was established to define the technical requirements for the study. A copy of the design criteria (document number QN10312-EAM-DC-G5-0001) is provided in Appendix A.

2.3 Disposal options

The reject disposal options considered for this study are outlined in Table 2-1.

Table 2-1 Reject disposal options considered

Option	Disposal location	Description
1A	Surface	Disposal at expanded existing reject emplacement area
2	Underground	Dry material
3A	Underground	Paste Material (Disused Road, Goafs via Pipeline)
3B	Underground	Paste Material (Former Goaf areas via Boreholes from access roadways)
3C	Underground	Paste Material (Active goafs via a trailing pipe)
4A	Underground	Slurry Material (Disused Road, Goafs via Pipeline)
4B	Underground	Slurry Material (Former Goaf areas via Boreholes from access roadways)
4C	Underground	UG Disposal : Slurry Material (Active goafs via a trailing pipe)
5	Beneficial re-use	Reuse of Rejects Materials as Road base.

2.4 Multi-criteria analysis

To provide a more cost effective study, an initial qualitative assessment (multi-criteria analysis (MCA)) of the options was undertaken. The aim of the MCA was to eliminate a large percentage of the options, thereby, reducing the number of options to be fully analysed including cost benefit analysis.

MCA is a systematic, semi-quantitative approach to decision making through the application of numerical weightings to a set of principles, goals and objectives to enable the net advantages and disadvantages of each option to be assessed.

2.4.1 Set up

The inputs adopted for the MCA process are outlined below:

1) Listing of options that require assessment
    - Refer Table 2-1 above.
2) Category preferences or weightings
    - The categories adopted for the MCA, including their respective weightings, were agreed with Tahmoor Coal prior to undertaking the assessment, and are shown in Table 2-2.
3) Criteria against which to evaluate the options
    - The criteria adopted for the MCA was agreed with Tahmoor Coal prior to commencement of the assessment process. The agreed criteria are outlined in Table 2-3.
4) Importance and minimum ratings
    - As agreed with Tahmoor Coal, the importance of each criteria was established and where applicable a minimum rating was specified (for instance in the case of safety a minimum rating of average was required). The importance and minimum ratings are shown in Table 2-3.

Table 2-2 Criteria weightings

Category	Importance	Score	Rating Scale	Score
Economic	Very High	5	Excellent	5
Environmental	High	4	Very Good	4
Social	Medium	3	Average	3
Technical	Low	2	Fair	2
Safety	Very Low	1	Poor	1

Table 2-3 MCA assessment criteria

Category	Criteria	Importance	Minimum Rating
Economic	Economic interference	Medium	
Economic	Low CAPEX (compared to other options)	Very High	
Economic	Low impact on available reserves	High	
Economic	Low impact on production	Very High	Average
Economic	Low OPEX (compared to other options)	Very High	
Economic	Requires minimum processing of the rejects to achieve satisfactory backfill performance	High	
Environmental	Dust emissions are minimal	Very High	
Environmental	Low GHG Emissions	High	
Environmental	Low risk of groundwater and sub-surface water table contamination	Very High	
Environmental	Low water usage	High	
Environmental	No leachate contamination to the ground waters and sub-surface water table	Very High	
Environmental	Offers good control of spills	High	
Environmental	Reduced Visual Impact	Low	
Environmental	Rejects are emplaced / contained within the mine lease	Medium	
Environmental	Requires minimal use of foreign reagents	High	
Safety	Is safe in application and causes no hazards to the mine operations	Very High	Average
Safety	Level of experience at Tahmoor Coal on the operation of the system	Medium	
Safety	Low impact on mine stability	Medium	
Safety	Low Risk of liquefaction of emplaced fill	Medium	
Safety	Risk of damaging bulkheads	Low	
Social	Limited noise emission	High	
Social	Reduced footprint, limiting the impact on local	Medium	

Category	Criteria	Importance	Minimum Rating
	environment and native heritage		
Technical	Dependence on local geologic conditions	High	
Technical	High Automation	Low	
Technical	High reliability	High	
Technical	Increased subsidence control	Medium	
Technical	Is versatile and flexible	Medium	
Technical	Low Geological confidence needed	Medium	
Technical	Low Maintenance	High	
Technical	Proven technology	Medium	

2.4.2 Process

The steps undertaken in carrying out the MCA are graphically depicted in Figure 2-1 below.

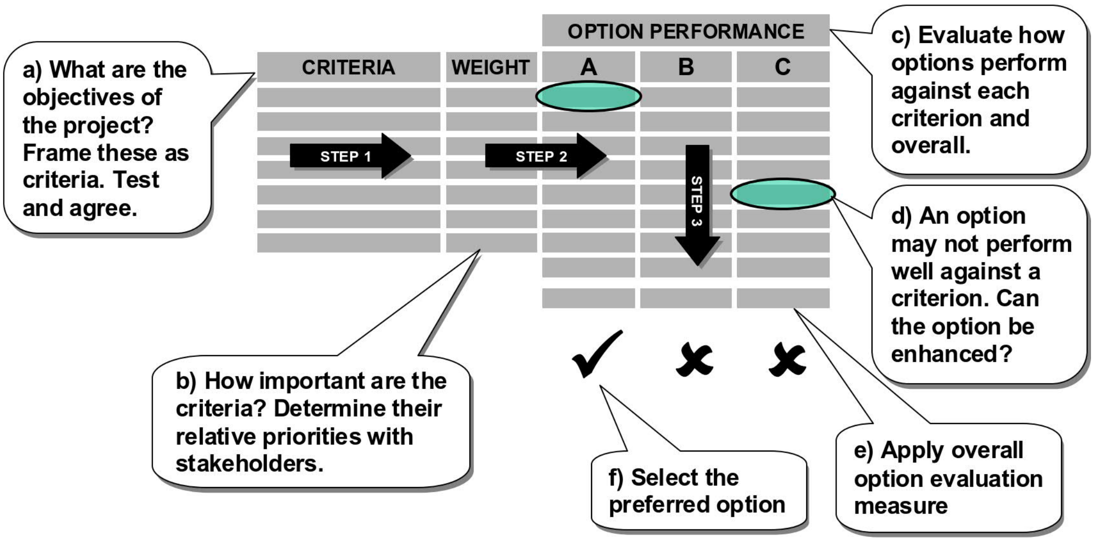

Figure 2-1 Steps and information structure in MCA decision making

2.4.3 Results

The results of the MCA are contained within Appendix B and further discussion on all options is provided in Section 6, with more detailed discussion on the short-listed options provided in Section 7.

2.5 Cost Benefit Analysis

A cost-benefit analysis approach was adopted to compare the disposal options. The analysis was undertaken consistent with *NSW Treasury Guidelines for Cost Benefit Analysis (2012)* and in accordance with the *NSW Department of Planning and Infrastructure Guidelines for Strategic Regional Land Use Planning.*

The cost-benefit analysis was undertaken on the short-listed options following the MCA, outlined above in Section 2.4. The options were modelled to determine each options relative economic merit. A sensitivity analysis was undertaken to understand and evaluate the relationship between key variables.

The outcomes of the cost-benefit analysis are provided in Section 8.

2.6 Options Analysis

As discussed in Section 2.4, a MCA was conducted to reduce the number of potential alternatives available. The MCA, conducted during the Preliminary Analysis Phase of the study, resulted in two likely alternatives. These two alternatives were subjected to further examination in a facilitated workshop environment with a view to finding a preferred option with which to proceed.

This subsequent examination of the two remaining options involved assessing them against a series of criteria and scoring their suitability against each. An Options Analysis process was used in a professionally facilitated environment to find a preferred “go forward” option.

To commence the Options Analysis process, a set of criteria was developed that was applied equally to each option. To retain the integrity of the analysis, each criterion was assigned a weighting that applied to both options. The criterion and their respective weightings, as agreed by the workshop participants, are as shown in Table 2-4.

Table 2-4 Assessment Criterion and Weighting

Assessment Criterion	Weighting
Improves or Contributes to Local Economy	Useful
High Benefit to Cost Ratio	Essential
Low Impact on Available Coal Reserves	Important
Low Impact on Production	Essential
Minimal Processing of Rejects Required	Important
Minimal Dust Emissions	Important
Low Greenhouse Gas Emissions	Important
Low Water Usage	Important
Low risk of surface/groundwater and subsurface water particle contamination	Important
Low risk of surface/groundwater and subsurface water chemical contamination	Important
Good Control of Spills	Desirable
Reduced Visual Impact	Desirable
Rejects Contained within Mine Lease and EPL	Important
Minimal Use of Foreign Re-agents	Desirable
Safe in Application	Essential
Causes no Hazards to Mine Operations	Essential
Ease of Operation	Important
Potential for Liquefaction of Emplaced Fill	Important
Potential to Damage Bulkheads	Essential

Assessment Criterion	**Weighting**
Low Noise Emissions	Important
Potential to Impact to Heritage Artefacts and Vegetation	Important
Impact of Geology/Geotech to Design and Operate System	Essential
Ease of Automation	Desirable
High Reliability/Availability of the System	Essential
Increased Subsidence Control	Negligible
Versatility and Flexibility of Solution	Important
Low Maintenance	Important
Proven Technology	Important
Meets Capacity and Throughput Requirements	Essential
Consistency with Mine Closure Plan	Desirable

Once these criteria and their weightings were agreed by the workshop participants, the facilitator worked through each of the options, encouraging the participants to assess the option's compatibility with each criterion. This assessment was conducted with input from all participants.

The compatibility ratings used were:

- Excellent
- Good
- Compatible
- Partially Compatible
- Not Compatible

A simple algorithm was then used to aggregate a score for each option based on its compatibility with each of the criteria.

Immediately upon completion of this process, scores and status of each option were available. The results from the process are presented within Section 9.

3. Literature review

A number of technical papers, available within the public domain and provided by Tahmoor Coal, were reviewed to consider alternatives to surface disposal in use or being trialled for disposal of reject material. Many of these papers were found to be quite generic in nature and whilst providing an overview of techniques, lacked specific technical detail. In addition, greater emphasis was provided to papers deemed more applicable to the operation at Tahmoor Mine, for instance coal mines in the USA are typically very shallow and therefore the techniques adopted at such mines may be less relevant than those discussed for the Illawarra or southern coalfields of NSW. The intent of this Section of the report is to summarise background information on techniques currently employed elsewhere and to provide sufficient information to inform the options workshop (refer Section 9). It is not intended that this Section outline verbatim each and every one of the reports reviewed and where additional specific information is required, the specific paper should be consulted.

3.1 Mineral Characteristics and Weathering Behaviour of N.S.W. Colliery Waste Materials

Author: Colin R. Ward

Issue date: October 1980

Publisher: Department of Applied Geology, The New South Wales Institute of Technology

Abstract

This report presents an assessment of the rate of rejects outputted from coal washeries in New South Wales (NSW). Particle sizes, ash content, production rates, and disposal and utilisation methods were discussed. The mineralogy of the non-coal components of the rejects was studied to help assessing potential environmental impacts. Weathering characteristics were also considered in relation to possible reuse of the rejects.

Disposal options investigated

Waste disposal was carried out through:

- Surface Dumping
- Disposal in open cuts
- Landfill and reclamation
- Use in road construction
- Garbage depots
- Packing around pipes
- Horticulture
- Underground stowage
- Disposal at sea

Emplacement of coal mine waste has been completed through construction of spoil heaps, landfilling of various types, underground stowage and tailings dams. The impacts most commonly associated with emplacement include:

- Landslide effects on spoil heaps
- Visual pollution of the landscape
- Air pollution from dust or burning
- Water pollution from waste heaps and lagoons
- Land pollution or withdrawal of land from other uses

- Ecological impact due to removal of flora and fauna from the site

Possible utilisation methods for the washery waste include road materials, concrete aggregate, brick manufacture, sulphur derivatives and heat production.

Key Findings

Coal Rejects Production Rates

During the 1976-1977 period, over 8 million tonnes of rejects per annum was being produced by coal washeries in the State of NSW. This was from 36 washeries across the state that mined 31.7 million tonnes of coal.

Mineralogical Characteristics

Coal washery rejects consist of a mixture of particles that includes shaley coal, coal shale, carbonaceous shale, grey shale, sandstone, clay ironstone and kaolinite clayrock. NSW Coal was characterized to have a relatively high mineral content which includes clay, quartz, sulphides and carbonate minerals.

Mineralogical investigation was conducted through x-ray diffraction. Investigations into the non-coal components of the rejects showed significant variations in pyrite and carbonate contents, and the amount and types of swelling clay minerals in the rejects, which were the most significant variations from an environmental point of view.

Weathering Characteristics

Building on the mineralogical investigations a series of chemical leaching tests were conducted to help determine weathering characteristics. Acid runoff conditions were only likely in rejects samples from specific areas, namely Lithgow and South Maitland, in most other cases the rejects behaved in much the same way as shales found away from coal seams.

3.2 Subsidence Control by Backfilling

Author: A Allen, J Paone

Issue date: January 1981

Publisher: SME

Abstract

The paper details backfilling methods for active and abandoned mines to control or avoid subsidence at surface level. Several techniques and cases are detailed, describing their efficiency and costs.

Key Findings

- Controlled backfilling can be done in safe and accessible workings as it requires manual placement of the backfilling pipe in the workings. This backfilling method can achieve the highest backfill percentage of all methods
- Conventional blind backfilling achieves a much lower degree of backfilling compared to controlled backfilling. Using this method, material is washed into the flushing boreholes by gravity until the boreholes no longer accept material. Using this method about 20 to 25 boreholes are needed per 4000m^2, with only 61m^3 of material injected through each borehole before it is blocked.
- Pumped slurry backfilling has a higher efficiency, and is most effective in submerged working. Water is pumped out of the workings and used in the slurry. It is then pumped back together with the material in the submerged workings. Using this method, material can reach distances up to 250m away from the borehole. In one project 19,000 tonnes of material was injected through a single borehole. In order not to disturb

overlaying aquifers and prevent caving of the borehole, the borehole had to be cased and concreted down to several meters above the roof of the workings.

- With the pumped-slurry process, pressures in shallow underground voids could become great enough for the slurry to surface through fissures in the overburden, causing potentially dangerous situations.

3.3 Coal Reject Disposal in the Southern Coalfields

Author: The Coal Reject Disposal Sub-Committee (Department of Mineral Resources)

Issue date: May 1983

Publisher: Unknown

Abstract

The report considered reject disposal options for the Southern Coalfields of NSW, May 1983. It was stated that none of the methods in this report considered for utilisation of the coal rejects would make a significant impact on the requirements of rejects disposal. It was found that surface emplacement was the only feasible option for rejects disposal at the time. Possible sites for surface emplacement were located and considered based on proximity to the reject source and the extent of development work necessary.

Disposal options investigated

Options considered in the report other than surface emplacement included:

a) Offshore disposal

b) Underground disposal

c) Utilisation of rejects for land fill, structural fill, road and civil engineering works

d) Possible fluidised bed combustion

e) Brick making

f) Utilising the reject as an alternative to bauxite, as a raw material source for alumina.

Key Findings

Recommendations

The most relevant recommendations are:

- After conducting detailed engineering studies and environmental impact assessment, establish possible emplacement sites that could be developed for rejects disposal. This is based on the capacity and proximity of the sites, the required development work and the land ownership.
- To forward Report findings to the Department of Environment and Planning to be included in an overall policy for coal rejects disposal.
- To identify and select emplacement sites for the purpose of long term emplacement, considering the appropriate local environmental plans.
- To examine measures to secure long term emplacement sites, including possible amendments to legislation to ensure sites can be acquired and used for emplacement.
- For government authorities to work with research organisations and engineering groups to develop a manual or code of practice that provides specifications for testing, supply and use of coal rejects for structural and engineering applications

In assessing the present and future outlooks for coal reject disposal a survey was undertaken across all the companies involved with or considering coal preparation in the Southern Coalfields. This survey evaluated the total projected reject production.

Surface Emplacement

The report concluded that at least for the future twenty years, surface emplacement of coal rejects was the only viable solution.

Site Selection

The following criteria were considered in site selection:

- Sufficient capacity available for the long term disposal of rejects to avoid the repeated difficulties associated with development of multiple smaller emplacement sites
- Consideration of existing land use and planning constraints
- Considerations to transport and the environment

The transportation modes required to deliver the reject to disposal sites were considered including possible routes, transport corridors, costs and avoidance of urban areas.

Securing sites also requires mechanisms to ensure they are not committed for other incompatible uses in the meantime. This can be done through State Environmental Planning Policies, Regional Environmental Plans or Local Environmental Plans.

3.4 Washery Waste and Tailings Disposal

Author: D McCarthy, L Pullum, N Longworth

Issue date: December 1989

Publisher: ACARP

Abstract

The report details the testings and procedures on rejects from West Cliff, Lemington and Hunter valley with concentrations of 78-84 w/w%, 65-83 w/w% and 72-77 w/w% respectively. Results were gathered in determining flow regimes and stability; as well as the effects of particle and pipe size.

Key Findings

Tests on the West Cliff samples (78-84 w/w%) were pumpable with a 10mm particle top size for the use of concrete roof supports. Flow regime appeared to be a function of concentration with concentrations above 80 w/w% exhibiting homogenous behaviour and below 80 w/w% stratified sliding bed behaviour; an existing model was used for the flow curve of this stratified behaviour, which has been tested for solids densities <2100kg/m^3.

Stable sliding bed flows of ROM occurred when:

i. The ratio of the pipe internal diameter to particle diameter was >5

ii. The ratio of the actual concentrations of solids to the maximum possible concentration from 0.85 - 0.95, with water

iii. The mean velocity is greater than a particular value set by a function of the following variables: the ratio in ii); the mean value of the density of the solids; and the rheological properties of the carrier fluid

Figure 3-1 shows the size distribution of the samples pumped as sliding beds in 250mm and 300mm pipes.

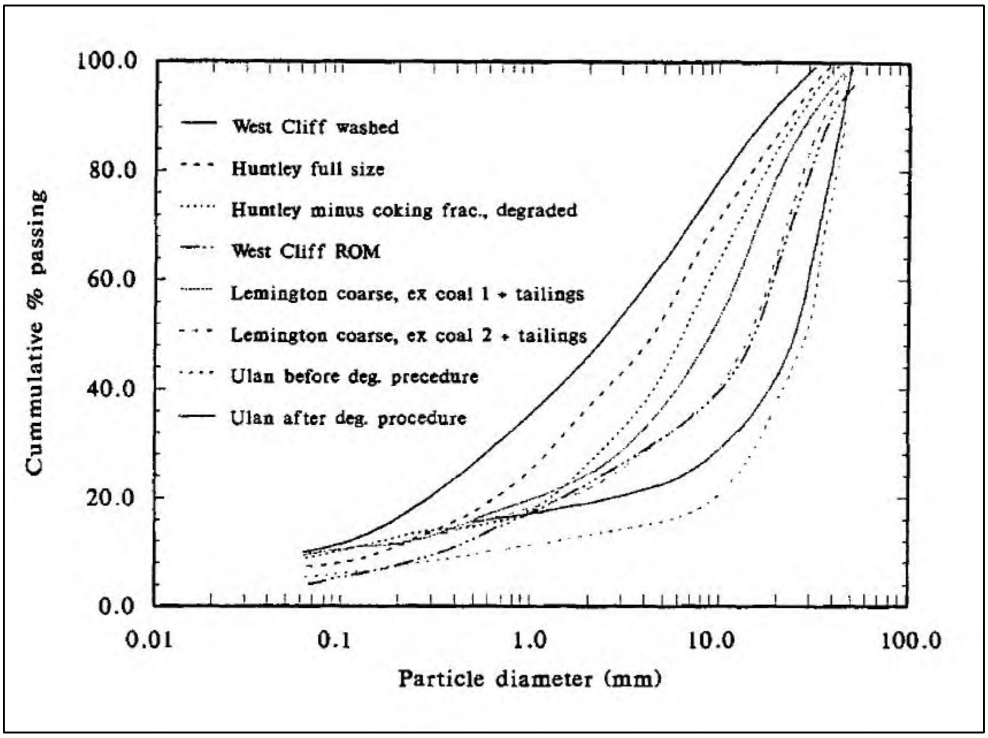

Figure 3-1 Size of distributions of materials pumped. Source: ACARP (Ref.[1])

Degradation was experienced for each site's samples during pumping trials; with degradable portions of rejects breaking down with a time constant longer than 5 minutes for West Cliff, 30 minutes for Hunter Valley and 60 minutes for Lemington. The rates and extents of degradation for Lemington and Hunter Valley suggest that the data obtained is unsuitable for predicting pumping performance. It appeared that the Lemington and West Cliff rejects dominant mechanism for degradation was hydration/decrepitation of clays and mudstones rather than mechanical breakage.

3.5 Blind Pneumatic Stowing in Voids in Abandoned Mines

Author: P Sands, C Boldt, T Ruff

Issue date: January 1990

Publisher: U.S. Bureau of Mines

Abstract

The paper details the testing of blind stowing concepts in abandoned mines using pneumatic stowing of rejects. Four test cases; all performed in the USA were reviewed. Both wet and dry particles were tested to demonstrate their advantages and disadvantages. Effectiveness of the methods were assessed by lowering cameras into the voids.

Key Findings

The systems tested were capable of propelling material approximately 20m away from the injection point. Wear to the pipes and pneumatic systems was found to be high, needing rebuilds of the pneumatic system after approximately 320 tonnes at half the capital cost of the system. More research had to be done evaluating different nozzle designs also more research has to be done into material properties to make this an economically feasible option.

3.6 Backfilling of Caved-in Goafs with Pastes for Disposal of Residues

Author: W Mez, W Schauenburg

Issue date: April 1998

Publisher: Minefill conference 1998

Abstract

The paper details the active goaf, trailing pipe backfilling operation, which was in operation at the Walsum Colliery in the 1990's. It indicates that the trial was successful and rejects have effectively been placed behind the goaf.

Key Findings

- At the Walsum Coliery successful stowing of paste into the active goaf using a trailing pipe has been achieved.
- Stowing of the paste has been achieved up to 200m^3/hr using a 200mm pipe.
- Using 25Mpa of pressure it was possible to transport the paste trough 12km of pipe to a depth of 800m.
- The paste is pumped into voids which are reported to exist up to 30m behind the longwall shield, where it can still be regarded as lose debris.
- Voids exist up to a height of 3 times the seam height above the seam floor.
- Experience with the trailing pipe has shown that the trailing pipes are not deformed or lost due to the roof material collapsing on top of it.
- Solids content in the paste has to be high enough to prevent water from being released into the open excavations.

3.7 Backfilling technology and strata behaviours in fully mechanized coal mining working face

Author: Zhang Qiang, Zhang Jixioung, Huang Yanli, Ju Feng

Issue date: March 2012

Publisher: International Journal of Mining Science and Technology

There are a number of papers that outline the process currently being trialled in China, utilising dry material backfilling at the coal mining face. These papers tend to relate to the main benefit of this system, i.e. where a strong degree of subsidence control is required, such as mining under water bodies and buildings. The paper that provides a more detailed outline of the process is by Qiang et al and is discussed further below.

Abstract

The paper describes a backfilling technique used in the Xingtai Coal mine in China. In the technique described, backfill is discharged from a conveyor extended from a canopy which is attached to the back of the longwall shield. Dry material is discharged trough ports on the bottom of the conveyor, dropping the material into the void behind the shield. A tamping arm pushes material into the upper part of the void and compacts the material. This method allows for almost 100 per cent of the goaf area to be backfilled.

Key Findings

The method described in this paper has been developed to minimise the amount of backfill because mining is taking place under residential areas.

Currently three methods of backfilling are used in China, these are:

- Super high-water packing material
- Paste backfilling
- Solid material fully mechanised coal mining

These methods are used to keep subsidence to a minimum; as a consequence the unit cost of coal mining is much higher. The application of backfilling using a fully mechanised coal mining process has distinct advantages when extracting coal from beneath water bodies, railways and buildings where subsidence control is essential.

The solid material fully mechanised coal mining which is currently being tested in the Xingtai Coal mine uses a shaft and conveyor system to transport reject material underground. As noted by Freiberg et al (ref [11]) careful consideration needs to be given to transporting material underground via a vertical or declined pipe in order to avoid clogging. Incorporating velocity damping, continuous unloading at the bottom, low moisture content and careful selection of pipe diameter will assist alleviating these issues.

At the back of the longwall an adapted shield design, equipped with an additional canopy, provides roof support and space for backfill demand. Under the canopy a chain conveyor is installed with ports on regular intervals from which material is discharged. Tamper arms are located under these discharge points pushing the material into the active goaf area. Refer to Figure 3-2.

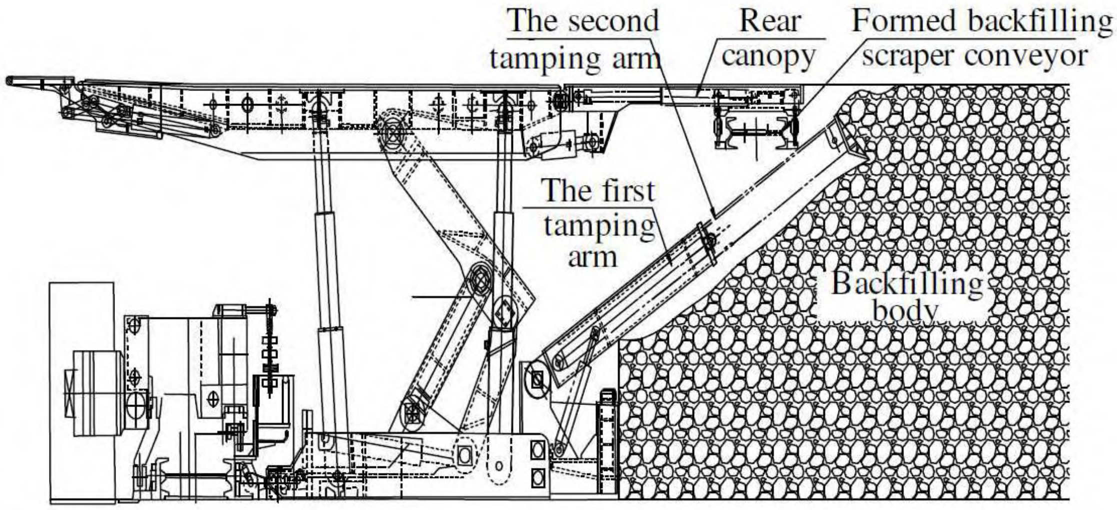

Figure 3-2 Tamping material to connecting immediate roof. Source: Qiang et al

When material is packed to a certain height, it is pushed and compacted by the first and second tamping arms, additional material is deposited and the process repeated to achieve the desired density. When the first round of backfilling is completed, the backfill conveyor is advanced to commence the second round of backfilling and the process repeated. Through a series of adjustments of the tamping arms, backfill material is pushed to connect the immediate roof and hydraulic supports.

Stress sensors were placed in the active goaf behind the longwall to monitor the caving process, the maximum stress measured to be 5.5 MPa. A maximum face advance of 3.6 meters was achieved using this backfilling method and a maximum surface subsidence of 231 mm was observed.

3.8 Metropolitan Mine underground emplacement of coal rejects – A case study

Authors: Greg Tarrant (Peabody Energy), Tim Gilroy, Gasper Sich, Dane Nielsen

Issue date: 2012

Publisher: University of Wollongong

Abstract

Metropolitan Collieries Pty Ltd (MCPL) has developed and tested an underground coal mine rejects emplacement method which is currently operating on a pilot scale to fill underground voids. Reject materials include coarse rejects, teeter bed separator (TBS) rejects and floatation tailings.

Key Findings

The MCPL produce high density slurry that can be pumped between 500m and 8000m with a minimal risk of pipe blockage and no groundwater contamination. MCPL also endeavour to minimise their water usage and utilises no additional material, such as fly ash.

Potential voids for filling at MCPL include:

- Abandoned roadways accessible by mine personnel and inaccessible by mine personnel depending on the fill's flows characteristics
- Previously extracted and future longwall areas

The limitations driving the specifications include:

- A friction loss of less than 4 kPa/m, initially set to help achieve required pumping distances
- A low free water release slurry, with moisture content below 30 per cent and non-settling behaviour
- Continuous processing with no milling or grinding
- An emplacement strength (UCS) above 100 kPa and a beach angle of 3-4°
- Also the use of any additives must not be potentially harmful to the environment

The particle size distributions of the rejects at MCPL are shown in Figure 3-3.

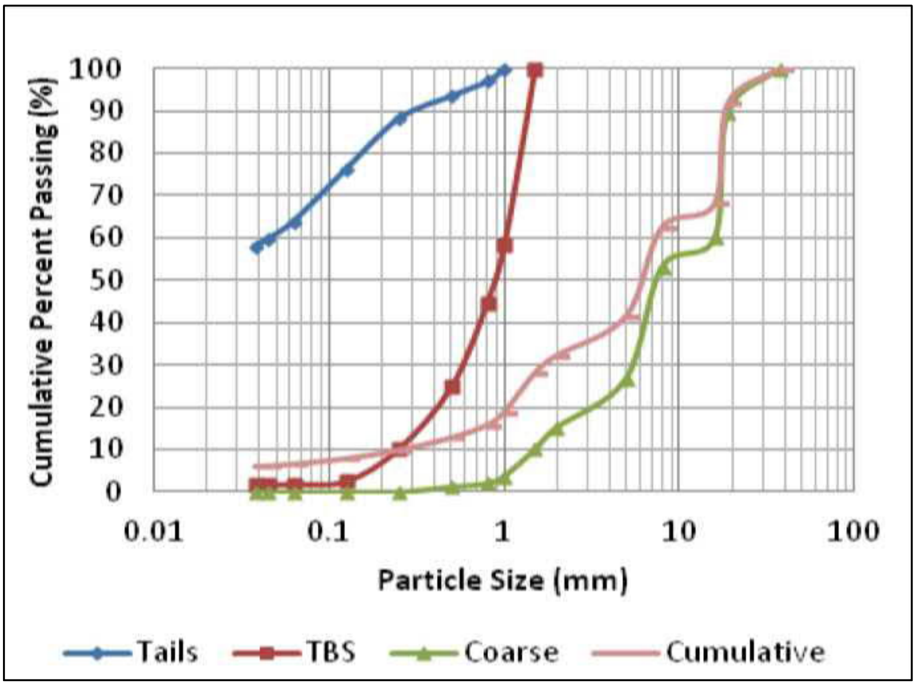

Figure 3-3 MPCL particle size distribution for coarse rejects, TBS, tailings and combined. Source: Tarrant et al (Ref. [3])

The reject material had the following characteristics

•	Coarse Reject	density (solids) = 2000kg/m^3, moisture=6 w/w%
•	TBS Reject	density (solids) = 1700kg/m^3, moisture=19 w/w%
•	Floatation tailings	density (solids) = 1700kg/m^3, moisture=70 w/w%

Figure 3-4 shows the combined particle size distribution compared to the distribution after crushing trials and an actual sample of the rejects MCPL has been emplacing underground.

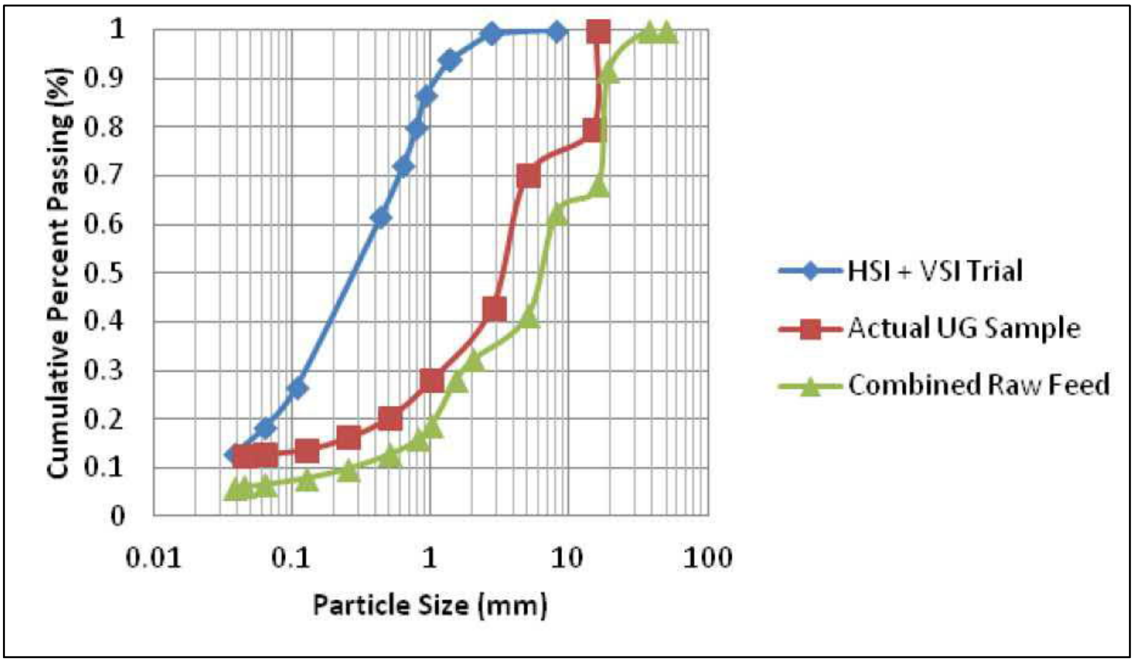

Figure 3-4 MCPL particle size distribution for rejects emplaced underground. Source: Tarrant et al (Ref. [3])

Investigations and Testing

Investigations into projects with experience in this application found that chemical pumping aides can achieve a 40-60 per cent reduction in viscosity in both very fine pastes and coarse concretes. Also, long distance pumping of coarse and fine particle size distributions has been proven and established across various industries; as has been coal mine goaf and roadway disposal of hydraulic fill into coal mines.

Studies by DMT and TUNDRA indicated that a suspension of 1:6.75 tailing to coarse rejects, which is the washery output, would be pumpable with a top size of 5mm.

Field trials used a swing tube positive displacement pump with a variable speed drive established the flow characteristics shown in Table 3-1.

Table 3-1 Field trial test results

Friction loss within a 100mm pipe range	2-6kPa (nominally 4kPa)
Moisture content	15-36% (nominally 30%)
Density	1500-1700kg/m^3 (nominally 600kg/m^3)
Pipe retention time	<9 days

Using a pumping aid, (EZ Flow from Cellcrete Australia Pty Ltd) in the 50-150mL/t range, reduced friction losses and provided suitable pipe lubrication. Results showed that the drained shear strength of the emplaced slurry reached 50kPa after approximately 75 days and 95kPa after 140 days; which was adequate enough to eliminate the risk of liquefaction.

Pilot Plant and Future Developments

The Pilot plant combined 50 per cent TBS and floatation tailings with 50 per cent coarse rejects sized to -15mm, corresponding to the combined raw feed shown in Figure 3-4.

Emplacement commenced in May 2011 with the underground pipe range extended for 890m; by October 2011, 15,000 tonnes of rejects had been emplaced.

3.9 Key findings from other sources

In addition to the above mentioned documents, a number of confidential reports have been reviewed to support many of the assumptions and to estimate values in lieu of actual test data. During this review, the key findings were:

- A ratio of 6.75:1 between coarse and fine rejects was suggested by one of the reports to prepare a similar paste.
- The same report describes the prepared backfill paste with an 80% Cw of solids and a TPS of 5mm.
- Another report discusses the convenience of using rheology modifier reagents to enhance the pumpability of pastes.
- Most reports consider it technically very challenging to retrofit a trailing pipe system into existing longwall equipment. In the same way, the implementation of backfill paste systems in mines that have not been designed for that purpose often find their limitations in the existence of reduced available volumes underground, in addition to significant technical difficulties and safety issues.
- An internal SKM reports suggests that two stages of dry crushing are required to produce enough fines to achieve a homogeneous flow regime of the paste as opposed to the segregated regime that characterises most slurries in long distance pipelines.

3.10 Summary

A summary of the literature review undertaken is provided in Table 3-2. The key findings were taken into the preliminary analysis of options outlined in Section 6.

Table 3-2 Summary of literature review

Paper	Technology	Key findings
Mineral characteristics and weathering behavior of NSW colliery waste materials	Not technology specific	• Impacts associated with emplacement include landslide effects, visual pollution, air pollution, water pollution, land pollution and ecological impact. • Possible beneficial reuse includes road materials, concrete aggregate, and brick manufacture • Washery rejects contain significant variants in pyrite and carbonate content and clays • Acid runoff conditions only likely from specific areas
Subsidence control by backfilling	Underground disposal as a slurry	• Manual placement of backfill found to be safe and achieve highest backfill percentage • Blind backfilling is limited by the amount of

Paper	Technology	Key findings
		material that can be injected before borehole blocking - Pumped slurry has a high efficiency however may surface through fissures in the overburden
Coal reject disposal in the southern coalfields	Alternatives to surface emplacement	- Surface emplacement was found to be the only feasible option at the time - A number of recommendations were made looking to further study alternative emplacement methods including engineering and environmental studies of long term effects, possible amendments to legislation and testing for beneficial reuse alternatives
Washery waste and tailings disposal	Testing of pumpability of reject material	- Pumpable with a 10mm particle top size - Homogenous behaviour exhibited in concentrations greater than 80w/w% - Ratio of internal pipe diameter to particle diameter >5 - Time constant unreliable for predicting pumping performance
Blind pneumatic stowing in voids in abandoned mines	Underground disposal into former goafs via boreholes	- Dispersion of material up to 20m from injection point - Wear to pipes and pneumatic systems found to be high - More research required on nozzle design and material properties to make the solution economically feasible
Backfilling of caved in goafs with pastes for disposal of residues	Underground disposal into the active goaf	- Successful stowing of paste into the active goaf at the Walsum Colliery, Germany - Achieved at up to 200m^3/hr - Transport of paste 12km to a depth of 800m - Voids exist 3 times the height above seam floor - Solids content needs to be high enough to prevent water release
Backfilling technology and strata behaviors in fully mechanical coal mining working face	Underground disposal as dry material	- Backfilling technique used at the Xingtai mine in China - Dry material is transported underground via a series of shafts and conveyors - Material is packed into the active goaf behind the longwall operation using a number of tamping arms - Adopted where a high degree of control is required over subsidence. Typically considered when mining beneath buildings, water courses and railways - Productivity is significantly impacted with advance of the longwall limited by compaction of the backfill material

Paper	Technology	Key findings
Metropolitan Mine underground emplacement of coal rejects	Underground disposal into former workings	• Current pilot scale test to fill underground voids with reject material • Chemical pumping aids can achieve a 40-60% reduction in viscosity • Long distance pumping proven • 5mm particle top size • Pipe retention time up to nine days • Drained shear strength of emplaced slurry 50kPa after 75 days and 95kPa after 140 days was adequate to eliminate the risk of liquefaction • 15,000 tonnes emplaced underground over a 6 month period

4. Metallurgical review

A metallurgical review was conducted on available studies and data.

Rejects composition:

The fraction of coarse and fine rejects is assumed to be as per the Coal Preparation Plant Process Flowsheet 650tph (Ref. [8]).

Coarse rejects	83.2 per cent
Fine rejects	16.8 per cent

This provides a coarse to fine rejects ratio of nearly 1:5.

Rejects specific gravity:

The solids nominal specific gravity (SG) is assumed to be as per Tahmoor Backfilling Concept (Ref. [6]). The proposed minimum and maximum SG are presented below:

Minimum SG	1.7
Nominal SG	2.0
Maximum SG	2.3

4.1 Particle size distribution

4.1.1 Coarse rejects particle size distributions

Table 4-1 and Figure 4-1, both show the coarse rejects particle size distribution (PSD), extracted from the Tahmoor Weekly Reject Samples report, prepared by Bureau Veritas (Ref. [5]).

Table 4-1 Coarse rejects PSD

Sieve Size, mm^2	Finest, %	Nominal, %	Coarsest, %
>50 - 50	100.0	100.0	100.0
50 - 31.5	95.9	93.8	91.8
31.5 - 16	62.5	61.6	59.8
16 - 8	31.2	32.0	29.8
8 - 4	15.4	16.2	14.7
4 – 2	6.7	7.1	6.2
2 – 1	3.3	3.5	2.9
1 – 0.5	1.0	0.9	0.8
0.5 - <0.5	0.7	0.5	0.5

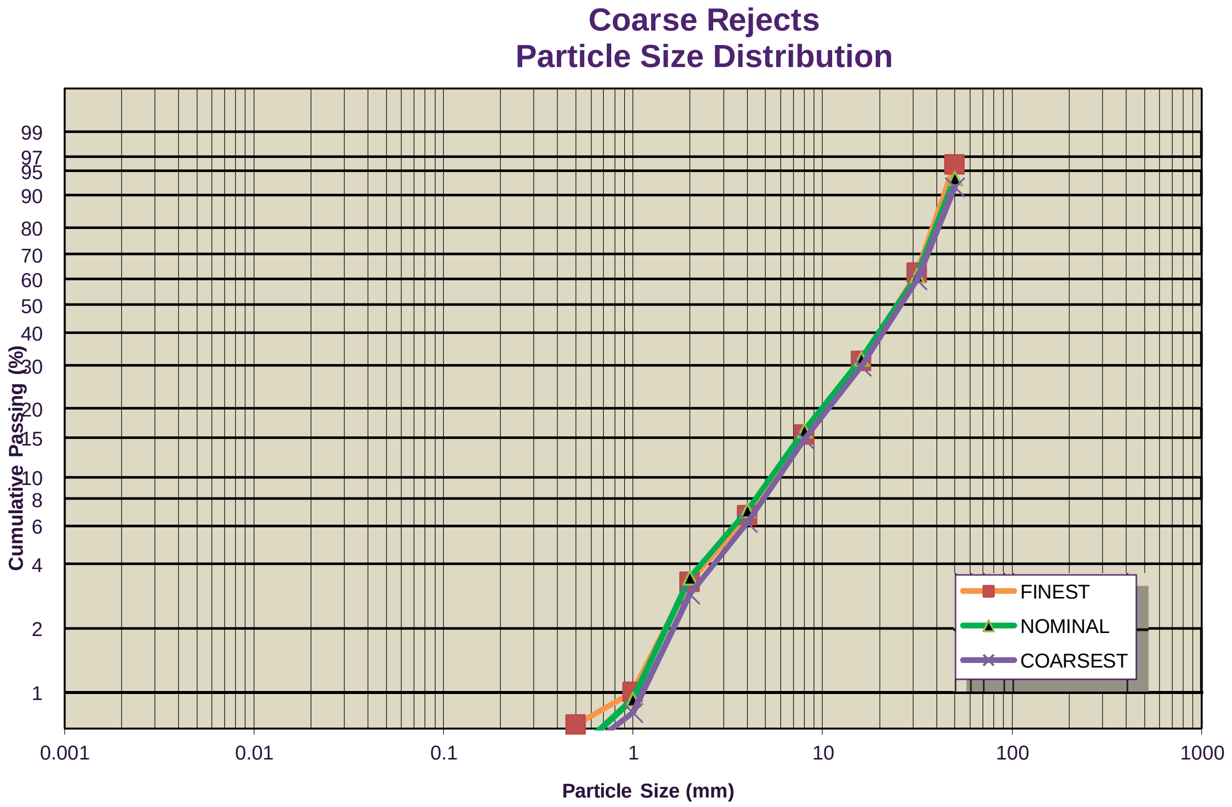

Figure 4-1 Coarse rejects PSD

4.1.2 Fine rejects particle size distributions

Table 4-2 and Figure 4-2 below show the fine rejects particle size distribution (PSD), estimated from the Tahmoor Weekly Reject Samples report, prepared by Bureau Veritas (Ref. [5]).

Table 4-2 Fines rejects PSD

Sieve Size, mm^2	Finest, %	Nominal, %	Coarsest, %
>0.5 – 0.5	100.0	100.0	100.0
0.5 – 0.25	98.6	96.8	96.5
0.25 – 0.125	88.3	81.8	72.1
0.125 – 0.063	78.6	72.4	64.9
0.063 – 0.038	71.8	64.7	58.4
0.038 - <0.038	59.0	52.9	48.0

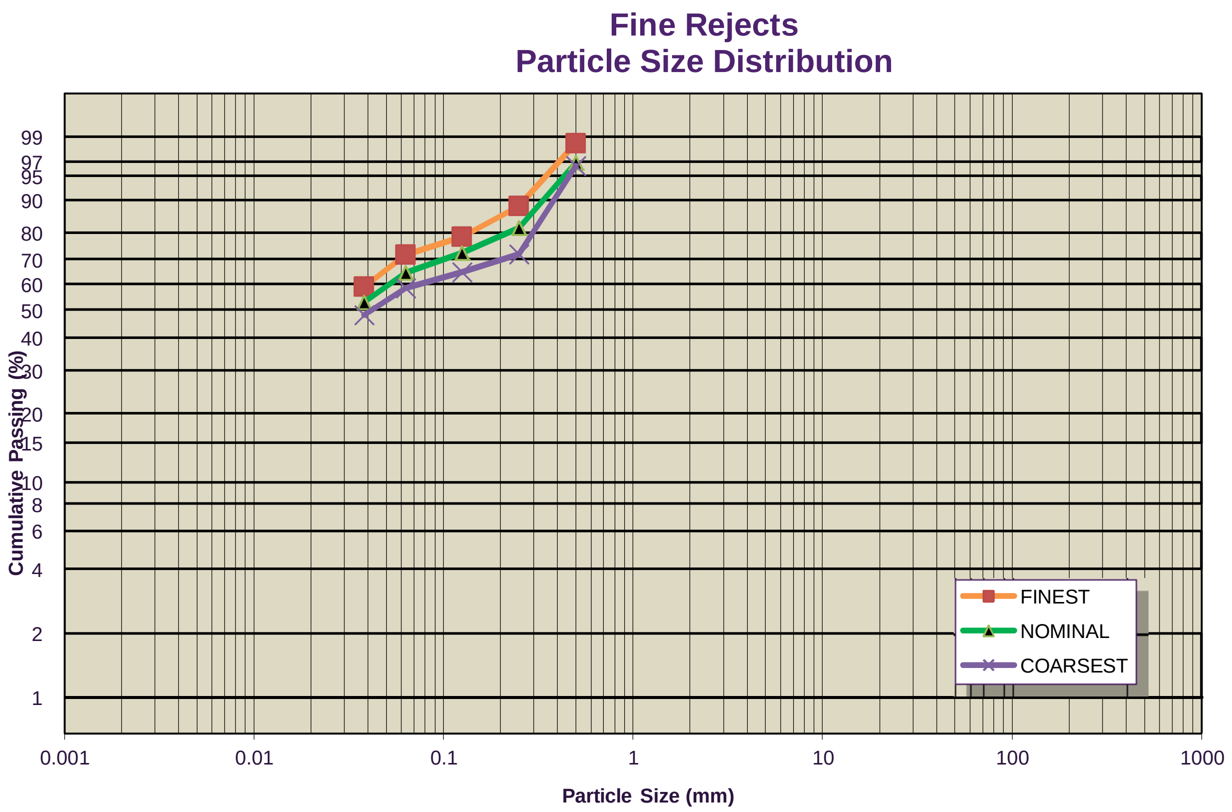

Figure 4-2 Fine Rejects PSD

4.1.3 HSI/VSI product particle size distributions

The use of a tandem of horizontal shaft impact (HSI) and vertical shaft impact (VSI) crushers is proposed in the preparation of CPP coarse rejects.

Table 4-3 and Figure 4-3 below shows the estimated product PSD after the HSI/VSI crushing process. The PSD that this process yields is assumed to be similar to that presented at the Metropolitan Mine Underground Emplacement of Coal Rejects (Ref. [3]).

Table 4-3 HSI/VSI Product PSD

Sieve Size, mm^2	Finest, %	Nominal, %	Coarsest, %
5	100	100	100
4	99	99	99
2	98	98	98
1	91	91	91
0.5	71	71	71
0.25	52	51	50

Source: SKM calculations

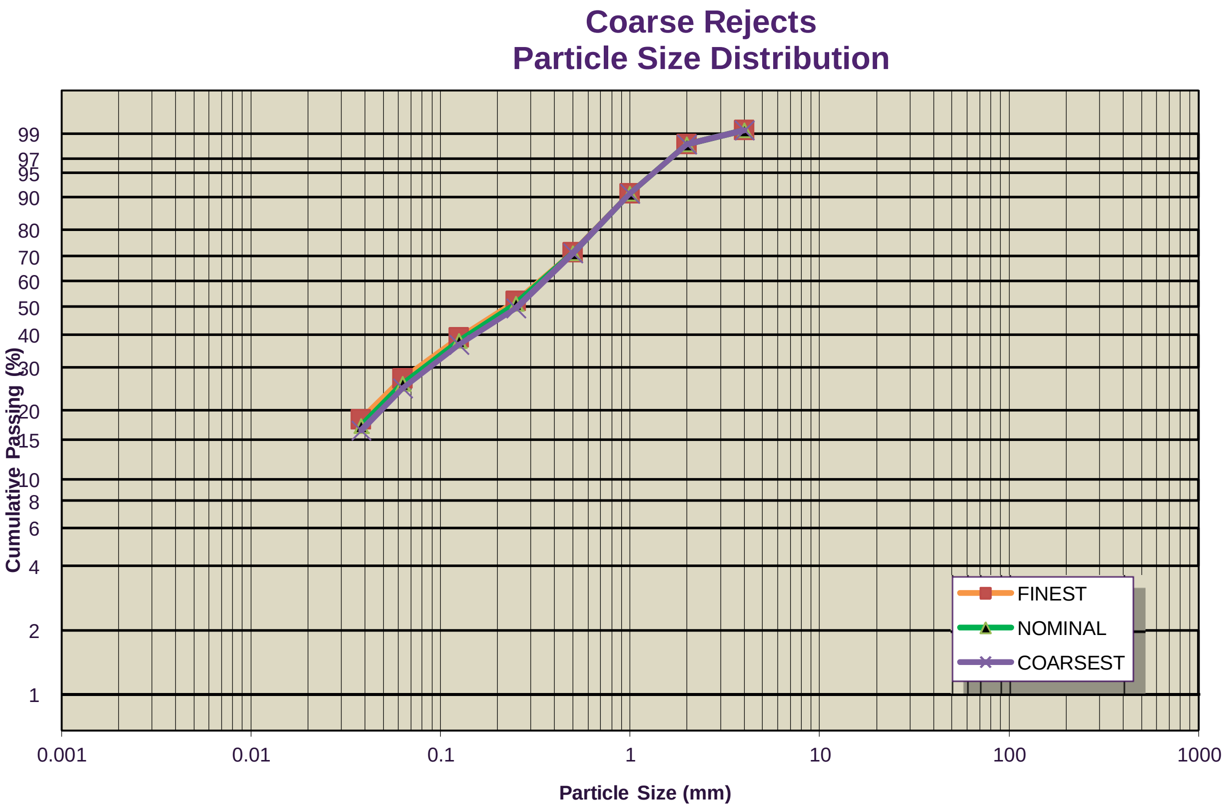

Figure 4-3 HSI/VSI product PSD

4.2 Rheology and pumpability

4.2.1 Slurry

Based on the size distribution and specific gravity previously discussed, any prepared slurry is assumed to be non-Newtonian, settling type.

On slurry systems, the flow velocity inside pipes will be 25 per cent above the settling velocity as per calculated utilising the Durand equation.

The critical velocity was also estimated based on Weir (Ref. [10]) method to determine the flow regime.

It is assumed that the ash content of the slurry will influence its SG and rheology. However, at present there is no specific correlation available between these parameters for the Tahmoor rejects. The ash content of the rejects is estimated to be around 83 per cent from the data presented at the Reject Material Test Data report (Ref. [5]). The use of additives is envisaged to improve the slurry rheology.

4.2.2 Paste

In lieu of actual test data, the paste rheology was assumed as a Bingham plastic with a shear thinning rheology (thixotropic). The following parameters were estimated:

- Yield stress, T_Y = 100Pa
- Coefficient of rigidity, η = 0.1Pa·s
- Density, ρ =1774 kg/m^3

These preliminary assumptions are based on the high ash content (83 per cent) reported by Bureau Veritas [Ref. 5]; a desired concentration of solids by weight of 80 per cent; a PSD as per reported by Tarrant et al. [Ref. 3]; and SKM previous experience.

At the present stage, preliminary calculations on its critical velocity show that the paste flow regime is laminar. Hand calculations based on the Buckinghmam Equation and computational hydraulic models were in close agreement when estimating the pressure loss to be approximately 2kPa/m.

It is highly recommended that the rheological characteristics and pumpability of the paste be verified tests at a pilot facility as part of a pre-feasibility study.

4.2.3 Capacity

The capacity of the rejects system to process solids (dry basis) will be:

Minimum flow rate	130tph
Nominal flow rate	228tph
Maximum flow rate	350tph

5. Audit of available areas / volumes

5.1 Surface disposal

Tahmoor's existing REA is located to the east of the main southern railway and the mine's surface facilities, and has been in operation and accepting coal washery reject since approximately 1980.

The current REA occupies approximately 73ha of land and measures approximately 1300m in the north - south direction and approximately 650m in the east - west direction. Based on the current design and management practice, the last stage of the current REA is projected to be completed in 2023.

Based on the projected level of rejects beyond 2023 for the Tahmoor South Project, the future REA expansion has been designed to accommodate an additional 20Mt. Adopting a compacted density of 2.02t/m^3 as advised by Douglas Partners (ref [12]), this can be achieved by extending the REA by approximately 80ha in order to provide an additional volumetric storage capacity of 9.9Mm^3.

With reference to Figure 5-1, extracted from the Preliminary Environmental Assessment undertaken by AECOM for Tahmoor Coal [Ref. 4], the expanded REA could be accommodated around the existing REA and within the extents of the existing Tahmoor mining lease with authorisation for additional surface rights. It is however understood that the proposed expansion area contains native vegetation including threatened species.

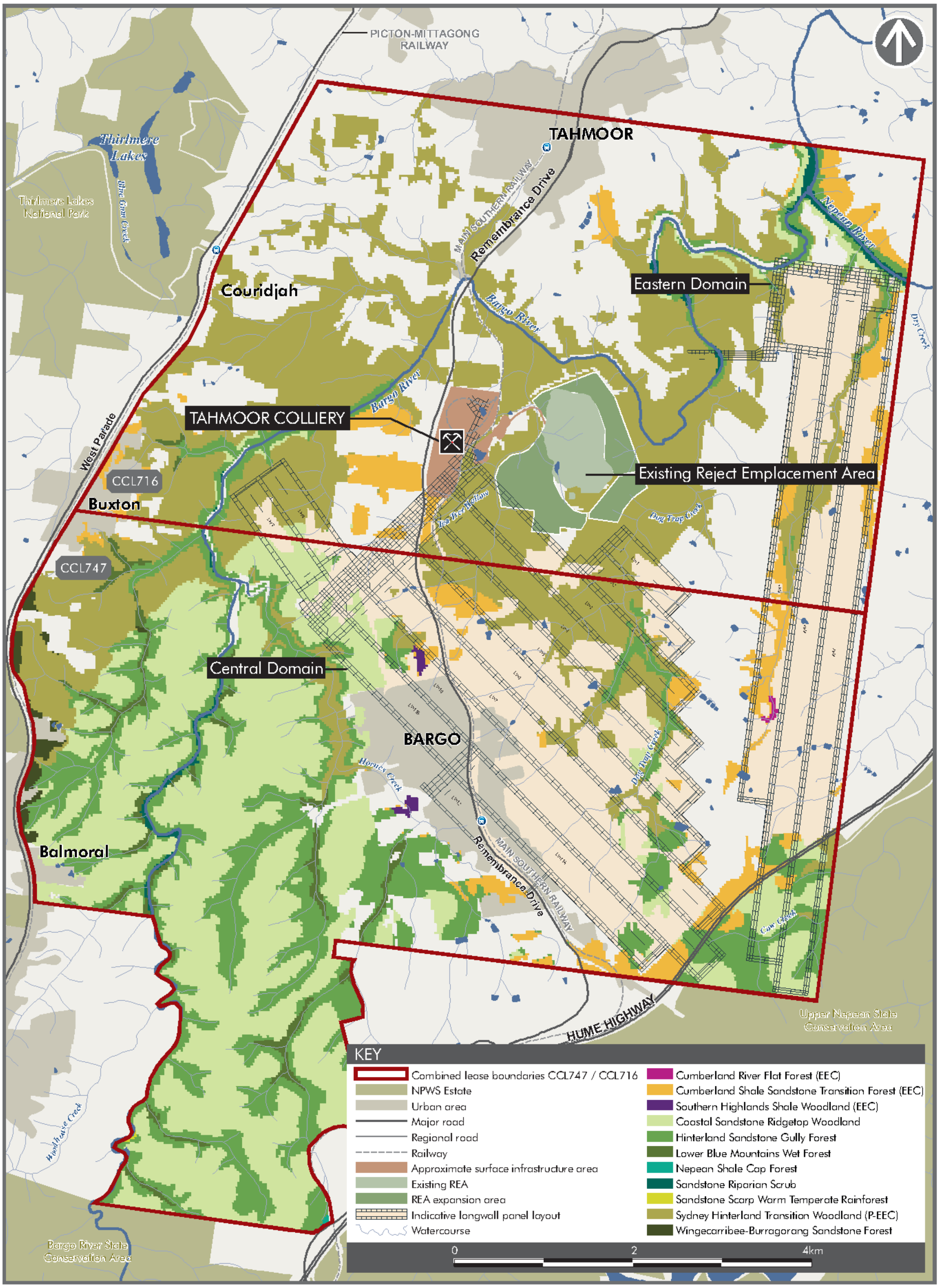

Figure 5-1 Rejects emplacement area expansion (source: AECOM Preliminary Environmental Assessment report (Ref 60267390)

5.1.1 Other surface disposal areas

A reject emplacement area at Bargo was approved in 1975 with approximately 65Mt storage capacity with the approval of coal mining within the Bargo Lease CCL747. The Bargo 1975 consent included a new pit top adjacent to the REA, which was sited within a valley of a tributary of the Bargo River.

Construction of the approved Bargo REA would present significant potential environmental issues.

A means of transporting the reject material from the Tahmoor site to Bargo would need to be established, potentially incorporating one of the following solutions:

- Road transport
- Overland conveyor
- Dedicated rail line
- Pumping

Based on the indicative capital and operating costs and significant potential environmental issues associated with each of these options, the easements/corridors required for the transport solution, and in consideration of the coal washery rejects levy that would apply, disposal off-site at an alternative facility was not considered further.

5.2 Underground disposal

As an alternative to disposing rejects above ground, an audit into the available volumes underground was undertaken. Depositing rejects can theoretically be carried out in the following areas:

- Existing old workings
- Future disused infrastructure
- Former goaf areas
- Active goaf areas

The following sections address the available volumes and technical difficulties with accessing these areas.

5.2.1 Disused workings

The intact infrastructure developed for producing the former panels can potentially be used to store reject material. However as this infrastructure is used for access and ventilation purposes, the area would not be available until all mining operations in that area have been completed. Three different reject delivery methods are available for disposing of the rejects, being:

1) Dry rejects by truck or LHD
2) Rejects in a slurry or paste by pipe underground
3) Rejects in a slurry or paste through boreholes from surface

The infrastructure bordering a produced longwall panel is assumed to have collapsed. Literature suggests that these collapsed walls will have a “higher” porosity, however it is assumed that penetration of the slurry or paste into these areas will be minimal. Therefore these former roadways are not included in the volume estimation.

An estimation of the total volume of one of the possible locations; the infrastructure surrounding longwall panels 1, 2, 8, 10,11,12 and 13 has been undertaken, adding to a total potential volume of approximately 320,000m^3, which would only offer space to a small fraction of the expected rejects (see Figure 5-2). In addition, none of the other former infrastructure areas seem to have sufficient volume to be feasible for rejects storage.

Figure 5-2 Available disused working Tahmoor North, southern section

The disused workings area dipping upward from the current active mine, therefore pumping material into this area from the currently in use roadways is not an option. In addition, the dip of the infrastructure is generally lower than the beaching angle of the paste or slurry which would result in only a small volume being accessed from a single injection point.

The following can therefore be concluded:

- The total available volume in disused workings is limited
- The accessibility of volume is expensive and could be potentially dangerous as these areas are currently sealed and will need to be re-ventilated and geotechnically stabilised for access. This is a risk issue and should be addressed accordingly.

5.2.2 Future available roadways

After longwall panel 36 has been produced, a larger volume of disused roadways will become available. A total length of approximately 80 km of roadways, which will have been in use up to that point, will be available for potential rejects depositing. The total volume available equates to approximately 880,000m^3.

However, if this volume was used for dry backfill storage this would result in a very long haul cycle. Also, because of the limited dimensions of the infrastructure, haul speeds will be low, low capacity equipment needs to be used and operational issues might arise with loading and dumping rejects. In addition, the regions that would become available for backfilling will require ventilation, diverting air from being used at Tahmoor South. As a result, additional vent shafts and fans may be required to be incorporated for the Tahmoor South development. Groundwater will need to be continued to be pumped from the underground emplacement area to the surface and then be treated, adding significantly to the cost of emplacement.

The following can therefore be concluded:

- Large future volume available
- High costs associated with haulage and depositing of material dry material. An estimated average cost of $30 per tonne can be expected for depositing dry rejects in the future disused roadways.
- Ventilation and groundwater issues may increase the complexity and cost of using the disused roadways for backfill storage.

5.2.3 Former goaf areas

Previous research undertaken into former (old) goaf areas suggests porosity between 6 and 10 per cent can be expected. As most panels are located far away from maintained infrastructure, boreholes from surface are needed to access these areas.

Using a porosity of 8 per cent in the former goaf areas, a total volume of approximately 2,011,000m^3 is estimated to be available. However this volume will only be available if extensive drilling is performed to access all the available areas and fill the goaf to their theoretic maximum capacity.

The reject pastes or slurries are unlikely to flow very far away from their injection points through these goaf areas, making the amount of material that can be stored per injection point approximately 25 per cent, which equates to 502,750 tonnes. Because the high capital costs involved with drilling boreholes from surface and the limited volume of rejects that is expected to be able to be injected from a single borehole, this method will economically be unfeasible. Cavities could exist along the goaf near the safety panels, which possibly can be filled using a limited number of boreholes assuming surface access for the boreholes can be obtained.

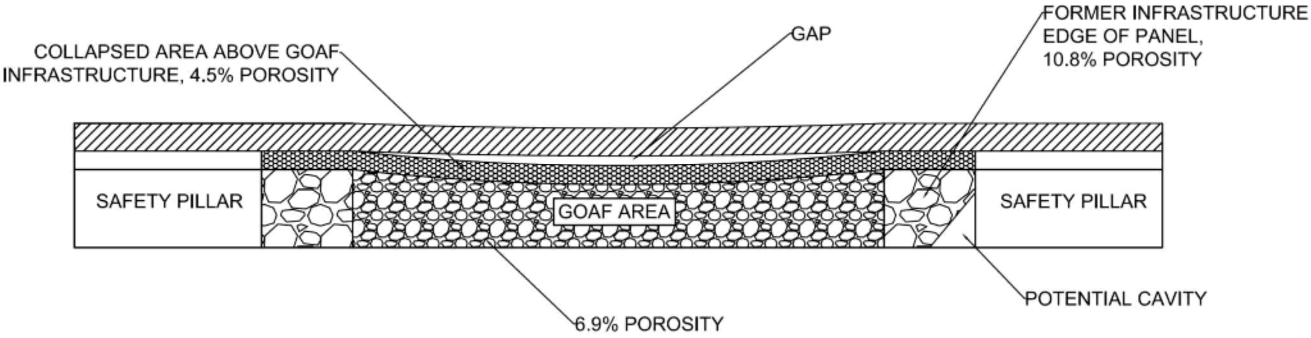

Figure 5-3 Theoretical porosities in and along goaf

The following can therefore be concluded:

- Large potential volume, however low practical volume
- Very high capital and operating costs
- High technical challenges
- Potentially feasible as an additional reject disposal option
- Difficulties due to surface access required including landowner consent

5.2.4 Active goaf areas via boreholes from current infrastructure

Rejects could be disposed in the active goaf areas in the caved zone above the caved material. (see Figure 5-4) However due to the bulking factor resultant from the difference in volume of the material before and after collapsing, the total volume available in these cavities is considered to be low.

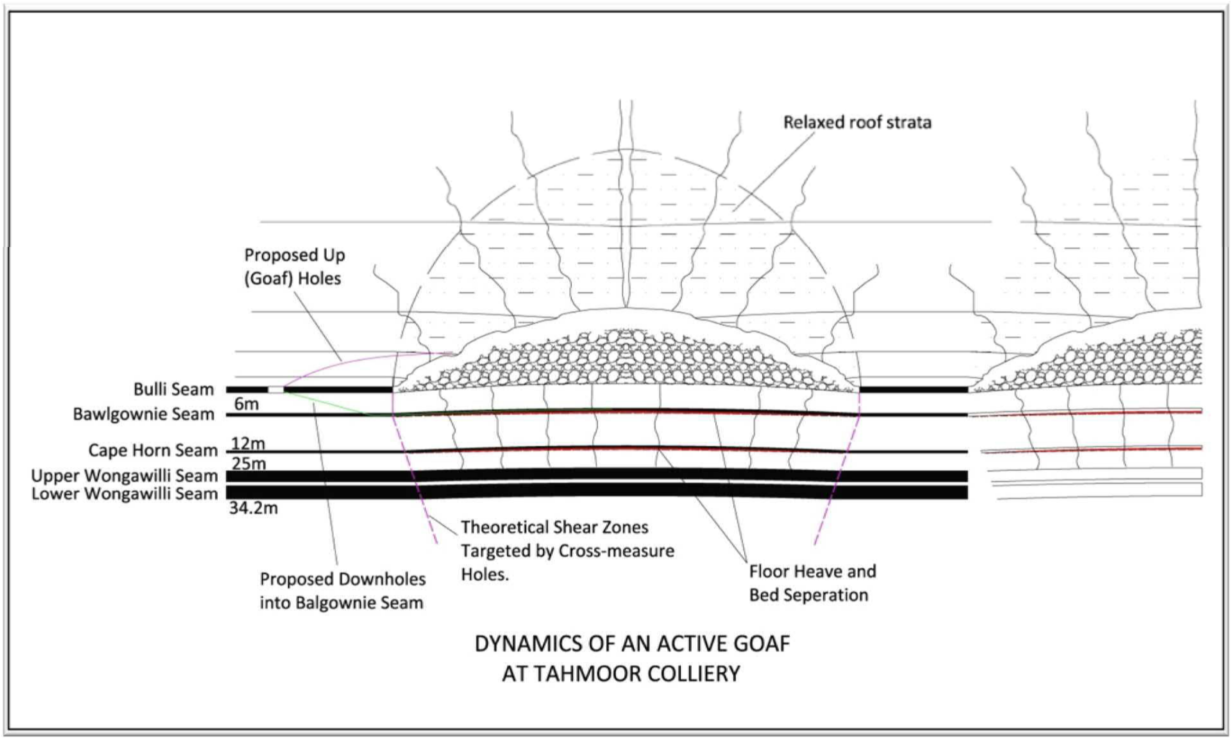

Figure 5-4 Zone above caved material

Bulking factors can generally range between 1.25 and 1.8 depending on the type of material. The caving zone height can generally be considered to range between 2 and 8 times the panel height, although the paper "Backfilling of Caved-in Goafs with Pastes for Disposal of Residues" by W, Mez, uses a more conservative estimate of 2 to 3 times the face thickness or panel height.

An estimation of the possible cavity above the collapsed cave material can be calculated using the following formula:

$$Cave\ zone\ height = (Panel\ height * Cave\ factor)$$

$$Cavity\ height = (Cave\ zone\ height + Panel\ height) - (Cave\ zone\ height * Bulking\ factor)$$

Local geological conditions suggest that the volume of the cavities above the caved zones might be very limited due to expansion of the overlaying sandstone layers.

When plotting the cavity height against the cave factor for materials with a bulking factor ranging between 1.25 and 1.5 it can be seen that for materials with a bulking factor larger than 1.45 no open cavity will be formed, in addition, if the caving factor is larger than 4 no open cavity will be formed (refer to Figure 5-4). The maximum cavity height possible under perfect circumstances is 1m, taking into account the shape of the cavity and the possibility of rejects not filling all available volume, a 0.5 factor was applied for calculating the volume.

A total volume of 20,664,000m^3 could be available in the panels of the Tahmoor South operation, if ideal rock conditions are present. However, this volume will be lower or negligible if rock conditions are less than ideal. In addition, for a cavity to form as suggested in the picture, perfect rock conditions would be needed, this occurring at all is therefore deemed very unlikely.

Injecting rejects into the active goaf areas also will require boreholes to be drilled trough the still active overlaying layers. Because these layers will still be moving these boreholes will quickly get blocked making this option unfeasible.

The total volume of the cavities caused by bed separation can be disputed. If a cavity does form it would only have a limited volumetric capacity. Exactly pinpointing its location would be difficult, which will make it likely that drill holes drilled to access these cavities will fail.

Depending on the rejects ability to permeate into the active goaf material, the number of boreholes that can be practically drilled might be very limited, reducing the total volume that can practically be accessed. Taking this into account, a total available volume of 10 per cent of the theoretical volume can be assumed, equating to 2,066,400m^3

The following can therefore be concluded:

- Large potential volume, however limited to minimal volume under less than ideal circumstances
- Very high technical challenges
- Access from the surface required with difficulties associated with landowner access.

5.2.5 Active goaf area via trailing pipe

As outlined in Section 3.6 for the Walsum colliery in Germany, using a trailing pipe behind the longwall is a method that has been successfully applied in longwall operations to deposit rejects in the active goaf area behind the longwall (see Figure 5-5). Rejects in a slurry or paste are pumped through this trailing pipe into the material that has recently collapsed after the coal seam has been mined. Because of the relative short time between collapse and injection, only limited settlement of the rock will have occurred, giving a higher porosity which will allow for a larger volume to be injected.

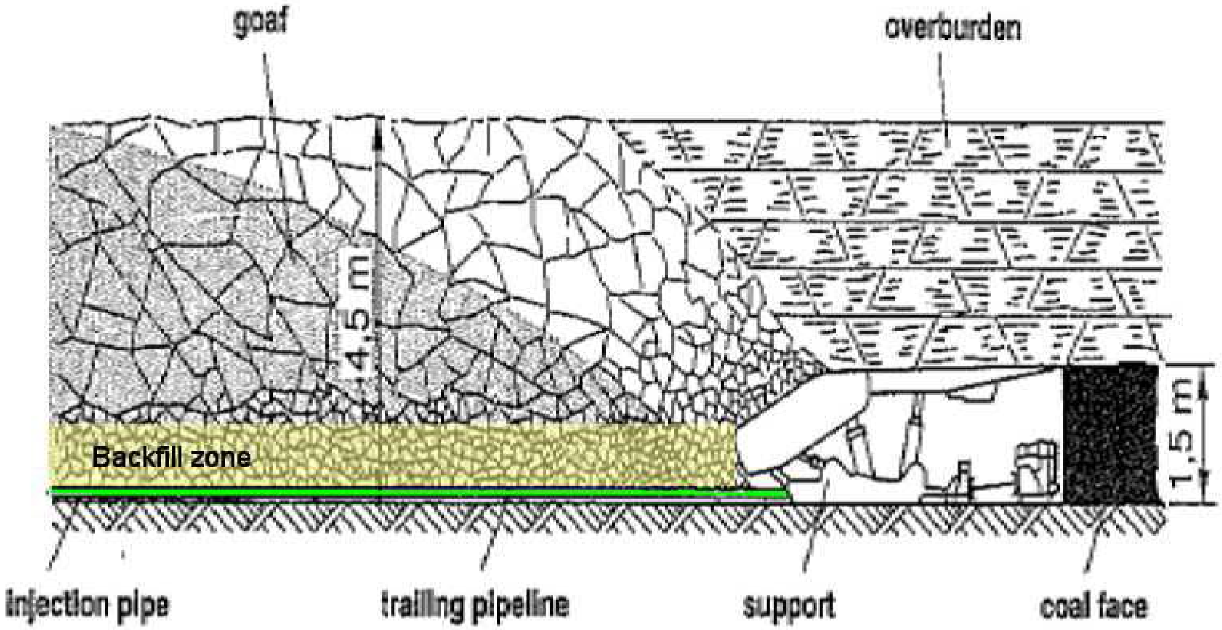

Figure 5-5 Example of trailing pipe in active goaf area (trailing pipe in green)

If the longwall operation is advancing down dip, gravity will pull the slurry or paste to the longwall operation. In addition, when advancing down dip, water in the slurry will flow into the longwall causing operational issues for the longwall, making this option unfeasible.

Slurry or paste flow could also be an issue if the longwall is operating under an angle away to either end, where water from the rejects could gather at each far side of the operation. Under this scenario, the volume that is available for backfilling is significantly reduced.

Based on the current mine plan for Tahmoor South, there is a large portion of the mine with unsuitable inclination for backfilling by trailing pipe, with an area of 24,797,221m^2 estimated to have suitable inclination. Based on a limited depth of backfill zone, and an assumed porosity of the collapsed goaf material, a total available volume for backfilling by trailing pipe was estimated at 6,199,305m^3. Refer to Section 7.3 for further discussion on volumes required for underground disposal by trailing pipe.

As goaf material will be collapsing and settling on top of the trailing pipe, damage to the trailing pipe might occur. Because the trailing pipe is buried and located in the goaf area repairing the trailing pipe is not possible. To protect the trailing pipe, a sacrificial element might have to be added to the system such as protective plating. However as outlined in Section 3.6, at the Walsum Colliery it was reported that damage or deformation to the trailing pipes was minimal.

In order to distribute the desired volume of rejects, the pipe should be flexible enough to cope with the changing location of the supports relative to each other.

This option is further discussed in more detail in Section 7.2 however the following can be concluded:

- Large potential volume however may still require alteration to the mine plan
- Risk of interference with mining operations
- High technical challenges
- Large quantities of processing water required
- Not feasible under all mining conditions, for instance when mining down dip.

5.2.6 Underground disposal summary

Table 5-1 provides a summary of estimated volumes available for disposal of reject material underground. The estimates provided are highly theoretical in nature and subject to fluctuation due to actual mining profiles and geological conditions. On this basis, the figures presented are likely to vary significantly and have a low level of accuracy.

Table 5-1 Underground disposal volumes

Disposal location	Estimated volume available (m^3)
Disused workings	320,000
Future available roadways	880,000
Former goaf areas	2,011,000
Active goaf areas via boreholes from roadways	2,066,400
Active goaf via trailing pipe	6,199,305
Total	**9,410,305***

Notes: ***** *The active goaf can only contribute once to the total, hence the total is based on the trailing pipe disposal method (6,199,305m^3)*

6. Preliminary analysis of options

6.1 Option 1 – Surface disposal at existing rejects emplacement area

This option consists of continuing the emplacement of rejects from the current CPP via road haulage to the REA site.

Advantages

- Poses little risk to mine personnel and operations since it does not involve underground activities.
- No need for transition into a new system
- Low capital and operating costs
- Rejects available for future reuse if reuse becomes viable option.

Disadvantages

- Hauling costs may increase in the future
- The noise and dust impact of dozer and dump trucks on urban areas
- Capacity might be limited if expansion is not approved
- Vegetation clearing
- Land sterilisation from expanded REA.

Conclusion

Environmental issues, such as noise and possible licensing restrictions may threaten this alternative. However, it is a technically simple and economical option.

6.2 Option 2 – Underground disposal as dry material

6.2.1 Manual disposal underground

This option explores the underground emplacement of rejects using a low loader via the mine access roads into disused workings.

Because of the infrastructure dimensions a small low loader like the CAT1300G may need to be used, with a payload capacity of 6.8 tonnes. If all the available volume in the Tahmoor North operation is to be used, and thus also the most remote parts of the mine are to be backfilled, cycle times of up to 53 minutes for the low loaders can be expected. These cycle times will result in a capacity of approximately 7.6tph per loader. In order to place 300 tonnes of reject each hour a fleet of up to 40 low loaders would be needed, operating 24 hours, 7 days a week.

Advantages

- Low impact on the environment
- Low complexity, high reliability
- Areas being abandoned in the future can be backfilled before being sealed off without extra capital costs to prepare the infrastructure. Although the available volume will be limited, this could be used to complement another reject system

Disadvantages

- Roads, ventilation shaft and mine old and waste workings will need to be maintained and/or repaired, at a capital cost, prior to backfilling

- Volumes available at old workings are insufficient for rejects generated over the life of mine
- A safety risk exists to personnel operating in old workings
- Generally, this is a labour intensive operation
- Some areas of the old workings may be flooded and hence unavailable
- Increased traffic underground might cause delays to mining operations
- Due to limited height of roadways, placement of material might be difficult and/or inefficient
- Materials handling area will have to be constructed underground with sufficient height to unload trucks
- Haul distances of up to 10km in length and cycles of up to 53 minutes
- Very low disposal capacity, estimated as 7.61tph per loader hence a large fleet of low loaders (up to 40) are necessary
- Very high operating costs of up to $29 per tonne for underground haulage
- Large fleet of low loaders necessary
- High capex and operational issues
- Due to the limited dimensions of the underground workings, passing oncoming traffic is impossible. In order not to cause “traffic jams” only a limited fleet of low loaders can be operated simultaneously. This will limit the maximum hourly backfill capacity that can be achieved. “Traffic jams” caused by the increased amount of equipment operating underground can cause delays to the mining operation.
- Increased ventilation requirements, in approximately 5m^3/s per low loader, would require higher capital costs to increase the ventilation capacity.

Conclusion

The relatively high operating costs when compared to other options and the limited available volume make this option unviable as a standalone solution. It may be viable as an additional option when only targeting areas that are easily accessible and where backfilling can be performed causing minimal interference to the mining operation.

6.2.2 Fully mechanised backfilling coal mining

This is a backfilling technique currently in use at the Xingtai Coal mine in China. The reject material is discharged from a conveyor (extended from a canopy) which is attached to the back of the longwall shield. Dry material is discharged through ports on the bottom of the conveyor, dropping the material into the void behind the shield. Tamping arms push material into the upper part of the void to compact the material. This method allows for almost 100 per cent of the goaf area to be backfilled. This method has been used where subsidence is required to be kept to a minimum such as mining beneath water bodies, buildings and railways.

Advantages

- Low impact on the environment
- Large volumes of material can be backfilled into the active goaf area leaving minimal subsidence.
- Approximately 15 per cent of the material produced from the longwall operation is rejects, as this backfill technique can backfill up to almost 100 per cent of the produced volume extra material has to be found to overcome this difference. Therefore potential exist to use material of existing dump piles, decreasing the impact of these dump piles on the environment.

Disadvantages

- Low productivity, this backfilling technique goes through several stages of discharging and compacting of the discharged material using the tamping arm. Maximum of 3.6 meter advance per day has been achieved.

- The canopy supporting the backfilling conveyor does not have the structural strength to support the full weight of the overhanging roof, therefore complete backfilling of the goaf area is required to prevent the roof from exerting too much pressure on the canopy. Additional backfill material from other sources will need to be inserted to reach the required backfill ratio. When the supply of backfill material is disrupted, the longwall operation will not be able to continue.
- An additional conveyor system will need to be installed to convey the material to the longwall along the tailgate, triggering additional capital costs and potentially interfering with operations and production.
- The technique has been used in a single operation, therefore operational and technical issues are likely to exist.
- Careful consideration needs to be given to transporting material underground via a vertical or declined pipe in order to avoid clogging. Incorporating velocity damping, continuous unloading at the bottom, low moisture content and careful selection of pipe diameter will assist alleviating these issues.

Conclusion

- The low advance rate of the longwall will result in a productivity that much lower than the current target production and therefore this option is unlikely to be feasible. This option is primarily suitable for mining operations where subsidence has to be avoided.
- Further research and development is required on this technique to overcome potential operational and technical issues

6.3 Option 3A – Underground disposal as paste material (disused roads, goafs via pipeline)

Under this option, a high density (80 w/w%) paste is to be prepared and pumped into disused roads, goafs and other available volumes using a pipeline.

Advantages

- Low visual impact, noise and dust generation
- Low water usage compared to slurry systems.

Disadvantages

- Roads, ventilation shaft and mine old workings will need to be maintained and/or repaired prior to backfilling, at a significant cost, to ensure safety of operations
- Volumes available at old workings are insufficient for life of mine
- A safety risk exist to personnel operating in old workings
- Some areas of the old workings may be flooded
- High costs associated with the paste plant and pipeline.

Conclusion

The high cost compared to other options and limited available volumes make this option unviable

6.4 Option 3B – Underground disposal as paste material (former goaf areas via boreholes)

This option differentiates from option 3A in that the backfilling is made from boreholes drilled from the surface.

Advantages

- Low visual impact, noise and dust generation
- Low water usage compared to slurry systems.

Disadvantages

- The state of former goafs underground is generally unknown. In most cases, these areas have partially or totally collapsed providing little certainty on how much backfill can be emplaced. This may render this option very expensive if several boreholes have to be drilled to accommodate the backfill.
- Exploration to establish available volumes is a major difficulty. It is believed that as few as three boreholes could be successfully drilled along an entire longwall. This may render a small fraction of the potential volume for this option (2,956,600m^3)
- Risk of increased gas/water migration into the goaf
- Risk of borehole causing water contamination of groundwater resources.
- High cost associated with the paste plant and pipeline
- Limited area available on surface for necessary infrastructure.

Conclusion

The high cost and risk, compared to other options, and limited available volumes make this option unviable

6.5 Option 3C – Underground disposal as paste material (active goafs via a trailing pipe)

Under this option, a high density (80 w/w%) paste is to be prepared for pumping underground, and injected into the active goaf before it collapses via trailing pipes from the longwall.

Advantages

- This method promotes a much better paste dispersion into the goaf
- Low visual impact, noise and dust generation
- Low water usage compared to slurry systems.

Disadvantages

- High capital and operating costs
- The system depends on the longwall advance to create the necessary space
- The backfill paste has to be carefully emplaced to avoid disturbance by the ingress of paste to the longwall working area
- There is still moderate risk of paste liquefaction due to shocks or vibration
- In the event that flushing of the pipeline is required, considerable water flow may ingress the active goaf.

Conclusion

This option has high cost, high technical difficulties and may potentially interfere with operations. Moreover, the paste plant availability might be as low as 70 per cent and it is not clear whether there is enough volume available underground. To overcome these volume limitations, this option has to include a by-pass mode that allows processing the rejects as dry material, using the current system. With this addition in place, this option will be taken for further analysis at Section 7.2.

6.6 Option 4A – Underground disposal as slurry (disused roads, goafs via pipeline)

This option considers the preparation of slurry (up to 50 w/w%) to be pumped into disused roads, goafs and other available volumes utilising a centrifugal pumps and pipelines. The water that drains off the emplaced slurry must be pumped back to the surface for reutilisation.

Advantages

- Slurry systems configured around low pressure centrifugal pump are less capital intensive than high pressure pipelines and positive displacement pumps required for paste systems
- Crushing of rejects may not be required
- Low visual impact, noise and dust generation.

Disadvantages

- Moderate to high cost compared to dry disposal options
- High volumes of water to be, either, utilised or recirculated
- The slurry is transported at higher velocity and has a larger average particle size when compared to paste; therefore it is expected to result in high pipe wear
- There is significant risk of pipe clogging and regular 'pigging' may be required
- High pressure build-ups at bulkheads might occur, causing high risks to operation/personnel.

Conclusion

This option is not recommended due the limited volumes available underground and the high flow velocity required to maintain the solids in suspension.

6.7 Option 4B – Underground disposal as slurry (former goaf areas via boreholes)

Advantages

- Slurry systems configured around low pressure centrifugal pump are less capital intensive than high pressure pipelines and positive displacement pumps required for paste systems
- Crushing of rejects may not be required
- Low visual impact, noise and dust generation.

Disadvantages

- High volumes of water to be utilised
- The slurry is transported at higher velocity and has a larger average particle size when compared to paste; therefore it is expected to result in high pipe wear
- The permeability through the collapsed goaf may be very low, forcing a large number of boreholes to be drilled which will, in turn, increase the cost significantly
- There is significant risk of pipe clogging and regular 'pigging' may be required
- Ground water inflow due the drilling of boreholes is a significant risk
- Moderate to high cost compared to dry disposal options
- The available volume underground is very limited due to high housing density.

Conclusion

This option is not recommended due the operational risk and high velocity required to maintain the slurry solids in suspension.

6.8 Option 4C – Underground disposal as slurry (active goafs via a trailing pipe)

Advantages

- Slurry systems configured around low pressure centrifugal pump are less capital intensive than high pressure pipelines and positive displacement pumps required for paste systems
- Crushing of rejects may not be required
- Low visual impact, noise and dust generation.

Disadvantages

- High risk of slurry or water ingress into working areas
- High volumes of water to be reclaimed to the surface
- The slurry is transported at higher velocity and has a larger average particle size when compared to paste; therefore it is expected to result in high pipe wear
- Collection drains, sump pumps and piping must be installed to reclaim the water to the surface resulting in additional capital and operating costs
- Special bulkheads may have to be constructed to let water drain out of slurry while retailing the solids
- Water drainage increases risks of mine gasses accessing active workings
- There is significant risk of pipe clogging and regular 'pigging' may be required
- Risk of paste liquefaction due to shocks or vibration.

Conclusion

This option is not recommended due the operational risk and high velocity required to maintain the slurry solids in suspension.

6.9 Option 5 – Reuse of rejects materials as road base

This option explores the use of rejects as road base material.

Advantages

- Reuse of waste, minimum impact to the environment. This option does not require the clearing of further potentially sensitive environments or installation of additional infrastructure.
- Poses little risk to mine personnel and operations since it does not involve underground activities.
- No need for transition into a new system
- A general waste exemption for coal washery rejects materials has already been approved for use by the EPA.

Disadvantages

- Currently, the market is not big enough to absorb all rejects. It would have to be developed and the timeframe of this project does not allow for it.
- The noise and general traffic impact of trucks on urban areas is significant and may limit its operation
- Other external environmental issues, such as noise, air quality and traffic impacts
- Will need separate project approvals.

Discussion

Rejects typically comprise a mixture of sandstone/shale coarse rejects and coal fines. Laboratory tests of the rejects materials have been undertaken by Tahmoor Coal, with results included in Appendix F. Testing included Particle Size Distribution, Atterberg Limits, Compaction, CBR and strength testing. Testing was undertaken to assess whether the materials could be used as an unbound road-base quality material, with results compared against the RMS Specification 3051 in the laboratory certificates.

The testing undertaken indicated that the material was non-conforming to sub-base quality material, without further processing and modification of the material sampled. The material grading was generally within specification for sub-base quality, however the wet strength of (39kN) was out of specification and the soaked CBR (13 per cent) indicates that the material is being affected by compaction cycles and breaking down under soaking making it unsuitable for a sub-base quality material. However, it should be note that only one test was undertaken, and that this sample may not be fully representative of the rejects materials being produced and that further testing may be warranted.

Based on the laboratory testing undertaken, the rejects material can be used as general fill material, provided oversize (>250 mm fragments) are broken down during compaction and spreading.

A general waste exemption for coal washery rejects has already been approved for use by the EPA (refer *Protection of Environmental Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A*, copy attached as Appendix G).

Laboratory tests of the chemical concentration of the rejects material have been undertaken by Tahmoor Coal, with results included in Appendix F. From the test undertaken, the material complies with the chemical concentration requirements of the coal washery exemption; refer Table 2 in Appendix G. However it should be noted that a single sample cannot be considered as being representative of the material and as a minimum, the sampling and testing of the rejects would need to be undertaken in accordance with the coal washery rejects general waste exemption.

The site receiving the washery rejects will need to be lawfully allowed to receive waste that is consistent with the rejects characteristics; this may require the receiving site to have an Environmental Protection Licence (EPL) or other planning approvals as required (waste tracking etc.) which confirms it is able to accept the washery rejects material.

The transportation of the washery rejects will increase the number of heavy vehicles on public roads, increasing the impact upon the local community and possibly increasing dust impacts.

The following tasks / activities would need to be undertaken prior to adopting a re-use solution for the reject material:

- Locating a suitable Client / site's that require the fill material consistent with CWR characteristics; that has an EPL which allows the CWR to be received and is willing to accept the material can be highly variable and unreliable.
- Further testing of the geotechnical properties to determine suitability for proposed use
- Further testing of the chemical properties in accordance with the general exemption for washery rejects. This can be completed within 1-2 months (mobilisation through to reporting), although additional ongoing testing may be required during the removal of the rejects to confirm the chemical properties remain consistent.
- Receiving Client / site application and receival of appropriate EPL, which can range from one to twelve months (depending upon Client relationship and previous dealings with the EPA).
- Approvals from government regulators including EPA, OEH, RMS and WollSC are required, prior to commencement.

6.9.1 Conclusion

This option is unviable as a complete rejects disposal solution due to the limited market size. However, this option may be partially utilized to address events of peak load on the system or as a future alternative.

7. Detailed analysis of short-listed options

To assist in referencing the short listed options analysed, each of the options has been given a number in which to identify them. For the remainder of this report, these options will be identified as:

- Option 1 – Surface disposal – Rejects emplacement area, modified EPL boundary
- Option 1A – Surface disposal – Rejects emplacement area, existing EPL boundary
- Option 2 – Co-disposal – Surface rejects emplacement and underground paste material (active goaf via trailing pipe)

7.1 Option 1 Surface disposal – Rejects emplacement area, modified EPL boundary

The surface disposal option is a continuation of the current rejects disposal method. This option assumes the approvals within the EIS for the expansion are accepted and that the EPL boundary is modified to meet the REA design.

7.1.1 General description

The waste product produced by the washing process is composed of a coarse and fine reject stream. The fine stream is dewatered using a belt press before being combined with the coarse stream, and transported by the 3R conveyor to the reject bin, for loading into rear-dump haul trucks.

The rejects are transported by haul trucks, on private roads within the site, and emplaced at the site REA. Rejects are dumped, compacted, shaped, topsoiled and progressively rehabilitated.

7.1.2 Process flow diagram

Figure 7-1 shows a proposed block flow diagram for the surface disposal option.

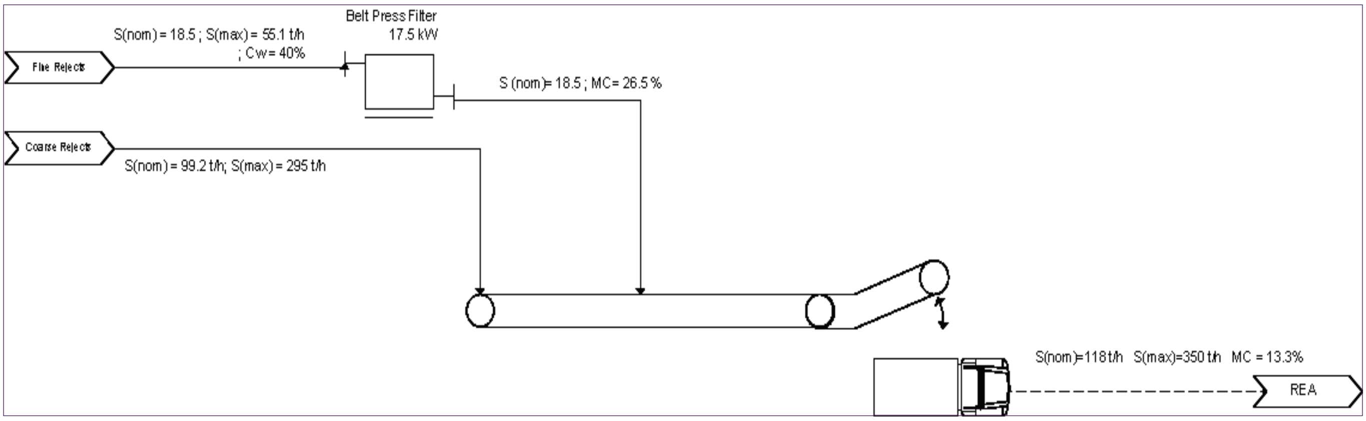

Figure 7-1 Process flow diagram, surface disposal

7.1.3 Proposed expansion

The existing REA will be fulfilled in 2023. A recent REA expansion design has been completed, targeting an additional 20Mt. The additional storage capacity, equating to 9.9Mm^3, is to accommodate emplacement of rejects from the Tahmoor North project and the proposed Tahmoor South project.

Three new areas adjoining the existing REA are proposed within the design, as shown in Figure 7-2, using a stagged fill plan approach.

ROM tonnages provided by Tahmoor Coal were used for the CAPEX and OPEX calculations associated with this rejects disposal options study.

The calculated REA volumes (and baseline tonnage capacities) for the proposed expansion are summarised in Table 7-1. The total rejects emplacement tonnage capacity will be dependent on compaction levels achieved over the course of the emplacement operations. The calculated design tonnage capacity of 20Mt is based on limited or reduced compaction levels (2.02t/m^3 loose density).

Table 7-1 REA volume summary

Description	**Area (m^2)**	**Fill (m^3)**	**Storage capacity (t)**
Area 1	592,989	8,168,317	16,500,000
Area 2	210,677	1,732,673	3,500,000
Totals	**803,666**	**9,900,990**	**20,000,000**

Based on the expanded REA area volumes and the nominal rejects filling rate, Table 7-2 indicates the proposed staging of the capital works matching a staged filling plan.

Figure 7-2. Proposed REA expansion

Table 7-2 REA fill plan summary and proposed staging of works

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Reject Emplacement Area:																											
Existing:	■	■	■	■	■	■	■	■	■																		
Area 2: 3.5 Mt						■	■	■	■	■	■																
Area 1: 16.5 Mt										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Staged Works Plan																											
Haul Roads						MC01 & MC03					MC02 (Area1)																
Drains						MD03 & MD04 (Area 2)					MD01 (Area 1) & MD02 &MD05																
Sediment Basins						S11					S12																
Pump Station						S11					S12																
Power Line Relocation											100%																

7.1.4 Infrastructure relocation

In the process of investigating the possibilities for future expansion of the existing REA, the need to relocate a number of power infrastructure assets was identified, namely Endeavour Energy's 66kV Tahmoor – Maldon ZS overhead transmission line and 11kV Tahmoor – Maldon ZS distribution line.

The extension to the REA will require the existing electricity overhead lines within the proposed REA extension in Area 1 to be removed and installation of new overhead lines around the boundary of the proposed REA extension.

Removal of existing assets consists of removing the existing 66kV on concrete poles with 11kV underbuilt overhead line. The asset removal scope is from A to J (824 m in route length) and from J to H (626m in route length). This is marked in the Figure 7-3.

It was assumed that the capacity of Endeavour Energy's existing assets in the vicinity of section proposed to be removed are loaded to optimum level, and as such, they do not have the spare capacity to accommodate additional load.

With reference to Figure 7-3 over page, the preferred option includes the installation of both 66kV and underbuilt 11kV overhead lines around the north-east to the REA Area 2, including:

- Connection to existing 66 kV and 11kV lines with reinforcement of existing structure at P with tie down cables/guy pole;
- 66kV on concrete poles with 11kV underbuilt overhead lines from P to N spanning 347m in route length;
- 66kV on concrete poles with 11kV underbuilt overhead lines from N to M spanning 653m in route length;
- 66kV on concrete poles with 11kV underbuilt overhead lines from M to L spanning 655m in route length; and
- Connection to existing 66kV and 11kV lines with replacement of existing structure at L with stronger pole.

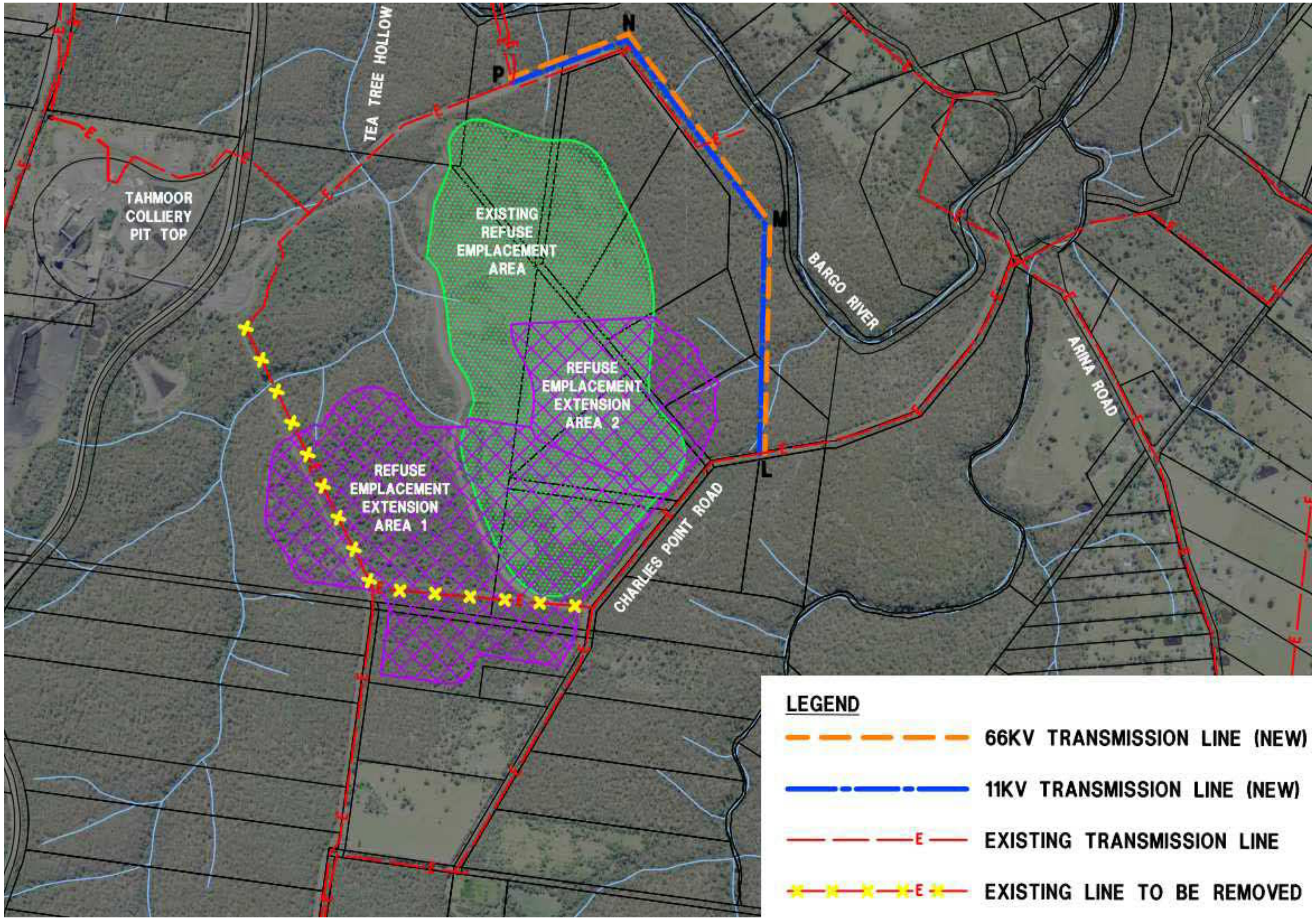

Figure 7-3 Transmission line relocation

7.1.5 Emplacement area operation

The existing REA is operated by a Contractor, currently Trazblend, specifically engaged for this task. The REA is operated 24 hours per day Monday to Friday. It is understood that a similar arrangement would be carried forward for the proposed expanded REA.

The scope of the REA operation contract includes:

- Removing existing vegetation, including all trees and shrubs
- Stripping and stockpiling of topsoil, typically the top 150mm of soil
- Transporting of reject material, including minimisation of dust through the use of water carts
- Placing of the reject material, including spreading and compacting of the reject in layers to a density of 95 per cent standard
- Trimming and shaping to achieve the planned landform
- Covering the reject material with the stockpiled topsoil when the landform has reached its planned shape.

The contractor is not responsible for:

- Contour drains
- Preparation for seeding and planting
- Seeding and planting of finished areas

The latest listing provided by Trazblend indicates that the following plant and equipment are available for use in the operation of the REA:

- Kenworth Dart haul trucks
- Caterpillar D8 dozer
- Caterpillar 966 font end loader
- Caterpillar 631B scraper

Consideration has been given to future replacement of the existing Kenworth Dart haul trucks, possibly with new Komatsu HD465-7EO trucks (or similar).

7.1.6 Environmental issues

The following environmental issues have been identified by SKM in our assessment of this disposal option.

Opportunities

- Mining infrastructure has already been constructed to distribute rejects to the REA.
- The disposal method is proven to be acceptable and low-complexity.
- The REA is within the existing mining lease held by Tahmoor Coal.

Constraints

- The proposed extension of the REA will require the clearing of ecological areas for flora and fauna.
- The REA extension is known to include threatened species of vegetation including Personia bargoensis.
- The proposed extension of the REA may fill or alter the path of several small streams that feed into the Bargo River.

- The extension of the proposed REA may create further dust and noise problems for surrounding community.

7.1.7 Capital costs

Capital costs were based on the design of the reject emplacement area expansion dated May 2013. Whilst there have been modifications to the forecast rejects tonnages and hence modifications to the REA design, for the purposes of this disposal options study, it is not considered such modifications are significant and therefore May 2013 costs have been adopted.

The basis of estimate for the capital costs associated with the expansion of the rejects emplacement area is contained in Appendix C.1. A detailed breakdown of capital costs is provided in Appendix C.2.

The REA expansion is to be staged for progressive capacity increases. Table 7-3 provides a summary of total capital costs.

Table 7-3 Summary of capital costs

Item	UoM	Cost
Haul roads	$	4,332,621
Sedimentation basins	$	6,448,727
Drains	$	6,748,850
Pumping and piping	$	2,092,784
Power line relocation	$	1,700,000
EPCM, Owners Costs, Contingency	$	7,569,516
Total CAPEX	$	**28,892,498**

7.1.8 Operating costs

The annual and total forecast rejects from the mine, are provided in Table 7-4 from the mine plan data (ref. Tahmoor Coal data issued 15 August 2013). Whilst there have been subsequent revisions to the annual and forecast rejects, for the purposes of this disposal options study the August 2013 data has been adopted for the calculation of operating costs.

Table 7-4 Annual and forecast rejects (Mtpa)

Yield Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ROM (Mt)	2.500	2.559	2.599	2.608	2.556	2.744	3.174	2.924	2.750	2.903	4.434	3.470	3.538	3.604
Product (Mt)	1.750	1.791	1.819	1.826	1.789	1.921	2.222	2.047	1.925	2.032	3.104	2.429	2.477	2.523
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	0.750	0.768	0.780	0.782	0.767	0.823	0.952	0.877	0.825	0.871	1.330	1.041	1.061	1.081
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

Yield Year	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
ROM (Mt)	4.210	3.779	3.575	4.286	3.912	3.846	4.421	2.636	3.463	3.322	3.467	3.425	2.663
Product (Mt)	2.947	2.645	2.503	3.000	2.738	2.692	3.095	1.845	2.424	2.326	2.427	2.397	1.864
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	1.263	1.134	1.073	1.286	1.174	1.154	1.326	0.791	1.039	0.997	1.040	1.027	0.799
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

The OPEX has been estimated based on the total forecast rejects from the mine. Calculations for the OPEX will commence upon fulfilment of the existing REA. For the REA disposal option, the major contributors to operating costs are:

- Labour
- Consumables (fuel, tyres)
- Maintenance
- Equipment leasing
- Vegetation clearing.

The OPEX for this option is presented in detail at Appendix D.1. The operating costs for the first year of operation are presented on Table 7-5.

Table 7-5 OPEX for year 1

Year	UoM	Value
Rejects at forecast Yield	Mtpa	0.440
Average rejects throughput	tph	132
Labour	$	1,456,000
Consumables	$	216,617
Maintenance	$	225,564
Heavy plant leasing	$	382,065
Vegetation clear and grub	$	48,373
Contractor Profit	$	91,144
Total OPEX	**$** **$/t**	**2,419,764** **5.50**

7.1.9 SWOT analysis

The Strength, Weakness, Opportunity and Threat (SWOT) analysis of this option is presented in Figure 7-4 below.

Strength

- Low CAPEX
- Low OPEX
- No modifications required to the existing coal process plant
- Maintains the existing reject disposal method - hence, operations is already familiar with the disposal method
- Provides local employment in the form of Contract personnel

Weakness

- Visual impact, although limited by surrounding vegetation
- Noise and dust generation
- Green house gas contribution by haul trucks and dozers
- Increases water captured in the REA drainage. Thus the maintenance of drainage, storage and pumping, and risks associated with increase drainage water to manage
- Spontaneous combustion risk

Opportunity

- Leaves open the opportunity to beneficially use rejects for construction materials in the future (pending adequate material properties and demand)

Threat

- Authority approval yet to be granted for the REA expansion
- Operations could be restricted to day haulage only, requiring additional storage capacity at the end of the reject conveyor

Figure 7-4 SWOT analysis, surface disposal – expanded rejects emplacement area

7.2 Option 1A Surface disposal – Rejects emplacement area, existing EPL boundary

The Option 1A surface disposal option is a continuation of the current rejects disposal method, similar to Option 1, described above in Section 7.1, however, it assumes the EPL boundary is not modified and the existing EPL boundary remains.

7.2.1 Proposed expansion

As per Option 1, the existing REA will be fulfilled in 2023. Rejects will then be disposed according to a staged fill plan, with the rejects disposed of in areas outside the EPL as late as possible.

This option assumes any tonnes disposed beyond the EPL boundary, as shown in Figure 7-5, will attract a $15/t coal washery rejects levy, as determined by the Department of Environment, Climate Change and Water NSW. The forecast tonnes to be disposed beyond the existing EPL boundary are listed within Table 7-6.

Table 7-6 Forecast rejects tonnes beyond EPL boundary

Description	Forecast tonnes (t)	Remaining Capacity within EPL (t)	Forecast Fill tonnes outside EPL (t)
Area 1	16,500,000	15,766,089	733,911
Area 2	3,500,000	3,073,965	426,035
Totals	**20,000,000**	**18,840,054**	**1,159,946**

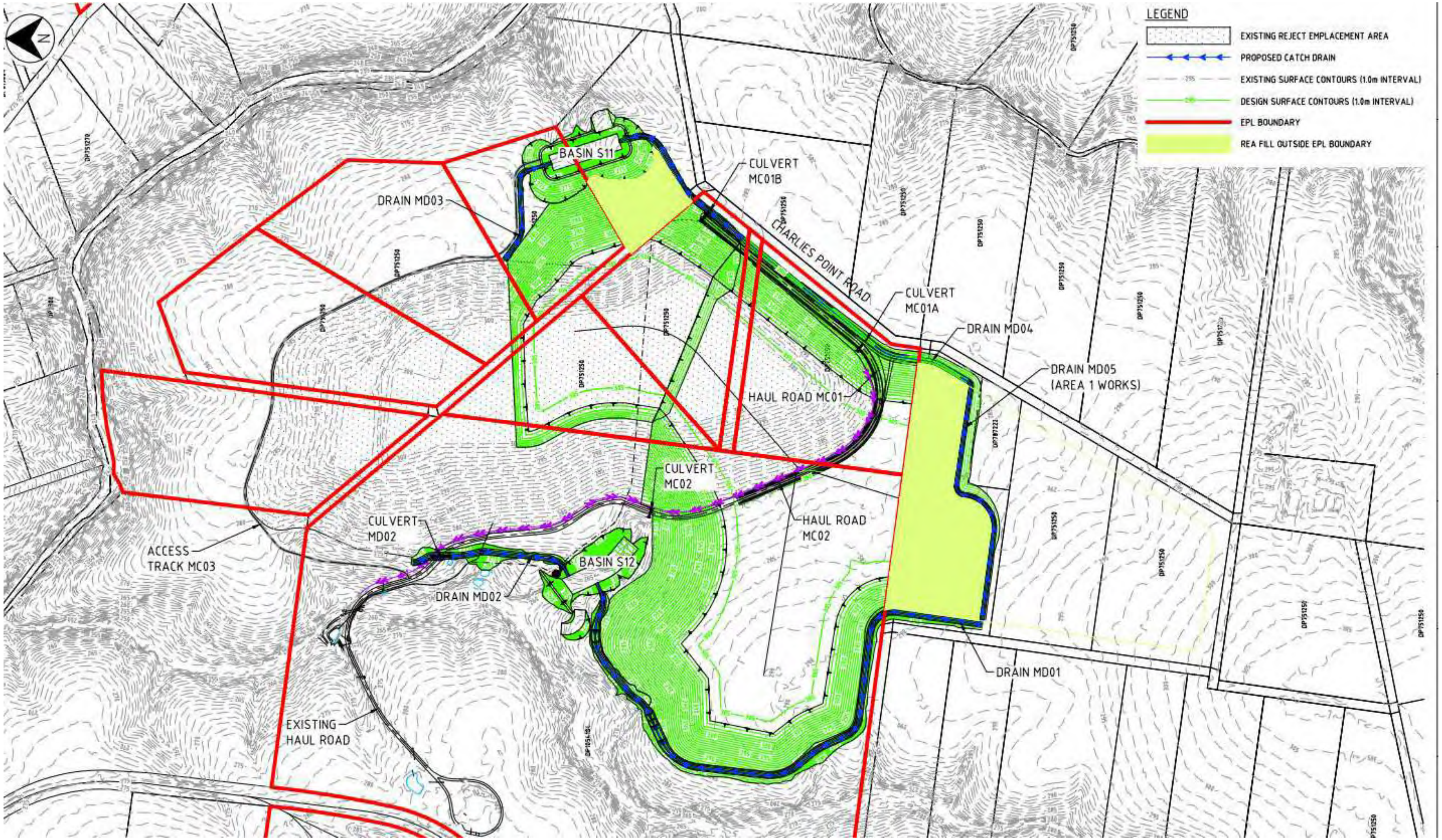

Figure 7-5 Design REA areas beyond existing EPL boundary

7.2.2 Capital costs

Capital costs were based on the design of the reject emplacement area expansion dated May 2013. Whilst there have been modifications to the forecast rejects tonnages and hence modifications to the REA design, for the purposes of this disposal options study, it is not considered such modifications are significant and therefore May 2013 costs have been adopted.

The basis of estimate and staging of the capital costs associated with the expansion of the rejects emplacement area, is identical to Option 1 and contained in Appendices C.1 and C.2. A summary of capital costs is provided in Table 7-7.

Table 7-7 Summary of capital costs

Item	UoM	Cost
Haul roads	$	4,332,621
Sedimentation basins	$	6,448,727
Drains	$	6,748,850
Pumping and piping	$	2,092,784
Power line relocation	$	1,700,000
EPCM, Owners Costs, Contingency	$	7,569,516
Total CAPEX	**$**	**$ 28,892,498**

7.2.3 Operating costs

The annual and total forecast rejects from the mine, are provided in Table 7-8 from the mine plan data (ref. Tahmoor Coal data issued 15 August 2013). Whilst there have been subsequent revisions to the annual and forecast rejects, for the purposes of this disposal options study the August 2013 data has been adopted for the calculation of operating costs.

Table 7-8 Annual and forecast rejects (Mtpa)

Yield Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ROM (Mt)	2.500	2.559	2.599	2.608	2.556	2.744	3.174	2.924	2.750	2.903	4.434	3.470	3.538	3.604
Product (Mt)	1.750	1.791	1.819	1.826	1.789	1.921	2.222	2.047	1.925	2.032	3.104	2.429	2.477	2.523
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	0.750	0.768	0.780	0.782	0.767	0.823	0.952	0.877	0.825	0.871	1.330	1.041	1.061	1.081
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

Yield Year	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
ROM (Mt)	4.210	3.779	3.575	4.286	3.912	3.846	4.421	2.636	3.463	3.322	3.467	3.425	2.663
Product (Mt)	2.947	2.645	2.503	3.000	2.738	2.692	3.095	1.845	2.424	2.326	2.427	2.397	1.864
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	1.263	1.134	1.073	1.286	1.174	1.154	1.326	0.791	1.039	0.997	1.040	1.027	0.799
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

The OPEX has been estimated based on the total forecast rejects from the mine. Calculations for the OPEX will commence upon fulfilment of the existing REA. For the REA Option 1A disposal option, the major contributors to operating costs are:

- Labour
- Consumables (fuel, tyres)
- Maintenance
- Equipment leasing
- Vegetation clearing
- Coal washery rejects levy ($15/t).

The OPEX for this option is presented in detail at Appendix D.2. The operating costs for the first year the rejects levy is incurred are presented in Table 7-9.

Table 7-9 OPEX for year 13

Year	UoM	Value
Rejects at forecast Yield	Mtpa	1.286
Average rejects throughput	tph	206
Labour	$	2,730,000
Consumables	$	1,013,015
Maintenance	$	389,420
Heavy plant leasing	$	991,900
Vegetation clear and grub	$	141,443
Reject disposal levy	$	10,693,020
Contractor's Profit	$	207,198
Total OPEX	**$**	**16,165,996**
	$/t	**12.57**

7.2.4 SWOT analysis

The Strength, Weakness, Opportunity and Threat (SWOT) analysis of this option is presented in Figure 7.6 below.

Strength

- Low CAPEX
- Low OPEX within EPL boundary
- No modifications required to the existing coal process plant
- Maintains the existing reject disposal method - hence, operations is already familiar with the disposal method
- Provides local employment in the form of Contract personnel

Weakness

- High OPEX when disposing beyond EPL boundary
- Visual impact, although limited by surrounding vegetation
- Noise and dust generation
- Green house gas contribution by haul trucks and dozers
- Increases water captured in the REA drainage. Thus the maintenance of drainage, storage and pumping, and risks associated with increase drainage water to manage
- Spontaneous combustion risk

Opportunity

- Leaves open the opportunity to beneficially use rejects for construction materials in the future (pending adequate material properties and demand)
- Time rich for seeking approvals for modifying EPL boundaries

Threat

- Authority approval yet to be granted for the REA expansion
- Operations could be restricted to day haulage only, requiring additional storage capacity at the end of the reject conveyor

Figure 7-6 SWOT analysis, surface disposal – expanded rejects emplacement area

7.3 Option 2 Co-disposal – Surface rejects emplacement and underground paste material (active goaf via trailing pipe)

As outlined in Section 2.6, an options workshop was held in conjunction with Tahmoor Coal on the 26 July 2013 to analyse the shortlisted options. During the workshop, it was identified that the underground disposal option will be constrained to the availability of the paste plant and is dependent on the longwall operation. Therefore, a percentage of the coal rejects will still be required to be disposed of at the proposed REA expansion, albeit, a significantly reduced volume and subsequent REA footprint. Consequently, Option 2 has effectively become a co-disposal option.

7.3.1 General description

Option 2 will primarily dispose of the rejects material underground. The fine rejects will be conveyed to a thickener by a pipe that by-passes the existing belt press filter. The coarse rejects are directed into a series of crushing stages before being combined with the thickened fine rejects and a rheology modifier agent to become paste. The paste will then be pumped underground via a pipe network to eventually be discharged into the active goaf behind the longwall. As indicated by Tahmoor Coal, sufficient power capacity is available for the operation of the paste plant.

When the paste plant system is unavailable due to planned maintenance or breakdown, the fine rejects are dewatered using a belt press before being combined with the coarse rejects, and transported by conveyor to the reject bin, for loading into rear-dump haul trucks and disposed of within the REA expansion similar to Option 1.

The availability of the paste plant system is estimated to be marginally above 70 per cent. For the purposes of this study, it is assumed 70 per cent of the rejects will be disposed of underground using the paste plant system, whilst the remaining 30 per cent of rejects, will be disposed within the REA expansion.

As indicated by Tahmoor Coal, the dry by-pass system will be operated by the same team that manages the paste system, or an equivalent workforce, and hence there is no requirement for additional personnel. However, in terms of equipment, the CPP belt press filter, a D6 sized dozer and two haul trucks will be required in addition to the paste plant system.

7.3.2 Block flow diagram

Figure 7-7 shows a proposed block flow diagram for the backfill paste system.

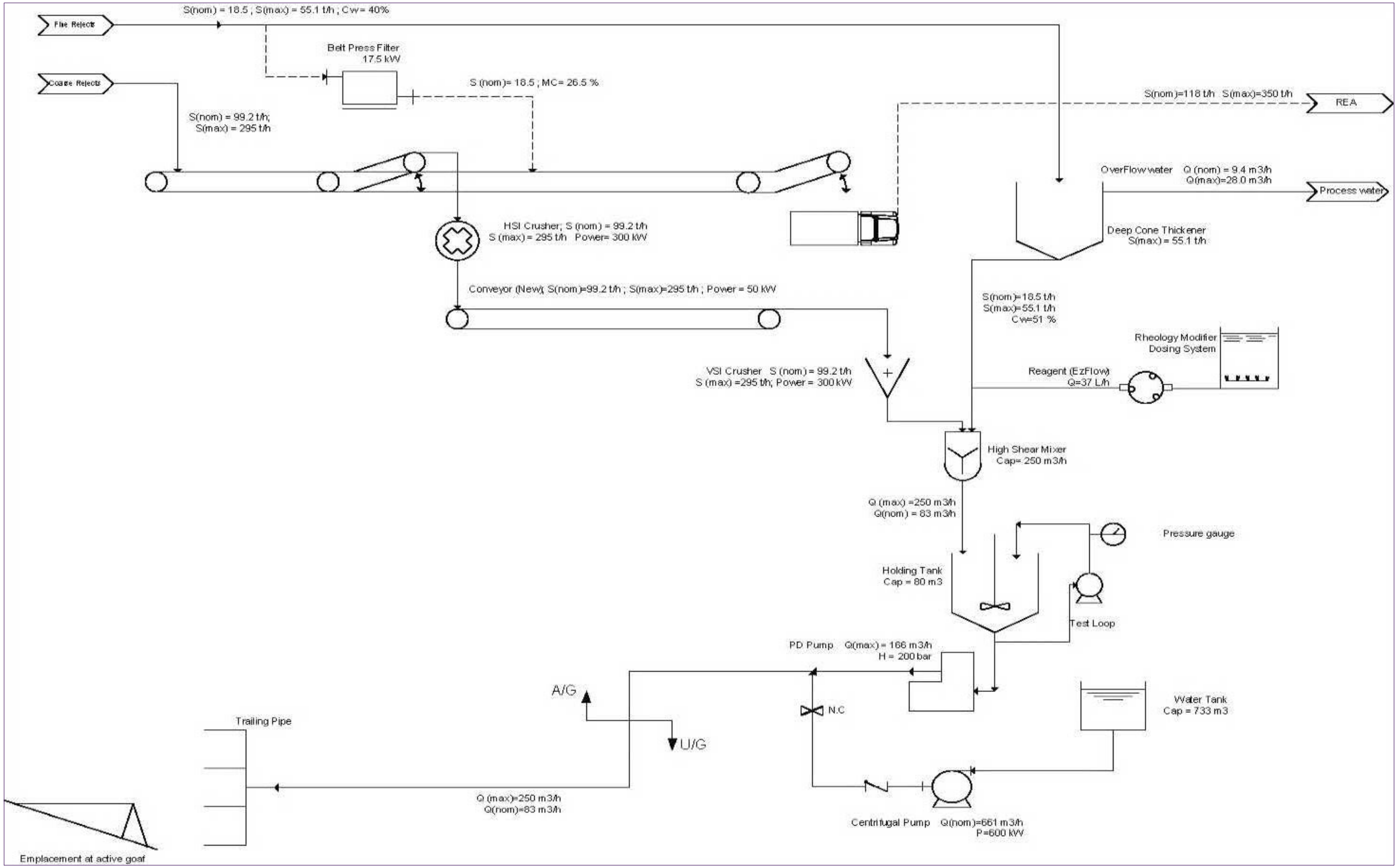

Figure 7-7 Process flow diagram, paste system

7.3.3 Pipeline route

Figure 7-8 shows the longest pipeline route identified, measuring approximately 13.5km long. This pipe route was utilised to estimate the pumping requirements and to estimate the diameter of the pipeline. A more detailed study may find that it is more convenient to avoid the drift as operations within it may have to be suspended to allow the installation and maintenance of the pipeline.

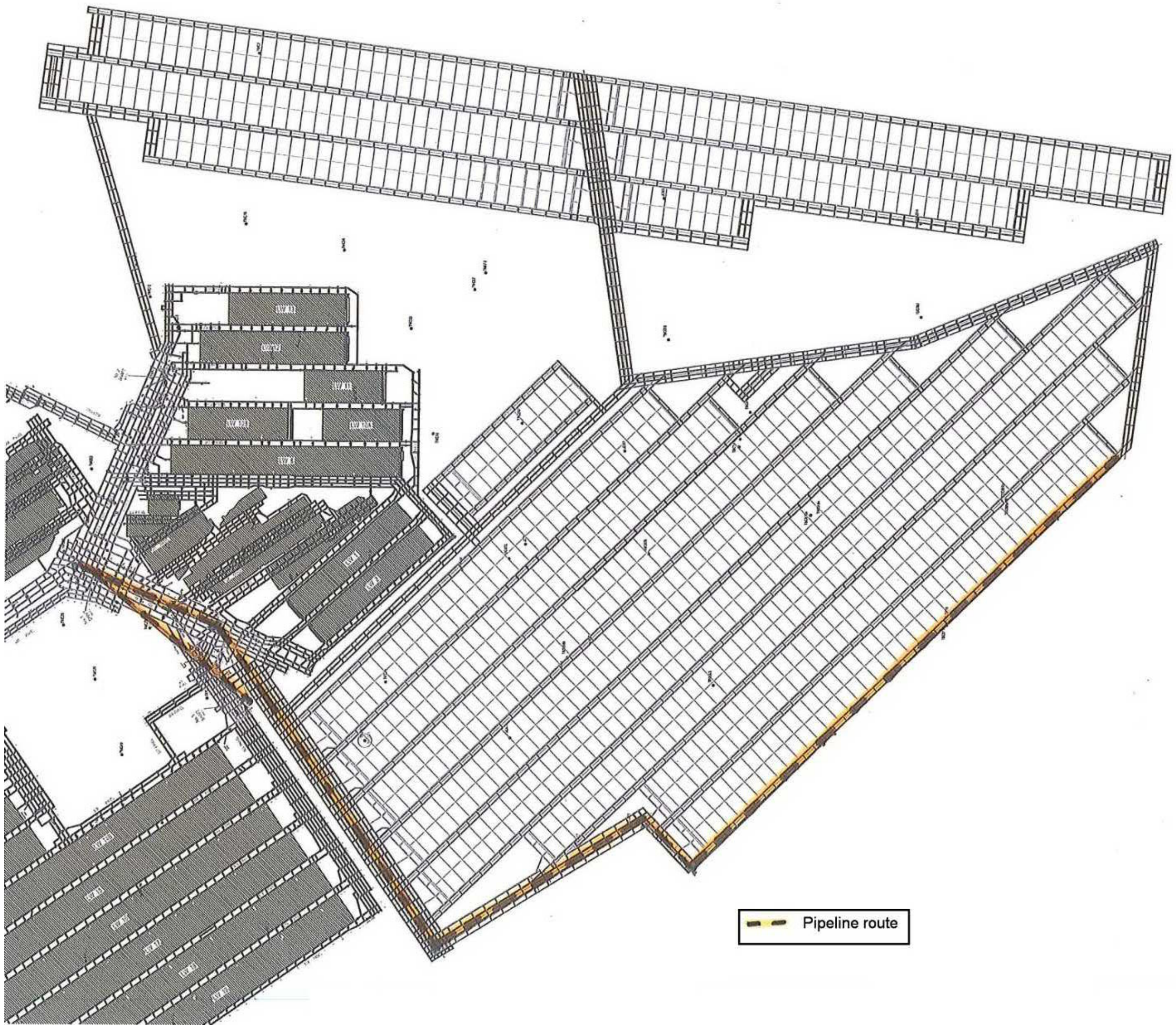

Figure 7-8 Pipeline route

7.3.4 Operational and Technical Assessment

The paste backfill system can be operated in normal, flushing and by-pass modes.

Normal operation

During normal operation, the fine rejects are conveyed to the deep cone thickener (DCT) by a pipe that by-passes the existing belt press filter. The level of the DCT is controlled by means of re-directing the flow to the belt press filter (BPF) when a high level at the DCT is reached (see by-pass mode).

The coarse rejects are directed into the horizontal shaft impact (HIS) crusher for the first sizing stage. It is expected a reduction in size of 6:1 at this stage. The material is then conveyed to a vertical shaft impact (VSI) crusher where further size reduction (2:1 ratio) is achieved.

The material produced is fed into a high rate shear mixer tank combined with the underflow of the DCT and a rheology modifier reagent which is dosed in an approximate proportion of 150mL per cubic metre of paste. Depending on the results from laboratory tests to establish the capacity of the paste to retain water, a 1% Cw of commercial grade Portland cement as a binding agent may be also required.

The resultant paste is then transferred into a holding tank from where a positive displacement (PD) pump is loaded. The PD has a maximum design capacity of 250m^3/h and should discharge the paste at nearly 200 bar into the pipeline. The number of strokes per minute of the PD is automatically modulated to match the throughput of the plant.

The pipeline (DN350 Sch 160, A-106 GRADE B, rubber lined) leaves the paste backfill area and follows the decline to the underground mining areas where the majority of its length lies. Although the diameter of the pipeline has been selected to produce friction loses equivalent to those required to compensate for the hydraulic grade line slope at the decline, a choke station at the bottom of the decline prevents column separation or “slack flow” to occur at any local high point upstream of it. The choke station consists of a series of ceramic rings of smaller diameter than the pipeline and is normally bypassed utilising pneumatically actuated hardened metal seat ball valves. These ball valves are automatically and remotely operated depending on the readings sent by pressure transducers located along the pipeline. Once the pipeline has reached the bottom of the drift, some pipelines branch off to other available areas, thus creating a reticulation that adds flexibility to operate in case the active mining area cannot accept the backfill.

As the main pipeline advances toward the active mining area, the paste flow loses significant pressure due to its length (~13km). Upon reaching the active mining area, the pipeline is connected to the long wall equipment through a flexible hose and then, into a manifold from where several trailing pipes distribute the paste in the active goaf. This last operation requires one to two operators to ensure the flow is optimally distributed into the goaf; avoid the ingress of paste to the working area; and to immediately resolve any issues that may arise. When the floor gradient conditions do not allow a safe emplacement of the paste at the active mining area, the paste flow can be diverted to other available areas underground.

As a consequence of the emplacement and settling of the paste some water will drain off the paste. It is estimated that the paste will drain off between 6 and 8 per cent of its weight as water. This translates nearly into 100L/min, in average. To prevent this water drain from reaching the active mining area, a movable sump pump or a slurry pump with trailing hose can be used. However, this adds operational complexity.

Major risks associated with the operation of the paste backfill system include out-of-range variations of the rheology, chemistry and particle size distribution of the rejects. To minimize this, the paste plant works in batches, confirming the viscosity prior to pumping underground. This is done with a small test loop sampling from the buffer tank.

Another inherent risk is the variable flow rate from the CPP. This potential problem is attenuated by the holding tank, which acts as a buffer to smooth out peak loads. Other control mechanisms include the interlocking of subsystems and the presence of variable speed motors.

The high pressure contained in the system poses a risk for operators. Regular pipeline thickness measurement; burst disks; and maintenance of the pipeline will aid in preventing any sudden burst of a pipe.

Flushing operation

According to Tarrant [Ref. 3], the paste prepared can remain stagnant in the pipeline for up to nine days without noticeable stratification or deposition of solids. In the event that flushing of the pipeline is required, the operator must first pump a batch of water using the PD pump. Once the water has pushed the remaining paste out of the pipeline, the PD pump enters standby mode and the centrifugal pump starts pumping at a flow rate of 661m^3/hr to achieve the required flow velocity to flush out the remaining solids. Given the lower viscosity of water, additional rings at the choke station are automatically set on-line (interlocked with the centrifugal pump) to maintain the upstream pressure above atmospheric pressure. Once flushing is complete, the centrifugal pump stops and the rings bypassed in preparation for normal operation.

A considerable volume of water must be available for this operation and, hence, a water storage tank is required. It is estimated that 733m^3 of water would flow underground when this operation is performed, presenting an operational risk. To mitigate the ingress of water to the active mining area, the water flow can be diverted to other underground area or pond by means of a pipe branching off the main pipeline just before it reaches the active goaf. Once the upstream piping is deemed clean, the water flow can be re-directed to the longwall, to clean the manifold and trailing pipes for a few minutes only.

By pass mode operation

The availability of the paste plant has been estimated as 70 per cent. Therefore, 30 per cent of the time operator will bypass the paste plant and haul the rejects to the REA. It is estimated that this by-pass mode will require a two trucks, one D6 sized dozer and three operators.

It is foreseeable that there will be times when even though mining has stopped, the CPP plant will still need to operate. Since there will be no generation of volume underground, the paste can be redirected to another available underground area through the piping reticulation. If this is not possible, the plant will be by-passed.

Provided there is enough space available at the REA, this operation poses minimal risk to operations.

Assessment

The technical and operational challenges are significant under this option and further engineering is required.

The trailing pipe is required to have sufficient strength to cope with the impact of rock in the goaf area collapsing on top of it. The length of the trailing pipe will largely depend on the permeability of the paste through the rock in the collapsed goaf; if the permeability allows emplacing large volumes, then longer trailing pipes will be required to prevent the paste from reaching the active area. Conceptually it is believed that this pipe should be 8-10m long. Figure 7-9 illustrates this concept through a simple sketch.

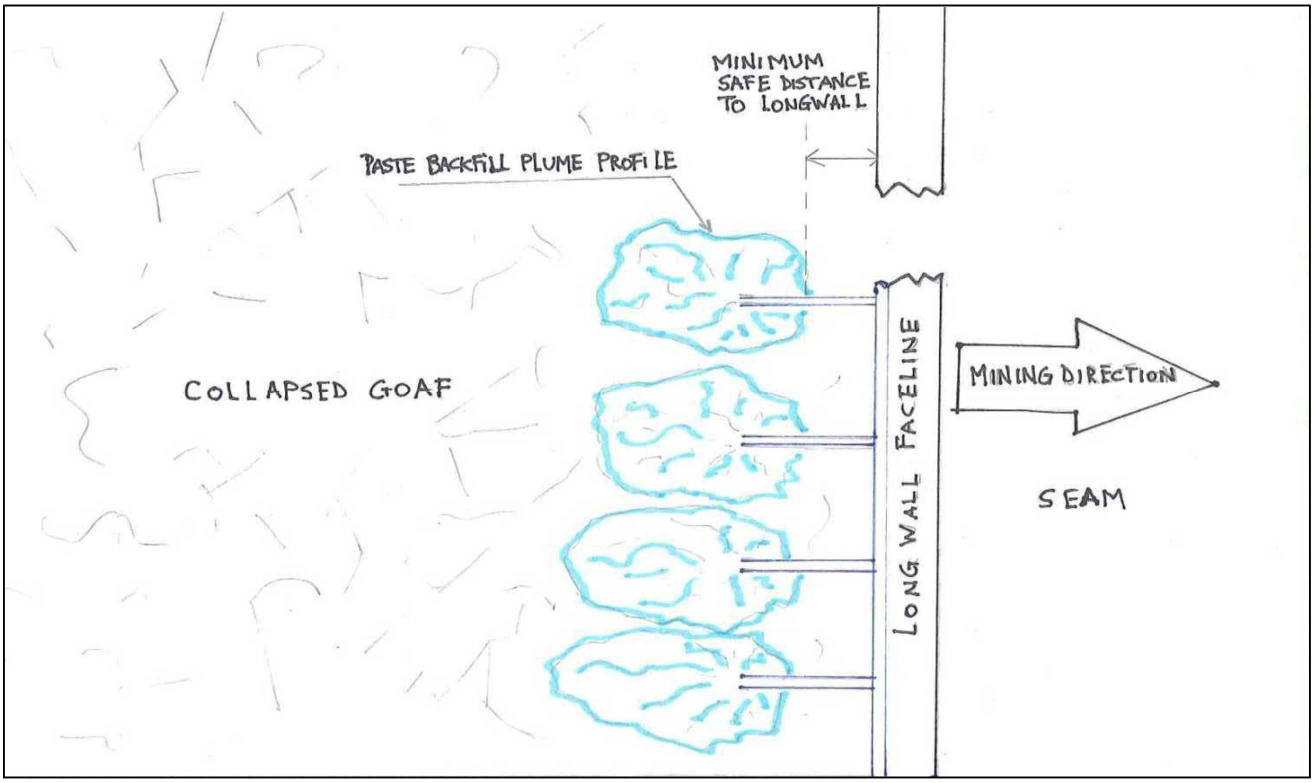

Figure 7-9 Backfill Plume

Mechanical protection may be required at the trailing pipe to prevent impacts or bucking due the weight of the collapsed rock. This is technically challenging and adds more complexity to the already difficult retrofit of the longwall miner with the trailing pipe system. Retrieving a damaged trailing pipe is very difficult; a replacement would have to be installed, potentially interfering with the mining process.

Although the paste can theoretically remain stagnant in the pipeline for up to nine days without noticeable deposition, pipe blockages can still occur due to poor paste properties, flow disturbances, starting and stopping, and leaking joints. Flushing with water should prevent the pipeline from becoming inoperative; however, significant process water would be required.

Extreme transients, such as water hammer, have been minimized by considering low velocity of the paste and the choke station that prevents column separation of the paste or water flows. Stored energy due to the high pressurisation of the system is still a risk that has to be addressed during the detail design.

Pipe wear and monitoring are major concerns. Paste backfill tends to be abrasive and the need to count with wear resistant liners with wear indicators is foreseeable to maintain a safe and reliable operation of the pipeline. Piping wear rates for this particular application cannot be determined without knowing the exact paste physical properties. Thus, an abrasiveness test similar to the Bond Abrasion Test would be required to establish an Abrasion Index of the pipework. At the present stage, rubber liners have been suggested, though further tests may indicate the need to utilise a different material.

The current drift has limited capacity for additional services. Operations within the drift may have to be suspended during the installation and maintenance of the pipeline. An alternative to this is to drill a large diameter borehole to route the pipeline to the underground areas.

Significant floor heave is expected in the goaf as the longwall miner advances. Heave has been observed in Tahmoor North and it is expected to become an issue in Tahmoor South. This may offset the effect of floor grading in some cases forcing to redirect the backfill flow to another available area underground or to by-pass the paste system altogether.

The system reliability is dependent on the reliability of its individual components, which is critical as most of them are in series. Preventive maintenance of each of the components will minimise unplanned stoppages. However, the plant availability is estimated at around 70 per cent and therefore it is strongly recommended to preserve the existing surface emplacement method in an operative condition (hence the co-disposal option under consideration).

When mining down dip or when the longwall operation is tilted to either side there will be an increased possibility of water from the rejects entering the active longwall operation. As a result, a large area of the future active goafs will be unsuitable for backfilling. As can be seen in Figure 7-10, rejects and water from rejects will be more likely to flow back to the operation when operating down dip.

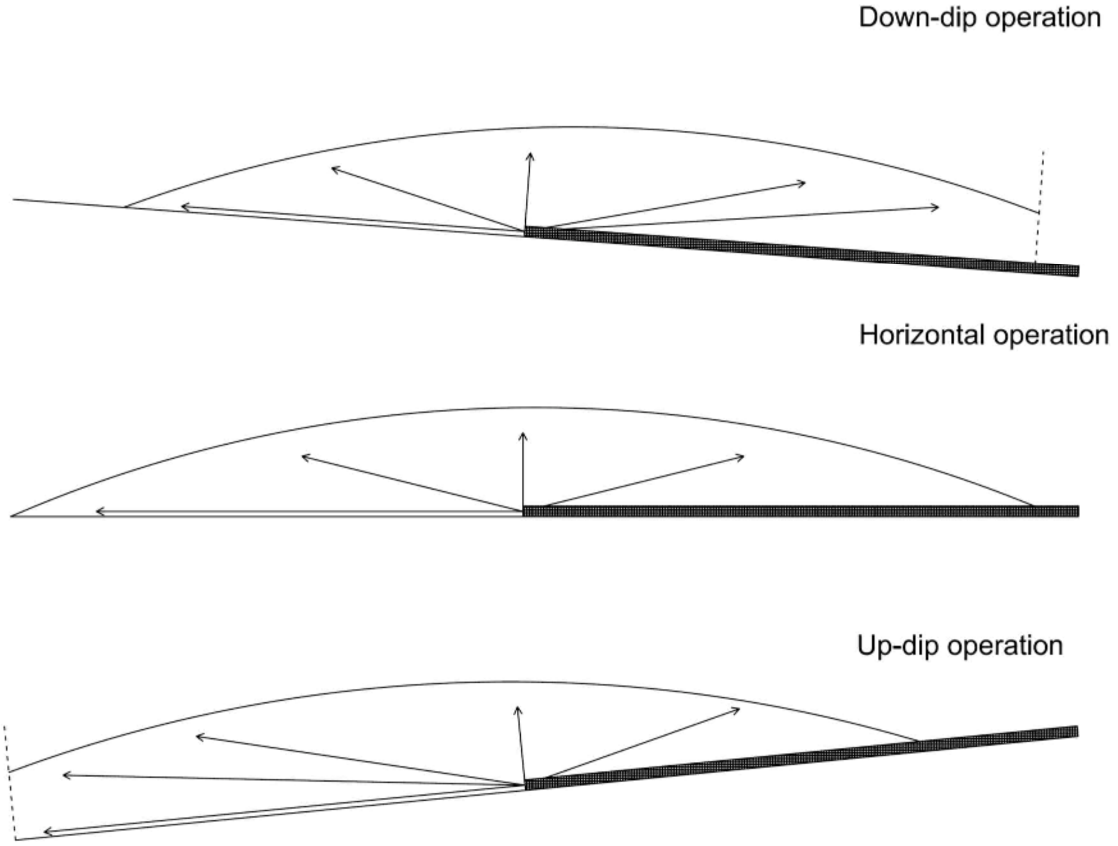

Figure 7-10 Slurry or paste injection from trailing pipe

Water flowing into the operation can cause poor floor conditions; this can increase the chance of the longwall chocks sinking into the ground and becoming bogged. Movable pumps or pumps with a trailing hose setup can help alleviate water management issues. However, these will have to be moved across the face by the operators and repositioned to areas where the slurry is accumulating. This increases the operational complexity of the longwall. On a lower seam longwall there is little room to move across the face and this option might create safety issues.

Alternatively, a binding agent such as standard commercial-grade Portland cement can be added to the paste, in low proportion (~1 per cent), to help prevent water from draining off the paste. Due consideration has to be given to the fact that, as the cement reacts, heat is released to the surroundings. The heat produced may promote the ignition of adjacent coal or gas. Workers in the longwall may also be impacted due to the characteristic smell of cement curing and the higher temperature and humidity levels. In order to remove this additional heat load and humidity, the ventilation system may require upgrading, forcing the implementation of a third heading gate road setup which would render this alternative unviable. In addition, with the incorporation of a binder, the amount of time the product can be retained in the pipe may significantly decrease. This, in turn, leads to more stringent operating constraints. In the case of a major stoppage, it may be necessary to dismantle all the pipe work for clean out or the use of a pig to clean the pipeline. There will be an increase in traffic movements to site as the binding agent will have to be trucked, additional capital costs and additional real-estate required for cement storage. Finally, the addition of cement would modify the rheology of the paste and further studies may have to be undertaken to confirm its pumpability.

To determine the total available volume in the goaf area, a better understanding of the permeation of material through the rubble in the active goaf area is needed. According to W Mez, W Schauenburg in “Backfilling of Caved-in Goafs with Pastes for Disposal of Residues” (refer Section 3.6) the rubble in the active goaf can be regarded as loose dirt piles up to 20 to 30 metres from the longwall. This rubble pile is reported to be up to 2 to 3 times the seam height. To test the volume of rejects that can be injected from a single injection location a true to scale test should be done on an impenetrable surface. By creating a pile of lose material which should consist of goaf roof material and injecting the paste at the centre of the pile at the design injection pressure, a reliable estimation can be made of the volume of rejects that can be injected. This test will also give an indication of the length and number of trailing pipes necessary. It can also provide knowledge about the amount of water that will flow from the rejects. An example of a possible test setup is shown in Figure 7-11.

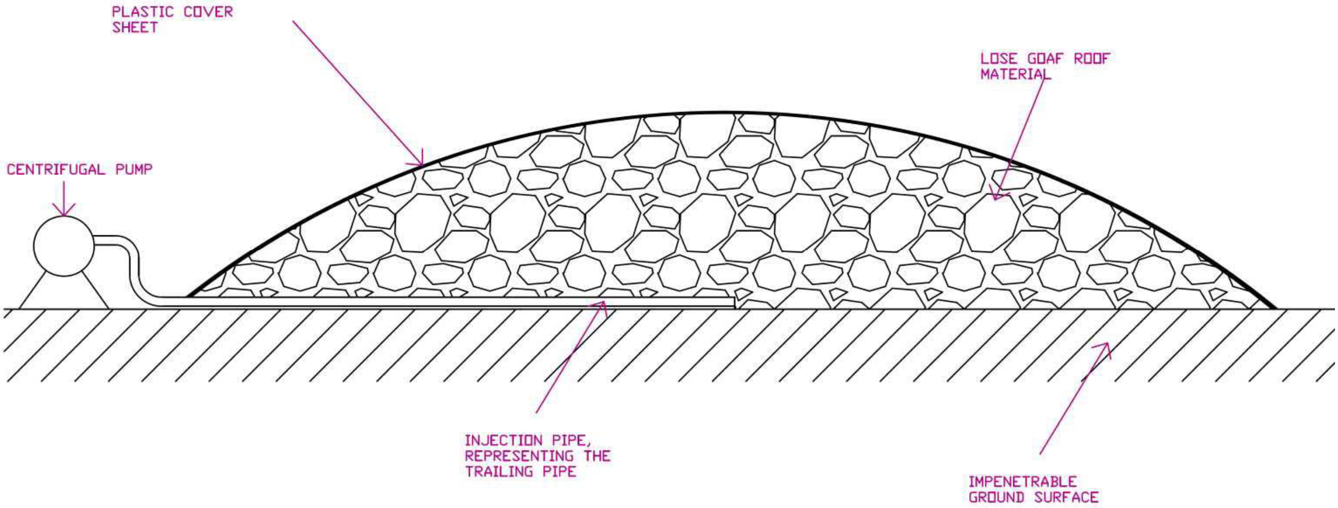

Figure 7-11 Proposed Test Setup

In summary, it is believed that it will be technically very difficult to retrofit a trailing pipe system to the existing longwall machine that ensures a safe and reliable operation. Being part of the longwall, maintenance and malfunctions of the trailing pipe system is likely to cause operational delays.

7.3.5 Equipment list for backfill paste system

The proposed paste backfill system was preliminary sized to accommodate the flow rates stated at Section 4.2.3.

A preliminary list of major equipment and piping required for the system is presented in Table 7-10 below.

Table 7-10 Preliminary equipment list

Description	Capacity	Power, kW	QTY	UoM
Horizontal Shaft Impact crusher (HSI)	300tph	300	1	EA
Vertical Shaft Impact Crusher (VSI)	300tph	300	1	EA
Deep Cone Thickener	50tph (Solids)	-	1	EA
Water tank, min effective capacity	800m^3	-	1	EA
Rheology modifier agent dosing system	40L/hr	4	1	EA
High Shear Mixer, complete with motor	250m^3/hr	10	1	EA
Belt conveyor (between crushing stages)	300tph	50	1	EA
Holding tank for high density paste, with mixer	80m^3	25	1	EA
Horizontal Centrifugal Water Pump, complete with motor	661m^3/hr, 500kPa	600	1	EA
Positive Displacement Pump, including hydraulic power pack	250m^3/hr@ 21000kPa	1800	2	EA
200 NB Sch 40 Pipe SMLS (A-106 GRADE B) Carbon Steel	-	-	15	m
350 NB Sch 160 Pipe SMLS (A-106 GRADE B) Carbon Steel, Rubber lined	-	-	13,650	m
250 NB Sch 120 Pipe SMLS (A-106 GRADE B) Carbon Steel, Rubber lined	-	-	20	m
200 mm Manual Operated Gate Valve Flanged Carbon Steel	-	-	2	EA
300 mm hardened metal seat ball valves for slurry	-	-	4	EA
200 mm Check Valve Flanged Stainless Steel	-	-	1	EA
HV distribution board with incomer circuit breaker	-	2500	1	EA
Sump pump	329 l/min @500kPa	5	1	EA

7.3.6 Environmental issues

The following issues have been identified by SKM in our assessment of this disposal option.

Opportunities

- This option would not require the extent of surface vegetation clearing.
- Underground disposal will be within the extent of the current Tahmoor Coal mining lease.

Constraints

- Adds complexity and potential safety issues to the underground working environment.
- The pumping system (and associated infrastructure) required to dispose the paste underground requires the use of high volumes of water to flush the pipework to avoid blockages. This could increase the use of potable water supply if mine water is not used.
- The development of crushing, mixing and pumping plant may increase the mines consumption of power, however as indicated by Tahmoor Coal, sufficient power capacity is available.

Gaps

- The rheology of the paste is currently unknown
- The chemical properties of the paste (following mixing with CWR, tailings and reagents) are unknown at this stage.
- The leachability of the paste in the potentially acidic environment underground is unknown.
- The effect of the paste over time on the groundwater table is unknown
- The crushability of the coal to produce a paste is unknown

Timings

- Rheology test work will need to be undertaken
- Trials will need to be undertaken to develop a suitable chemical composition and consistency for the reject material paste, tailored for Tahmoor.
- Due to the proximity of the Tahmoor to the Sydney drinking water catchment, Tahmoor Coal will need to understand the potential effects (if any) of the rejects paste over time on the groundwater table (in consultation with the SCA), prior to commissioning any underground systems.
- Crushability tests will need to be undertaken

7.3.7 Infrastructure relocation

As per Option 1, there is still a requirement to relocate a number of power infrastructure assets, namely Endeavour Energy's 66kV Tahmoor – Maldon ZS overhead transmission line and 11kV Tahmoor – Maldon ZS distribution line.

The extension to the REA will require the existing electricity overhead lines within the proposed REA extension in Area 1 to be removed and installation of new overhead lines around the boundary of the proposed REA extension. The forecast year for the relocation of these power assets is 2024.

7.3.8 Rejects disposal

Revised ROM tonnages provided by Tahmoor Coal on the 15 August 2013, were used for the CAPEX and OPEX calculations. With 70 per cent of the rejects forecast to be disposed underground, the remaining 30 per cent will be disposed within a reduced REA expansion. Area 1 has sufficient design capacity for the rejects forecast for the REA expansion. Consequently, Area 2 was excluded from CAPEX and OPEX calculations.

The total rejects emplacement tonnage capacity will be dependent on goaf void capacity underground and compaction levels achieved within the surface REA emplacement operations.

Table 7-11 Rejects emplacement forecast summary

Description	**Forecast disposal (t)**
Existing REA	4,233,890
Underground	15,916,736
Area 1	6,821,458
Total	**26,972,084**

As outlined in Section 5.2.5, based on the current mine plan, the volume available for underground disposal by trailing pipe is only 6,199,305m^3, which is significantly less than the 15,916,736t (or 7,879,572m^3) required. As such, for this option to be feasible the mine plan may need to be revised to specifically consider maximising volume for backfill by trailing pipe and/or creating additional void space by mining. This may require additional longwall change outs, more infrastructure and could impact on available coal reserves. Consequently this may be unfeasible from a mine planning perspective. Alternatively, paste could be disposed of in other underground areas, commented above in Sections 5.2.1 through 5.2.3.

Based on the expanded REA area volumes and the nominal rejects filling rate, Table 7-12 indicates the proposed staging of the capital works matching a staged filling plan for the REA expansion surface disposal component of the co-disposal option.

Table 7-12 Co-disposal Fill Plan for the REA Expansion

	Tahmoor North operation								Tahmoor South operation																		
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Reject Deposition Area:																											
Existing	■	■	■	■	■	■																					
Area 2: 3.5 Mt																											
Area 1: 16.5 Mt						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Staged Works Plan:																											
Haul Roads												■															
Drains												■				■											
Sediment Basins												■				■											
Pump Station												■				■											
Power Line Relocation												■															

7.3.9 Capital costs

Capital costs for the REA expansion component were based on the design of the reject emplacement area expansion dated May 2013. Whilst there have been modifications to the forecast rejects tonnages and hence modifications to the REA design, for the purposes of this disposal options study, it is not considered such modifications are significant and therefore May 2013 costs have been adopted.

The estimated CAPEX for the co-disposal option, under an EPCM contract, is presented in Table 7-13 below.

Table 7-13 Summary of capital costs

Item	UoM	Cost ($)
Paste Plant System		
Earthworks	$	1,754
Concrete	$	385,121
Structural	$	337,424
Architectural	$	718,838
Mechanical	$	2,862,592
Piping	$	33,036,930
Electrical	$	2,585,870
Miscellaneous	$	770,551
EPCM - 20%	$	8,201,435
Provisions	$	7,689,378
Subtotal	***$***	***56,589,893***
REA Expansion		
Civil Works	$	11,089,938
Pump and Piping	$	2,092,784
Power Line	$	1,700,000
EPCM Costs	$	2,013,494
Owner's Costs	$	844,811
Heavy Plant	$	2,600,000
Contingency	$	2,611,687
Subtotal	**$**	***22,952,713***
Total CAPEX	**$**	**79,542,606**

The costs are based on the equipment list presented at Section 7.3.5, associated supporting structures, civil works, and EPCM costs. Greater detail of this estimate can be found at Appendix C.3.

7.3.10 Operating costs

The annual and total forecast rejects from the mine, are provided in Table 7-14 (received from Tahmoor Coal 15 August 2013). Whilst there have been subsequent revisions to the annual and forecast rejects, for the purposes of this disposal options study the August 2013 data has been adopted for the calculation of operating costs. The table shows the forecast tonnages both underground and within the REA expansion.

Table 7-14 Annual and forecast rejects (Mtpa)

Yield Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ROM (Mt)	2.500	2.559	2.599	2.608	2.556	2.744	3.174	2.924	2.750	2.903	4.434	3.470	3.538	3.604
Product (Mt)	1.750	1.791	1.819	1.826	1.789	1.921	2.222	2.047	1.925	2.032	3.104	2.429	2.477	2.523
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	0.750	0.768	0.780	0.782	0.767	0.823	0.952	0.877	0.825	0.871	1.330	1.041	1.061	1.081
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Underground Rejects (Mt)	0.000	0.000	0.000	0.000	0.000	0.3078	0.6665	0.614	0.5775	0.6096	0.9311	0.7287	0.743	0.7568
REA Rejects (Mt)	0.750	0.768	0.780	0.782	0.767	0.5154	0.2856	0.2632	0.2475	0.2612	0.399	0.3123	0.3184	0.3243

Yield Year	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
ROM (Mt)	4.210	3.779	3.575	4.286	3.912	3.846	4.421	2.636	3.463	3.322	3.467	3.425	2.663
Product (Mt)	2.947	2.645	2.503	3.000	2.738	2.692	3.095	1.845	2.424	2.326	2.427	2.397	1.864
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	1.263	1.134	1.073	1.286	1.174	1.154	1.326	0.791	1.039	0.997	1.040	1.027	0.799
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Underground Rejects (Mt)	0.8841	0.7936	0.7508	0.9001	0.8215	0.8077	0.9284	0.5536	0.7273	0.6977	0.7281	0.7192	0.5592
REA Rejects (Mt)	0.3789	0.3401	0.3218	0.3858	0.3521	0.3462	0.3979	0.2373	0.3117	0.299	0.3121	0.3082	0.2397

The OPEX has been estimated based on the total forecast rejects from the mine. For energy consumption, the major contributors are the paste preparation plant and pump station. Water consumption was estimated from the water content of the paste and periodic flushing of pipelines. The rheology modifier reagent consumption was indicatively advised by Cellcrete Australia Pty. Finally, for labour estimation, 2.5 equivalent persons were assumed necessary to operate the plant, pump station and pipeline underground. The same equivalent labour workforce has been allowed for when the paste plant is unavailable and the rejects are hauled to the REA expansion.

The OPEX for this option is presented in detail in Appendix D.3. The operating costs for the first year of operation are presented on Table 7-15.

Table 7-15 OPEX for year 1

Year		**Year 1**
Rejects at forecast Yield	Mtpa	0.440
Average rejects throughput	tph	132
Surface disposal at REA		
Rejects at forecast Yield	Mtpa	0.132
Average rejects throughput	tph	40
Labour	$	640,640
Consumables	$	183,632
Maintenance Costs	$	129,229
Heavy plant	$	-
Vegetation clear and grub	$	48,373
Sub-total OPEX - surface disposal	**$**	**1,001,874**
Underground disposal as paste		
Rejects at forecast Yield	Mtpa	0.308
Average rejects throughput	tph	92
Energy	kWh	2,024,723
@ 0.05 $/kWh	$	101,236
Water	m^3	77,753
@ 2.13 $/$m^3$	$	165,613
Reagent	L	32,532
@ 20 $/L	$	650,640
Maintenance Costs	hr	2,362
@87.21 $/h	$	205,986
Labour	$	1,653,369
Sub-total OPEX - underground disposal	**$**	**2,776,845**
Total OPEX - co disposal	**$**	**3,778,719**
	$/t	**8.59**

7.3.11 SWOT analysis

The Strength, Weakness, Opportunity and Threat (SWOT) analysis of this option is presented in Figure 7-12 below.

Strength

- Potentially reduce subsidence at the surface
- Spontaneous combustion risk limited to a reduced surface emplacement area
- Reduced visual impact, noise and dust generation
- Volume appears to be available underground for this method of emplacement
- Emplacement strength (UCS) above 100 kPa and a beach angle of 3-4°
- Co-disposal option provides flexiblity
- Maintains local employment in the form of personnel

Weakness

- CAPEX and OPEX intensive
- Additives or binding agents may be required
- Loss loop test required to confirm rheology
- Depends on the longwall advance to generate the necessary volume
- Additional training required for plant operators to operate trucks & dozers
- Green house gas contribution by haul trucks and dozers
- High water use in the paste plant process and flushing of pipework
- Spontaneous combustion risk
- The belt press filter plant will still need to be maintained as a backup
- Requires either amendment to the mine plan and/or other underground disposal locations for the volume of rejects forecast

Opportunity

- Enhancing skill base of operators
- Leaves intact the opportunity to prepare road base in the future

Threat

- High pressure on piping (hazard)
- Paste consistency and rheology is to some degree dependant on the composition of rejects
- In the event that flushing of the pipeline is required, considerable water will flow underground
- Authority approval yet to be granted for the REA expansion
- Surface emplacement operations could be restricted to day haulage only, requiring additional storage capacity at the end of the reject conveyor
- It is understood that Peabody is investigating using ball mill grinding as an alternative to dry crush due unstable paste rheology.

Figure 7-12 SWOT analysis, Co-disposal Option – REA Expansion plus UG disposal – paste material (active goaf via trailing pipe)

8. Cost benefit analysis

8.1 Purpose

The purpose of the cost benefit analysis (CBA) is to assess the net economic benefit associated with a given project option against a base case or ‘business as usual’ scenario. Cost benefit analysis is a comprehensive form of evaluation which assesses the economic, social and environmental impacts of a project. Cost benefit analysis differs from financial analysis in that it evaluates the costs and benefits beyond the project proponent to include a wider set of stakeholders (i.e. the community or local economy).

Cost benefit analysis has been chosen as the preferred method of project evaluation for options analysis of rejects disposal for the proposed Tahmoor South project. The CBA method was preferred over a financial analysis to account for the other economic, social, or environmental costs that may be occurring as a result of coal rejects disposal (i.e. land acquisition, loss of native vegetation associated with clearing, etc.).

The cost benefit analysis has been conducted in accordance with *NSW Treasury Guidelines for Cost Benefit Analysis (2012)*.

8.2 Assumptions and information sources

The CBA has relied on information from Tahmoor Coal, internal SKM estimators, research conducted during the literature review and general guidance provided by the *NSW Treasury Guidelines for Cost Benefit Analysis (2012)*. Specific data sources relating to the estimation of costs and benefits are provided in Section 8.5.

The following assumptions have been utilised in the development of the CBA:

- Scope – the CBA evaluates the costs and benefits associated with coal rejects disposal at Tahmoor South. The CBA does not extend to the actual mining operation or include costs and benefits resulting from the mining activities. The CBA is based on the capital and operating costs associated with the REA expansion design dated May 2013.
- Evaluation Period – The CBA evaluates discounted cashflows over a period of 26 years from 2014 to 2039 (end of asset operational life).
- Base Year – The base year of the evaluation is 2013. All costs and benefits are provided in 2013 dollar terms (unless otherwise stated).
- Discount Rate – The CBA uses a discount rate of 7 per cent in accordance with the *NSW Treasury Guidelines for Cost Benefit Analysis (2012)*. Results are also presented at 4 and 10 per cent to show the sensitivity of the discount rate.
- Inflation and Indexation – All costs are modelled in real constant 2013 dollars. Inflationary effects are therefore not considered in the evaluation. Any costs estimated prior to 2013 have been escalated by CPI to 2013 to reflect current dollar terms.
- Environmental Impacts – Environmental impacts have been monetised wherever possible using existing market prices. The CBA assumes that the cost of environmental offsets includes externality costs such as noise, dust, pollution, and amenity. Cost of environmental impacts provided by Tahmoor Coal.
- Rehabilitation – The CBA assumes a rehabilitation cost associated with the REA. This rehabilitation cost is assumed to represent the alternative economic value of the surface land area currently being used for the REA.

8.3 Decision criteria

The CBA utilises key economic decision criteria to determine the cogency of an investment opportunity compared with the base case. The decision criteria measures economic efficiency, present value of investment, and return on investment.

Table 8-1 Economic decision criteria used in the CBA

Economic indicator	Definition	Decision criteria
Benefit Cost Ratio (BCR)	The BCR is a ratio which measures the proportion of a project option's benefits relative to its costs. BCR measures the economic efficiency of a project option.	A BCR greater than 1 results in a net benefit, thereby making the project viable. BCR > 1 = economically efficient
Net Present Value (NPV)	NPV is the total discounted sum of a project option's cashflows. It measures the net worth of a project by accounting for the time value of money.	A positive NPV results in a net gain. +NPV ($) = economic gain over time.
Internal Rate of Return (IRR)	The IRR is rate at which benefits are realised from investment in a project option. IRR measures the profitability of a project option.	The IRR should be equal to or greater than the discount rate used in the CBA. IRR > 7% = net profit

8.4 Options for analysis

The CBA is utilised in the assessment of the costs and benefits of a project option against a base case scenario. The base case is generally a 'do nothing' scenario and the project case represents an investment opportunity (i.e. capital expenditure). The CBA then estimates the incremental costs and benefits of the project option against the base case. The project options modelled in the CBA were shortlisted during the MCA and represent the most economically viable, technically sound, and environmentally conscious solutions that could be feasibly considered for the disposal of coal rejects at the proposed Tahmoor South project.

8.4.1 Base Case

The base case is the 'do nothing' scenario. The base case was defined considering the following:

- existing capacity life of the existing REA area
- life of the asset (2039)
- alternative disposal options not representing a capital investment (i.e. project case)

Based on the information outlined above, the base case is considered to be the continued disposal of coal rejects at the existing REA site until capacity is reached. At this point it is assumed that without expanding the area or developing an alternative disposal method, coal rejects would have to be disposed at an offsite location. Offsite disposal of the coal rejects has been estimated by a third party contractor at $6.20 per tonne. Additionally, the coal rejects will be subject to an offsite disposal levy. The NSW offsite coal rejects levy was mandated in 2009 at $15 per tonne and is escalated annually by CPI[1].

It should be noted that the operational costs estimated in the base case (i.e. the offsite disposal costs and associated levy) have an order of magnitude which far exceeds the alternative project options.

8.4.2 Project Case

The project case represents the investment opportunity and alternative to the base case. Project options are generally defined by a capital investment requirement and considered to be the 'do something' scenario. Three

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[1] NSW Office of Environment and Heritage, *Coal Washery Rejects Levy Operational Guide 2009, http://www.environment.nsw.gov.au/resources/waste/09697CWRlevyguidance.pdf, accessed 27 June 2013*

project options were identified through the Multi Criteria Analysis (MCA), SWOT analysis and shortlisting exercise.

1) Option 1 – Expansion of the existing REA area for continued disposal of coal rejects
2) Option 1A – Expansion of the existing REA for continued disposal but outside of the EPL (attracting a partial levy application to rejects disposed in years 2030 and 2039)
3) Option 2 – Underground disposal of coal rejects via paste solution into an active goaf area (70 per cent) and continued disposal in the REA when underground disposal is offline (30 per cent)

In both project cases continued use of the existing REA disposal site is assumed to occur until capacity is reached. The project option disposal method is assumed to continue until 2039 when the mine closes. Table 8-2 outlines the project option and associated land-use change requirements.

Table 8-2 Project options and land-use requirements

Project Option	**Land acquisition requirement**	**Environmental offset requirement**	**Rehabilitation requirement**
Option 1	132 ha	400 ha	200 ha
Option 1A	132 ha	400 ha	200 ha
Option 2	40 ha	168 ha	113 ha

8.5 Estimation of costs and benefits

The CBA considers all relevant costs and benefits associated with the base case and project options. As provided in Section 8.2, the CBA only compares costs and benefits associated with coal rejects disposal and does not consider impacts resulting from the mining operation.

Based on the information provided by Tahmoor Coal, all impacts have been identified to the best of SKM's knowledge. Costs and benefits have been monetised wherever possible to reflect impacts in dollar terms.

8.5.1 Costs

In the CBA, costs are considered to be monetary outlays borne by Tahmoor Coal. Costs considered by the CBA include capital expenditure, rehabilitation bond, environmental offsets and operating expenditure.

Table 8-3 Cost inputs to the CBA – in millions of Australian dollars discounted at 7%

Option	Capital expenditure	Operating expenditure	Rehabilitation bond payment	Environmental offset payments	Total costs
Base case – continued use of existing REA + offsite disposal once existing REA if filled	-	$201.64	-	-	$201.64
Option 1 – expansion of the REA	$17.64	$44.82	$0.57	$6.20	$68.81
Option 1A – expansion of the REA outside the EPL	$17.64	$49.95	$0.57	$6.20	$73.95
Option 2 – underground disposal	$63.05	$77.83	$0.17	$1.86	$142.91

The base case requires no capital outlay, rehabilitation payment or purchase of environmental offsets. However, once the existing REA is filled, operational expenditure significantly increases due to the need for offsite disposal of coal rejects. The total costs in the base case discounted at 7 per cent. The significant capital expenditure required in the project cases are relatively comparable. However, there are significant environmental management costs associated with Option 1 and Option 1A, resulting from the need to acquire land, guarantee the rehabilitation of the surface disposal area, and offset environmental impacts to the project area. Option 2 incurs less capital outlay and requires less environmental offsets. However, the operational costs required to maintain Option 2 significantly exceed those in Option 1 and Option 1A.

8.6 Estimation of benefits

The CBA considers benefits accruing to Tahmoor Coal as well as the wider community. Benefits include costs foregone (operational or otherwise), biodiversity benefits and amenity benefits. Benefits are calculated as the net difference between the base case and project option. For instance, if operational cost is $10/tonne in the base case and $8/tonne in the project case, the benefit would be $2/tonne operational cost savings.

8.6.1 Operational cost savings

Operational cost savings occurs when operational cost in the project option is less than in the base case. Operational costs have been estimated by SKM's mining and process engineers using key inputs from Tahmoor Coal. In the base case, operational costs for rejects disposal after the existing REA is filled is calculated using forecasted rejects tonnage and the NSW offsite disposal levy.

8.6.2 Rehabilitation cost savings

Surface disposal of coal rejects requires the investment of a site rehabilitation bond, as regulated by the NSW government. The bond payment guarantees rehabilitation once the site has been closed and includes costs such as capping the site area, treatment, structural work, spread of top soil and ongoing maintenance of the rehabilitated area.

8.6.3 Environmental offset cost savings

Depending on the existing and intended land-use (where native vegetation must be cleared or new land acquired), environmental offsets must sometimes be acquired. Environmental offsets are intended to counterbalance an unavoidable environmental cost. The NSW government places value on particular types of existing land-uses and requires the proponent to either purchase or develop their own environmental offsets to meet the cost.

Option 1 and Option 1A require the acquisition and clearing of 132ha of mixed rural residential and native bushland for the new disposal site. To compensate for this environmental cost, it is estimated that Tahmoor Coal will need to spend $12 million in 'Shale Sandstone Transition Forest' (SSTF) and 'Other Native Vegetation' offsets. The base case lacks this investment requirement. Option 2 requires 30 per cent of the estimated acquisition and environmental offset purchase, in line with a 70 per cent estimated performance of the underground disposal.

8.6.4 Biodiversity benefits

Biodiversity benefits may accrue in a project option which does not require the clearing of native vegetation. Biodiversity refers to the range of organisms present in a particular ecosystem. The range in numbers and types of organisms are considered to provide essential services to society, which goes unaccounted for in traditional forms of economic analysis. Recent willingness to pay studies has valued Australian biodiversity at $275.40 annually for every hectare of remnant vegetation protected[3]. Where remnant vegetation is foregone (i.e. expansion of the REA resulting in land clearing) the $275.40 value may result in a net *dis-benefit* (i.e. cost).

8.6.5 Amenity benefits

Amenity benefits may be accrued in a project option which does not require the clearing of native vegetation. Amenity refers to the enjoyment value that remnant vegetation provides. Amenity is different to recreation or biodiversity in that it represents the *existence* value or satisfaction value that remnant vegetation may provide (i.e. driving past a forest, a person values the forest being there as opposed to not). Recent willingness to pay studies have valued amenity at $224.70 annually for every hectare of remnant vegetation protected[4]. Where remnant vegetation is foregone (i.e. expansion of the REA resulting in land clearing) the $224.70 value may result in a net *dis-benefit* (i.e. cost).

8.7 Disaggregated benefits by project option

The disaggregated benefits by project option shows where savings are occurring and to what party they are accruing. Option 1 results in $156.82m operational cost savings for Tahmoor Coal, but also just over $7m in dis-benefits to Tahmoor Coal as well as just over $1m in dis-benefits to third parties. Option 1A results in over $149m in benefits including $151m in operational cost savings and $7m in dis-benefits for Tahmoor Coal, and $1m in dis-benefits to third parties. Option 2 results in $122m in benefits to Tahmoor Coal, but and no third party benefits. Table 8-4 outlines the disaggregate benefits by project option.

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[3] Marsden Jacobs, *Managing what matters: the cost of environmental decline in South East Queensland* (2010)

[4] Ibid.

Table 8-4 Disaggregated benefits by project option - m$AUD discounted at 7%

Option	**Tahmoor Coal**			**Third parties**		**Total benefits**
	Operating expenditure savings	Rehabilitation bond savings	Environmental offset savings	Biodiversity benefits	Amenity benefits	
Option 1 – expansion of the REA	$156.82	-$0.57	-$6.20	-$0.51	-$0.42	$149.13
Option 1A – expansion of the REA outside the EPL	$151.69	-$0.57	-$6.20	-$0.51	-$0.42	$144.00
Option 2 – underground disposal	$123.81	-$0.17	-$1.86	$0.00	$0.00	$121.78

8.8 Results

The results of the CBA indicate that all project options are economically viable, result in net benefit over time, and provide significant return on investment compared with the base case. Option 1 is significantly more attractive with a BCR of 7.91, a NPV of $121.9m and an IRR of 58 per cent. The expansion of the REA (option 1) would provide over $139.6m in benefits over the evaluation period to Tahmoor Coal and the wider community.

Option 1A is only slightly less attractive with a BCR of 7.69, an NPV of $118m and over $135m in benefits over the evaluation period.

Option 2 requires more capital expenditure at $63m, but only provides $114m in benefits. The BCR of Option 2 is 1.82 and NPV is $51m. IRR for Option 2 is 9 per cent.

Table 8-5 CBA results

Decision criteria	**Option 1**	**Option 1A**	**Option 2**
PV Costs	-$17.6	-$17.6	-$63.1
PV Benefits	$139.6	$135.7	$114.3
NPV	$121.9	$118.0	$51.3
BCR	7.91	7.69	1.81
IRR	58%	58%	9%

8.9 Sensitivity testing

Sensitivity testing has been conducted to determine the responsiveness the CBA results have to key variables. Sensitivity testing has been conducted on the discount rate, capital expenditure, and the value of amenity and biodiversity for the project area.

Sensitivity testing of the discount rate shows how heavily the results rely on discounting and whether the time value of money significantly changes results (i.e. an investment in 10 years costs less than the same investment now). The discount rate was tested at 4 and 10 per cent, in line with the NSW Treasury Guidelines for cost benefit analysis. Both project options remain viable under the sensitivity tests.

Table 8-6 Sensitivity testing of the discount rate at 4%

Decision criteria	Option 1	Option 1A	Option 2
PV Costs	-$21.3	-$21.3	-$70.7
PV Benefits	$198.0	$191.8	$162.2
NPV	$176.7	$170.5	$91.5
BCR	9.28	8.99	2.29
IRR	63%	63%	12%

Table 8-7 Sensitivity testing of the discount rate at 10%

Decision criteria	Option 1	Option 1A	Option 2
PV Costs	-$14.9	-$14.9	-$56.8
PV Benefits	$101.3	$98.8	$83.3
NPV	$86.3	$83.8	$26.5
BCR	6.78	6.61	1.47
IRR	54%	54%	6%

Capital expenditure is the major cost driver in a CBA. As capital estimates tend to overrun or scope changes, costs can increase. It is important to test the CBA results against a change in capital expenditure to ensure the project options will still be viable if costs increase. Sensitivity of capital expenditure was conducted at 10 per cent. The following table shows the results of the CBA with a 10 per cent increase in the capital expenditure estimate. Both project options remain viable under this sensitivity test.

Table 8-8 Sensitivity of CAPEX +10%

Decision criteria	Option 1	Option 1A	Option 2
PV Costs	-$19.40	-$19.40	-$69.36
PV Benefits	$139.6	$135.7	$114.5
NPV	$120.2	$116.3	$45.2
BCR	7.19	6.99	1.65
IRR	58%	58%	9%

Sensitivity testing was conducted on the estimated willingness to pay values for biodiversity and amenity. As the willingness to pay studies was conducted for South East Queensland catchment areas, the natural environment characteristics may not be entirely comparable. It is considered that the project area is in/near an existing mine site and as such, the wider community may not have access to the biodiversity or amenity or may not value it as highly. For this reason, the willingness to pay to protect remnant vegetation there may be significantly less. The results of the CBA have been tested at a 50 per cent reduction in the willingness to pay for biodiversity and amenity. Table 8-9 shows that at a 50 per cent reduction, both projects are still economically viable.

Table 8-9 Sensitivity test of 50% reduction in biodiversity and amenity values

Decision criteria	Option 1	Option 1A	Option 2
PV Costs	-$17.64	-$17.64	-$63.05
PV Benefits	$140.0	$136.1	$114.5
NPV	$122.4	$118.5	$51.5
BCR	7.94	7.72	1.82
IRR	58%	58%	9%

8.10 Recommendations

Based on the economic decision criteria used to evaluate the CBA results, Option 1 (the expansion of the existing REA area) is the preferred option. It provides over $139m in benefits over the evaluation period, has a net present value of $121m, a benefit cost ratio of 7.91 far exceeding the requirement and an internal rate of return at 58 per cent. Option 1 remains viable under a number of sensitivity tests including an increase in capital cost, changes to the discount rate, and a decrease in the value of the expansion area.

The results show that the operational cost savings associated with Option 1 far exceed those of Option 2, and that the environmental cost associated with the expansion is not significant enough to deter the project investment. Although Option 1A provides similar results to Option1 and a similar magnitude of benefit, disposal of coal rejects outside the EPL is not considered to be an ideal outcome. It is therefore recommended that Option 1 be the preferred disposal method for Tahmoor South coal rejects based on the results of the CBA.

9. Options analysis

A facilitated options workshop was held in conjunction with Tahmoor Coal and Glencore personnel at the Tahmoor Coal site offices to further analyse the shortlisted options. The examination of options involved subjecting them to a series of criteria and scoring their suitability against each.

During the workshop it was identified that the Paste Disposal Underground into Active Goaf would still require a proportion of the rejects to be disposed within an expanded REA, due to the availability of the paste plant system. Consequently, this option developed into and was evaluated as a co-disposal option.

The two options assessed during the options workshop were:

- Option 1 Surface disposal – Rejects emplacement area, modified EPL boundary
- Option 2 Co-disposal – Surface rejects emplacement and underground paste material (active goaf via trailing pipe)

The results of the options analysis' ratings and findings are summarised within Appendix E:

- Table E-1 Compatibility Ratings
- Table E-2 Report Findings

9.1 Options analysis results

The results from the Options analysis preference Option 1 - Expanded Surface Rejects Emplacement Area, as summarised in Table 9-1.

Table 9-1 Options Analysis Results

Primary options	**Option Compatibility**	**Option Score**	**Preferred Option**	**Potential Option**
1. Expanded Surface Rejects Emplacement Area	Compatible	1880	Preferred Option	Yes
2. Co-disposal Paste Disposal Underground into Active Goaf and Expanded Surface REA	Not Suitable	1005	Not preferred	No

As the results are only available upon completion of the workshop, the Options Analysis process has the ability to remove biases from the result.

Appendix A. Design criteria

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Tahmoor Coal, Coal Assets Australia

Glencore

Tahmoor South Project

– Rejects Disposal Options Study

DESIGN CRITERIA

QN10312-EAM-DC-E1-0001 | Revision 1

SINCLAIR KNIGHT MERZ

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Contents

1. Introduction

1.1 Purpose

This document defines the Plant to be created and the client technical requirements placed upon it. This includes performance requirements, requirements on physical characteristics, and logistic support requirements.

The purpose of this document is to:

- constitute the client technical requirement part of the Project definition;
- provide a record of any changes to the Plant
- provide the requirements against which the Plant is tested prior to handover

This document constitutes the highest level of project documentation; all other documentation is related to these two documents in a parent-child relationship, with documentation on lower levels providing additional detail.

As this document is based on preliminary design work, it contains descriptions of that design and definitions of its elements. Such descriptions and definitions are shown in italics.

The following convention is used:

- *shall* indicates a mandatory requirement;
- *should* indicates a desirable requirement, and any non-conformance needs to be justified on the basis of value for money; and
- *will* indicates an intention on the part of the Principal.

1.2 Project Scope

Refer to the Project Execution Plan (QN10312-AAA-PL-G5-0001) for details of the scope of works. A brief summary of the scope of works is as follows:

- Review of rejects disposal options for the Tahmoor South Project
- Multi-criteria analysis of options to eliminate unfeasible options, with the remaining options (max 3) to be analysed including technical issues, risks and economics.
- Assessment of short-listed options, including technical issues, risks and economics
- Preparation of Order of Magnitude estimates (Class 4)
- Preparation of a cost benefit analysis of options
- Preparation of technical and strategy reports

1.3 Background

Mining commenced at Tahmoor in 1975 with board and pillar underground mining operated by Kembla Coking Coal. Long wall mining was introduced from the late 1980's / early 1990's with mining of long wall 27 currently being undertaken (the mine has approval up to long wall 32). The mine has had a number of owners since Kembla Coking Coal, including Austral Coal and Centennial Coal. Tahmoor Coal, Coal Assets Australia, Glencore (formerly Xstrata) have owned the mine since 2007.

The Bulli seam is the only one mined at Tahmoor, which dips approximately 2-4 degrees to the North-East. The coal produced by Tahmoor is semi-hard coking coal for the export market, shipped out of Port Kembla. The existing Tahmoor North operation currently produces nominally 2 million tonnes per annum (Mtpa) from 3Mtpa raw coal.

The coal yield from the existing mining operations is reportedly as high as 80%, although historically the yields have been typically in the low 70's and 2012 recorded a yield in the mid 60's. At a yield of 75%, the production of 3Mt of raw coal from the mine will result in an output of up to 0.75Mt of reject material, subject to the plant recoveries.

The coal processing plant can process 750 tonnes per hour (tph), which at 75% yield would result in 562.5tph product and 187.5tph rejects. This equates to 4,500 tonnes of reject material per day. From data provided by Tahmoor Coal (ref email correspondence dated 22nd April 2013), the maximum daily rejects from 2011 and 2012 was 5,600 tonnes.

Reject material consists mainly of shale with some clay and a small percentage of low grade coal. Fine reject material is dried in a band press and blended with the course reject material.

Currently, an enclosed conveyor transports the reject material from the mine's process plant to a truck loading bin. The reject material is hauled by truck on an internal haul road system and deposited into a Rejects Emplacement Area (REA).

1.4 Project Description

The Tahmoor South project is a continuation of mining operation that will extend the mine life at Tahmoor by approximately 20 years, with development targeted for the beginning of 2016. Tahmoor South proposes to mine approximately 4.5 MTPA through an expansion to the underground operation in order to produce nominally 3 MTPA. The mine will move from North to South with no overlap of operations. Tahmoor Coal's current plan is to dispose of the rejects in a similar manner to their existing operation, via an expanded REA.

The preliminary environmental assessment for Tahmoor South, based on an expended REA, was submitted in September 2012, with responses from authorities received by Tahmoor Coal in late 2012. The response received from the EPA states that "the EA [environmental assessment] should detail a more sustainable solution for the management of coal wash".

A number of reject disposal options have been identified for this study, including:

- Surface disposal:
    - Disposal at Existing Reject Emplacement Area
- Underground (UG) disposal:
    - Dry Material
    - Paste Material (Disused Road, Goafs via Pipeline)
    - Paste Material (Former Goaf areas via Boreholes from access roadways)
    - Paste Material (Active goafs via a trailing pipe)
    - Slurry Material (Disused Road, Goafs via Pipeline)
    - Slurry Material (Former Goaf areas via Boreholes from access roadways)
    - Slurry Material (Active goafs via a trailing pipe)
- Reuse of Rejects Materials as Road base

The deliverables for this study will consist of a technical report that will be used as an internal SKM/Tahmoor Coal document to assess the options, and also as a precursor to an options workshop. A strategy report will also be provided, which will be included as an Appendix to the Environmental Impact Statement (EIS).

1.5 Location

The Tahmoor Colliery is located south of the township of Tahmoor approximately 80 km south west of Sydney. The Mine's Surface facilities are situated to the South of the Bargo River and adjacent to Remembrance Driveway (Old Hume Highway). The existing Reject Emplacement Area (REA) is located to the East of the main southern railway and the Mine's Surface facilities. Site data for Tahmoor is provided in Table 1-1 below.

Table 1-1 – Site data

Item	Description
Project site location	80 km south-west of Sydney NSW
Elevation	Nominally 300m above sea level

1.6 Ambient Conditions

Climatic conditions for the site, obtained from nearest weather stations are provided in Table 1-2 and Table 1-3. This data has been obtained from the Bureau of Meteorology website and shall be confirmed by the design engineers as required.

Table 1-2 – Temperature data

Statistic (°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum	29.5	28.5	26.7	23.8	20.5	17.7	17.2	19.0	21.9	24.1	26.1	28.4	23.6
Mean minimum	16.8	16.8	14.8	11.0	7.0	4.5	3.0	3.8	6.7	9.9	12.9	15.1	10.2
Highest	32.5	32.0	29.9	26.4	22.3	19.2	18.9	22.0	25.5	28.0	30.1	32.4	25.1
Lowest	14.3	14.8	13.1	8.5	3.7	2.0	0.7	1.8	4.9	8.3	11.0	13.0	9.3

(Source: Bureau of Meteorology, Camden Airport weather station)

Table 1-3 – Rainfall data

Statistic (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	87.3	91.2	88.2	69.9	57.1	65.1	50.6	44.1	44.5	64.7	72.2	69.8	804.4
Median	67.1	70.8	68.3	49.3	31.8	42.9	26.1	25.1	37.8	49.6	55.5	53.2	761.0
Highest	393.6	482.5	410.7	243.1	302.9	419.4	328.6	295.0	183.0	339.9	461.8	238.7	1723.2

(Source: Bureau of Meteorology, Picton Council Depot weather station)

1.7 Operating Conditions

The operating hours for the mine are shown in Table 1-4.

Table 1-4– Mine Operating Hours

Description	Value
Operating hours per shift	12
Shifts/day	2
Days/week	7
Days/year	365

The current operating hours for the existing REA / stockpile are shown in Table 1-5.

Table 1-5 – REA Operating Hours

Description	Value
Operating hours per shift	12
Shifts/day	2
Days/week	5
Days/year	360

It is understood that there are neighbours in close proximity to the mine boundary and as such, noise is a concern. Therefore, reduced REA operating hours could be imposed on the mine, limiting haul truck operations to a single 11 hour day shift, between 7am and 6pm.

2. References

2.1 Overview

The documents applicable to the Design Criteria fall into two main groups:

- Those created either within the Project or specifically for the Project; and
- External documents referenced by the Design Criteria; in particular, corporate documents, legislation and standards.

The project-specific documents include specifications, manuals, working papers, and reports. There are various types of specifications; in particular, system specifications, equipment specifications, material specifications, and test specification. Each one of these may have subordinate documents associated with it, such as drawings, calculation sheets, and, in the case of the test specifications, procedures.

Manuals include operating manuals, maintenance manuals, and training manuals, and each one of these may also have subordinate documents associated with it, e.g. spare parts lists.

2.2 Project Specific Documents

The project specific documents upon which this document is written includes:

- Project Execution Plan QN10312-AAA-PL-G5-0001
- Safety Plan QN10312-AAA-PL-G5-0002
- Proposal document NWP3028-AAA-PR-M3-0001

2.3 External reference documents

The following documents have been provided by Tahmoor Coal as reference documents for the project:

[1] ACARP reports (C1014 and C16023)

[2] CHPP flow sheet (TCC-1310)

[3] Tarrant G., Gilroy T., Sich G., Nielsen D. (2012), Metropolitan Mine Underground Emplacement of Coal Rejects. University of Wollongong.

[4] AECOM Preliminary Environmental Assessment report (Ref 60267390) and responses from EPA, NSW Office of Water, Office of Environment and Heritage, Resources and Energy, Roads and Maritime Services, Sydney Catchment Authority, Wollondilly Shire Council and Director General Requirements

[5] Bureau Veritas (2011), Tahmoor Weekly Reject Samples - Reject material test data 85007431

[6] Tahmoor Coal Coal (2011), Tahmoor Backfilling Concept.

[7] Pre-feasibility report by Engenicom dated October 2011

[8] Tahmoor Coal (2008), Coal Preparation Plant Process Flowsheet 650 tph.

[9] Engenicom (2011), Tahmoor Coal Coal Tahmoor Evaluation Of Rejects Disposal Options

[10] Minecraft Consulting (2009), Metropolitan Mine Feasibility Study Rejects Backfill Project Paste Delivery System

[11] Weir Minerals (2009), Technical Bulletin Nº 14: Pumping Non-Newtonian Slurries

2.4 Legislation, codes and standards

All aspects of the work will comply with relevant Government Acts and Regulations which have jurisdiction over them. These Acts and Regulations include, but are not limited to:

- Coal Mine Health and Safety Act 2002 (NSW)
- Coal Mine Health and Safety Regulation 2006 (NSW)
- Mine Health and Safety Act 2004 (NSW)
- Mine Health and Safety Regulation 2007 (NSW)
- Occupational Health and Safety Amendment (Coal Workplaces) Regulation 2006 (NSW)
- Occupational Health and Safety Amendment (Applicable to Mining Workplaces and Coal Workplaces) Regulation 2008 (NSW)
- Occupational Health and Safety Act 2000 (NSW)
- Occupational Health and Safety Regulation 2001 (NSW)
- Work Health and Safety Act 2011
- Work Health and Safety Regulations 2011
- NSW Department of Primary Industries Mining Design Guidelines
- NSW Environmental Protection Act and Regulations
- Electrical Act (NSW)
- Electrical Safety Regulation (NSW)
- Site Specific Statutory Requirements and Environmental Guidelines
- AS 1349 Bourdon Tube Pressure and Vacuum Gauges
- AS 1554.1 Structural steel welding – Welding of steel structures
- AS 1554.6 Structural steel welding – Welding stainless steels for structural purposes
- AS 1627 Metal finishing—Preparation and pre-treatment of surfaces
- AS 1646 Elastomeric seals for waterworks purposes
- AS 2129 Flanges for pipes, valves and fittings
- AS 3007 Electrical Installations – Surface mines and associated processing plant (all ports)
- AS 3500.1 Plumbing and Drainage Part 1: Water Services;
- AS 3500.2 Plumbing and Drainage Part 2: Sanitary Plumbing and Drainage
- AS 4024.1 Safety of machinery
- AS 4041 Pressure piping
- ASME B31.4 Pipeline transportations Systems for Liquids and Slurries

Additionally, design work will comply with rules and provisions of the latest editions and amendments of relevant Australian Standards, Regulations and Codes of Practice unless other codes are specifically named.

2.5 Codes of Practice

- Workplace Safety and Health NSW – Plant Code of Practice 2005
- National Standard for Plant [NOHSC:1010(1994)]
- Code of Environmental Compliance for Mining Lease Projects (January 2001)

2.6 Precedence of documents

Where the requirements of project specifications, data sheets and drawings do not comply with the minimum requirements of the Statutory Regulations and Australian Standards, the latter shall prevail.

Where the requirements of project specifications, data sheets and drawings are more exacting that the minimum requirements of the Statutory Regulations and Australian Standards, the former shall prevail

3. General Requirements

3.1 Mine Life

The predicted life of mine for the existing Tahmoor North operation is 2022. The Tahmoor South operation extends the life of mine to 2040.

3.2 Operational Requirements

3.2.1 Capacity

The capacity of the rejects system to process solids (dry basis), as advised by Tahmoor Coal, will be:

Minimum flow rate	130tph
Nominal flow rate	228tph
Maximum flow rate	350tph

The annual and total forecast rejects from the mine, are provided in Table 3-1 from the data provided by Tahmoor Coal (data issued 15th August 2013).

Table 3-1 – Annual and forecast rejects (Mtpa)

Yield Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ROM (Mt)	2.500	2.559	2.599	2.608	2.556	2.744	3.174	2.924	2.750	2.903	4.434	3.470	3.538	3.604
Product (Mt)	1.750	1.791	1.819	1.826	1.789	1.921	2.222	2.047	1.925	2.032	3.104	2.429	2.477	2.523
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	0.750	0.768	0.780	0.782	0.767	0.823	0.952	0.877	0.825	0.871	1.330	1.041	1.061	1.081
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

Yield Year	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
ROM (Mt)	4.210	3.779	3.575	4.286	3.912	3.846	4.421	2.636	3.463	3.322	3.467	3.425	2.663
Product (Mt)	2.947	2.645	2.503	3.000	2.738	2.692	3.095	1.845	2.424	2.326	2.427	2.397	1.864
Yield - Product (%)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Rejects (Mt)	1.263	1.134	1.073	1.286	1.174	1.154	1.326	0.791	1.039	0.997	1.040	1.027	0.799
Yield - Rejects (%)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

3.2.2 Reject material properties

The rejects material properties are provided in Table 3-2.

Table 3-2 – Annual and forecast rejects

Description	Value
Rejects loose density - for volume calculations	2.02 t/m^3
Rejects compacted density - for strength calculations	2.13 t/m^3
Moisture Content – to be used in Design	2.5% average by weight

(Ref. Network Geotechnics Material Analysis W07/2163, issued 27/2/2013)

3.3 Availability of Rejects Disposal System

Availability is defined as the amount of time that a system is able to operate over a certain period, divided by the amount of the time in the period.

The availability of the Rejects Disposal System shall be 95%. Therefore, the system will operate 8313 hours per annum.

4. Civil Requirements

4.1 REA / Stockpile Design

The geometry criteria for the REA / stockpile earthworks are provided in Table 4-1.

Table 4-1 – Stockpile geometry criteria

Description	Value
Batter slope – Permanent (maximum)	1:5 (V:H) 20%
Batter slope – Temporary (maximum)	1:3 (V:H) 33.33%
Top surface slope	1:200 (V:H) or 0.5%
Horizontal ledges (maximum vertical spacing)	Not required
Height (maximum)	RL 302m
Height above existing ground (maximum)	30m
Catch drain in-fill (gully filling) slope (maximum)	1:2 (V:H) 50% or 1:5 (V:H) 20% if adjacent to the dump *
Catch drain grade (minimum)	1:200 (V:H) or 0.5%

** 1:5 (V:H) 20% dump toe batter not to extend beyond drain toe batter*

4.2 Buffer Zones (from REA / Stockpile)

The buffer zones distances for the REA / stockpiles are provided in Table 4-2.

Table 4-2 – Stockpile buffer zone distances

Description	Value	Source
Buffer / offset from waterway / ‘top of the bank’	40 - 45m	Cardno (Ph2 report 6/11 p5)
Buffer / offset from road reserve	30m	Assumed similar to existing REA
Buffer / offset from property boundary (residential)	30m	Agreed Tahmoor Coal/SKM 14/11/2012
Buffer / offset from property boundary (non residential)	5m	SKM / Tahmoor Coal 14/11/2012

Notes:

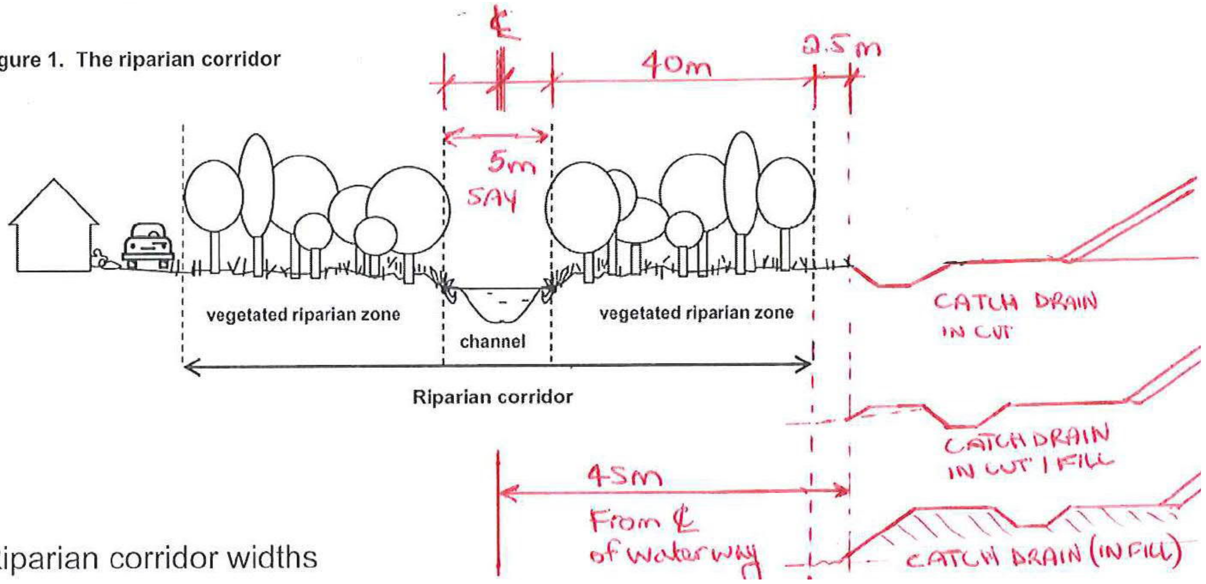
- Buffers / offset excludes access roads, access ways, drainage structures and catch drive in-fill earthworks required for the REA development (refer sketches)
- Water way / ‘top of bank’, is the edge of the creek or the creek channel bank.

4.3 Buffer zones - Sketches

4.3.1 Top of Bank

Water way / ‘top of bank’ or the vegetated riparian zone is taken to start at the edge of the low flow channel (i.e. the edge of the water in average dry weather flow). For ephemeral streams without a defined channel, the start of the riparian zone is the creek center line. Refer to the sketch below:

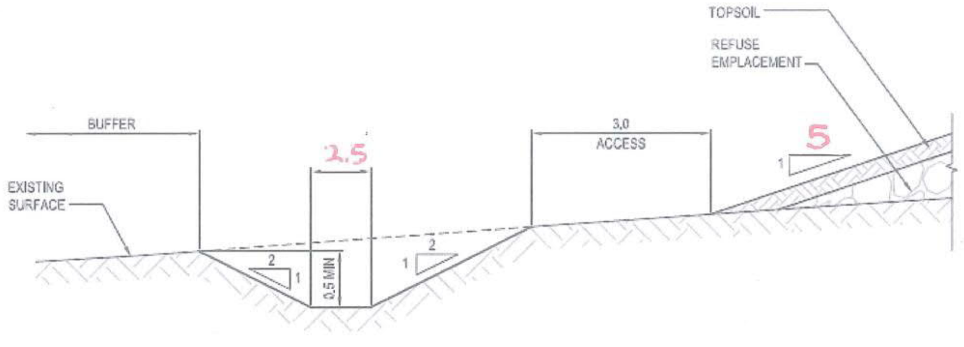
Figure 1. The riparian corridor



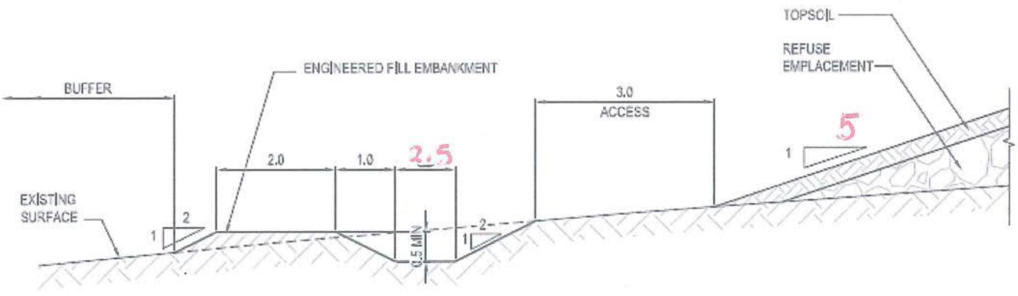
Riparian corridor widths

4.3.2 Catch drain – buffer zone battery limit

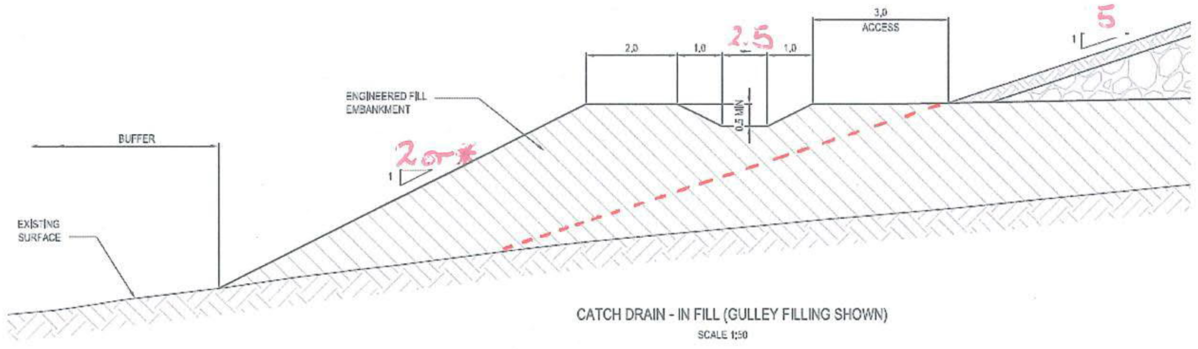
The buffer zone edge point / battery limit is shown below for several possible catch drain arrangements:



CATCH DRAIN – IN CUT
SCALE 1:50



CATCH DRAIN - IN CUT/FILL
SCALE 1:50



CATCH DRAIN - IN FILL (GULLEY FILLING SHOWN)
SCALE 1:50

** 1:5 (V:H) 20% dump toe batter not to extend beyond drain toe batter*

Note: catch drain width to be 2.5m

4.4 Earthworks

Earthworks design criteria for stockpiles, access roads, and erosion and sediment control dam structures are provided in Table 4-3.

Table 4-3 – Earthworks design criteria

Description	Value
Maximum cut slopes (clay)	1:2 (V:H) 50%
Maximum cut slopes (rock)	1:0.5 (V:H) (Subject to Geotechnical Investigation)
Topsoil stripping depths	150mm
Dam embankment slopes (upstream)	1:3 (V:H) 33.3%
Dam embankment slopes (downstream)	1:3 (V:H) 33.3%
Earthworks compaction requirements	95% standard compaction

Bulk earthworks will be designed to minimise cut as much of the site has shallow rock. Where additional fill is required rejects material may be used provided there is a 1m capping of suitable fill material.

4.5 Haul Roads

The haul roads between the rejects hopper / bin and the REA are to be sealed pavement surface suitable for all weather conditions and to minimise dust during hauling operations. The haul roads in the REA area (temporary roads) are to be unsealed all weather roads.

Minimum vertical clearance to all haul roads and access tracks shall be 5.5 m from all constructed overhead structures.

Earth safety bunding (windrow) shall have a minimum height of at least half the largest wheel using the road and be in accordance with Tahmoor Coal specifications.

Guard railing may be used where safety bunding is not practical. Guard railing shall meet the requirements of the Coal Mine Health and Safety Regulations and the RMS safety requirements.

4.5.1 Design Standards

Road standards shall comply with the requirements of Austroad Guide to Road Design for sealed and unseal roads as appropriate, and the Coal Mine Health and Safety Act and Regulations.

4.5.2 Design Vehicles

The haul roads shall be designed to accommodate heavy highway type vehicles, off road haul trucks, low loaders, medium sized graders and typical road construction traffic.

Off road haul trucks design vehicles are as follows:

▪ Current / existing vehicles	Kenworth Dart – Approx. 70t pay load (Refer to Appendix A for estimated loading)
▪ Future vehicles:	55t dump truck (Komatsu HD465-7EO or similar)

4.5.3 Key design criteria

Key design criteria area is provided in Table 4-4.

Table 4-4 – Road design criteria

Description	Value
Design Life – permanent / paved haul roads	5 years
Design Speed	60km/h
Carriageway cross fall	3 to 4%
Shoulder cross fall	3 to 4%
Superelevation	None
Vehicle width – KW Dart	
Vehicle Width – Komatsu HD465-7EO	5.4m
Total width of carriageway	10.8m
Width of Shoulders (each side)	1m
Maximum grade	6%
Minimum grade	1%
Batter Slopes (Cut)	1:4 (V:H) Cut or 1:2 (V:H) Cut with safety berm
Batter Slopes (Fill)	1:4 (V:H) Fill or 1:2 (V:H) Fill with safety berm
Guide posts	Straights 60m, Intersections 30m (to 50m from intersection), 3m white poly pipe on timber pegs.

4.5.4 Pavement Design

Design shall cater for minimum equivalent expected construction movements of 9 trucks per hour for 8 hours, 5 days a week for a period of 6 months.

Design shall cater for minimum equivalent expected haulage movements of 3 to 4 trucks per hour for 24 hours, 7 days a week for the design life of the REA.

Consideration shall be given to 100% heavy vehicles and lane distribution factor (LDF) of 1.

4.5.5 Wearing Course

Haul road pavements shall be sealed and unsealed (in specified areas) and provided with a base course wearing surface. Design and construction standards shall generally comply with the requirements of the “Austroads Guide to Pavement Technology Part 3: Pavement Surfacing”.

4.6 Access Roads (Tracks)

4.6.1 General

Internal roads shall be designed as 4.0 m wide single-lane unsealed roads with 1.0m wide shoulder (on each side) to allow passage of opposing plant service vehicles. The internal roads shoulder shall be suitable for wet weather conditions.

4.6.2 Design Standards

Road design shall comply with the requirements of Austroad Guide to Road Design for unseal roads.

4.6.3 Design Vehicles

The Internal Access Roads shall be designed to accommodate 4 wheel drive vehicles and the occasional medium size vehicle. It is understood that heavy load mine vehicles or equipment will not use these roads.

4.6.4 Drainage

Stormwater overland flows shall be controlled via a system of open cut drains, wherever practicable. Where required, culverts/floodways shall be sized to cater for a 10 year ARI storm event.

5. Drainage

5.1 Statutory Compliance

In all instances, the requirements of NSW Department of Primary Industries and the Project's Environmental Authority shall apply in conjunction with the Tahmoor Coal Mine Water Management Plan. Requirements shall be confirmed prior to designing any drainage or water management structure.

5.2 Rainfall and run-off

Run-off shall be collected in drainage facilities that separate water contaminated in rejects emplacement (bulk earthworks land filling) operations and the water discharging from natural catchments, where possible.

Peak discharges from catchment areas shall be derived using the Rational Method as described in Australian Rainfall and Runoff (1998). Where sufficient site-specific data is available, the relationship between rainfall and run-off measured on site shall be used to develop rainfall loss and run-off parameters. The rainfall intensities shall be interpolated from the Rainfall Intensity Frequency Duration Curves. Run-off coefficients shall be determined from an assessment of expected catchment conditions and from information contained in Australian Rainfall and Runoff.

5.3 Design flows and floods levels

Open drains shall be designed for the greater of Q100 + 500mm freeboard or Q1000 + 100mm freeboard

5.4 Open Drain Construction

All open drains, both the interim and ultimate extent of catchment areas shall maintain the acceptable main channel (i.e. not overbank) stream velocities as follows:

- Minimum self-cleansing velocity of 0.7 m/s for a 2 year Average Recurrence Interval
- General maximum 1.0 m/s for a 2 year Average Recurrence Interval for unlined earth channels with no specific erosion protection
- General maximum 1.5 m/s for a 2 year Average Recurrence Interval for grassed channels with no specific erosion protection
- Absolute maximum 2.5 m/s for a 20 year Average Recurrence Interval for well grassed channels with no specific erosion protection. (3 m/s for Q100)
- Where velocities exceed 3 m/s erosion protection control will be used.

5.5 Drainage channel erosion control

Protection against erosion shall be provided in the following forms:

- All drains shall be grassed and vegetated
- For Q100 velocities 3 m/s to 4.9 m/s, TerraMat ECP-2 - Turf Reinforcement Mat will be used.
- For Q100 velocities greater than 4.9 m/s, drop structures will be used to dissipate energy.

5.6 Culverts

Culverts shall be installed at slopes that provide self-cleansing velocities of 0.7 m/s minimum for one-third depth of full-flow, wherever possible. In areas where such grades cannot be achieved, silt traps shall be provided at the culvert inlets. The maximum flow velocity shall be 4.0m/s.

Culverts are to be designed for maximum loadings of SM 1600 loading, HLP 400 loading and the haul truck loads.

The minimum culvert diameter/depth shall be 45mm.

Culverts will be either reinforced concrete pipes (RCP) with rubber ring joints or reinforce concrete box culverts (RCBC).

5.7 Water Quality

5.7.1 Stormwater Runoff Control

In line with the Tahmoor Coal water management plan, the storm water runoff shall be controlled to ensure:

- Storm water runoff from the undisturbed catchment areas is to be diverted away from the REA, where possible
- Storm water runoff from disturbed areas is to be directed into a sedimentation basin for treatment prior to controlled release into existing waterways
- Captured storm water to promote recycling for mining production/operation use and minimize discharge off-site, where possible

5.8 Sedimentation Basins / Ponds

Sedimentation Ponds for storm water from disturbed areas shall be designed to provide sufficient detention time for the settlement of the nominated particles in accordance with the requirements of the Tahmoor Coal Storm water Management Plan and associated documents as follows:

Tahmoor Coal’s current environmental license and the Blue Book “Managing Urban Storm water – Soils and Construction – Volume 2E Mines and Quarries” as follows:

- Settling zone volume is to be calculated based on the 5 day, 95th percentile rainfall depth. This assumes that 5 days or less are required to achieve flocculation, settling and discharge of the supernatant stormwater.
- length to Width ratio: 3:1 (typical) with 2:1 (minimum)
- water retaining embankments: 1:3 batters with 3.0m top width (crest) for perimeter access
- minimum Pond water depth: 2.0m with Freeboard of 1.0m
- maximum Pond formation depth: 5.0m (measured below the 3m wide perimeter access)
- decant outlet diameter: 450mm (min)
- decant spillway width: 20m (broad crested weir)
- primary outlet: typically a perforated riser, a gravel/geotextile filter or similar
- short Circuiting Avoidance: perforated curtain wall located approximately two-thirds of the distance from the inlet pipe work

Final sizing and location are subject to the findings of the geotechnical investigation of the REA site and the proposed sitting and location of the basins.

5.9 Sedimentation Basin Spillways / Discharge Constraints

All clean and contaminated water dam structures are to be provided with an emergency spillway. Spillways are to be capable of safely discharging a 1 in 100 year storm event with 500mm freeboard. The spillway is designed as a broad crested weir and should be wide enough to limit water velocities to 2.5 m/s. Higher velocities can be designed for by providing concrete, rock or Reno mattress stabilising.

5.10 Storm water Management

Storm water from the REA is to be transferred from new and existing sediment retention dams (existing dams S5, S6, S7, S7a, S7b, S8 and S9), to the S4 dam for automatic coagulant (flocculent) dosing prior to discharge via Licensed Discharge Point 4 (LDP4).

The REA is currently served by the following discharge and overflow points:

- Overflow Point 3 – discharge from the haul road dam (S9)
- Overflow Point 5 – discharge from reject seepage dam (S8).

Note: LDP3 and LDP5 were recently changed to Overflow Points with reduced monitoring requirements, as detailed on the Environmental Protection License, following completion of the Stormwater Consolidation Project in 2010.

5.11 Water transfer infrastructure

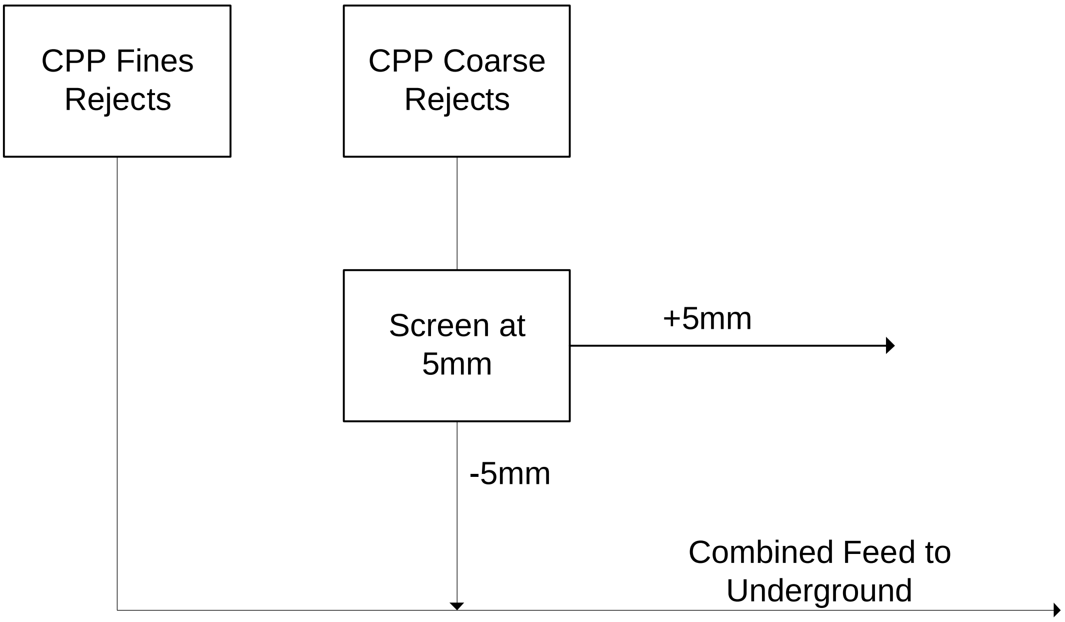
Single pipelines will be used to transfer water between the new sedimentation dams (S11 and S12) and the main retention dam (S4). These pipelines are used in conjunction with pumps to transfer water where required. Site water transfer lines will all be HDPE pipes in a range of diameters, these HDPE

6. Process Requirements

6.1 Processes Overview

6.1.1 Screening process

6.1.1.1 Preliminary Block Flow Diagram

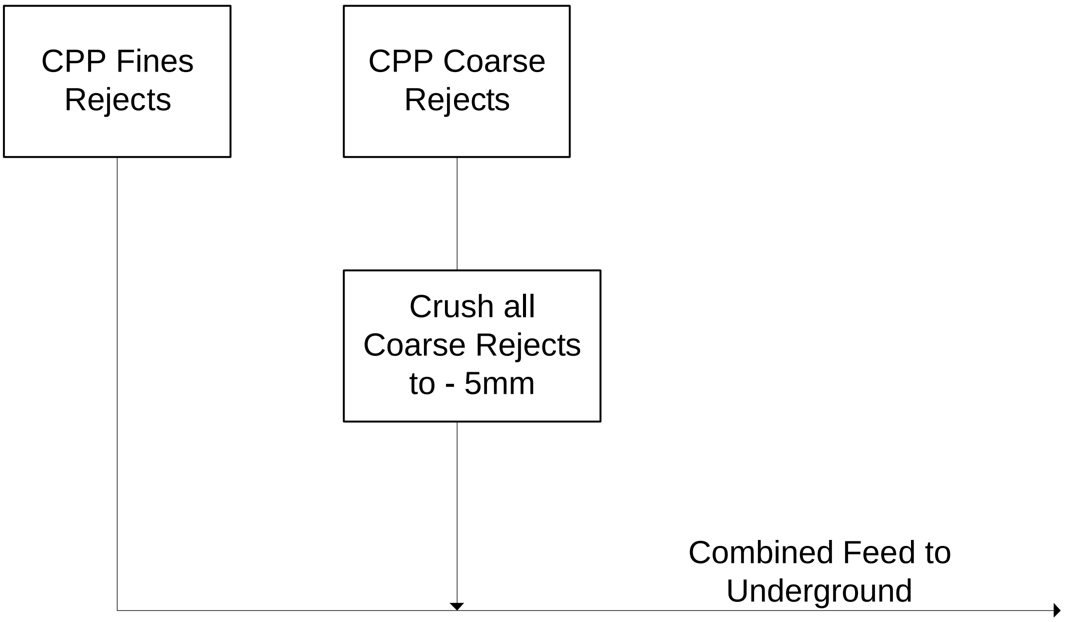


6.1.1.2 Description

This CPP tailings processing option considers screening the Coarse Rejects from the CPP at 5mm and then combining the 5mm (screen underflow) fraction with the CPP Fines to be pumped underground.

6.1.1 Crushing Process

6.1.1.1 Block Flow Diagram



6.1.1.2 Description

This CPP tailings processing option explores crushing all the CPP coarse rejects to a size of -5mm (d100), utilising Horizontal Shaft Impact (HSI) and Vertical Shaft Impact (VSI) crushers. The HSI/VSI product is then combined with the CPP Fines as feed to underground goafs or other available volumes.

6.2 General Process Requirements

6.2.1 Capacity

6.2.1.1 Capacity (dry basis)

Refer Section 3.2.1.

6.2.1.2 Capacity (Slurry – Volumetric Flow Rate)

Table 6-1 below presents the volumetric flow rate of slurry (m^3/h) under different combinations of rejects and solids concentration.

Table 6-1 – Slurry volumetric flow rate (m^3/h)

Rejects, tph	**Solids Concentration, CW (%)**		
	30	**40**	**50**
130	325	226	168
228	568	396	294
260	649	452	335

Source: SKM preliminary calculations

6.2.1.3 Capacity (Paste – Volumetric Flow)

Table 6-2 below presents the volumetric flow rate of paste (m^3/h) under different combinations of rejects and solids concentration.

Table 6-2 – Paste volumetric flow rate (m^3/h)

Rejects, tph	Solids Concentration, CW (%)		
	75	**80**	**85**
130	95	86	79
228	166	151	138
260	190	173	158

Source: SKM preliminary calculations

6.2.1.4 Rejects composition (solids)

The fraction of coarse and fine rejects is assumed to be as per Ref [8]].

Coarse rejects	83.2%
Fine rejects	16.8%

This provides a Fines to Coarse rejects ratio of nearly 1:5 for the crushing option.

6.2.1.5 Rejects SG

The solids Specific Gravity (SG) is assumed to be as per Tahmoor Backfilling Concept (Ref. [6]). The proposed minimum and maximum SG are also presented below:

Minimum	1.7
Nominal	2.0
Maximum	2.3

6.2.2 Particle Size Distribution (PSD)

6.2.2.1 Coarse Rejects Particle Size Distributions (PSD)

Table 6-3 below shows the Coarse Rejects Particle Size Distribution (PSD), extracted from the Tahmoor Weekly Reject Samples report, prepared by Bureau Veritas (Ref. [5]).

Table 6-3 – Coarse Rejects.

Sieve Size, mm^2	Finest, %	Nominal, %	Coarsest, %
>50 - 50	100.0	100.0	100.0
50 - 31.5	95.9	93.8	95.9
31.5 - 16	62.5	61.6	62.5
16 - 8	31.2	32.0	31.2
8 - 4	15.4	16.2	15.4
4 – 2	6.7	7.1	6.7
2 – 1	3.3	3.5	3.3
1 – 0.5	1.0	0.9	1.0
0.5 - <0.5	0.7	0.5	0.7

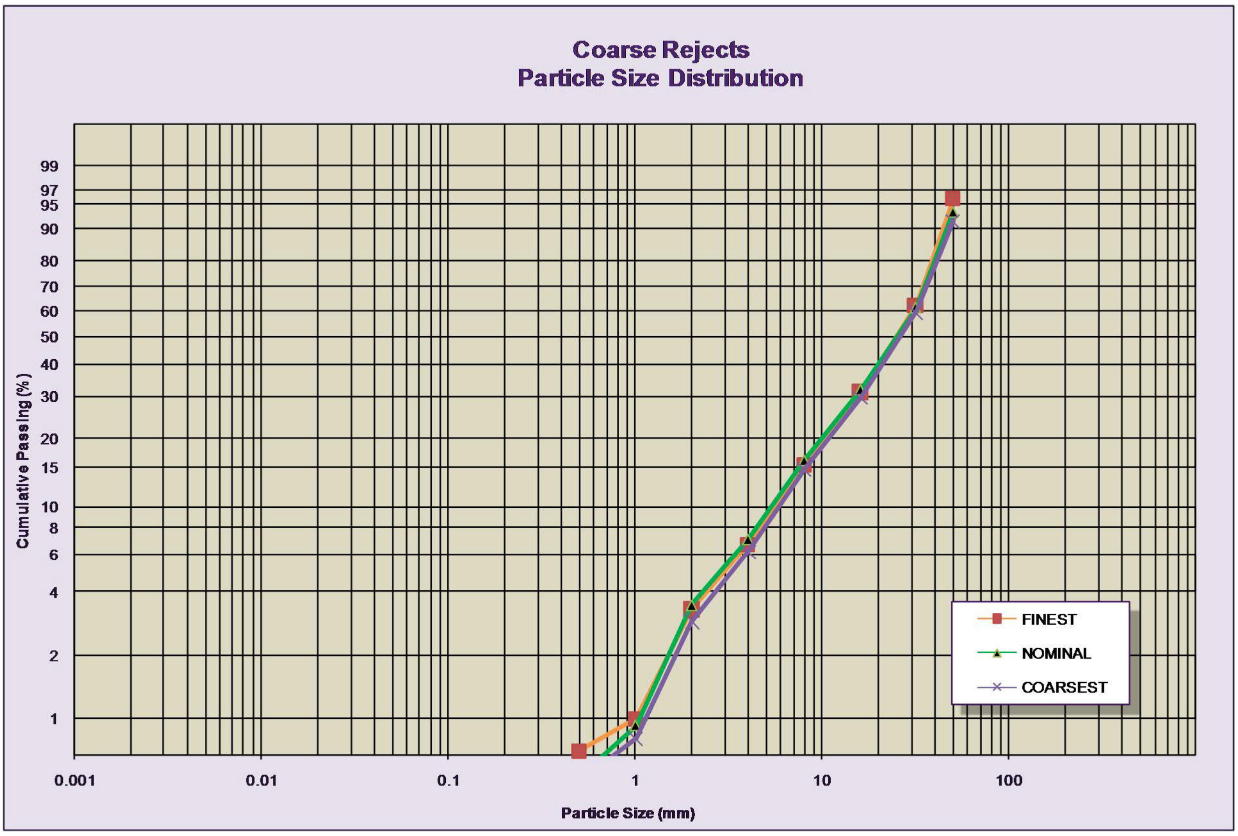


Figure 6-1 - Coarse rejects PSD

6.2.2.2 Fine Rejects Particle Size Distributions (PSD)

Table 6-4 below shows the fine rejects Particle Size Distribution (PSD), estimated from the Tahmoor Weekly Reject Samples report, prepared by Bureau Veritas (Ref. [5]).

Table 6-4 – Fines Rejects.

Sieve Size, mm^2	Finest, %	Nominal, %	Coarsest, %
>0.5 – 0.5	100.0	100.0	100.0
0.5 – 0.25	98.6	96.8	96.5
0.25 – 0.125	88.3	81.8	72.1
0.125 – 0.063	78.6	72.4	64.9
0.063 – 0.038	71.8	64.7	58.4
0.038 - <0.038	59.0	52.9	48.0

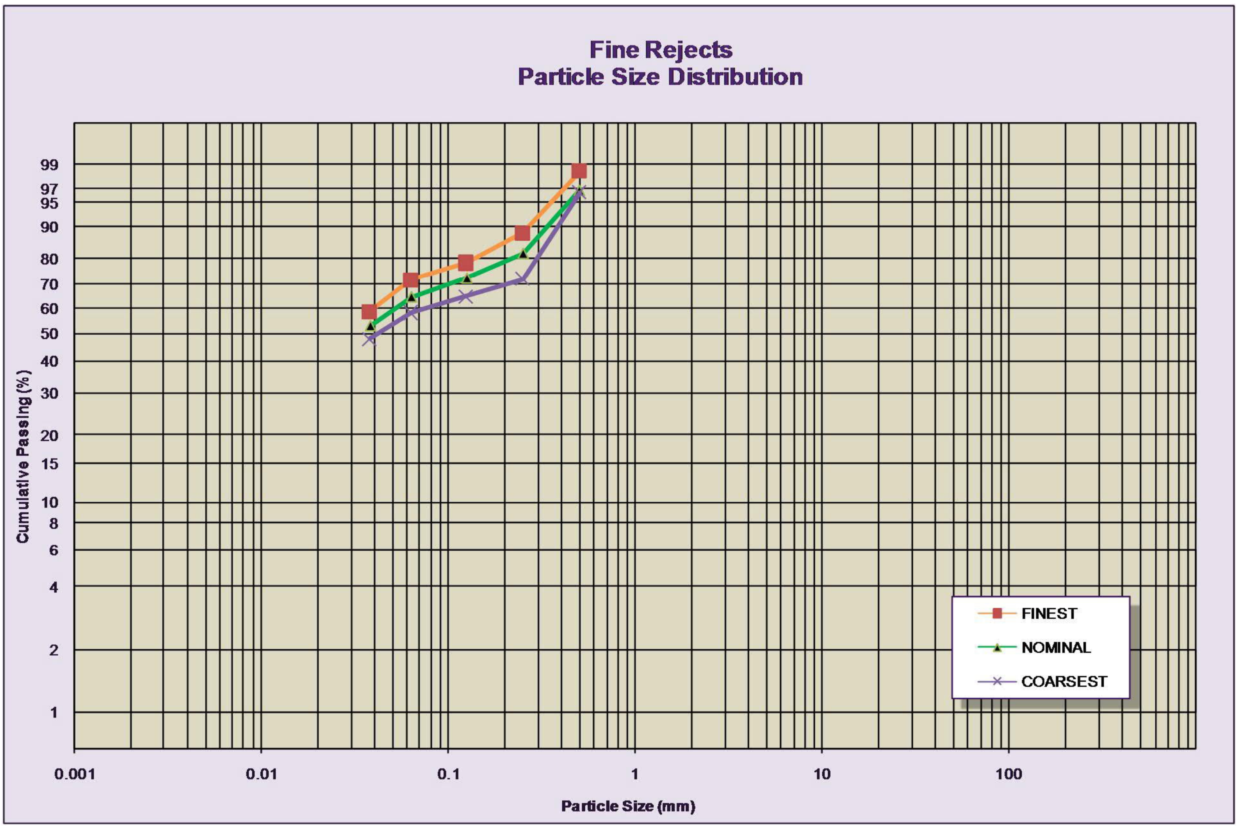


Figure 6-2 - Fine Rejects PSD

6.2.2.3 HSI/VSI Product Particle Size Distributions (PSD)

It is envisaged the use of a tandem of HSI and VSI crushers in the preparation of CPP coarse rejects.

Table 6-5 below shows the estimated product Particle Size Distribution (PSD) after the HSI/VSI crushing process. The PSD that this process yields is assumed to be similar to that presented at the Metropolitan Mine Underground Emplacement of Coal Rejects (Ref. [3]).

Table 6-5 – HSI/VSI Product

Sieve Size, mm^2	Finest, %	Nominal, %	Coarsest, %
5	100%	100%	100%
4	99%	99%	99%
2	98%	98%	98%
1	91%	91%	91%
0.5	71%	71%	71%
0.25	52%	51%	50%

Source: SKM preliminary calculations

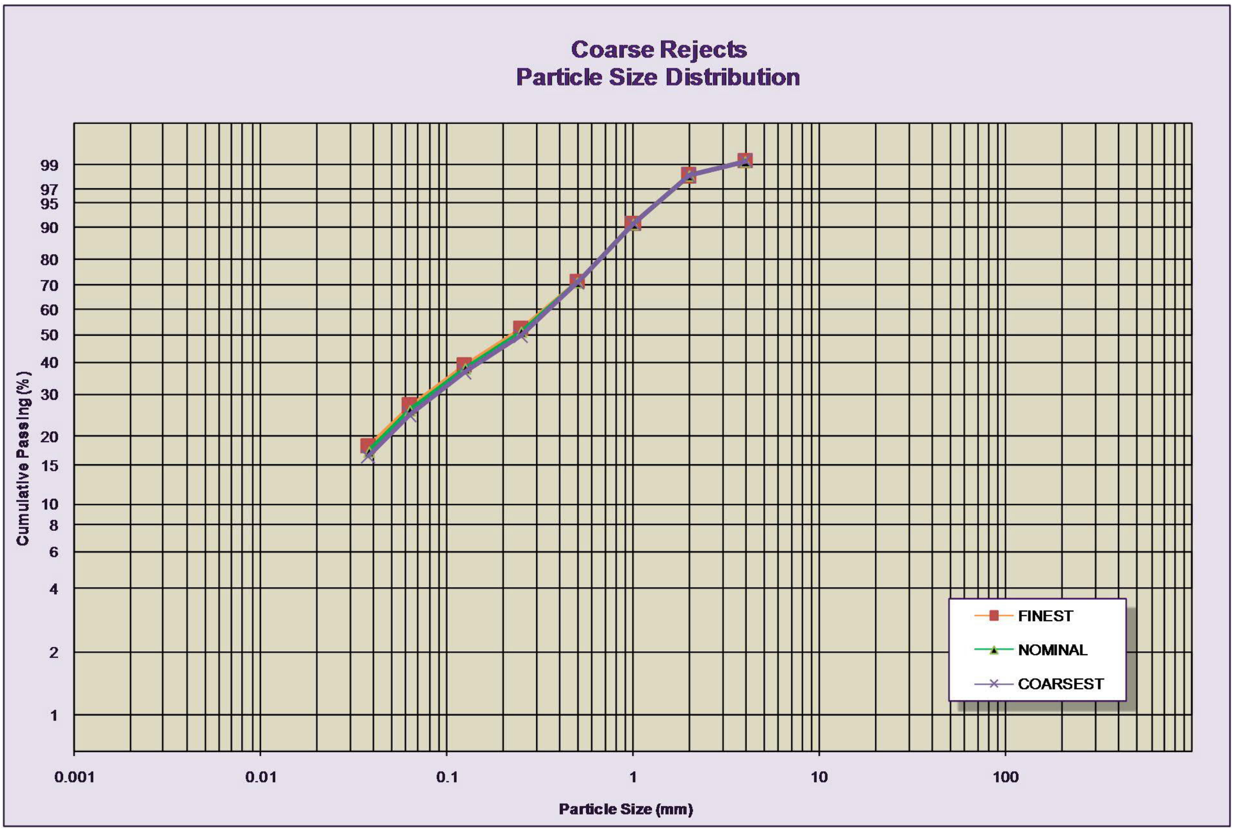


Figure 6-3 - HSI/VSI product

6.3 Rheology and Pumpability

6.3.1 Slurry

The slurry is assumed to be a non-Newtonian settling slurry.

On slurry systems, the flow velocity inside pipes will be 25% above the settling velocity as per calculated utilising the Durand equation.

The critical velocity will also be estimated based on Weir (Ref. [11]) method to determine the flow regime.

It is assumed that the ash content of the slurry will influence its SG and rheology. However, at present there is no correlation available between these parameters for the Tahmoor rejects. The ash content of the rejects is 68% as per pointed out by Engenicom (Ref. [9]). The use of additives is envisaged to improve the slurry rheology.

6.3.1 Paste

It is assumed that paste will behave as Bingham plastic with a rheopectic and shear thinning rheology. Utilising the PSD from the HIS/VSI (above) and the initial shear stress and coefficient of rigidity table presented by Weir Minerals (Ref. [11]), the following values are initially assumed:

t_0= 8.3 Pa

h_0= 0.25 PaS

As per recommended by Minecraft (Ref. [10]), a maximum particle size (d100) of 5 mm will be adopted for this project.

As in the case of slurry, it is assumed that the ash content will influence the SG and rheology of the paste. The paste SG is expected to be between 1.7 and 1.8.

Paste produced shall be able to permeate through collapsed goaf and be resistant to re-fluidization.

On paste systems, the flow velocity will be limited to 1.5 m/s (TBC) and friction losses will be limited to 5 MPa per kilometre (TBC).

6.4 Piping and Pumping Criteria

6.4.1 Pipe Supports

Pipe supports, anchors, guides and other support attachments shall be proprietary design or an approved fabricated alternative and will provide adequate support of the piping against the weight of the pipe, thermal expansion and reactions at changes in direction, reducers and at outlets

6.4.2 Pipe Stress Analysis

Pipe stress analysis if required shall conform to AS4041 Pressure Piping. The assessment will take the following steps:

- Application of the criteria in Clause 3.27.2.2 of AS 4041 Pressure Piping. If the criterion is met then rigorous analysis is not required

- Similarity methods that validate by comparison to previously analysed piping or piping already satisfactorily operating

- Rigorous analysis using approved computer program.

Vessel nozzle flexibility is to be determined using Welding Research Council WRC107 & WRC 297 methodology.

6.4.3 Pump Piping

Piping at pumps shall be sufficiently flexible and adequately supported to prevent the equipment nozzles from being subjected to any load that could disturb the alignment or internal clearances or otherwise affect the equipment and jeopardise operation. Flexible joints shall be avoided and only permitted when it can be demonstrated that piping space limitations necessitate their use.

Positive displacement pumps should be provided with a full capacity relief valve between the pump discharge and the first block valve.

Pump suction lines shall be horizontal, free of any pocket formations and arranged as short and direct as possible. Suction pipe size shall be designed to avoid deposition of solids in the pipe. Multiple pumps operating simultaneously shall preferably have a separate suction line to each pump. Pump suction lines shall include a full bore valve for isolation and a drain valve positioned at the bottom of the pipe and directed towards the appropriate floor drain.

Discharge lines of reciprocating pumps shall be considered as being in vibrating service. The lines shall be adequately restrained to comply with the recommendations of natural frequency calculations. Fatigue analysis shall be performed for lines in vibrating service. If required, vibration dampers shall be used for all lines in vibratory services. This analysis will be performed as part of the detailed engineering and design phase.

Air-actuated knife gate isolation valves (slurry rated) shall be installed on the suction and discharge side of slurry pumps. These valves shall be fitted with flush systems that operate during valve actuation

Non-return valves will not be used on slurry systems

An automated flush system shall inject flush water on the discharge side of slurry pumps, between the pump and the discharge isolation valve. This will allow the pumps to be flushed back through the dump valve on the suction side of the pump

6.4.4 Vents and Drains

Vents and drains required for start-up and shutdown of the plant and equipment shall be indicated on the P&IDs. Drain nozzles shall be of the shortest possible fitting-to-fitting construction to minimise the length of dead leg.

The discharge from drain valves on pipelines located on elevated floors shall have a short pipe leading to a tundish, permitting observation of the draining process. The drain line from the tundish shall be piped down to grade.

Operating vents and drains shall be located at high and low points of vessels, equipment and on piping respectively where required and shall be provided with valves in accessible locations. Piping in a long run shall be fitted with low point drains.

For other services, unless otherwise specified, the drainage from sample points, gauge glasses and level controllers should be led via tundishes into an adjacent drain.

Vents and drainage lines for hazardous fluids shall be accessible for inspection and maintenance. Unless otherwise specified, drainage from such equipment shall be individually piped to a sump tank or a safe area. Overflow lines from equipment shall be extended to grade.

7. Mining Requirements

7.1.1 Mining operations

The reject system shall have minimal to no impact on capacity of the existing and planned mining operations. No or minimal production shall be lost due to the implementation of the reject system. Installing the reject system shall cause minimal to no delays to the construction of a new longwall panel.

7.1.2 Reserves

No or minimal reserves shall be lost due to the implementation of the reject system. Preferably the reject systems shall make use of areas where no future mining of coal is planned anymore. The rejects system shall also not impact the availability of reserves in its close vicinity for example in higher or lower seams.

7.1.3 Mine stability

The reject system shall not decrease the stability of parts of the mine in operation, which would increase the chances of collapses. By adding a binding agent to the rejects, local stability can be improved. However this can also cause additional stresses to occur in the underground increasing the risks of fractures forming which can potentially decrease the overall stability of the underground.

7.1.4 Assumptions

Several assumption have been used to assess the viability of the reject disposal options, these are:

- Porosities
  - 8% in the majority of old goaf areas
  - 10% porosity in old goaf areas near the panel
  - 4% porosity in collapsed roof material above old goaf
- Bulking factor of material between 1.2 to 1.8
- Goaf caving height of 2 to 3 times the seam height

8. Economic Requirements

8.1.1 Tools for Economic Appraisal

The recommended economic appraisal method for the rejects disposal options is Cost-Benefit Analysis (CBA). A CBA is a tool used to measure the net public benefit of a project against a base case scenario. CBA is different to a Financial Analysis in that it measures the costs and benefits to *society* rather than the proponent. A CBA is often used to determine appropriate public expenditure or benefits associated with a project that has significant likely impacts to the community. CBA takes into account social, environmental, and economic outcomes.

Where the major benefits associated with a project cannot readily be provided, a Cost Effectiveness Analysis will be used. Cost effectiveness is similar to CBA in that it measures costs and benefits, but does not attempt to include measures of social or environmental welfare where the values are not easily monetised.

8.1.2 Timeframes

Timeframes used in a CBA are typically a minimum of 20 years. Longer time frames can be used to capture the project specific impacts that may be associated with more distant horizons.

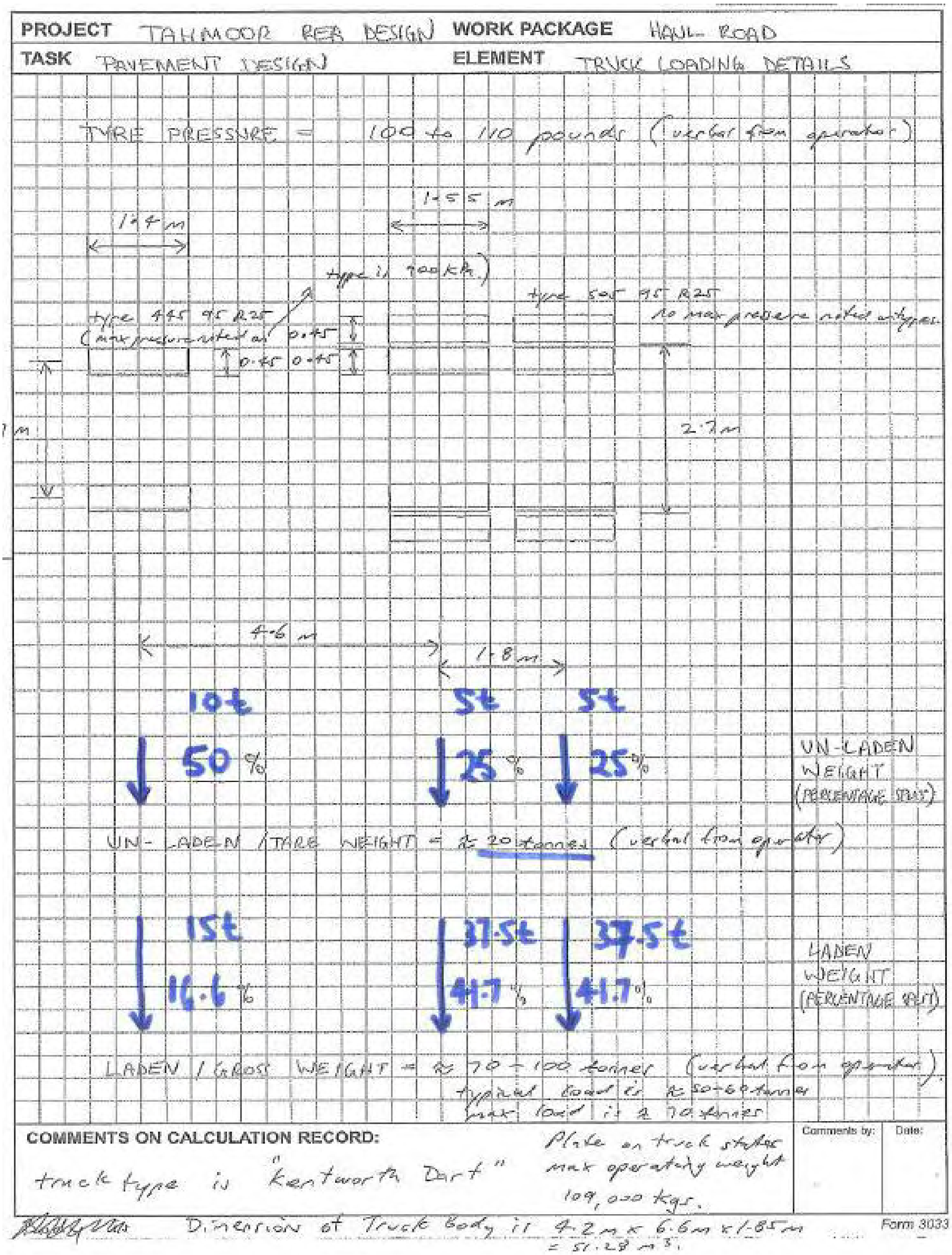
This project will use a **30 year timeframe** for the economic analysis. Any infrastructure or significant project investment which has a design life beyond the 30 year period will have a residual value applied. The residual value will capture any longer term benefits which extend beyond the evaluation period.

8.1.3 Discount Rate

In line with the *NSW Government Guidelines for Economic Appraisal* and the *Strategic Regional Land Use Policy* at **discount rate of 7%** will be used, with sensitivity testing at 4% and 10%.

Appendix A. Existing Haul Truck Data

The existing haul truck loading is shown below:



PROJECT TAHMOOR REB DESIGN **WORK PACKAGE** HAUL ROAD
TASK PAVEMENT DESIGN **ELEMENT** TRUCK LOADING DETAILS

TYRE PRESSURE = 100 to 110 pounds (verbal from operator)

UN-LADEN / TARE WEIGHT = ≈ 20 tonnes (verbal from operator)

LADEN / GROSS WEIGHT = ≈ 70 – 100 tonnes (verbal from operator).
typical load is ≈ 50-60 tonnes
max load is ≈ 70 tonnes

COMMENTS ON CALCULATION RECORD:

truck type is "Kentworth Dart"

Plate on truck states max operating weight 109,000 kgs.

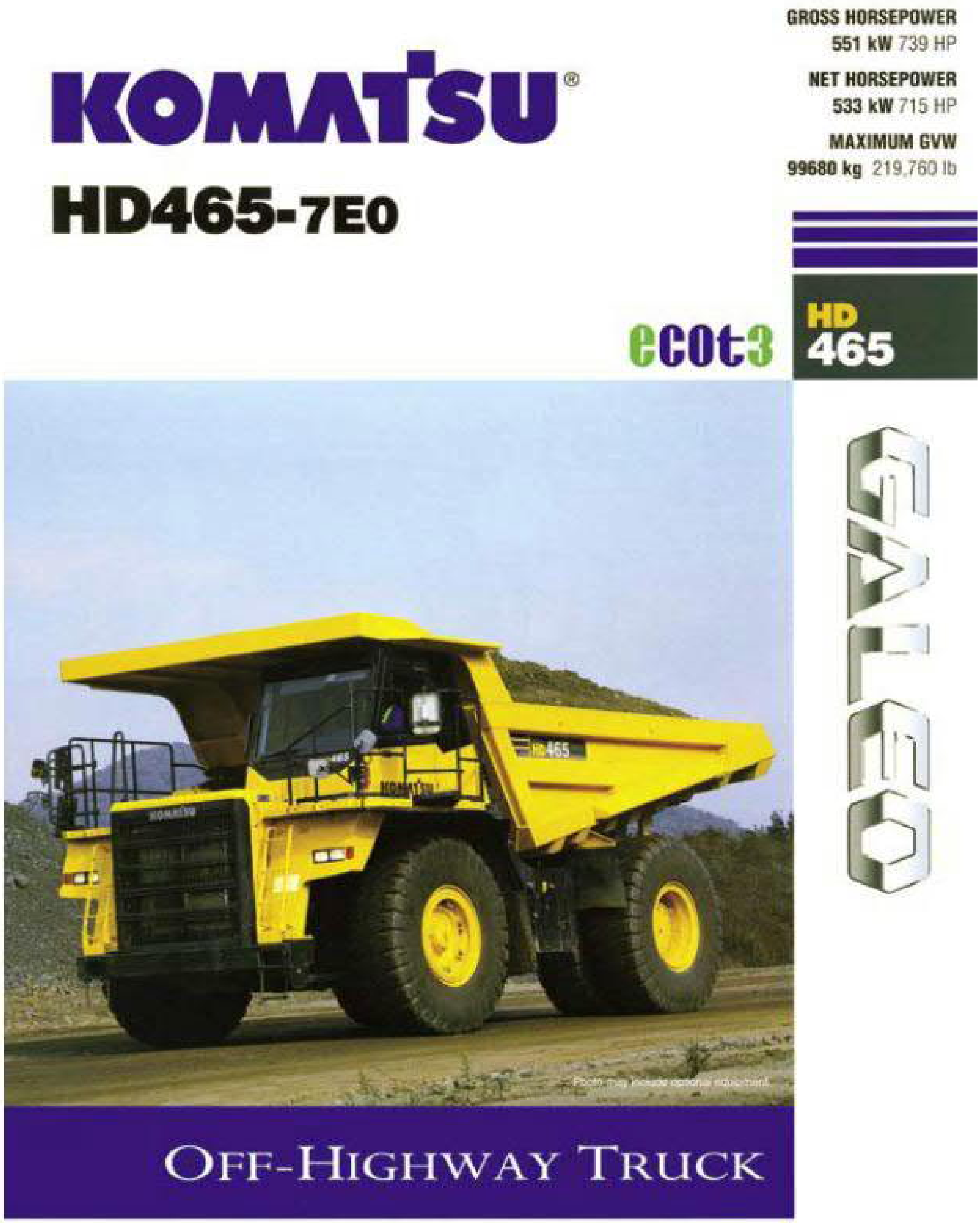
Comments by:

Date:

Dimension of Truck Body is 4.2m x 6.6m x 1.85m
= 51.28 m³.

Form 3033

Appendix B. Future Haul Truck Data



KOMATSU®

HD465-7E0

GROSS HORSEPOWER
551 kW 739 HP

NET HORSEPOWER
533 kW 715 HP

MAXIMUM GVW
99680 kg 219,760 lb

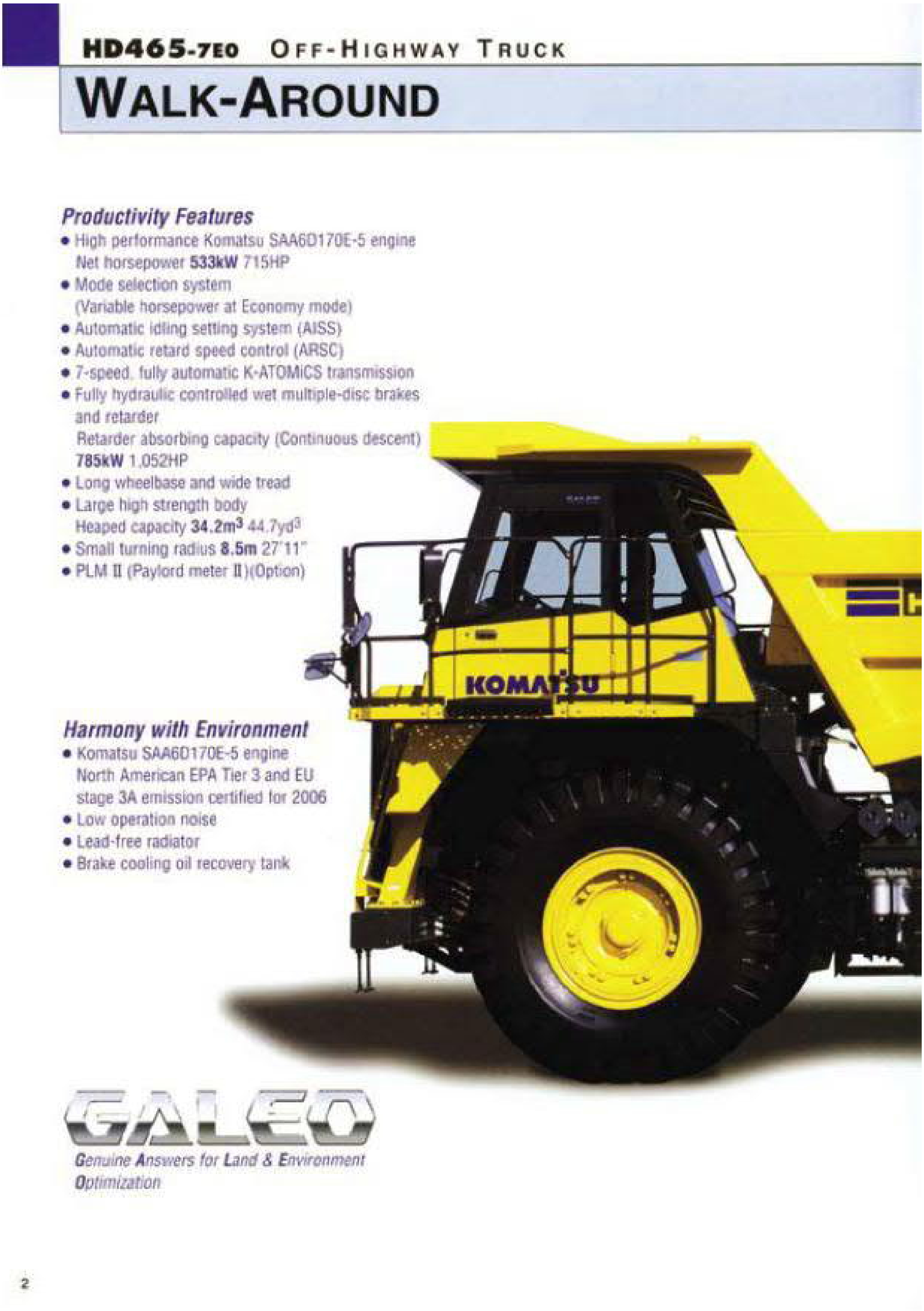
ecot3

HD 465

GALEO

Photo may include optional equipment.

OFF-HIGHWAY TRUCK



HD465-7E0 OFF-HIGHWAY TRUCK

WALK-AROUND

Productivity Features

- High performance Komatsu SAA6D170E-5 engine
  Net horsepower **533kW** 715HP
- Mode selection system
  (Variable horsepower at Economy mode)
- Automatic idling setting system (AISS)
- Automatic retard speed control (ARSC)
- 7-speed, fully automatic K-ATOMiCS transmission
- Fully hydraulic controlled wet multiple-disc brakes and retarder
  Retarder absorbing capacity (Continuous descent)
  785kW 1,052HP
- Long wheelbase and wide tread
- Large high strength body
  Heaped capacity **34.2m³** 44.7yd³
- Small turning radius **8.5m** 27'11"
- PLM II (Paylord meter II)(Option)

Harmony with Environment

- Komatsu SAA6D170E-5 engine
  North American EPA Tier 3 and EU stage 3A emission certified for 2006
- Low operation noise
- Lead-free radiator
- Brake cooling oil recovery tank

Genuine Answers for Land & Environment Optimization

2

OFF-HIGHWAY TRUCK

HD465-7EO

GROSS HORSEPOWER
551 kW 739 HP @ 2000 rpm

NET HORSEPOWER
533 kW 715 HP @ 2000 rpm

MAXIMUM GVW
99680 kg 219,760 lb

Operator Environment

- Wide, spacious cab with excellent visibility
- Ergonomically designed cab
- Easy-to-see instrument panel
- Ideal driving position settings
- K-ATOMiCS with "Skip-shift" function
- Hydropneumatic suspension
- Built-in ROPS/FOPS
- Viscous cab mounts
- Electric body dump control lever
- Supplementary steering and secondary brakes
- Three-mode hydropneumatic suspension (Automatic suspension) (Option)

Photo may include optional equipment.

Reliability Features

- Komatsu components
- High-rigidity frame
- Rigorous dump body design
- Reliable hydraulic system
- Flat face-to-face O-ring seals
- Sealed DT connectors
- ABS(Antilock brake system)(Option)
- ASR(Automatic spin regulator)(Option)
- Pedal-operated secondary brake

Easy Maintenance

- Advanced monitoring system
- Wet multiple-disk brakes and fully hydraulic braking system
- Extended oil change interval
- Centralized arrangement of filters
- Flange type rim
- Electric circuit breaker
- Centralized greasing points
- Vehicle health monitoring system (VHMS) (Option)

3

HD465-7EO OFF-HIGHWAY TRUCK

PRODUCTIVITY FEATURES

Komatsu technology

Komatsu develops and produces all major components, such as engines, electronics and hydraulic components, in house.

With this "Komatsu Technology," and adding customer feedback, Komatsu is achieving greater advancements in technology.

To achieve both high levels of productivity and economical performance, Komatsu has developed the main components with a total control system.

The result is a new generation of high performance and environment friendly machines.

High performance Komatsu SAA6D170E-5 engine

This engine delivers faster acceleration and higher travel speeds with high horsepower per ton. Advanced technology, such as Common Rail Injection system (CRI), air to air aftercooler, efficient turbo-charger, and heavy duty cooled EGR enables the engine to be North American EPA Tier 3 and EU stage 3A emission certified. High torque at low speed, impressive acceleration, and low fuel consumption ensure maximum productivity.

Mode selection system

The system allows selection of the appropriate mode between two modes <Power mode > or <Economy mode> according to each working condition. The mode is easily selected with a switch in the operator's cab.

Power mode

Great productivity can be attained by taking full advantage of high output power. It is appropriate for job sites where larger production uphill-hauling is required.

Economy mode (Variable horsepower)

The engine power automatically changes depending on loaded or unloaded conditions always to use an optimum speed gear. It is appropriate for light work on flat ground.

Automatic Idling Setting System (AISS)

This system facilitates quick engine warm-up and cab cooling/warming. When setting the system ON, engine idle speed is kept at 945 rpm when coolant temperature is **50°C** 122°F or lower. Speed automatically returns to 750 rpm when coolant temperature reaches **50°C** 122°F.

7-speed, fully automatic K-ATOMiCS transmission

The K-ATOMiCS (Komatsu Advanced Transmission with Optimum Modulation Control System) automatically selects the optimum gear according to vehicle speed, engine speed and the shift position you've chosen. The result: the best gear for any driving situation.

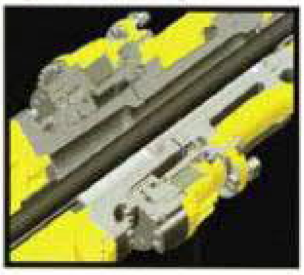
K-ATOMiCS
(Komatsu Advanced Transmission with Optimum Modulation Control System)

Automatic Retard Speed Control (ARSC)

ARSC allows the operator to simply set the downhill travel speed and go down slopes at a constant speed. As a result, the operator can concentrate on steering. The speed can be set at increments of **1 km/h** 0.6 MPH per click (**±5 km/h** 3.1 MPH of maximum speed adjustment) to match the optimum speed for the slope. Also, since the retarder cooling oil temperature is always monitored, the speed is automatically lowered.

Fully hydraulic controlled wet multiple-disc brakes and retarder

Wet multiple-disc brakes ensure highly reliable and stable brake performance. The large-capacity, continuously cooled, wet-multiple disc brakes also function as a highly responsive retarder which gives the operator greater confidence at higher speeds when travelling downhill.



- Retarder Absorbing Capacity (continuous descent): **785 kW** 1,052 HP
- Brake Surface Area (rear): **64,230 cm²** 9,956 in²

Long wheelbase and wide tread

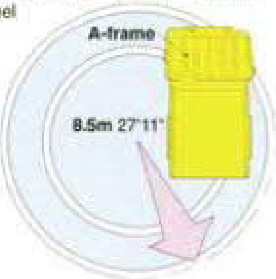
With an extra-long wheelbase, a wide tread and an exceptionally low center of gravity, the HD465-7 hauls the load at higher speed for more production, and delivers superior driving comfort over rough terrain.

Large high strength body

A wide target area makes for easy loading with minimal soil spillage and more efficient hauling. The body is built of **130 kg/mm²** 184,900 PSI wear-resistant high-tensile steel with a Brinell hardness of 400.
The V-shape design also increases structural strength, and provides excellent load stability.

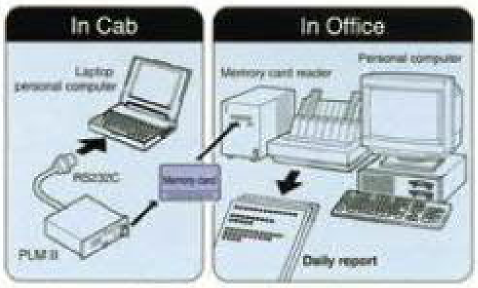
Small turning radius

The MacPherson strut type front suspension has a special A-frame between each wheel and the main frame. The wider space created between the front wheels and the main frame increases the turning angle of the wheels. The larger this turning angle, the smaller the turning radius of the truck.

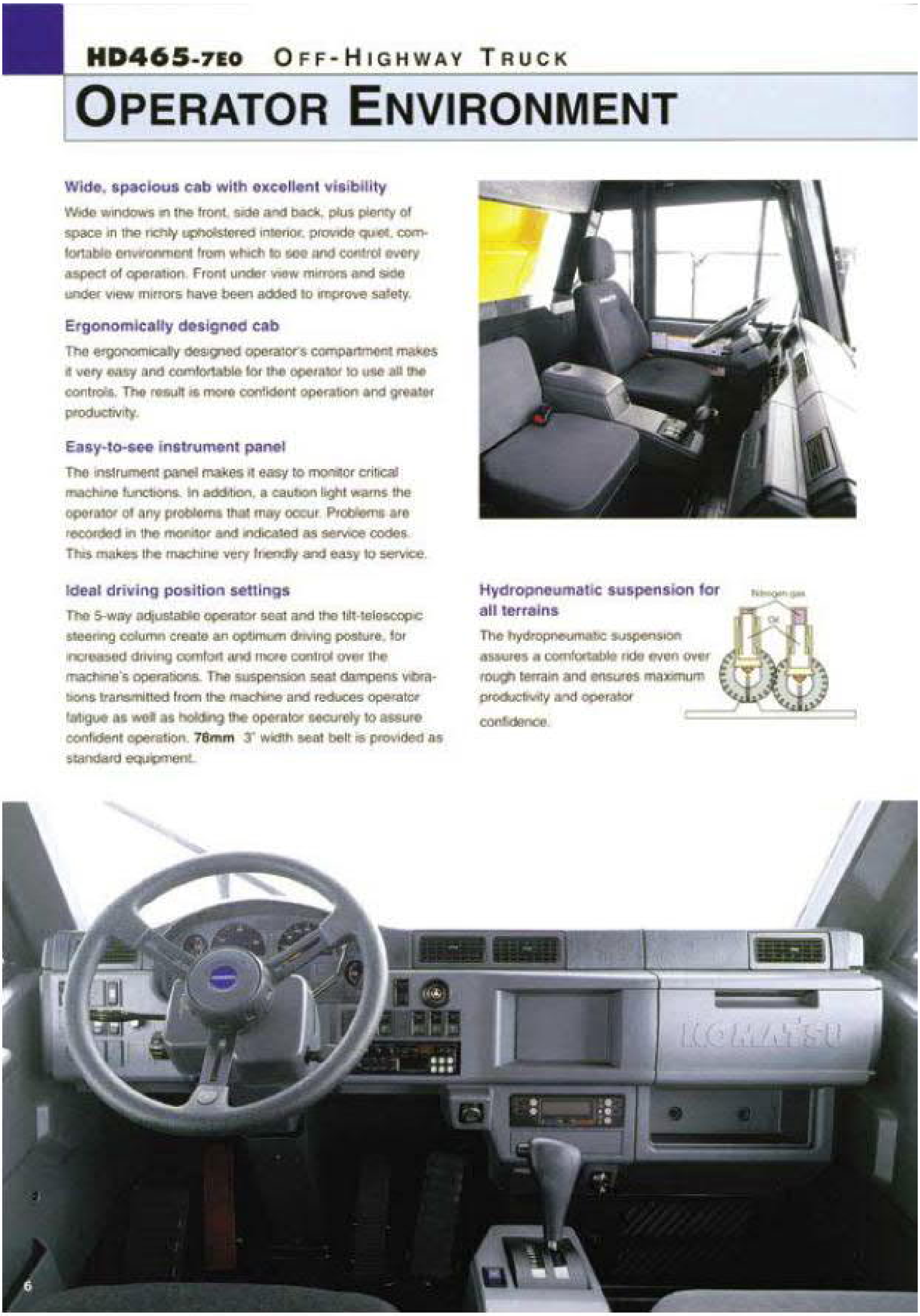


PLM II (Payload Meter II) (Option)

PLM II allows the production volume and the working conditions on the dump truck to be analyzed and controlled directly via a personal computer. The system can store up to 2900 working cycles.



Note) The memory card, card reader and software for data processing are available as options.



HD465-7EO OFF-HIGHWAY TRUCK

OPERATOR ENVIRONMENT

Wide, spacious cab with excellent visibility

Wide windows in the front, side and back, plus plenty of space in the richly upholstered interior, provide quiet, comfortable environment from which to see and control every aspect of operation. Front under view mirrors and side under view mirrors have been added to improve safety.

Ergonomically designed cab

The ergonomically designed operator's compartment makes it very easy and comfortable for the operator to use all the controls. The result is more confident operation and greater productivity.

Easy-to-see instrument panel

The instrument panel makes it easy to monitor critical machine functions. In addition, a caution light warns the operator of any problems that may occur. Problems are recorded in the monitor and indicated as service codes. This makes the machine very friendly and easy to service.

Ideal driving position settings

The 5-way adjustable operator seat and the tilt-telescopic steering column create an optimum driving posture, for increased driving comfort and more control over the machine's operations. The suspension seat dampens vibrations transmitted from the machine and reduces operator fatigue as well as holding the operator securely to assure confident operation. **78mm** 3" width seat belt is provided as standard equipment.

Hydropneumatic suspension for all terrains

The hydropneumatic suspension assures a comfortable ride even over rough terrain and ensures maximum productivity and operator confidence.

OFF-HIGHWAY TRUCK **HD465-7EO**

K-ATOMiCS with "Skip-shift" function

An electronically controlled valve is provided for each clutch pack in the transmission for independent clutch engagement/disengagement. It enables an ideal change in clutch modulation pressure and torque cut-off timing in response to travel conditions. This system and newly added "skip-shift" function ensure smooth shifting and responsive acceleration.

"Skip-shift" function

Optimum travel speed automatically selected in response to angle of ascent. Reduced frequency of downshift and smoother operation are provided.

Three-mode hydropneumatic suspension (Automatic suspension) (Option)

Suspension mode is automatically switched to one of three stages (soft, medium and hard) according to load and operating conditions, for a more comfortable and stable ride.

Built-in ROPS/FOPS

These structures conform to ISO3471 and SAE J1040 ROPS standards, and ISO 3449 and SAE J231 FOPS standards.

Viscous cab mounts

Viscous mounts reduce the noise transmitted to the cab and achieve a quiet 77 dB(A) noise level.

Electric body dump control lever

The low effort lever makes dumping easy.

A positioning sensor is installed for dump body control which significantly reduces the shock made by the lowering of the dump body.

Supplementary steering and secondary brakes

Supplementary steering and secondary brakes are standard features.

Steering: ISO 5010, SAE J1511, SAE J53

Brakes: ISO 3450, SAE J1473

HD465-7EO OFF-HIGHWAY TRUCK

RELIABILITY FEATURES

Komatsu components

Komatsu manufactures the engine, torque converter, transmission, hydraulic units, and electrical parts on this dump truck. Komatsu dump trucks are manufactured with an integrated production system under a strict quality control system.

High-rigidity frame

Cast-steel components are used in the main frame for high-stress areas where loads and shocks are most concentrated.

Rigorous dump body design

The standard dump body is made of **130 kg/mm²** 184,900 PSI high-tensile-strength steel for excellent rigidity and reduced maintenance cost. The V-shape and V-bottom design also increase structural strength. The side and bottom plates of the dump section are reinforced with ribs for added strength.

Reliable hydraulic system

The oil cooler is installed in the radiator lower tank, improving the reliability of the hydraulic system during sudden temperature rises. Further, in addition to the main filter, a 25-micron line filter is at the entrance to the transmission control valve. This system helps to prevent secondary faults.

Flat face-to-face O-ring seals

Flat face-to-face O-ring seals are used to securely seal all hydraulic hose connections and to prevent oil leakage.

Sealed DT connectors

Main harnesses and controller connectors are equipped with sealed DT connectors providing high reliability, water resistance and dust resistance.

ABS (Antilock braking system) (Option)

Using its outstanding electronics technology, Komatsu is the first in the industry to introduce ABS on construction machinery. This system prevents the tires from locking, thus minimizes skidding under slippery conditions while applying the service brake.

ASR (Automatic spin regulator) (Option)

ASR automatically prevents the rear tires on either side from slipping on soft ground for optimal traction.

Pedal-operated secondary brake

If there should be a failure in the foot brake, the parking brake and front disc brakes are activated as pedal operated secondary brake. In addition, when hydraulic pressure drops below the rated level, the parking brake is automatically actuated.

Lead-free radiator

In addition to compliance with emission regulations, a lead-free aluminum core is adopted for the radiator to comply with global environmental requirements.

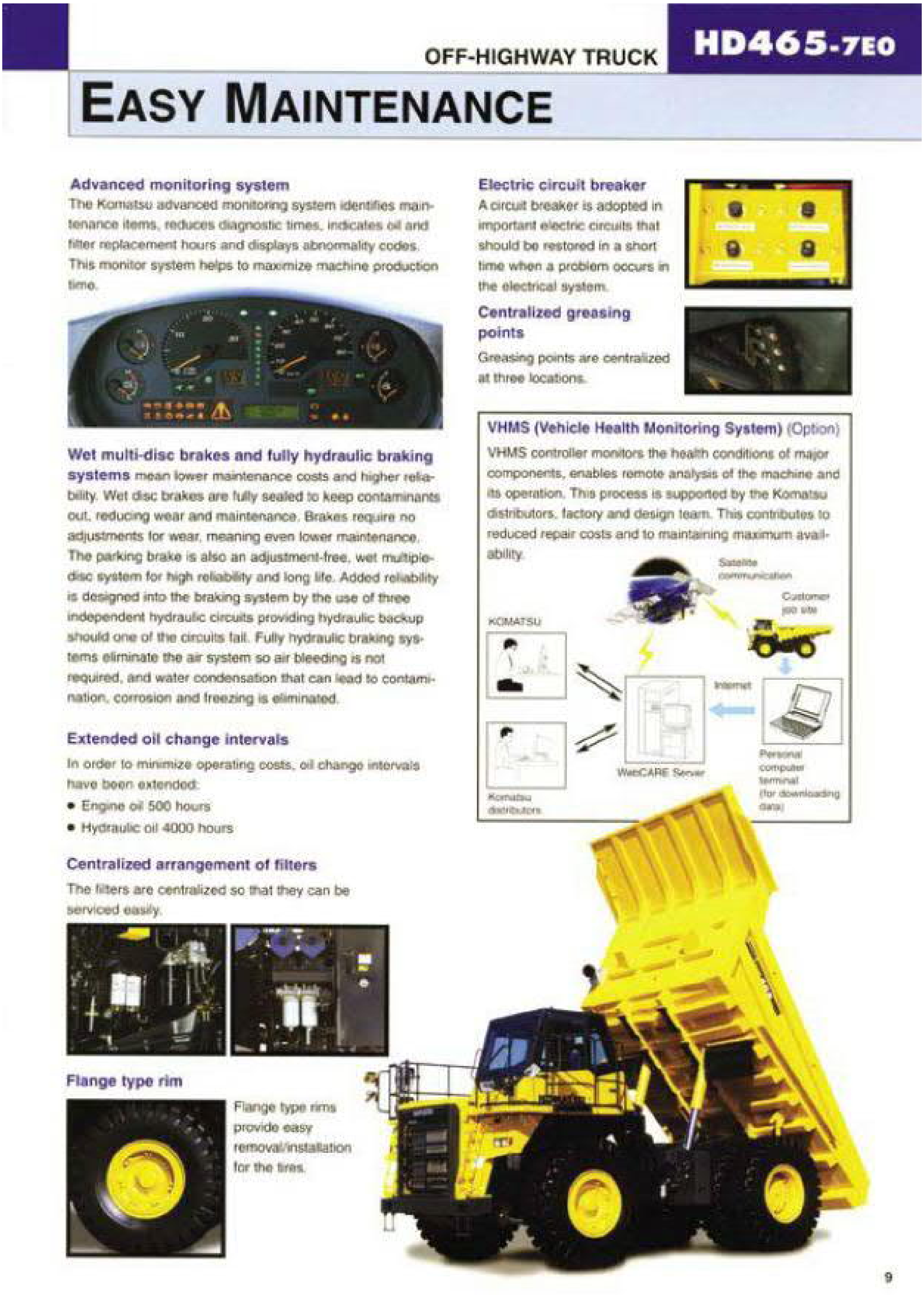
Brake cooling oil recovery tank

To protect environment, a tank is installed to recover brake cooling oil in the event of brake floating seal leakage.

Protection functions supported by electronic control

Item	Function
Downshift inhibitor	Even if the driver downshifts accidentally,a speed appropriate to the current gear is automatically set,preventing over-runs.
Over-run inhibitor	When descending grades, if the vehicle's speed surpasses the maximum for the current gear, the rear brakes automatically operate, preventing over-runs.
Reverse inhibitor	The vehicle is prevented from moving backward when operating the body.
Forward/Reverse shift inhibitor	This device makes it impossible to shift from forward to reverse when the vehicle's speed surpasses 4 km/hour.
Anti-hunting system	When running near a shift point, smooth automatic shifting takes place.
Neutral safety	The engine is prevented from starting when the shift lever is not in neutral.

8



OFF-HIGHWAY TRUCK **HD465-7EO**

EASY MAINTENANCE

Advanced monitoring system

The Komatsu advanced monitoring system identifies maintenance items, reduces diagnostic times, indicates oil and filter replacement hours and displays abnormality codes. This monitor system helps to maximize machine production time.

Wet multi-disc brakes and fully hydraulic braking systems mean lower maintenance costs and higher reliability. Wet disc brakes are fully sealed to keep contaminants out, reducing wear and maintenance. Brakes require no adjustments for wear, meaning even lower maintenance. The parking brake is also an adjustment-free, wet multiple-disc system for high reliability and long life. Added reliability is designed into the braking system by the use of three independent hydraulic circuits providing hydraulic backup should one of the circuits fail. Fully hydraulic braking systems eliminate the air system so air bleeding is not required, and water condensation that can lead to contamination, corrosion and freezing is eliminated.

Extended oil change intervals

In order to minimize operating costs, oil change intervals have been extended:

- Engine oil 500 hours
- Hydraulic oil 4000 hours

Centralized arrangement of filters

The filters are centralized so that they can be serviced easily.

Flange type rim

Flange type rims provide easy removal/installation for the tires.

Electric circuit breaker

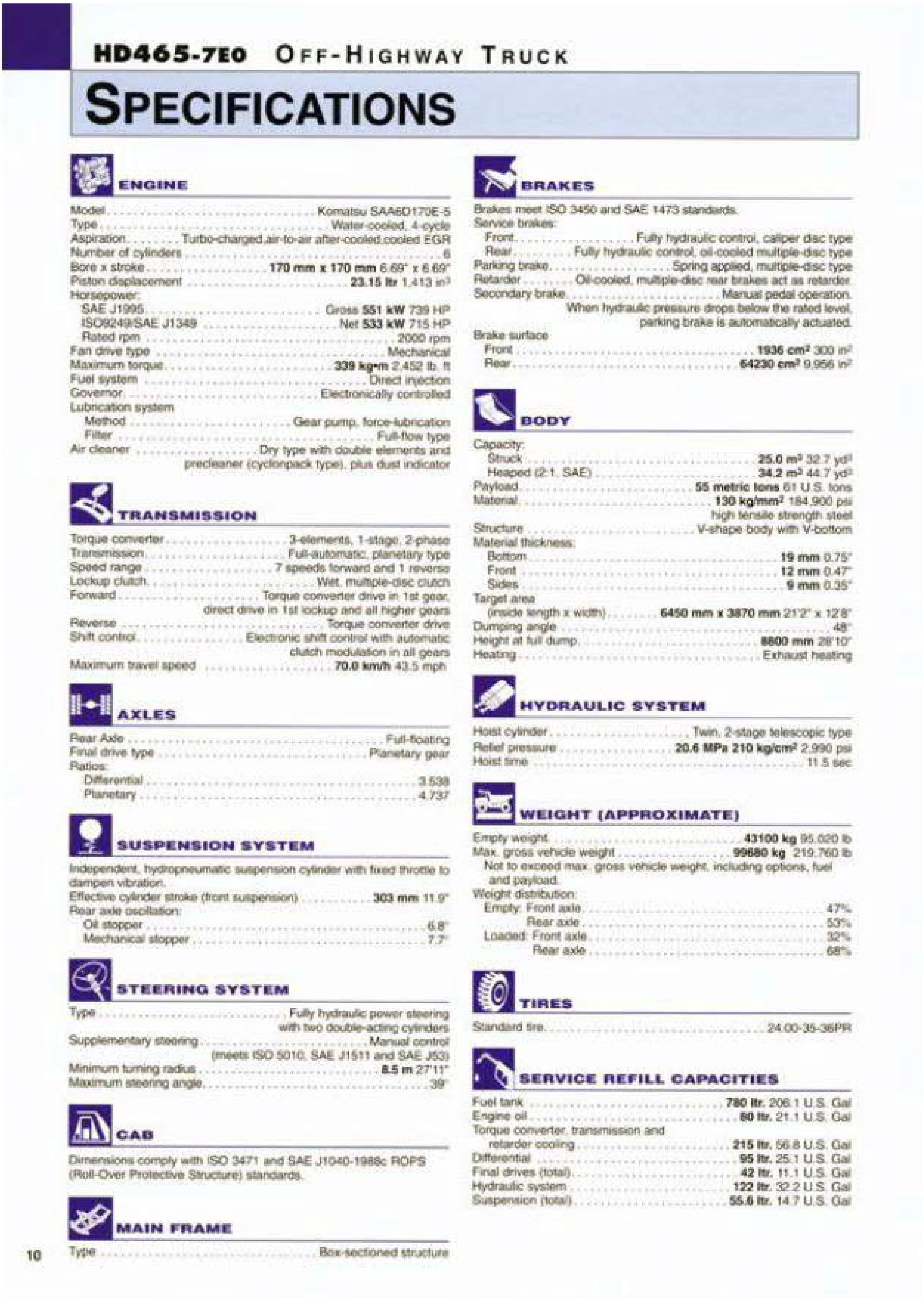
A circuit breaker is adopted in important electric circuits that should be restored in a short time when a problem occurs in the electrical system.

Centralized greasing points

Greasing points are centralized at three locations.

VHMS (Vehicle Health Monitoring System) (Option)

VHMS controller monitors the health conditions of major components, enables remote analysis of the machine and its operation. This process is supported by the Komatsu distributors, factory and design team. This contributes to reduced repair costs and to maintaining maximum availability.



HD465-7E0 OFF-HIGHWAY TRUCK

SPECIFICATIONS

ENGINE

Model	Komatsu SAA6D170E-5
Type	Water-cooled, 4-cycle
Aspiration	Turbo-charged,air-to-air after-cooled,cooled EGR
Number of cylinders	6
Bore x stroke	**170 mm x 170 mm** 6.69" x 6.69"
Piston displacement	**23.15 ltr** 1,413 in^3
Horsepower:	
SAE J1995	Gross **551 kW** 739 HP
ISO9249/SAE J1349	Net **533 kW** 715 HP
Rated rpm	2000 rpm
Fan drive type	Mechanical
Maximum torque	**339 kg•m** 2,452 lb. ft
Fuel system	Direct injection
Governor	Electronically controlled
Lubrication system	
Method	Gear pump, force-lubrication
Filter	Full-flow type
Air cleaner	Dry type with double elements and precleaner (cyclonpack type), plus dust indicator

TRANSMISSION

Torque converter	3-elements, 1-stage, 2-phase
Transmission	Full-automatic, planetary type
Speed range	7 speeds forward and 1 reverse
Lockup clutch	Wet, multiple-disc clutch
Forward	Torque converter drive in 1st gear, direct drive in 1st lockup and all higher gears
Reverse	Torque converter drive
Shift control	Electronic shift control with automatic clutch modulation in all gears
Maximum travel speed	**70.0 km/h** 43.5 mph

AXLES

Rear Axle	Full-floating
Final drive type	Planetary gear
Ratios:	
Differential	3.538
Planetary	4.737

SUSPENSION SYSTEM

Independent, hydropneumatic suspension cylinder with fixed throttle to dampen vibration.

Effective cylinder stroke (front suspension)	**303 mm** 11.9"
Rear axle oscillation:	
Oil stopper	6.8°
Mechanical stopper	7.7°

STEERING SYSTEM

Type	Fully hydraulic power steering with two double-acting cylinders
Supplementary steering	Manual control (meets ISO 5010, SAE J1511 and SAE J53)
Minimum turning radius	**8.5 m** 27'11"
Maximum steering angle	39°

CAB

Dimensions comply with ISO 3471 and SAE J1040-1988c ROPS (Roll-Over Protective Structure) standards.

MAIN FRAME

Type	Box-sectioned structure

BRAKES

Brakes meet ISO 3450 and SAE 1473 standards.

Service brakes:	
Front	Fully hydraulic control, caliper disc type
Rear	Fully hydraulic control, oil-cooled multiple-disc type
Parking brake	Spring applied, multiple-disc type
Retarder	Oil-cooled, multiple-disc rear brakes act as retarder.
Secondary brake	Manual pedal operation. When hydraulic pressure drops below the rated level, parking brake is automatically actuated.
Brake surface	
Front	**1936 cm^2** 300 in^2
Rear	**64230 cm^2** 9,956 in^2

BODY

Capacity:	
Struck	**25.0 m^3** 32.7 yd^3
Heaped (2:1, SAE)	**34.2 m^3** 44.7 yd^3
Payload	**55 metric tons** 61 U.S. tons
Material	**130 kg/mm^2** 184,900 psi high tensile strength steel
Structure	V-shape body with V-bottom
Material thickness:	
Bottom	**19 mm** 0.75"
Front	**12 mm** 0.47"
Sides	**9 mm** 0.35"
Target area (inside length x width)	**6450 mm x 3870 mm** 21'2" x 12'8"
Dumping angle	48°
Height at full dump	**8800 mm** 28'10"
Heating	Exhaust heating

HYDRAULIC SYSTEM

Hoist cylinder	Twin, 2-stage telescopic type
Relief pressure	**20.6 MPa 210 kg/cm^2** 2,990 psi
Hoist time	11.5 sec

WEIGHT (APPROXIMATE)

Empty weight	**43100 kg** 95,020 lb
Max. gross vehicle weight	**99680 kg** 219,760 lb

Not to exceed max. gross vehicle weight, including options, fuel and payload.

Weight distribution:	
Empty: Front axle	47%
Rear axle	53%
Loaded: Front axle	32%
Rear axle	68%

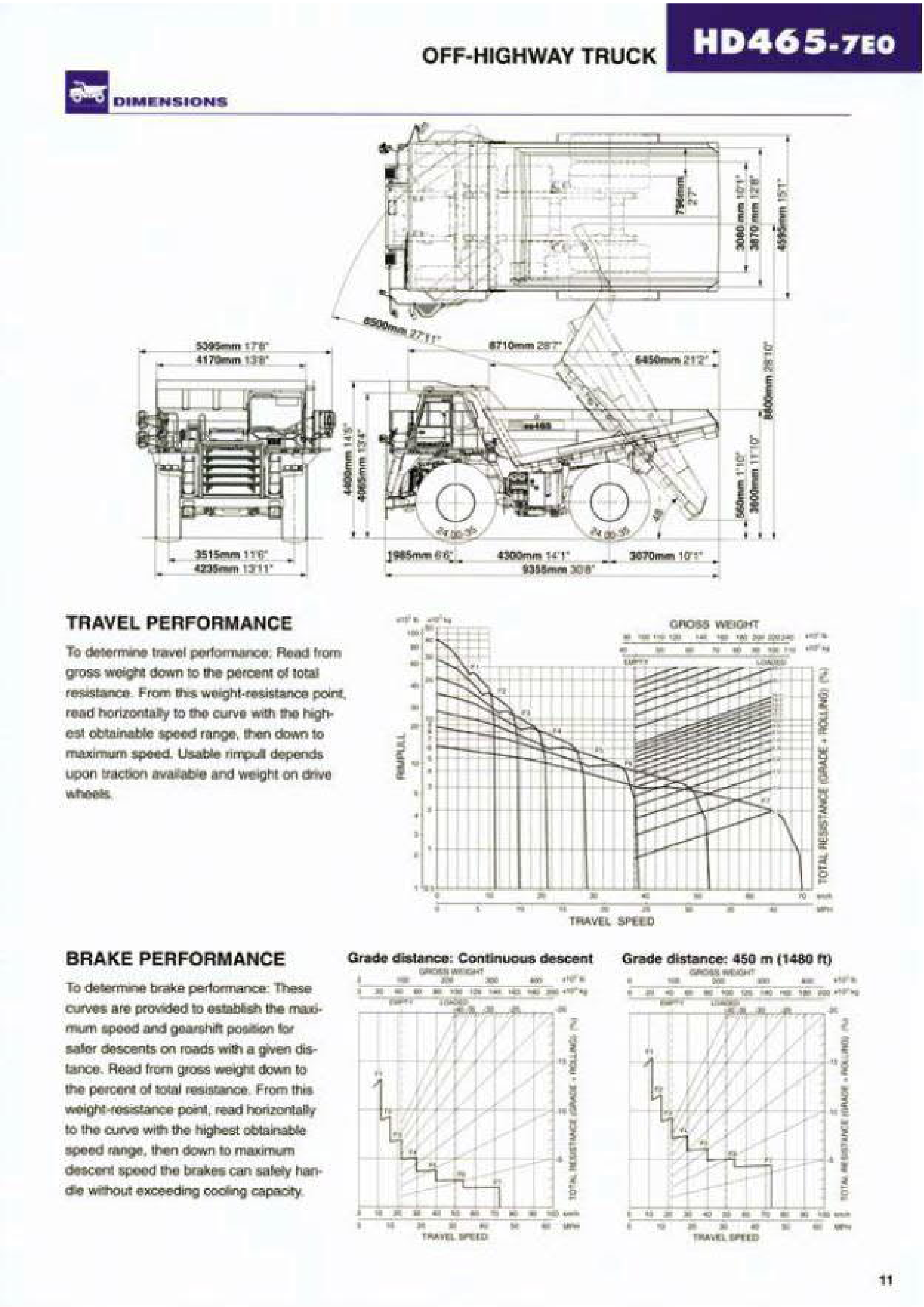
TIRES

Standard tire	24.00-35-36PR

SERVICE REFILL CAPACITIES

Fuel tank	**780 ltr.** 206.1 U.S. Gal
Engine oil	**80 ltr.** 21.1 U.S. Gal
Torque converter, transmission and retarder cooling	**215 ltr.** 56.8 U.S. Gal
Differential	**95 ltr.** 25.1 U.S. Gal
Final drives (total)	**42 ltr.** 11.1 U.S. Gal
Hydraulic system	**122 ltr.** 32.2 U.S. Gal
Suspension (total)	**55.6 ltr.** 14.7 U.S. Gal

10



OFF-HIGHWAY TRUCK HD465-7EO

DIMENSIONS

TRAVEL PERFORMANCE

To determine travel performance: Read from gross weight down to the percent of total resistance. From this weight-resistance point, read horizontally to the curve with the highest obtainable speed range, then down to maximum speed. Usable rimpull depends upon traction available and weight on drive wheels.

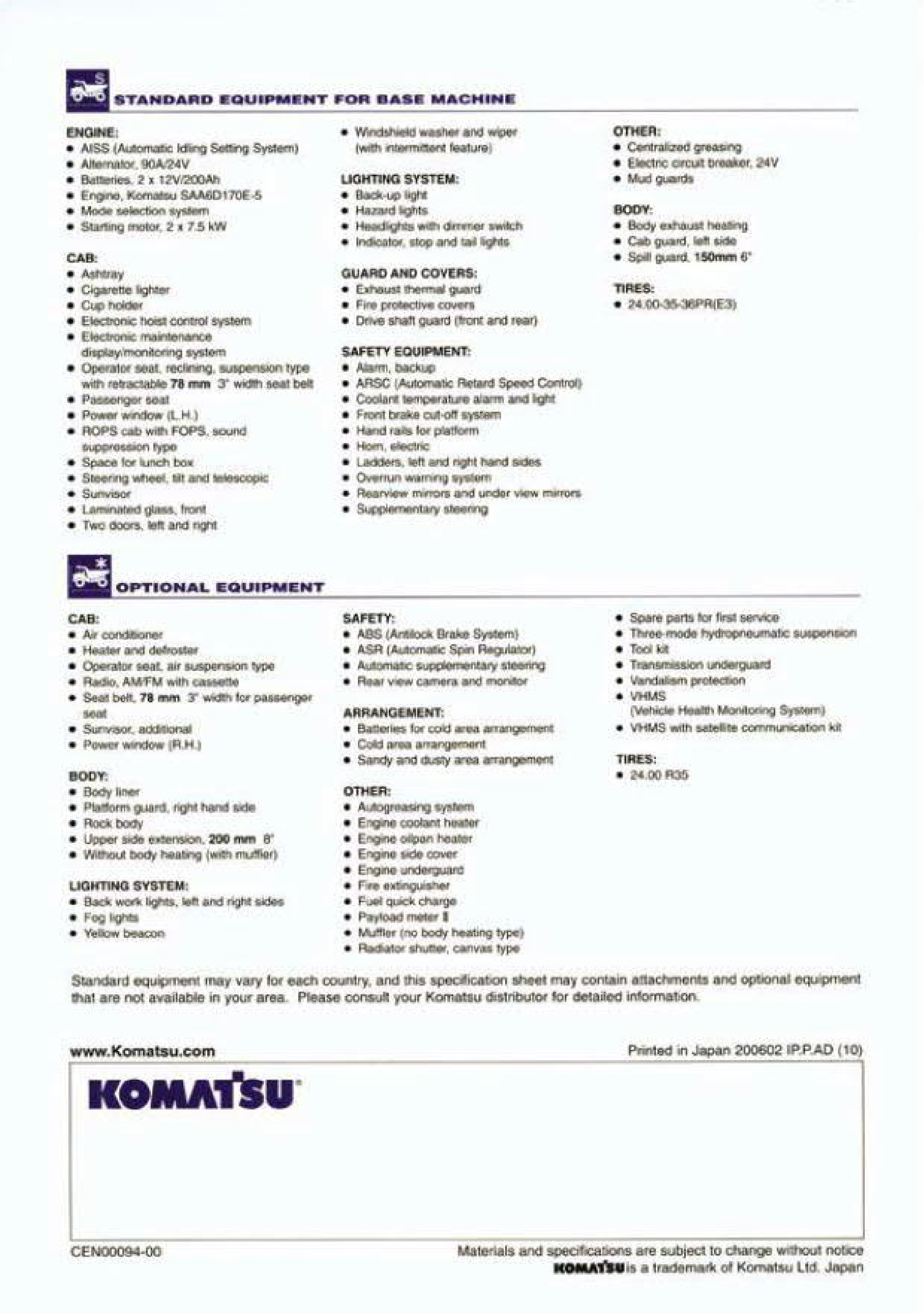
BRAKE PERFORMANCE

To determine brake performance: These curves are provided to establish the maximum speed and gearshift position for safer descents on roads with a given distance. Read from gross weight down to the percent of total resistance. From this weight-resistance point, read horizontally to the curve with the highest obtainable speed range, then down to maximum descent speed the brakes can safely handle without exceeding cooling capacity.

Grade distance: Continuous descent

Grade distance: 450 m (1480 ft)

11



STANDARD EQUIPMENT FOR BASE MACHINE

ENGINE:
- AISS (Automatic Idling Setting System)
- Alternator, 90A/24V
- Batteries, 2 x 12V/200Ah
- Engine, Komatsu SAA6D170E-5
- Mode selection system
- Starting motor, 2 x 7.5 kW

CAB:
- Ashtray
- Cigarette lighter
- Cup holder
- Electronic hoist control system
- Electronic maintenance display/monitoring system
- Operator seat, reclining, suspension type with retractable **78 mm** 3" width seat belt
- Passenger seat
- Power window (L.H.)
- ROPS cab with FOPS, sound suppression type
- Space for lunch box
- Steering wheel, tilt and telescopic
- Sunvisor
- Laminated glass, front
- Two doors, left and right
- Windshield washer and wiper (with intermittent feature)

LIGHTING SYSTEM:
- Back-up light
- Hazard lights
- Headlights with dimmer switch
- Indicator, stop and tail lights

GUARD AND COVERS:
- Exhaust thermal guard
- Fire protective covers
- Drive shaft guard (front and rear)

SAFETY EQUIPMENT:
- Alarm, backup
- ARSC (Automatic Retard Speed Control)
- Coolant temperature alarm and light
- Front brake cut-off system
- Hand rails for platform
- Horn, electric
- Ladders, left and right hand sides
- Overrun warning system
- Rearview mirrors and under view mirrors
- Supplementary steering

OTHER:
- Centralized greasing
- Electric circuit breaker, 24V
- Mud guards

BODY:
- Body exhaust heating
- Cab guard, left side
- Spill guard, **150mm** 6"

TIRES:
- 24.00-35-36PR(E3)

OPTIONAL EQUIPMENT

CAB:
- Air conditioner
- Heater and defroster
- Operator seat, air suspension type
- Radio, AM/FM with cassette
- Seat belt, **78 mm** 3" width for passenger seat
- Sunvisor, additional
- Power window (R.H.)

BODY:
- Body liner
- Platform guard, right hand side
- Rock body
- Upper side extension, **200 mm** 8"
- Without body heating (with muffler)

LIGHTING SYSTEM:
- Back work lights, left and right sides
- Fog lights
- Yellow beacon

SAFETY:
- ABS (Antilock Brake System)
- ASR (Automatic Spin Regulator)
- Automatic supplementary steering
- Rear view camera and monitor

ARRANGEMENT:
- Batteries for cold area arrangement
- Cold area arrangement
- Sandy and dusty area arrangement

OTHER:
- Autogreasing system
- Engine coolant heater
- Engine oilpan heater
- Engine side cover
- Engine underguard
- Fire extinguisher
- Fuel quick charge
- Payload meter II
- Muffler (no body heating type)
- Radiator shutter, canvas type
- Spare parts for first service
- Three-mode hydropneumatic suspension
- Tool kit
- Transmission underguard
- Vandalism protection
- VHMS (Vehicle Health Monitoring System)
- VHMS with satellite communication kit

TIRES:
- 24.00 R35

Standard equipment may vary for each country, and this specification sheet may contain attachments and optional equipment that are not available in your area. Please consult your Komatsu distributor for detailed information.

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Appendix B. Multi-criteria analysis results

CONSULTANT

OWNER

Xstrata Tahmoor South Project

Rejects Disposal Options Study

DOCUMENT NO: QN10312-EFF-CT-E1-0001

MULTI-CRITERIA ASSESSMENT

APPROVALS

	Name	Position	Digital Signature
Originator	Jon Magin	Project Manager	
Checked	David Jolly	Project Director	
Approved	David Jolly	Project Director	

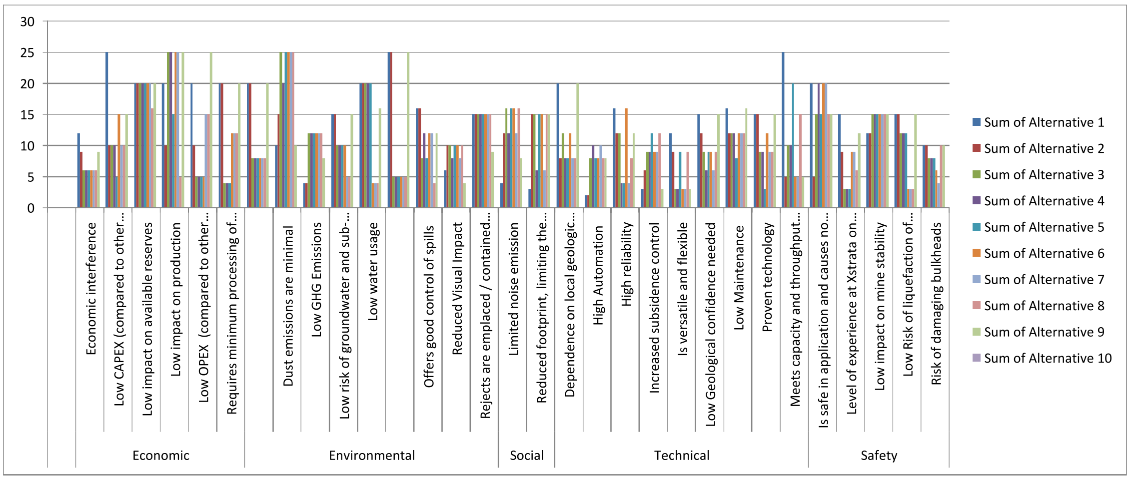
D	21-06-13	Updated for Study Report	JGM	DJ	DJ
C	20-05-13	Updated following Client Progress Meeting 01	JGM	DJ	DJ
B	17-05-13	Updated following MCA session	JGM		
A	8-05-13	Issued for Client Approval	NDP	JM	DJ
Rev	**Date**	**Description**	**By**	**Chk**	**Appd**

Category	Ranking	Score	Rating Scale	Score
Economic	Very High	5	Excellent	5
Environmental	High	4	Very Good	4
Social	Medium	3	Average	3
Technical	Low	2	Fair	2
Safety	Very Low	1	Poor	1

Criteria	Category	Comments (optional)	Importance	Minimum Rating
Economic interference	Economic	The option improves or contributes to the local economy	Medium	
Low CAPEX (compared to other options)	Economic		Very High	
Low impact on available reserves	Economic	System should have no or minimal negatvie impact on the total available reserves	High	
Low impact on production	Economic	Reject system should have no or minimal negative impact on the production capacity of the mine	Very High	Average
Low OPEX (compared to other options)	Economic	This needs to be expressed in terms of unit efficiency and compared with a mean value	Very High	
Requires minimum processing of the rejects to achieve satisfactory backfill performance	Economic		High	
Dust emissions are minimal	Environmental		Very High	
Low GHG Emissions	Environmental	Secondary emissions only	High	
Low risk of groundwater and sub-surface water table contamination	Environmental	Particle contamination	Very High	
Low water usage	Environmental		High	
No leachate contamination to the ground waters and sub-surface water table	Environmental	Chemical contamination.	Very High	
Offers good control of spills	Environmental		High	
Reduced Visual Impact	Environmental		Low	
Rejects are emplaced / contained within the mine lease	Environmental		Medium	
Requires minimal use of foreign reagents	Environmental		High	
Is safe in application and causes no hazards to the mine operations	Safety		Very High	Average
Level of experience at Xstrata on the operation of the system	Safety		Medium	
Low impact on mine stability	Safety	Reject system should have no or minimal negative impact on the mine stability	Medium	
Low Risk of liquefaction of emplaced fill	Safety	Risk to mine operations personnel	Medium	
Risk of damaging bulkheads	Safety		Low	
Limited noise emission	Social	High noise level may result in limitation on operations	High	
Reduced footprint, limiting the impact on local environment and native heritage	Social	This project is resulting from an EIS recommendation to limit the clearing of native habitat that is recognised for heritage value	Medium	
Dependence on local geologic conditions	Technical	Rock characteristics. Local conditions that differ from goaf to goaf	High	
High Automation	Technical	How automated is the process?	Low	
High reliability	Technical		High	
Increased subsidence control	Technical		Medium	
Is versatile and flexible	Technical	In terms of throughput	Medium	
Low Geological confidence needed	Technical	Amount of geological confidence needed to implement system, the less geological confidence needed the higher the chance of success	Medium	
Low Maintenance	Technical		High	
Proven technology	Technical	The more proven the technology the lower the risk to operations and commercial risk	Medium	
Meets capacity and throughput required of system	Technical	Throughput of rejects option meets rejects throughput generated by the plant	Very High	Average

Number of Alternatives	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9
9									
Description	Surface disposal at existing REA	UG disposal as dry material	UG disposal as paste material (Disused Road, Goafs via Pipeline)	UG disposal as paste material (Former Goaf areas via Boreholes)	UG disposal as paste material (Active goafs via a trailing pipe)	UG disposal as Slurry (Disused Road, Goafs via Pipeline)	UG disposal as Slurry (Former Goaf areas via Boreholes)	UG disposal as Slurry (Active goafs via a trailing pipe)	Reuse of Rejects Materials as Road base
Criteria	Rating	Rating	Rating	Rating	Rating	Rating	Rating	Rating	Rating
Economic interference	Very Good	Average	Fair	Fair	Fair	Fair	Fair	Fair	Average
Low CAPEX (compared to other options)	Excellent	Fair	Fair	Fair	Poor	Average	Fair	Fair	Average
Low impact on available reserves	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Very Good	Excellent
Low impact on production	Very Good	Fair	Excellent	Excellent	Average	Excellent	Excellent	Poor	Excellent
Low OPEX (compared to other options)	Very Good	Fair	Poor	Poor	Poor	Poor	Average	Average	Excellent
Requires minimum processing of the rejects to achieve satisfactory backfill performance	Excellent	Excellent	Poor	Poor	Poor	Average	Average	Average	Excellent
Dust emissions are minimal	Fair	Average	Excellent	Very Good	Excellent	Excellent	Excellent	Excellent	Fair
Low GHG Emissions	Poor	Poor	Average	Average	Average	Average	Average	Average	Fair
Low risk of groundwater and sub-surface water table contamination	Average	Average	Fair	Fair	Fair	Fair	Poor	Poor	Average
Low water usage	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Poor	Very Good
No leachate contamination to the ground waters and sub-surface water table	Excellent	Excellent	Poor	Poor	Poor	Poor	Poor	Poor	Excellent
Offers good control of spills	Very Good	Very Good	Fair	Average	Fair	Average	Average	Poor	Average
Reduced Visual Impact	Average	Excellent	Excellent	Very Good	Excellent	Excellent	Very Good	Excellent	Fair
Rejects are emplaced / contained within the mine lease	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Average
Requires minimal use of foreign reagents	Excellent	Excellent	Fair	Fair	Fair	Fair	Fair	Fair	Excellent
Is safe in application and causes no hazards to the mine operations	Very Good	Poor	Average	Very Good	Average	Very Good	Very Good	Average	Average
Level of experience at Xstrata on the operation of the system	Excellent	Average	Poor	Poor	Poor	Average	Average	Fair	Very Good
Low impact on mine stability	Very Good	Very Good	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Low Risk of liquefaction of emplaced fill	Excellent	Excellent	Very Good	Very Good	Very Good	Poor	Poor	Poor	Excellent
Risk of damaging bulkheads	Excellent	Excellent	Very Good	Very Good	Very Good	Average	Fair	Excellent	Excellent
Limited noise emission	Poor	Average	Very Good	Average	Very Good	Very Good	Average	Very Good	Fair
Reduced footprint, limiting the impact on local environment and native heritage	Poor	Excellent	Excellent	Fair	Excellent	Excellent	Fair	Excellent	Excellent
Dependence on local geologic conditions	Excellent	Fair	Average	Fair	Fair	Average	Fair	Fair	Excellent
High Automation	Poor	Poor	Very Good	Excellent	Very Good	Very Good	Excellent	Very Good	Very Good
High reliability	Very Good	Average	Average	Poor	Poor	Very Good	Poor	Fair	Average
Increased subsidence control	Poor	Fair	Average	Average	Very Good	Average	Average	Very Good	Poor
Is versatile and flexible	Very Good	Average	Poor	Poor	Average	Poor	Poor	Average	Poor
Low Geological confidence needed	Excellent	Very Good	Average	Fair	Average	Average	Fair	Average	Excellent
Low Maintenance	Very Good	Average	Average	Average	Fair	Average	Average	Average	Very Good
Proven technology	Excellent	Excellent	Average	Average	Poor	Very Good	Average	Average	Excellent
Meets capacity and throughput required of system	Excellent	Poor	Fair	Fair	Very Good	Poor	Poor	Average	Poor

UNWEIGHTED SCORES	Number of Alternatives									
	9	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9
	Description	Surface disposal at existing REA	UG disposal as dry material	UG disposal as paste material (Disused Road,	UG disposal as paste material (Former Goaf	UG disposal as paste material (Active goafs via a	UG disposal as Slurry (Disused Road, Goafs via	UG disposal as Slurry (Former Goaf areas via	UG disposal as Slurry (Active goafs via a trailing	Reuse of Rejects Materials as Road base
Category	**Criteria**	Compatible	Incompatible	Incompatible	Incompatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible
Economic	Economic interference	4	3	2	2	2	2	2	2	3
	Low CAPEX (compared to other options)	5	2	2	2	1	3	2	2	3
	Low impact on available reserves	5	5	5	5	5	5	5	4	5
	Low impact on production	4	2	5	5	3	5	5	1	5
	Low OPEX (compared to other options)	4	2	1	1	1	1	3	3	5
	Requires minimum processing of the rejects to achieve satisfactory backfill perfo	5	5	1	1	1	3	3	3	5
Environmental	Dust emissions are minimal	2	3	5	4	5	5	5	5	2
	Low GHG Emissions	1	1	3	3	3	3	3	3	2
	Low risk of groundwater and sub-surface water table contamination	3	3	2	2	2	2	1	1	3
	Low water usage	5	5	5	5	5	1	1	1	4
	No leachate contamination to the ground waters and sub-surface water table	5	5	1	1	1	1	1	1	5
	Offers good control of spills	4	4	2	3	2	3	3	1	3
	Reduced Visual Impact	3	5	5	4	5	5	4	5	2
	Rejects are emplaced / contained within the mine lease	5	5	5	5	5	5	5	5	3
	Requires minimal use of foreign reagents	5	5	2	2	2	2	2	2	5
Safety	Is safe in application and causes no hazards to the mine operations	4	1	3	4	3	4	4	3	3
	Level of experience at Xstrata on the operation of the system	5	3	1	1	1	3	3	2	4
	Low impact on mine stability	4	4	5	5	5	5	5	5	5
	Low Risk of liquefaction of emplaced fill	5	5	4	4	4	1	1	1	5
	Risk of damaging bulkheads	5	5	4	4	4	3	2	5	5
Social	Limited noise emission	1	3	4	3	4	4	3	4	2
	Reduced footprint, limiting the impact on local environment and native heritage	1	5	5	2	5	5	2	5	5
Technical	Dependence on local geologic conditions	5	2	3	2	2	3	2	2	5
	High Automation	1	1	4	5	4	4	5	4	4
	High reliability	4	3	3	1	1	4	1	2	3
	Increased subsidence control	1	2	3	3	4	3	3	4	1
	Is versatile and flexible	4	3	1	1	3	1	1	3	1
	Low Geological confidence needed	5	4	3	2	3	3	2	3	5
	Low Maintenance	4	3	3	3	2	3	3	3	4
	Proven technology	5	5	3	3	1	4	3	3	5
	Meets capacity and throughput required of system	5	1	2	2	4	1	1	3	1



WEIGHTED SCORES

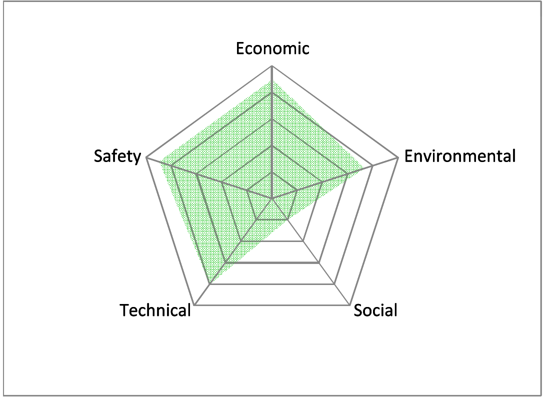
Category	**Criteria**	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9
Economic	Economic interference	12	9	6	6	6	6	6	6	9
	Low CAPEX (compared to other	25	10	10	10	5	15	10	10	15
	Low impact on available reserve	20	20	20	20	20	20	20	16	20
	Low impact on production	20	10	25	25	15	25	25	5	25
	Low OPEX (compared to other	20	10	5	5	5	5	15	15	25
	Requires minimum processing c	20	20	4	4	4	12	12	12	20
Environmental	Dust emissions are minimal	10	15	25	20	25	25	25	25	10
	Low GHG Emissions	4	4	12	12	12	12	12	12	8
	Low risk of groundwater and su	15	15	10	10	10	10	5	5	15
	Low water usage	20	20	20	20	20	4	4	4	16
	No leachate contamination to tl	25	25	5	5	5	5	5	5	25
	Offers good control of spills	16	16	8	12	8	12	12	4	12
	Reduced Visual Impact	6	10	10	8	10	10	8	10	4
	Rejects are emplaced / containe	15	15	15	15	15	15	15	15	9
	Requires minimal use of foreign	20	20	8	8	8	8	8	8	20
Safety	Is safe in application and causes	20	5	15	20	15	20	20	15	15
	Level of experience at Xstrata o	15	9	3	3	3	9	9	6	12
	Low impact on mine stability	12	12	15	15	15	15	15	15	15
	Low Risk of liquefaction of emp	15	15	12	12	12	3	3	3	15
	Risk of damaging bulkheads	10	10	8	8	8	6	4	10	10
Social	Limited noise emission	4	12	16	12	16	16	12	16	8
	Reduced footprint, limiting the	3	15	15	6	15	15	6	15	15
Technical	Dependence on local geologic c	20	8	12	8	8	12	8	8	20
	High Automation	2	2	8	10	8	8	10	8	8
	High reliability	16	12	12	4	4	16	4	8	12
	Increased subsidence control	3	6	9	9	12	9	9	12	3
	Is versatile and flexible	12	9	3	3	9	3	3	9	3
	Low Geological confidence need	15	12	9	6	9	9	6	9	15
	Low Maintenance	16	12	12	12	8	12	12	12	16
	Proven technology	15	15	9	9	3	12	9	9	15
	Meets capacity and throughput	25	5	10	10	20	5	5	15	5
Totals		451	378	351	327	333	354	317	322	420
Ranking		1	3	5	7	6	4	9	8	2
Compatible Solution		Yes	No	No	No	Yes	No	No	No	No

06 Category Scores

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9
Category	Surface disposal at existing REA	UG disposal as dry material	UG disposal as paste material (Disused Road, Goafs via Pipeline)	UG disposal as paste material (Former Goaf areas via Boreholes)	UG disposal as paste material (Active goafs via a trailing pipe)	UG disposal as Slurry (Disused Road, Goafs via Pipeline)	UG disposal as Slurry (Former Goaf areas via Boreholes)	UG disposal as Slurry (Active goafs via a trailing pipe)	Reuse of Rejects Materials as Road base
Economic	90	61	54	54	42	64	68	49	88
Environmental	73	78	63	61	63	56	52	49	66
Social	20	77	89	51	89	89	51	89	66
Technical	80	52	54	46	52	55	43	58	63
Safety	90	64	66	73	66	66	64	61	84

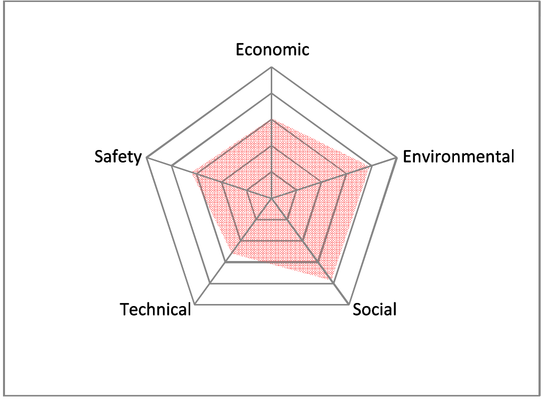
Alternative 1

Surface disposal at existing REA



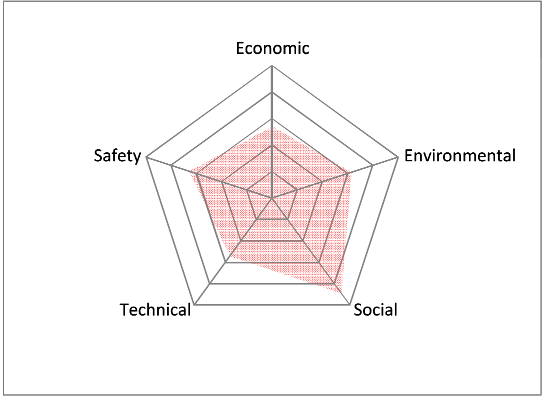
Alternative 2

UG disposal as dry material



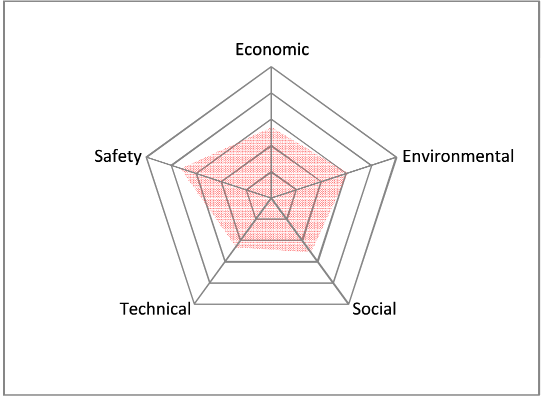
Alternative 3

UG disposal as paste material (Disused Road, Goafs via Pipeline)



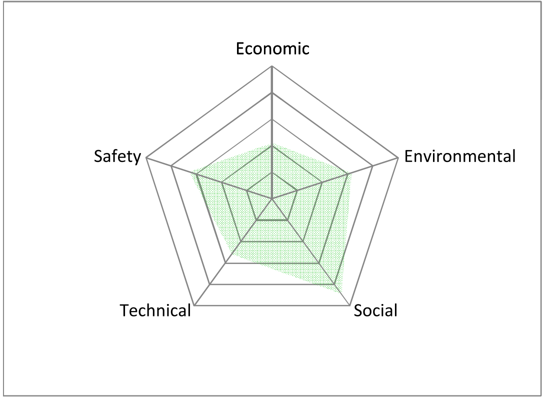
Alternative 4

UG disposal as paste material (Former Goaf areas via Boreholes)



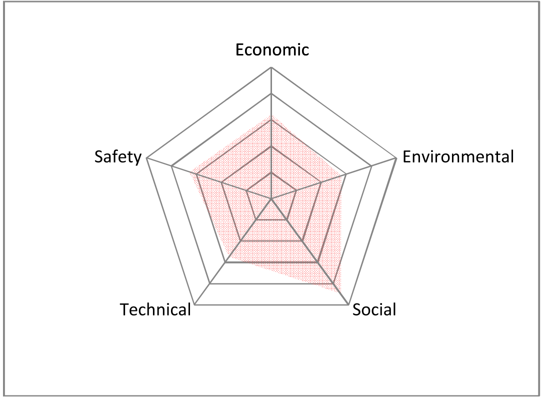
Alternative 5

UG disposal as paste material (Active goafs via a trailing pipe)



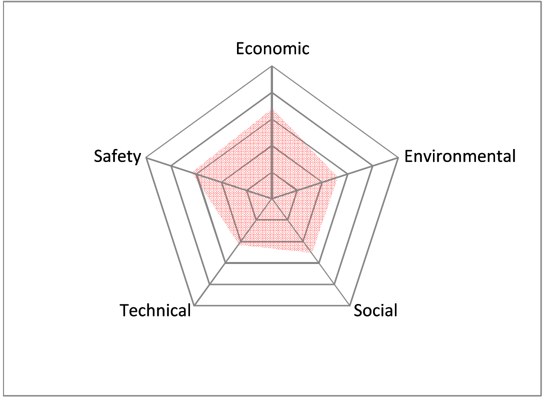
Alternative 6

UG disposal as Slurry (Disused Road, Goafs via Pipeline)



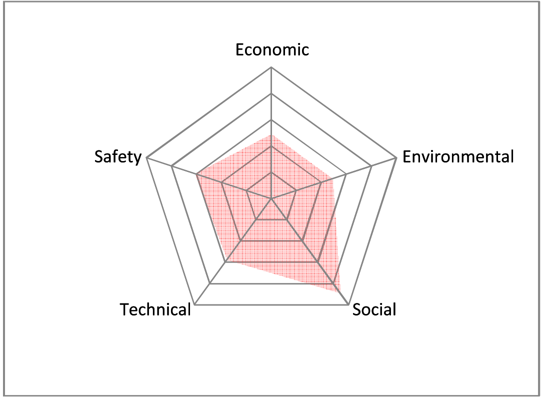
Alternative 7

UG disposal as Slurry (Former Goaf areas via Boreholes)



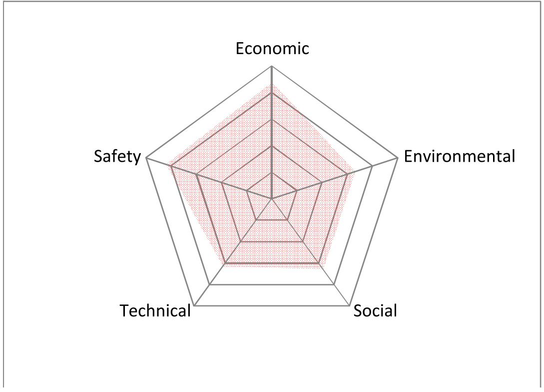
Alternative 8

UG disposal as Slurry (Active goafs via a trailing pipe)



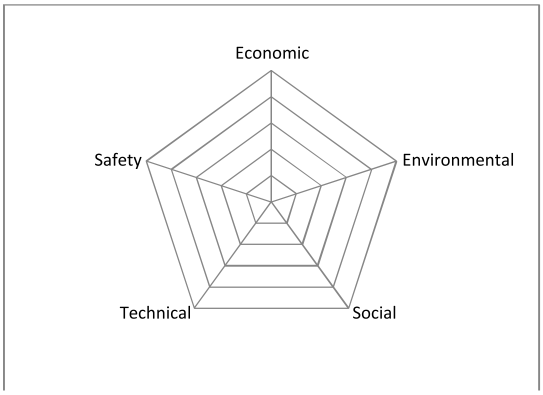
Alternative 9

Reuse of Rejects Materials as Road base



Alternative 10

0



Appendix C. Capital cost estimates

C.1 Basis of estimate

SKM has used its best endeavours within the context of a generally accepted definition of a study of this nature to determine current pricing and equipment lead times for items within this estimate. However, SKM cannot warrant the accuracy of this estimate to points in time significantly beyond the date at which this report has been prepared.

SKM advises that before applying the estimate provided herein, the user determines current market rates/prices at that point in time (including any foreign exchange variations), in order to capture any price/rate movements that have occurred since the production of this report. This process ensures that the currency and accuracy of this estimate are maintained.

C.1.1 Base Date

The base date for the estimate is 1 April 2013. All pricing data relates to this date. No escalation is included in the base estimate.

C.1.2 Estimate currency and exchange rates

The estimate is reported in Australian Dollars. There are no foreign currencies in the base estimate and exchange rate fluctuations are excluded from the estimate.

C.1.3 Estimate accuracy

In accordance with the guideline documentation, on completion of the overall scope within the estimate, the expected accuracy range of this estimate is consistent with an order of magnitude phase estimate (class 4), with a target accuracy of +/-35 per cent.

C.1.4 Estimate methodology

Estimates have been based on the design of the reject emplacement area expansion dated May 2013. Whilst there have been modifications to the REA design and subsequently the costs have been revised, for the purposes of this disposal options study and associated cost benefit analysis, May 2013 costs have been adopted.

Earthworks and drainage

Material take-offs (MTO's) for bulk earthworks and civil works were quantified with the use of 3D computer modelling, detail design arrangements and design sketches.

Unit rates are based upon pricing received from a regional contractor, with minor items priced using in house pricing applicable to other similar projects and current data for the region.

Concrete

Concrete quantities were prepared based on preliminary concepts of structural components required. Pricing has been obtained from a civil contractor for all-in concrete inclusive of detailed excavation, reinforcement, and formwork.

Structural Steel

Structural steel quantities were developed on a unit rate per area of building. Pricing was obtained from in house pricing applicable to other similar projects and current data for the region.

Architectural

Architectural elements such as roof and wall cladding were developed on a unit rate per area of building. Pricing was obtained from in house pricing applicable to other similar projects and current data for the region.

Mechanical and piping

Mechanical and piping quantities were developed from the preliminary equipment list developed for the options. Budget pricing was obtained from local suppliers for the following items:

- Tanks
- Horizontal crusher
- Vertical crushers
- Mixer
- Thickener
- Pumps
- Piping supply

Electrical, Instrumentation and Controls

Electrical, instrumentation and control work associated with the proposed options were estimated based on recent similar projects of this nature.

Freight, Duties and Taxes

All materials and equipment items included in the direct cost have been priced on the basis of delivered to site included within the rates provided by suppliers.

All taxes and duties, including Sales and Goods and Services Taxes are excluded.

Construction Contracts

Construction costs have been developed from first principles and have been validated with the pricing received from a local civil contractor. As the Contractor did not supply details of construction hours or plant and equipment required to complete the work, the first principle assessments have been utilised for reporting within the estimate.

Construction Labour – Direct labour work hours are estimated at the detail commodity level based on current unit rate data for the locale. No specific productivity allowances to the work hours been included in terms of productivity impacts.

In the absence of a site specific agreement for this project, the current *“Thomas & Coffey Ravensworth North Coal Mine Construction Project Union Collective Agreement 2012”* site agreement has been adopted as the base for the labour rates calculations. This is considered appropriate as a current labour rate agreement in use within 100km of developed regional centres of NSW coalfields.

The labour rate used in this estimate is based on local personnel on a six (6) day work cycle.

Contractor Distributable Costs – are calculated as a percentage of the direct labour cost based on historical data for similar projects, both from scope and location aspects.

The Contractor distributable includes items such as:

- Small tools and consumables;

- Contractor’s site facilities;
- Construction plant and equipment;
- Minor cranes (less than 100 tonne capacity);
- Indirect labour;
- Supervision;
- Project management;
- Tool box and safety meetings;
- Safety and quality management;
- Mobilisation and demobilisation; and
- Contractor’s overheads and profit (for labour hour and distributable costs only).

This is expressed as a percentage mark-up of the base labour rate.

Construction Equipment - is included in the contractor distributable.

Common Distributable Costs

In the absence of detailed execution strategy it has been assumed that there is sufficient area for contractors site facilities and that water fill points and electrical power supply for facilities would be available from current site facility locations.

EPCM Services

Detailed EPCM costs were not derived for this estimate, rather a percentage was applied based on the level of engineering already undertaken and historical project data. For civil works, where the design has progressed to construction level documentation, a figure of 12 per cent was adopted for EPCM services. For all other works, a figure of 18 per cent was adopted.

Owner’s Costs

Owner’s Costs were not provided by Tahmoor Coal, nor estimated in detail for this project. A figure of 5 per cent was adopted.

Escalation

The base date for the estimate is Q2 2013.

Escalation is excluded.

Contingency

A contingency analysis was not undertaken for this project; rather a 15 per cent contingency allowance was adopted for the civil works and a 25 per cent contingency allowance for the remainder.

Qualifications

Estimate qualifications are as follows:

- This estimate is based on the engagement of a management team with the experience and capacity to ensure delivery of the project is in accordance with industry standards and project execution schedule;
- All construction work is based on day shift work;

- All construction work is based on a continuous flow of work and any disruption may require changes to the programme and/or additional costs; and
- Works relating to the sites geotechnical characteristics are based on the preliminary geotechnical information

Assumptions

It has been assumed that sufficient labour resources would be available to perform the works.

The following direct labour has been assumed:

Local (<60km from site)	60 per cent
Non local regional (>60km but able to be commuted daily	30 per cent
Non local (Unable to commute daily, requires accommodation to be provided)	10 per cent

Scope of infrastructure would be awarded to a single contractor through a competitive tender.

All construction work is performed during daylight. No nightshift or acceleration to a construction schedule will be required.

A suitable area is made available for contractor facilities.

Power and water for the contractor are made available to the contractor at no additional cost.

C.2 Capital costs by stage – Surface disposal options (options 1 and 1A)

Table C-1 outlines the capital costs estimated for the surface disposal options as outlined in Sections 7.1 and 7.2. The costs are presented as the capital spend applicable for each year of the reject disposal operation. The staging is based on the REA design applicable at the time of undertaking the capital cost estimate, i.e. May 2013.

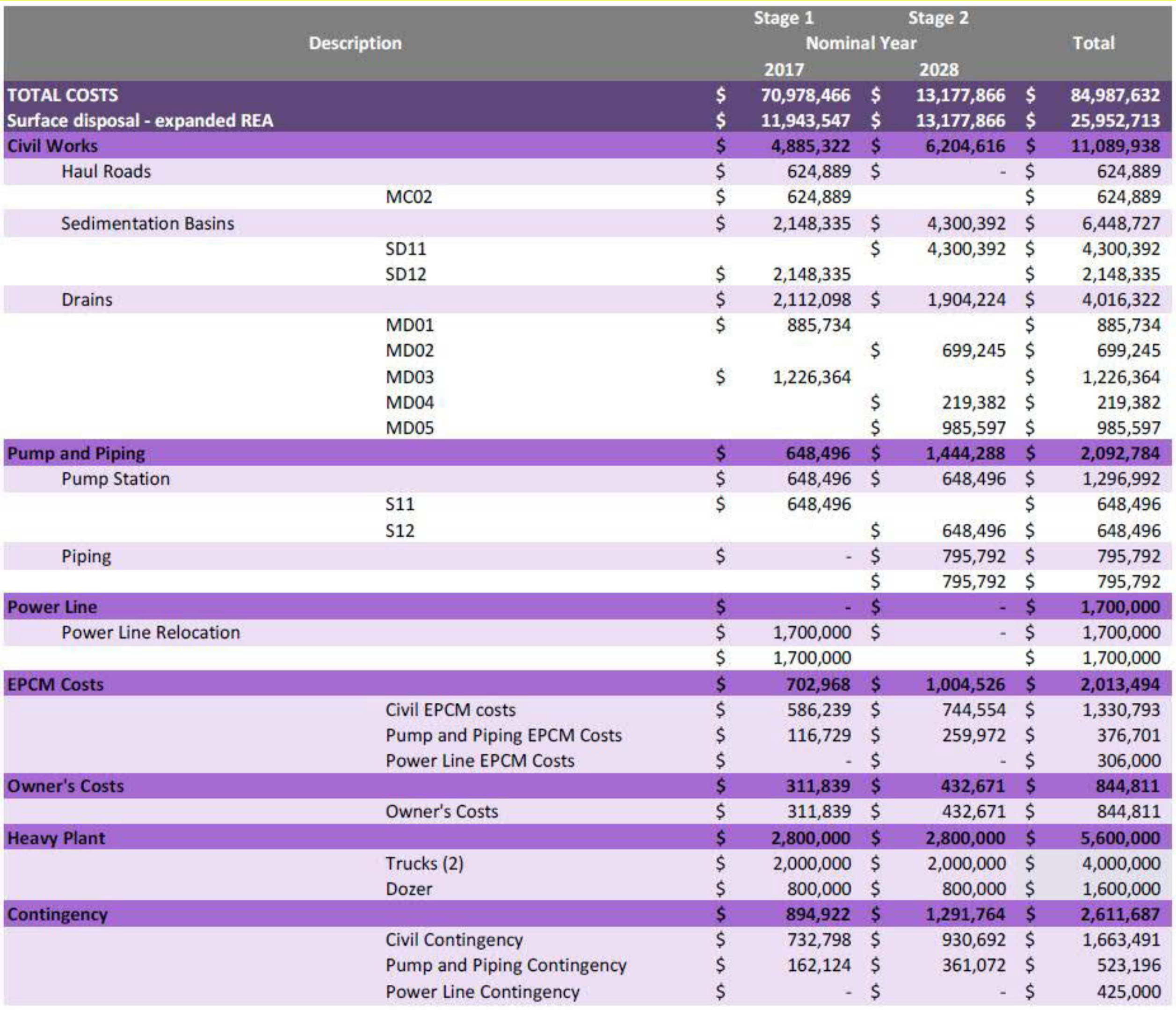
Table C-1 Capital costs by stage – surface disposal option (options 1 and 1A)

Description		Stage 1	Stage 2	Stage 3	Stage 4	Total
			Nominal Year			
		2017	2023	2030	2035	
TOTAL COSTS		$ 13,712,433	$ 7,213,963	$ 6,145,977	$ 1,820,125	$ 28,892,498
Civil Works		$ 9,612,988	$ 3,818,566	$ 2,726,001	$ 1,372,643	$ 17,530,198
Haul Roads		$ 3,082,843	$ -	$ 1,249,778	$ -	$ 4,332,621
	MC01	$ 3,082,843				$ 3,082,843
	MC02			$ 1,249,778		$ 1,249,778
Sedimentation Basins		$ 4,300,392	$ 2,148,335	$ -	$ -	$ 6,448,727
	SD11	$ 4,300,392				$ 4,300,392
	SD12		$ 2,148,335			$ 2,148,335
Drains		$ 2,229,753	$ 1,670,231	$ 1,476,223	$ 1,372,643	$ 6,748,850
	MD01			$ 1,476,223		$ 1,476,223
	MD02		$ 1,271,355			$ 1,271,355
	MD03	$ 2,229,753				$ 2,229,753
	MD04		$ 398,876		$ 387,046	$ 785,922
	MD05				$ 985,597	$ 985,597
Pump and Piping		$ 648,496	$ 1,444,288	$ -	$ -	$ 2,092,784
Pump Station		$ 648,496	$ 648,496	$ -	$ -	$ 1,296,992
	S11	$ 648,496				$ 648,496
	S12		$ 648,496			$ 648,496
Piping		$ -	$ 795,792	$ -	$ -	$ 795,792
			$ 795,792			$ 795,792
Power Line		$ -	$ -	$ 1,700,000	$ -	$ 1,700,000
Power Line Relocation		$ -	$ -	$ 1,700,000	$ -	$ 1,700,000
				$ 1,700,000		$ 1,700,000
EPCM Costs		$ 1,270,288	$ 718,200	$ 633,120	$ 164,717	$ 2,786,325
	Civil EPCM costs	$ 1,153,559	$ 458,228	$ 327,120	$ 164,717	$ 2,103,624
	Pump and Piping EPCM Costs	$ 116,729	$ 259,972	$ -	$ -	$ 376,701
	Power Line EPCM Costs	$ -	$ -	$ 306,000	$ -	$ 306,000
Owner's Costs		$ 576,589	$ 299,053	$ 252,956	$ 76,868	$ 1,205,465
	Owner's Costs	$ 576,589	$ 299,053	$ 252,956	$ 76,868	$ 1,205,465
Contingency		$ 1,604,072	$ 933,857	$ 833,900	$ 205,896	$ 3,577,726
	Civil Contingency	$ 1,441,948	$ 572,785	$ 408,900	$ 205,896	$ 2,629,530
	Pump and Piping Contingency	$ 162,124	$ 361,072	$ -	$ -	$ 523,196
	Power Line Contingency	$ -	$ -	$ 425,000	$ -	$ 425,000

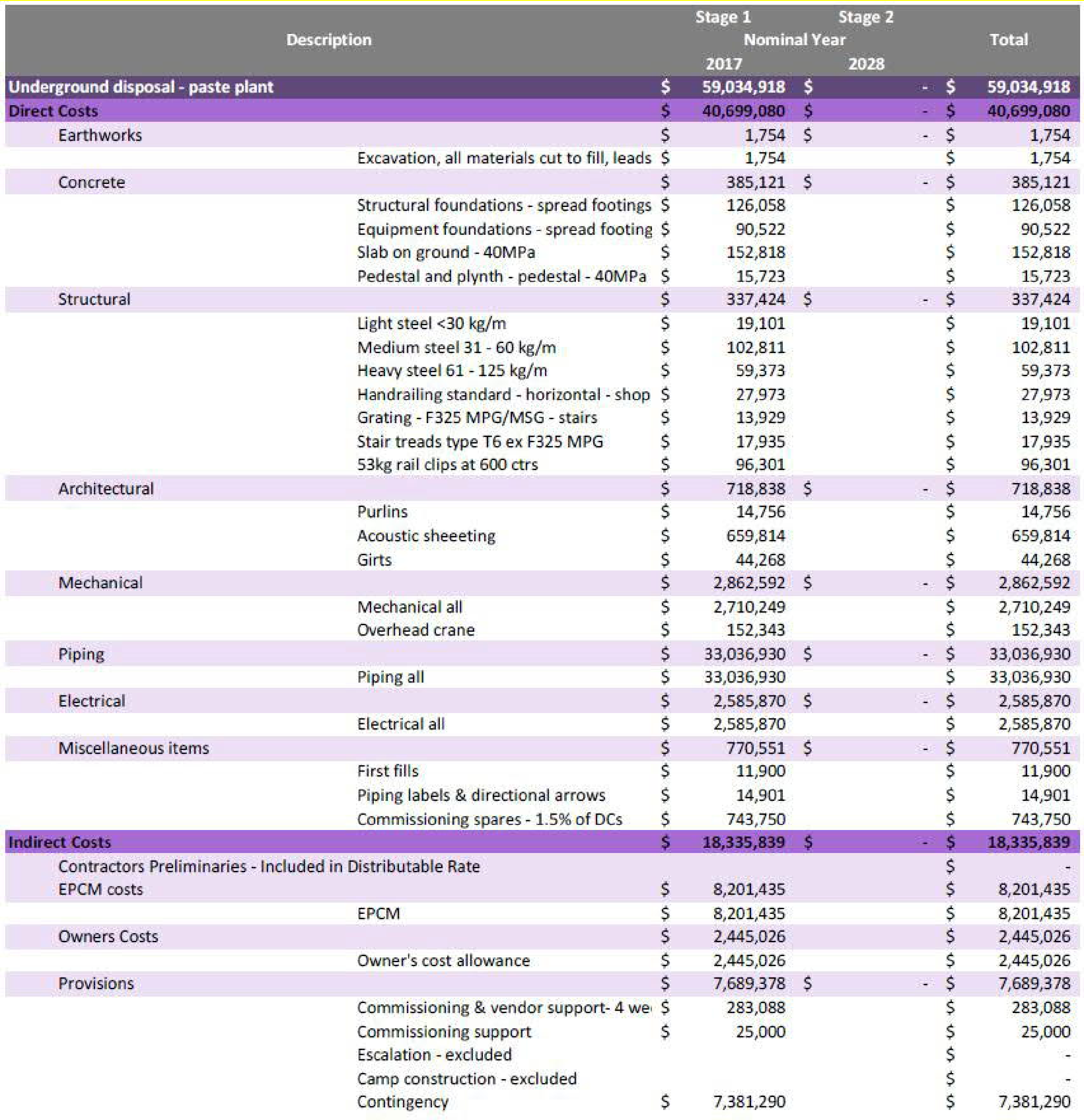
C.3 Capital costs by Stage – Underground disposal option (option 2)

Table C- 2 outlines the capital costs estimated for the underground paste disposal option as outlined in Section 7.2. The costs are presented as the capital spend applicable for each year of the reject disposal operation. The staging is based upon the forecast annual and rejects tonnages available at the time at which the estimate was undertaken, i.e. August 2013.

Table C- 2 Capital costs by stage – Co-disposal option (option 2)



Description		Stage 1	Stage 2	Total
		Nominal Year		
		2017	2028	
TOTAL COSTS		**$ 70,978,466**	**$ 13,177,866**	**$ 84,987,632**
Surface disposal - expanded REA		**$ 11,943,547**	**$ 13,177,866**	**$ 25,952,713**
Civil Works		**$ 4,885,322**	**$ 6,204,616**	**$ 11,089,938**
Haul Roads		$ 624,889	$ -	$ 624,889
	MC02	$ 624,889		$ 624,889
Sedimentation Basins		$ 2,148,335	$ 4,300,392	$ 6,448,727
	SD11		$ 4,300,392	$ 4,300,392
	SD12	$ 2,148,335		$ 2,148,335
Drains		$ 2,112,098	$ 1,904,224	$ 4,016,322
	MD01	$ 885,734		$ 885,734
	MD02		$ 699,245	$ 699,245
	MD03	$ 1,226,364		$ 1,226,364
	MD04		$ 219,382	$ 219,382
	MD05		$ 985,597	$ 985,597
Pump and Piping		**$ 648,496**	**$ 1,444,288**	**$ 2,092,784**
Pump Station		$ 648,496	$ 648,496	$ 1,296,992
	S11	$ 648,496		$ 648,496
	S12		$ 648,496	$ 648,496
Piping		$ -	$ 795,792	$ 795,792
			$ 795,792	$ 795,792
Power Line		**$ -**	**$ -**	**$ 1,700,000**
Power Line Relocation		$ 1,700,000	$ -	$ 1,700,000
		$ 1,700,000		$ 1,700,000
EPCM Costs		**$ 702,968**	**$ 1,004,526**	**$ 2,013,494**
	Civil EPCM costs	$ 586,239	$ 744,554	$ 1,330,793
	Pump and Piping EPCM Costs	$ 116,729	$ 259,972	$ 376,701
	Power Line EPCM Costs	$ -	$ -	$ 306,000
Owner's Costs		**$ 311,839**	**$ 432,671**	**$ 844,811**
	Owner's Costs	$ 311,839	$ 432,671	$ 844,811
Heavy Plant		**$ 2,800,000**	**$ 2,800,000**	**$ 5,600,000**
	Trucks (2)	$ 2,000,000	$ 2,000,000	$ 4,000,000
	Dozer	$ 800,000	$ 800,000	$ 1,600,000
Contingency		**$ 894,922**	**$ 1,291,764**	**$ 2,611,687**
	Civil Contingency	$ 732,798	$ 930,692	$ 1,663,491
	Pump and Piping Contingency	$ 162,124	$ 361,072	$ 523,196
	Power Line Contingency	$ -	$ -	$ 425,000



Description		Stage 1	Stage 2	Total
		Nominal Year		
		2017	2028	
Underground disposal - paste plant		**$ 59,034,918**	**$ -**	**$ 59,034,918**
Direct Costs		$ 40,699,080	$ -	$ 40,699,080
Earthworks		$ 1,754	$ -	$ 1,754
	Excavation, all materials cut to fill, leads	$ 1,754		$ 1,754
Concrete		$ 385,121	$ -	$ 385,121
	Structural foundations - spread footings	$ 126,058		$ 126,058
	Equipment foundations - spread footing	$ 90,522		$ 90,522
	Slab on ground - 40MPa	$ 152,818		$ 152,818
	Pedestal and plynth - pedestal - 40MPa	$ 15,723		$ 15,723
Structural		$ 337,424	$ -	$ 337,424
	Light steel <30 kg/m	$ 19,101		$ 19,101
	Medium steel 31 - 60 kg/m	$ 102,811		$ 102,811
	Heavy steel 61 - 125 kg/m	$ 59,373		$ 59,373
	Handrailing standard - horizontal - shop	$ 27,973		$ 27,973
	Grating - F325 MPG/MSG - stairs	$ 13,929		$ 13,929
	Stair treads type T6 ex F325 MPG	$ 17,935		$ 17,935
	53kg rail clips at 600 ctrs	$ 96,301		$ 96,301
Architectural		$ 718,838	$ -	$ 718,838
	Purlins	$ 14,756		$ 14,756
	Acoustic sheeeting	$ 659,814		$ 659,814
	Girts	$ 44,268		$ 44,268
Mechanical		$ 2,862,592	$ -	$ 2,862,592
	Mechanical all	$ 2,710,249		$ 2,710,249
	Overhead crane	$ 152,343		$ 152,343
Piping		$ 33,036,930	$ -	$ 33,036,930
	Piping all	$ 33,036,930		$ 33,036,930
Electrical		$ 2,585,870	$ -	$ 2,585,870
	Electrical all	$ 2,585,870		$ 2,585,870
Miscellaneous items		$ 770,551	$ -	$ 770,551
	First fills	$ 11,900		$ 11,900
	Piping labels & directional arrows	$ 14,901		$ 14,901
	Commissioning spares - 1.5% of DCs	$ 743,750		$ 743,750
Indirect Costs		**$ 18,335,839**	**$ -**	**$ 18,335,839**
Contractors Preliminaries - Included in Distributable Rate				$ -
EPCM costs		$ 8,201,435		$ 8,201,435
	EPCM	$ 8,201,435		$ 8,201,435
Owners Costs		$ 2,445,026		$ 2,445,026
	Owner's cost allowance	$ 2,445,026		$ 2,445,026
Provisions		$ 7,689,378	$ -	$ 7,689,378
	Commissioning & vendor support- 4 we	$ 283,088		$ 283,088
	Commissioning support	$ 25,000		$ 25,000
	Escalation - excluded			$ -
	Camp construction - excluded			$ -
	Contingency	$ 7,381,290		$ 7,381,290

Appendix D. Operating cost estimates

D.1 Breakdown of operating costs – Surface disposal option (option 1)

The basis of estimate adopted for the operating cost estimates was generally in accordance with the methodology outlined in Appendix C.1. The operating estimate for option 1 consists of the following specific elements:

Operating conditions

In order to calculate the operating estimate, the following variables were assumed:

Working days per year	260
Working hours per day	24
Equipment availability	75 per cent

Haul truck operating estimate

It is assumed that the REA operation contractor will lease haul trucks (Komatsu HD456 or equivalent) and incorporate the leasing cost into the cost per tonne that is charged to Tahmoor Coal. Pricing has been obtained from Komatsu, with a leasing price of $410,000 per truck, per annum, adopted.

The proposed Komatsu HD456 off-highway trucks will drive a cycle that has an average length of 4100 meters per trip, including a 500m downhill section, a 1300m uphill section and a 250m flat section on top of the waste dump. Allowing a 90 second load and 90 second dump time, a single trip will take approximately 720 seconds or 12 minutes. With a payload of 56.6 tonnes a tonnage of 283 tonnes per hour can be reached. This equates to an annual capacity of 1.3Mtpa.

The total amount of diesel consumed per truck has been calculated to be 45 litres per hour while operating.

It was assumed that the haul truck/s will operate 24 hours per day.

Dozer operating estimate

It is assumed that the REA operation contractor will lease a dozer (Caterpillar D6 or equivalent) and incorporate the leasing cost into the cost per tonne that is charged to Tahmoor Coal. Pricing has been obtained from Komatsu, with a leasing price of $171,900 per annum adopted.

On the waste dump a single track dozer will be operating to spread the rejects and form the dump. Assuming an average energy use of 50 per cent of maximum power available, this gives a diesel consumption of 23 litres per hour.

It was assumed that the dozer will only operate during the day shift.

Consumables

Consumables included in the operating cost estimate include:

- Diesel (with a 2013 assumed cost of $1.50 per litre)
- Haul truck tyres (at a 2013 cost of $30,800 per set to be replaced every 15,000hrs)
- Haul truck maintenance, including lubricants, parts and labour (calculated at $55 per operating hour)
- Dozer maintenance, including lubricants, parts and labour (calculated at $45 per operating hour).

Vegetation clearing

Included in the REA operation Contract (and therefore excluded from the capital costs) is the clearing of vegetation and stripping of topsoil, which in total over the life of the emplacement area equates to approximately 86 Ha at a total cost of approximately $1.3M.

Operator cost

The cost of the operators was assumed to be $175 per hour for the truck drivers and the dozer operator, this number includes all overhead costs. Assuming that the haul trucks are operated 24 hours per day and the dozer restricted to day operation only, a maximum of 2.5 operators will be required for the REA operation.

Estimate of operating costs

Table D-1 outlines the operating costs estimated over the life of the rejects disposal operation, as per the REA design as at May 2013 and mine plan data provided by Tahmoor Coal (ref. Tahmoor Coal data issued 15 Aug 2013).

Table D-1 Operating cost estimate – surface disposal option (option 1)

Year		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Rejects at forecast Yield	Mtpa	0.440	0.952	0.877	0.825	0.871	1.330	1.041	1.061	1.081	1.263	1.134
Average rejects throughput	tph	132	153	141	132	140	213	167	170	173	202	182
Labour	hr	8,320	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
	$	1,456,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000
Consumables	$	216,617	608,564	597,536	594,428	630,913	844,177	743,174	774,374	806,499	916,953	880,880
Maintenance	$	225,564	324,787	310,278	300,176	309,042	398,002	342,013	345,952	349,776	384,987	359,955
Heavy plant leasing	$	382,065	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900
Vegetation clear and grub	$	48,373	104,732	96,491	90,753	95,788	146,318	114,516	116,754	118,926	138,926	124,707
Contractor Profit	$	91,144	197,503	195,327	193,811	195,141	208,485	200,087	200,678	201,251	206,533	202,778
Total OPEX	**$**	**2,419,764**	**4,957,485**	**4,921,532**	**4,901,067**	**4,952,785**	**5,318,882**	**5,121,690**	**5,159,658**	**5,198,353**	**5,369,299**	**5,290,221**
	$/t	5.50	5.21	5.61	5.94	5.69	4.00	4.92	4.86	4.81	4.25	4.67

Year		**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Rejects at forecast Yield	Mtpa	1.073	1.286	1.174	1.154	1.326	0.791	1.039	0.997	1.040	1.027	0.799
Average rejects throughput	tph	172	206	188	185	213	127	166	160	167	165	128
Labour	hr	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
	$	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000
Consumables	$	876,232	1,013,015	983,105	1,001,532	1,128,973	850,245	1,024,563	1,028,952	1,087,306	1,111,349	990,164
Maintenance	$	348,114	389,420	367,673	363,869	397,242	293,571	341,603	333,423	341,847	339,381	295,122
Heavy plant leasing	$	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900
Vegetation clear and grub	$	117,982	141,443	129,091	126,930	145,886	87,001	114,283	109,637	114,422	113,021	87,882
Contractor Profit	$	201,002	207,198	203,936	203,365	208,371	192,821	200,025	198,798	200,062	199,692	193,053
Total OPEX	**$**	**5,265,230**	**5,472,976**	**5,405,705**	**5,417,596**	**5,602,374**	**5,145,538**	**5,402,374**	**5,392,710**	**5,465,537**	**5,485,343**	**5,288,121**
	$/t	4.91	4.26	4.61	4.69	4.22	6.51	5.20	5.41	5.25	5.34	6.62

D.2 Breakdown of operating costs – Surface disposal option, existing EPL boundary (option 1A)

The operating costs for option 1A are largely the same as for option 1, presented in Appendix D.1. However, option 1A includes the rejects disposal levy, calculated at $15/t for rejects emplaced outside the existing EPL boundary. Table D-2 outlines the operating costs estimated over the life of the rejects disposal operation, as per the REA design as at May 2013 and the mine plan data provided by Tahmoor Coal (ref. Tahmoor Coal data issued 15 Aug 2013).

Table D-2 Operating cost estimate – surface disposal option, existing EPL boundary (option 1A)

Year		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Rejects at forecast Yield	Mtpa	0.440	0.952	0.877	0.825	0.871	1.330	1.041	1.061	1.081	1.263	1.134
Average rejects throughput	tph	132	153	141	132	140	213	167	170	173	202	182
Labour	hr	8,320.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00
	$	1,456,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000
Consumables	$	216,617	608,564	597,536	594,428	630,913	844,177	743,174	774,374	806,499	916,953	880,880
Maintenance	$	225,564	324,787	310,278	300,176	309,042	398,002	342,013	345,952	349,776	384,987	359,955
Heavy plant leasing	$	382,065	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900
Vegetation clear and grub	$	48,373	104,732	96,491	90,753	95,788	146,318	114,516	116,754	118,926	138,926	124,707
Reject disposal levy	$	-	-	-	-	-	-	-	-	-	-	-
Contractor's Profit	$	91,144	197,503	195,327	193,811	195,141	208,485	200,087	200,678	201,251	206,533	202,778
Total OPEX	$	**2,419,764**	**4,957,485**	**4,921,532**	**4,901,067**	**4,952,785**	**5,318,882**	**5,121,690**	**5,159,658**	**5,198,353**	**5,369,299**	**5,290,221**
	$/t	5.50	5.21	5.61	5.94	5.69	4.00	4.92	4.86	4.81	4.25	4.67

Year		**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Rejects at forecast Yield	Mtpa	1.073	1.286	1.174	1.154	1.326	0.791	1.039	0.997	1.040	1.027	0.799
Average rejects throughput	tph	172	206	188	185	213	127	166	160	167	165	128
Labour	hr	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00	15,600.00
	$	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000	2,730,000
Consumables	$	876,232	1,013,015	983,105	1,001,532	1,128,973	850,245	1,024,563	1,028,952	1,087,306	1,111,349	990,164
Maintenance	$	348,114	389,420	367,673	363,869	397,242	293,571	341,603	333,423	341,847	339,381	295,122
Heavy plant leasing	$	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900	991,900
Vegetation clear and grub	$	117,982	141,443	129,091	126,930	145,886	87,001	114,283	109,637	114,422	113,021	87,882
Reject disposal levy	$	-	10,693,020	-	-	-	-	-	-	-	-	6,178,200
Contractor's Profit	$	201,002	207,198	203,936	203,365	208,371	192,821	200,025	198,798	200,062	199,692	193,053
Total OPEX	$	**5,265,230**	**16,165,996**	**5,405,705**	**5,417,596**	**5,602,374**	**5,145,538**	**5,402,374**	**5,392,710**	**5,465,537**	**5,485,343**	**11,466,321**
	$/t	4.91	12.57	4.61	4.69	4.22	6.51	5.20	5.41	5.25	5.34	14.35

D.3 Breakdown of operating costs – Co-disposal Option – Expanded REA and Underground disposal option (option 2)

The basis of estimate adopted for the operating cost estimates was generally in accordance with the methodology outlined in Appendix C.1. The operating estimate for option 2 incorporates the paste plant operation and the REA operation. The operating cost estimate therefore comprises the following specific elements:

Operating conditions

In order to calculate the operating estimate, the following variables were assumed:

Working days per year	260
Working hours per day	24
REA equipment availability	75 per cent
Paste plant availability	75 per cent
Rejects disposed of through paste plant	70 per cent
Rejects disposed of at surface REA	30 per cent

Haul truck operating estimate

For the co-disposal option, it is assumed that Tahmoor Coal will purchase the haul truck/s outright and use them on a stand-by basis. Pricing was obtained from Komatsu for Komatsu HD456 trucks, with a Q2 2013 cost of $1M per truck.

The proposed Komatsu HD456 off-highway trucks will drive a cycle that has an average length of 4100 meters per trip, including a 500m downhill section, a 1300m uphill section and a 250m flat section on top of the waste dump. Allowing a 90 second load and 90 second dump time, a single trip will take approximately 720 seconds or 12 minutes. With a payload of 56.6 tonnes a tonnage of 283 tonnes per hour can be reached. This equates to an annual capacity of 1.3Mtpa.

The total amount of diesel consumed per truck has been calculated to be 45 litres per hour while operating.

It was assumed that the haul truck/s will operate as required and as directed by Tahmoor Coal, will be operated by the paste plane operators (when not required to run the paste plant).

Dozer operating estimate

For the co-disposal option, it is assumed that Tahmoor Coal will purchase the dozer outright and use them on a stand-by basis. Pricing was obtained from Komatsu for a Caterpillar D6 (equivalent), with a Q2 2013 cost of $0.8M.

On the waste dump a single track dozer will be operating to spread the rejects and form the dump. Assuming an average energy use of 50 per cent of maximum power available, this gives a diesel consumption of 23 litres per hour.

It was assumed that the dozer will operate as required and as directed by Tahmoor Coal, will be operated by the paste plane operators (when not required to run the paste plant).

Consumables

Consumables included in the operating cost estimate include:

- Diesel (with a 2013 assumed cost of $1.50 per litre)
- Haul truck tyres (at a 2013 cost of $30,800 per set to be replaced every 15,000hrs)

- Haul truck maintenance, including lubricants, parts and labour (calculated at $55 per operating hour)
- Dozer maintenance, including lubricants, parts and labour (calculated at $45 per operating hour).

Paste plant energy consumption

For energy consumption, the major contributors are the paste preparation plant and pump station. Energy costs were calculated at $0.05 per kWh.

Paste plant water consumption

Water consumption was estimated from the water content of the paste and a periodic flushing of pipelines. Water costs were calculated at $2.13 per m^3.

Paste plant reagent

The rheology modifier reagent consumption was indicatively advised by Cellcrete Australia Pty. The reagent was assumed to cost $20 per L.

Maintenance

Maintenance of the paste plant was assumed to cost $87.21 per hour.

Plant labour

For labour estimation, 2.5 equivalent persons were assumed necessary to operate the plant, pump station and pipeline underground. The same equivalent labour workforce has been allowed for when the paste plant is unavailable and the rejects are hauled to the REA expansion. A labour rate of $175 per hour was adopted.

Estimate of operating costs

Table D-3 outlines the operating costs estimated over the life of the rejects disposal operation, as per the mine plan data provided by Tahmoor Coal (ref. Tahmoor Coal data issued 15 Aug 2013).

Table D-3 Operating cost estimate – underground disposal option (option 2)

Year		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Rejects at forecast Yield	Mtpa	0.440	0.952	0.877	0.825	0.871	1.330	1.041	1.061	1.081	1.263	1.134
Average rejects throughput	tph	132	153	141	132	140	213	167	170	173	202	182
Surface disposal at REA												
Rejects at forecast Yield	Mtpa	0.132	0.286	0.263	0.248	0.261	0.399	0.312	0.318	0.324	0.379	0.340
Average rejects throughput	tph	40	46	42	40	42	64	50	51	52	61	55
Labour	hr	3,661	6,864	6,864	6,864	6,864	6,864	6,864	6,864	6,864	6,864	6,864
	$	640,640	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200
Consumables	$	183,632	411,728	415,272	421,402	439,645	511,229	488,596	505,923	523,766	565,389	563,240
Maintenance Costs	$	129,229	195,716	191,363	188,333	190,993	217,681	200,884	202,066	203,213	213,776	206,266
Heavy plant	$	-	-	-	-	-	-	-	-	-	-	-
Vegetation clear and grub	$	48,373	104,732	96,491	90,753	95,788	146,318	114,516	116,754	118,926	138,926	124,707
Sub-total OPEX - surface disposal	**$**	**1,001,874**	**1,913,375**	**1,904,326**	**1,901,688**	**1,927,626**	**2,076,428**	**2,005,196**	**2,025,943**	**2,047,105**	**2,119,291**	**2,095,414**
Underground disposal as paste												
Rejects at forecast Yield	Mtpa	0.308	0.666	0.614	0.578	0.610	0.931	0.729	0.743	0.757	0.884	0.794
Average rejects throughput	tph	92	77	71	67	71	108	84	86	88	102	92
Energy	kWh	2,024,723	4,511,097	4,145,734	3,891,073	4,114,490	6,365,232	4,946,684	5,046,319	5,142,998	6,034,853	5,400,383
@ 0.05 $/kWh	$	101,236	225,555	207,287	194,554	205,724	318,262	247,334	252,316	257,150	301,743	270,019
Water	m3	77,753	167,414	154,303	145,174	153,186	233,574	182,980	186,540	189,995	221,813	199,193
@ 2.13 $/m3	$	165,613	356,591	328,666	309,221	326,286	497,512	389,747	397,330	404,690	472,463	424,281
Reagent	L	32,532	70,434	64,892	61,033	64,420	98,402	77,014	78,519	79,980	93,430	83,868
@ 20 $/L	$	650,640	1,408,682	1,297,842	1,220,660	1,288,395	1,968,037	1,540,287	1,570,386	1,599,600	1,868,608	1,677,363
Maintenance Costs	hr	2,362	6,132	6,132	6,132	6,132	6,132	6,132	6,132	6,132	6,132	6,132
@87.21 $/h	$	205,986	534,755	534,755	534,755	534,755	534,755	534,755	534,755	534,755	534,755	534,755
Labour	hr	9,448	24,528	24,528	24,528	24,528	24,528	24,528	24,528	24,528	24,528	24,528
@ 175 $/h	$	1,653,369	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400
Sub-total OPEX - underground disposal	**$**	**2,776,845**	**6,817,984**	**6,660,950**	**6,551,590**	**6,647,561**	**7,610,966**	**7,004,523**	**7,047,187**	**7,088,595**	**7,469,968**	**7,198,819**
Total OPEX - co disposal	**$**	**3,778,719**	**8,731,359**	**8,565,276**	**8,453,278**	**8,575,187**	**9,687,394**	**9,009,719**	**9,073,129**	**9,135,700**	**9,589,260**	**9,294,233**
	$/t	8.59	9.17	9.76	10.25	9.85	7.28	8.65	8.55	8.45	7.59	8.20

Year		**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Rejects at forecast Yield	Mtpa	1.073	1.286	1.174	1.154	1.326	0.791	1.039	0.997	1.040	1.027	0.799
Average rejects throughput	tph	172	206	188	185	213	127	166	160	167	165	128
Surface disposal at REA												
Rejects at forecast Yield	Mtpa	0.322	0.386	0.352	0.346	0.398	0.237	0.312	0.299	0.312	0.308	0.240
Average rejects throughput	tph	52	62	56	55	64	38	50	48	50	49	38
Labour	hr	6,864	6,864	6,864	6,864	6,864	6,864	6,864	6,864	6,864	6,864	6,864
	$	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200	1,201,200
Consumables	$	570,794	621,106	621,617	636,934	685,290	611,945	674,995	687,325	716,193	735,096	710,735
Maintenance Costs	$	202,714	215,106	208,582	207,441	217,453	186,351	200,761	198,307	200,834	200,094	186,817
Heavy plant	$	-	-	-	-	-	-	-	-	-	-	-
Vegetation clear and grub	$	117,982	141,443	129,091	126,930	145,886	87,001	114,283	109,637	114,422	113,021	87,882
Sub-total OPEX - surface disposal	**$**	**2,092,691**	**2,178,856**	**2,160,490**	**2,172,504**	**2,249,829**	**2,086,497**	**2,191,239**	**2,196,468**	**2,232,649**	**2,249,412**	**2,186,634**
Underground disposal as paste												
Rejects at forecast Yield	Mtpa	0.751	0.900	0.821	0.808	0.928	0.554	0.727	0.698	0.728	0.719	0.559
Average rejects throughput	tph	87	104	95	93	107	64	84	81	84	83	65
Energy	kWh	5,100,878	6,147,456	5,595,954	5,499,719	6,345,923	3,724,773	4,936,409	4,729,726	4,942,539	4,880,207	3,763,834
@ 0.05 $/kWh	$	255,044	307,373	279,798	274,986	317,296	186,239	246,820	236,486	247,127	244,010	188,192
Water	m3	188,494	225,819	206,168	202,730	232,887	139,206	182,609	175,218	182,830	180,602	140,608
@ 2.13 $/m3	$	401,491	480,994	439,137	431,814	496,050	296,509	388,958	373,214	389,428	384,681	299,494
Reagent	L	79,345	95,124	86,817	85,363	98,112	58,510	76,858	73,733	76,951	76,009	59,102
@ 20 $/L	$	1,586,904	1,902,472	1,736,330	1,707,264	1,962,233	1,170,199	1,537,154	1,474,663	1,539,023	1,520,181	1,182,049
Maintenance Costs	hr	6,132	6,132	6,132	6,132	6,132	6,132	6,132	6,132	6,132	6,132	6,132
@87.21 $/h	$	534,755	534,755	534,755	534,755	534,755	534,755	534,755	534,755	534,755	534,755	534,755
Labour	hr	24,528	24,528	24,528	24,528	24,528	24,528	24,528	24,528	24,528	24,528	24,528
@ 175 $/h	$	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400	4,292,400
Sub-total OPEX - underground disposal	**$**	**7,070,595**	**7,517,995**	**7,282,420**	**7,241,219**	**7,602,735**	**6,480,102**	**7,000,088**	**6,911,519**	**7,002,734**	**6,976,028**	**6,496,890**
Total OPEX - co disposal	**$**	**9,163,285**	**9,696,851**	**9,442,910**	**9,413,724**	**9,852,564**	**8,566,599**	**9,191,327**	**9,107,987**	**9,235,383**	**9,225,440**	**8,683,524**
	$/t	8.54	7.54	8.05	8.16	7.43	10.83	8.85	9.14	8.88	8.98	10.87

Appendix E. Options analysis results

E.1 Compatibility ratings

Table E-1 Compatibility Ratings

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
1. Expanded Surface Rejects Emplacement Area	Improves or Contributes to Local Economy	Useful	Opp: Locals may be employed to construct and operate	Partially compatible
			Risk: Local Civil Contractors may not have the capacity to compete for the work	
	High Benefit to Cost Ratio	Essential	Comm: BCR = 7.91	Excellent
	Low Impact on Available Coal Reserves	Important	Comm: Does not interfere with mine plan	Excellent
	Low Impact on Production	Essential	Risk: Poor truck availability may impact on coal washing process	Excellent
			Risk: Increased truck movements may increase the chance of a truck impacting the rejects plant	
			Risk: Relies on constant availability of rejects infrastructure	
			Opp: Current system includes capacity for growth	
	Minimal Processing of Rejects Required	Important	Risk: Yield may drop increasing the amount of rejects to emplacement site	Good
	Minimal Dust Emissions	Important	Risk: Increased dust may impact on approvals	Good

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
			compliance	
			Comm: Current emplacement method provides adequate dust control (progressive rehabilitation and water cart use)	
	Low Greenhouse Gas Emissions	Important	Comm: Potential to add to the diesel powered fleet	Compatible
	Low Water Usage	Important	Comm: Continued use of process water in water cart for dust suppression on haul roads	Excellent
			Comm: This option dewaters the rejects thus retaining water for plant usage	
	Low risk of surface/groundwater and subsurface water particle contamination	Important	Comm: Already employing adequate storm water controls	Good
			Comm: Licensed discharge points available	
	Low risk of surface/groundwater and subsurface water chemical contamination	Important	Comm: No current acid mine drainage	Good
			Risk: Elevated salinity in runoff water from emplacement area	
	Good Control of Spills	Desirable	Opp: Not trucking off-site (<300mm material)	Excellent
			Opp: No pipelines to transfer material	
	Reduced Visual Impact	Desirable	Risk: Additional surface emplacement may attract complaints	Partially compatible

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
			Comm: Noise/visual bunds in place	
	Rejects Contained within Mine Lease and EPL	Important	Risk: Extension to the ML/EPL may not be granted	Compatible
	Minimal Use of Foreign Re-agents	Desirable	Comm: None used	Excellent
	Safe in Application	Essential	Comm: Existing mobile equipment used	Compatible
			Risk: Potential for engulfment of operator while loading from rejects bin	
	Causes no Hazards to Mine Operations	Essential	Comm: External to mining operations	Excellent
	Ease of Operation	Important	Comm: Existing operations	Excellent
	Potential for Liquefaction of Emplaced Fill	Important	Comm: None	Excellent
	Potential to Damage Bulkheads	Essential	Comm: Not applicable	Excellent
	Low Noise Emissions	Important	Comm: Noise complaints from existing REA	Compatible
			Risk: New approval criteria for noise may restrict operations	
			Opp: Replace or improve truck fleet to reduce noise emissions	
	Potential to Impact to Heritage Artefacts and Vegetation	Important	Risk: 132 Hectares of significant vegetation will require biodiversity offsets	**Partially compatible**

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
			Comm: No Heritage Artefacts known to be impacted	
	Impact of Geology/Geotech to Design and Operate System	Essential	Risk: Low potential for slumping	Excellent
	Ease of Automation	Desirable	Comm: Not automated - manual system	Partially compatible
	High Reliability/Availability of the System	Essential	Comm: Have not had to shut the plant due to truck unavailability (increased capacity available)	Excellent
	Increased Subsidence Control	Negligible	Comm: Not applicable	Partially compatible
	Versatility and Flexibility of Solution	Important	Opp: REA has a greater potential to account for fluctuations in yield	Excellent
			Comm: Coal can be processed while long-wall is not operating	
	Low Maintenance	Important	Comm: System (haul roads, trucks, bins etc.) needs maintenance although there is a low management burden/requirement	Good
	Proven Technology	Important	Comm: Currently operating	Excellent
	Meets Capacity and Throughput Requirements	Essential		Excellent
	Consistency with Mine Closure Plan	Desirable	Comm: Additional rehabilitation requirements	Good
			Comm: Consistent with current Mine Closure Plan	

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
			(progressive rehabilitation)	
2. Paste Disposal Underground into Active Goaf	Improves or Contributes to Local Economy	Useful	Opp: Will need to employ more people to operate/maintain the rheology associated with the paste for the underground system (over and above those operating and maintaining the current plant)	Partially compatible
			Comm: Small incremental increase in operator numbers	
	High Benefit to Cost Ratio	Essential	Comm: BCR = 1.82	Compatible
	Low Impact on Available Coal Reserves	Important	Risk: Wongawilli Seam is located 30m below current Bulli Seam and inrush from an undrained fill mass may occur	Partially compatible
	Low Impact on Production	Essential	Opp: Design can accommodate a contingency whereby trucks may be used to take rejects to existing REA	Partially compatible
			Risk: Existing REA may not have the capacity to accommodate the contingency plan	
			Risk: System integration with longwall (disposal interruption stops longwall production)	
			Risk: Adds congestion in an already congested area (at the longwall)	
			Risk: Inrush into the next working area sterilising coal in the current seam	

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
			Risk: Low seam height areas of the mine increases dilution impacting on rejects circuit constraint, impacting plant throughput.	
	Minimal Processing of Rejects Required	Important	Comm: Additional processing required	Partially compatible
	Minimal Dust Emissions	Important	Comm: REA is still operating as a contingency	Good
			Comm: Additional crushers/sizers will be required which will generate additional dust	
	Low Greenhouse Gas Emissions	Important	Comm: Additional energy required to run crushers etc. in lieu of trucks	Compatible
	Low Water Usage	Important	Risk: Highly water intensive through constant pipe flushing	Partially compatible
			Risk: Ingress of water into mining areas	
			Risk: Additional water required to generate slurry for piping	
			Risk: Process water at the mine easily calcifies (although the paste may assist in keeping it clean)	
	Low risk of surface, groundwater and subsurface water particle contamination	Important	Comm: Particles should be captured in the Goaf	Compatible
	Low risk of surface, groundwater and subsurface	Important	Risk: Chemical contamination by flocculants and	Partially

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
	water chemical contamination		reagent modifiers may occur	compatible
	Good Control of Spills	Desirable	Risk: Greater potential for spills due to pipe usage	Partially compatible
			Opp: Not trucking off-site (<300mm material)	
	Reduced Visual Impact	Desirable	Comm: Additional plant located at the wash plant	Good
			Comm: Increased size of the REA	
	Rejects Contained within Mine Lease and EPL	Essential	Comm: No need to expand any existing EPL or ML	Excellent
	Minimal Use of Foreign Re-agents	Desirable	Risk: Uses a rheology modifier at an additional expense	Partially compatible
	Safe in Application	Essential	Risk: High pressure pipe system required	Compatible
			Risk: Small leaks may not be detected	
			Comm: Assume that the new Tahmoor South longwall system will be designed to incorporate paste pipeline	
	Causes no Hazards to Mine Operations	Essential	Risk: Add much more complexity to the longwall system	Partially compatible
			Risk: Higher possibility of inrush	
			Risk: Paste may disperse Goaf gas	
			Comm: More infrastructure attached to the longwall	

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
			can generate complaints (cultural issues)	
	Ease of Operation	Important	Comm: Highly complex process (esp. paste thickening)	Partially compatible
	Potential for Liquefaction of Emplaced Fill	Important	Comm: Not using a binder means that the paste may or may not drain (uncertainty)	Partially compatible
	Potential to Damage Bulkheads	Essential	Risk: Hydraulic pressure on bulkheads will increase potential for failure	Compatible
			Opp: Design the bulkheads to cope with the increased hydraulic pressure	
			Risk: Floor heave may render increased bulkhead design ineffective	
	Low Noise Emissions	Important	Comm: Additional crushers/sizers will be required which will generate additional noise	Compatible
	Potential to Impact to Heritage Artifacts and Vegetation	Important	Comm: May still need to expand the REA somewhat	Compatible
	Impact of Geology/Geotech to Design and Operate System	Essential	Risk: Unknown floor conditions	Partially compatible
			Risk: Seam floor contours (flat gradients resulting in decreased fill volumes and potential for flow back of paste and water to operating face)	
			Risk: Paste penetration through the rock mass may decrease volume available	

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
	Ease of Automation	Desirable	Comm: Mostly manual operation	Partially compatible
	High Reliability/Availability of the System	Essential	Opp: Increased reliability and availability due to the operation of both a surface and underground disposal systems	Compatible
			Comm: Underground system alone is low	
			Risk: Long distances of piping (13km)	
	Increased Subsidence Control	Negligible	Comm: System replaces "some" solid materials underground	Partially compatible
	Versatility and Flexibility of Solution	Important	Comm: System may not be able to handle variability above designed throughput	Compatible
			Comm: Accommodated only by co-disposal to REA	
	Low Maintenance	Important	Risk: Very high maintenance solution	Partially compatible
			Comm: Maintenance across multiple departments	
	Proven Technology	Important	Risk: Depth of cover to trailing pipe	Partially compatible
			Risk: Components of the system are proven. Our application as a system has not been proven "end-to-end".	
	Meets Capacity and Throughput Requirements	Essential	Comm: Meets 75% yield assumption throughput	Compatible

Primary options	Criteria	Criteria Weighting	Risks/Opportunities/Issues/Comments	Compatibility
		🟩	capacity	🟨
		🟩	Risk: If yield exceeds 35% additional approvals to further expand the REA may be required	
	Consistency with Mine Closure Plan	Desirable	Comm: The current REA will be expanded slightly impacting slightly on the Mine Closure Plan	Compatible
			Risk: Unknown obligations for water monitoring	

E.2 Report findings

Table E-2 Report Findings

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
1. Expanded Surface Rejects Emplacement Area			Improves or Contributes to Local Economy	Useful	Opp: Locals may be employed to construct and operate	Partially compatible	Marginal Compatibility	1880	Preferred Option	
					Risk: Local Civil Contractors may not have the capacity to compete for the work					
			High Benefit to Cost Ratio	Essential	Comm: BCR = 7.91	Excellent				
			Low Impact on Available Coal Reserves	Important	Comm: Does not interfere with mine plan	Excellent				
			Low Impact on Production	Essential	Risk: Poor truck availability may impact on coal washing process	Excellent				
					Risk: Increased truck movements may increase the chance of a truck impacting the rejects plant					
					Risk: Relies on constant availability of rejects infrastructure					
					Opp: Current system includes capacity for growth					

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
			Minimal Processing of Rejects Required	Important	Risk: Yield may drop increasing the amount of rejects to emplacement site	Good			🟩	
			Minimal Dust Emissions	Important	Risk: Increased dust may impact on approvals compliance	Good				
					Comm: Current emplacement method provides adequate dust control (progressive rehabilitation and water cart use)					
			Low Greenhouse Gas Emissions	Important	Comm: Potential to add to the diesel powered fleet	Compatible				
			Low Water Usage	Important	Comm: Continued use of process water in water cart for dust suppression on haul roads	Excellent				
					Comm: This option dewaters the rejects thus retaining water for plant usage				🟩	
			Low risk of surface/groundwater and subsurface water particle contamination	Important	Comm: Already employing adequate storm water controls	Good				
					Comm: Licensed discharge points available					
			Low risk of surface/groundwater and subsurface water chemical	Important	Comm: No current acid mine drainage	Good				
					Risk: Elevated salinity in runoff water from emplacement area					

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
			contamination							
			Good Control of Spills	Desirable	Opp: Not trucking off-site (<300mm material)	Excellent				
					Opp: No pipelines to transfer material					
			Reduced Visual Impact	Desirable	Risk: Additional surface emplacement may attract complaints	Partially compatible				
					Comm: Noise/visual bunds in place					
			Rejects Contained within Mine Lease and EPL	Important	Risk: Extension to the ML/EPL may not be granted	Compatible				
			Minimal Use of Foreign Re-agents	Desirable	Comm: None used	Excellent				
			Safe in Application	Essential	Comm: Existing mobile equipment used	Compatible				
					Risk: Potential for engulfment of operator while loading from rejects bin					
			Causes no Hazards to Mine Operations	Essential	Comm: External to mining operations	Excellent				
			Ease of Operation	Important	Comm: Existing operations	Excellent				
			Potential for Liquefaction of	Important	Comm: None	Excellent				

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
			Emplaced Fill							
			Potential to Damage Bulkheads	Essential	Comm: Not applicable	Excellent				
			Low Noise Emissions	Important	Comm: Noise complaints from existing REA	Compatible				
					Risk: New approval criteria for noise may restrict operations					
					Opp: Replace or improve truck fleet to reduce noise emissions					
			Potential to Impact to Heritage Artifacts and Vegetation	Important	Risk: 132 Hectares of significant vegetation will require biodiversity offsets	**Partially compatible**				
					Comm: No Heritage Artifacts known to be impacted					
			Impact of Geology/Geotech to Design and Operate System	Essential	Risk: Low potential for slumping	Excellent				
			Ease of Automation	Desirable	Comm: Not automated - manual system	**Partially compatible**				
			High Reliability/Availability of the System	Essential	Comm: Have not had to shut the plant due to truck unavailability (increased capacity available)	Excellent				

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
			Increased Subsidence Control	Negligible	Comm: Not applicable	Partially compatible				
			Versatility and Flexibility of Solution	Important	Opp: REA has a greater potential to account for fluctuations in yield	Excellent				
					Comm: Coal can be processed while long-wall is not operating					
			Low Maintenance	Important	Comm: System (haul roads, trucks, bins etc.) needs maintenance although there is a low management burden/requirement	Good				
			Proven Technology	Important	Comm: Currently operating	Excellent				
			Meets Capacity and Throughput Requirements	Essential		Excellent				
			Consistency with Mine Closure Plan	Desirable	Comm: Additional rehabilitation requirements	Good				
					Comm: Consistent with current Mine Closure Plan (progressive rehabilitation)					
2. Paste Disposal Underground into Active Goaf			Improves or Contributes to Local Economy	Useful	Opp: Will need to employ more people to operate/maintain the rheology associated with the paste for the underground system (over and above those operating and maintaining the current plant)	Partially compatible	Not Compatible	1005	Not Suitable	

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
					Comm: Small incremental increase in operator numbers					
			High Benefit to Cost Ratio	Essential	Comm: BCR = 1.82	Compatible				
			Low Impact on Available Coal Reserves	Important	Risk: Wongawilli Seam is located 30m below current Bulli Seam and inrush from an undrained fill mass may occur	Partially compatible				
			Low Impact on Production	Essential	Opp: Design can accommodate a contingency whereby trucks may be used to take rejects to existing REA	Partially compatible				
					Risk: Existing REA may not have the capacity to accommodate the contingency plan					
					Risk: System integration with longwall (disposal interruption stops longwall production)					
					Risk: Adds congestion in an already congested area (at the longwall)					
					Risk: Inrush into the next working area sterilising coal in the current seam					
					Risk: Low seam height areas of the mine increases dilution impacting on rejects circuit constraint, impacting plant					

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
					throughput.					
			Minimal Processing of Rejects Required	Important	Comm: Additional processing required	Partially compatible				
			Minimal Dust Emissions	Important	Comm: REA is still operating as a contingency	Good				
					Comm: Additional crushers/sizers will be required which will generate additional dust					
			Low Greenhouse Gas Emissions	Important	Comm: Additional energy required to run crushers etc. in lieu of trucks	Compatible				
			Low Water Usage	Important	Risk: Highly water intensive through constant pipe flushing	Partially compatible				
					Risk: Ingress of water into mining areas					
					Risk: Additional water required to generate slurry for piping					
					Risk: Process water at the mine easily calcifies (although the paste may assist in keeping it clean)					
			Low risk of surface, groundwater and subsurface water particle	Important	Comm: Particles should be captured in the Goaf	Compatible				

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
			contamination							
			Low risk of surface, groundwater and subsurface water chemical contamination	Important	Risk: Chemical contamination by flocculants and reagent modifiers may occur	Partially compatible				
			Good Control of Spills	Desirable	Risk: Greater potential for spills due to pipe usage	Partially compatible				
					Opp: Not trucking off-site (<300mm material)					
			Reduced Visual Impact	Desirable	Comm: Additional plant located at the wash plant	Good				
					Comm: Increased size of the REA					
			Rejects Contained within Mine Lease and EPL	Essential	Comm: No need to expand any existing EPL or ML	Excellent				
			Minimal Use of Foreign Re-agents	Desirable	Risk: Uses a rheology modifier at an additional expense	Partially compatible				
			Safe in Application	Essential	Risk: High pressure pipe system required	Compatible				
					Risk: Small leaks may not be detected					
					Comm: Assume that the new Tahmoor					

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
					South longwall system will be designed to incorporate paste pipeline					
			Causes no Hazards to Mine Operations	Essential	Risk: Add much more complexity to the longwall system	Partially compatible				
					Risk: Higher possibility of inrush					
					Risk: Paste may disperse Goaf gas					
					Comm: More infrastructure attached to the longwall can generate complaints (cultural issues)					
			Ease of Operation	Important	Comm: Highly complex process (esp. paste thickening)	Partially compatible				
			Potential for Liquefaction of Emplaced Fill	Important	Comm: Not using a binder means that the paste may or may not drain (uncertainty)	Partially compatible				
			Potential to Damage Bulkheads	Essential	Risk: Hydraulic pressure on bulkheads will increase potential for failure	Compatible				
					Opp: Design the bulkheads to cope with the increased hydraulic pressure					
					Risk: Floor heave may render increased bulkhead design ineffective					
			Low Noise	Important	Comm: Additional crushers/sizers will be	Compatible				

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
			Emissions		required which will generate additional noise					
			Potential to Impact to Heritage Artifacts and Vegetation	Important	Comm: May still need to expand the REA somewhat	Compatible				
			Impact of Geology/Geotech to Design and Operate System	Essential	Risk: Unknown floor conditions	Partially compatible				
					Risk: Seam floor contours (flat gradients resulting in decreased fill volumes and potential for flow back of paste and water to operating face)					
					Risk: Paste penetration through the rock mass may decrease volume available					
			Ease of Automation	Desirable	Comm: Mostly manual operation	Partially compatible				
			High Reliability/Availability of the System	Essential	Opp: Increased reliability and availability due to the operation of both a surface and underground disposal systems	Compatible				
					Comm: Underground system alone is low					
					Risk: Long distances of piping (13km)					
			Increased Subsidence Control	Negligible	Comm: System replaces "some" solid materials underground	Partially compatible				

Primary options	Sub Options	Description	Assessment Criteria	Weighting	Risks/Opportunities/Issues/Comments	Compatibility	Option Compatibility	Option Score	Preferred Option	Action Items
			Versatility and Flexibility of Solution	Important	Comm: System may not be able to handle variability above designed throughput	Compatible				
					Comm: Accommodated only by co-disposal to REA					
			Low Maintenance	Important	Risk: Very high maintenance solution	Partially compatible				
					Comm: Maintenance across multiple departments					
			Proven Technology	Important	Risk: Depth of cover to trailing pipe	Partially compatible				
					Risk: Components of the system are proven. Our application as a system has not been proven "end-to-end".					
			Meets Capacity and Throughput Requirements	Essential	Comm: Meets 75% yield assumption throughput capacity	Compatible				
					Risk: If yield exceeds 35% additional approvals to further expand the REA may be required					
			Consistency with Mine Closure Plan	Desirable	Comm: The current REA will be expanded slightly impacting slightly on the Mine Closure Plan	Compatible				
					Risk: Unknown obligations for water monitoring					

Appendix F. Rejects material testing

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 069 211 561
Unit 1/140 Industrial Road
Oak Flats,NSW,2529,AUSTRALIA
Telephone 61 2 4257 4458
Fax 61 2 4257 4463
Email: southcoast@netgeo.com.au

CALIFORNIA BEARING RATIO (CBR) TEST REPORT

Page 1 of 1

Client :	XSTRATA Coal	**Job Number:**	W07/2163
Project:	Material Testing	**Report Number:**	2
location:		**Report Date:**	5/03/2013
GTR Number :		**Tested By:**	Craig Salmon

TEST IDENTIFICATION

Sampling Method :Sampled By Client

Lab Number		W41386		
Sample Date		29/01/2013		
Lot Number		-		
Lot Description				
Component		Stockpile		
Chainage	(m)			
Offset	(m)	53mm Coal		
Layer				
Sample Description		Coal Wash		

LABORATORY DATA

		RTA T111	*RTA T120*	
Field Moisture Content	(%)	3.3		
Maximum Dry Density	(t/m^3)	1.97		
Optimum Moisture Content	(%)	8.5		

TEST RESULTS

		RTA T117	*RTA T120*	
Date Tested		10/02/2013		
Days Soaked		4		
Surcharge Weight		4.5 kg		
Before Soaking				
Dry Density	(t/m^3)	1.98		
Density Ratio	(%)	101 Standard		
Moisture Content	(%)	8.4		
Moisture Ratio	(%)	99		
After Soaking				
Dry Density	(t/m^3)	1.98		
Density Ratio	(%)	101 Standard		
Swell	(%)	0.1		
Moisture Content				
After Soaking	(%)	9.6		
Top 30mm	(%)	9.0		
Full Depth After Test	(%)	8.4		
CBR Value	(%)	**13 @ 5.0mm**		
Percentage retained on 19.0 mm	(%)	37.0 Excluded		

Note : -

Accredited for compliance with ISO/IEC 17025.

Wollongong Laboratory 1318

WORLD RECOGNISED ACCREDITATION

Approved Signatory:

Jason Danswan

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

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Oak Flats NSW 2529
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Facsimilie 61 2 4257 4463
Email southcoast@netgeo.com.au

TEST REPORT

Client:	X Strata Coal	**Job Number:**	W07/2163
Project:	Material Testing	**Report Number:**	-
Location:	Tahmoor	**Report Date:**	27.02.13
GTR Number :	-	**Tested By:**	TM & JT

Lot Number :	-	Lab Number :	W41386
Lot Description :	-	Date Sampled:	29.1.13
Component :	-	Layer :	-
Offset :	-	Sample Description:	-53mm Coal

Sampling Procedure: By Client

Fractured Faces - RTA T239

TEST PROCEDURE	TEST RESULTS
% Passing respective AS sieve	45
% of Aggregate with No Fractured Faces	0
% of Aggregate with at least 1 Fractured Faces	0
% of Aggregate with at least 2 Fractured Faces	100

REMARKS:

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Wollongong Laboratory 1318

APPROVED SIGNATORY
Harry Ubungen

27/2/13
DATE

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TEST REPORT

Client: X Strata Coal
Project: Material Testing
Location: Remembrance Drive, Tahmoor
GTR Number : -

Job Number: W07/2163
Report Number: -
Report Date: 27.02.13
Tested By: TM

Sample Identification

Sample Description : -53mm Coal
Sampling Procedure: Sampled by Client

Sample Number: 1

Laboratory Number: W41386
Date Sampled: 29.01.13

Client Number: -

GRADING ANALYSIS (WASHED) - AS1289 3.6.1

TEST PROCEDURE			TEST RESULTS	SPECIFICATION
Percentage (%) Passing	53.0	mm sieve	100	
Percentage (%) Passing	37.5	mm sieve	94	
Percentage (%) Passing	26.5	mm sieve	79	
Percentage (%) Passing	19.0	mm sieve	67	
Percentage (%) Passing	13.2	mm sieve	60	
Percentage (%) Passing	9.5	mm sieve	52	
Percentage (%) Passing	6.7	mm sieve	45	
Percentage (%) Passing	4.75	mm sieve	39	
Percentage (%) Passing	2.36	mm sieve	31	
Percentage (%) Passing	1.18	mm sieve	25	
Percentage (%) Passing	600	µm sieve	22	
Percentage (%) Passing	425	µm sieve	21	
Percentage (%) Passing	300	µm sieve	20	
Percentage (%) Passing	150	µm sieve	18	
Percentage (%) Passing	75	µm sieve	14	

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TEST REPORT

Client:	X Strata Coal	Job No:	W07/2163	Sheet:	1 of 1
Principal:					
Project:	Material Testing	Tested By:	JT & PB	Date:	29.01.13
Location:	Remembrance Drive, Tahmoor	Checked By:	HU	Date:	27.02.13

Sample Description:	**DGS40**	Sample Procedure:	Sampled by Client
Date Received:	**29.01.13**	Stockpile Number:	Stockpile 1

MATERIAL ANALYSIS (SUBBASE)

Test Procedure			Results	Specification
			W41386	RTA 3051 Unbound Material Table 3051.5 1998 Ed5
RTA T106				
Percentage Passing	53.0 mm sieve	%	100	100
Percentage Passing	37.5 mm sieve	%	94	-
Percentage Passing	26.5 mm sieve	%	79	-
Percentage Passing	19.0 mm sieve	%	67	50-85
Percentage Passing	13.2 mm sieve	%	59	-
Percentage Passing	9.5 mm sieve	%	51	-
Percentage Passing	6.7 mm sieve	%	44	30-55
Percentage Passing	4.75 mm sieve	%	37	-
Percentage Passing	2.36 mm sieve	%	28	25-50
RTA T106 / T107				
Percentage Passing	425 µm sieve	%	18	-
Percentage Passing	75 µm sieve	%	12	-
Percentage Passing	13.5 µm sieve	%	7	-
RTA T107 *				
A Ratio		%	66	35-60
B Ratio		%	68	35-60
C Ratio		%	60	35-65
RTA T108				
Liquid Limit		%	NO	Max 23 (if non plastic)
RTA T109				
Plastic Limit		%	NO	Max 20 (if plastic)
Plasticity Index		%	NP	Max 12
RTA T114				
Maximum Dry Compressive Strength		MPa	4.7	Min 1.0
Corresponding Moisture Content		%	6.3	-
Corresponding Dry Density		t/m^3	2.09	-
RTA T213				
Mis-shapen Particles (Ratio 2:1)			54	Max 35
Mis-shapen Particles (Ratio 3:1)			19	-
AS1141.22				
Nominal Size Fraction		mm		-19.0mm+9.5mm
Aggregate Wet Strength		kN	39	Min 50
Aggregate Dry Strength		kN	106	-
Wet/Dry Strength Variation		%	60	Local Value
RTA T276				
Type I		%	-	Max 3
Type II		%	-	Max 0.2
Type III		%	-	Max 0.1

REMARKS

*Note: Ratios for that portion of the material passing 2.36mm AS sieve. NO denotes Not Obtainable NP denotes Non Plastic

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APPROVED SIGNATORY
Harry Ubungen

27/2/13
DATE

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TEST REPORT

Client:	X Strata Coal	Job No:	W07/2163	Sheet:	1 of 1
Principal:	-				
Project:	Material Testing	Tested By:	GM	Date:	14.02.13
Location:	Remembrance Drive, Tahmoor	Checked By:	HU	Date:	27.02.13

Sample Description:	**DGS40**	Sample Procedure:	Sampled by Client
Sample Number:	**W41386**		
Date Received:	**29.1.13**		
Client Number:	**-**		

UNCONFINED COMPRESSIVE STRENGTH - RTA T116

TEST PROCEDURE		TEST RESULTS	
		A	B
Material Retained 19.0mm AS sieve	%	33	33
Additive Type		Nil	Nil
Additive Content	%	Nil	Nil
Time from Addition of Additive to Moulding	mins	N/A	N/A
Accelerated Curing	days	7	7
Type of Compaction		Standard	Standard
Dry Density	t/m^3	1.90	1.91
Moisture Content	%	4.0	4.0
Condition after curing		Dry	Dry
UCS (4 hr soak)	MPa	-	-
Average for Specimens A & B	MPa	Dispersed in water	

REMARKS: Specimens compacted to 100% Standard compactive effort and estimated optimum moisture content.

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APPROVED SIGNATORY
Harry Ubungen

27/2/13
DATE

Wollongong Laboratory 1318

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Tel: (02) 9462 4860
Fax:(02) 9462 4710

Aggregate/Soil Test Report

Report No: SYD1313504
Issue No: 1
This report replaces all previous issues of report no 'SYD1313504'.

Client:
Network Geotechnics Pty Ltd
1/140 Industrial Rd
Oak Flats NSW 2529

Project: 2116173

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: George Vukovic (Senior Laboratory Technician)
Date of Issue: 21/03/2013

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Details

Sample ID	SYD13-16338
Client Sample ID	W14386
Date Sampled	29/01/2013
Specification	
Location	
Sampled By	
Boring No.	W07/2163
Depth	
Soil Description	-53mm Coal (dark grey clayey GRAVEL)

Test Results

Description	Method	Result	Limits
Permeability (m/sec)	AS 1289.6.7.2	2 E -09	
Laboratory Moisture Ratio		95.0	
Laboratory Density Ratio		99.0	
CompactiveEffort		Standard	
Method of Compaction		Std Compaction Hammer	
Surcharge Applied (Kg)		0.3	
Pressure Applied (Kpa)		20	
Material Retained And Later Discarded (%)		0.0	
Sieve Size (mm)		26.50	

Comments

N/A

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **ES1304501**	Page	: 1 of 5
Client	: NETWORK GEOTECHNICS PTY LTD	Laboratory	: Environmental Division Sydney
Contact	: MR HARRY UBUNGEN	Contact	: Client Services
Address	: UNIT 1, 140 INDUSTRIAL ROAD OAK FLATS NSW, AUSTRALIA 2529	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: hubungen@netgeo.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 4257 5548	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 4257 4463	Facsimile	: +61-2-8784 8500
Project	: W07 2163	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 27-FEB-2013
Sampler	: ----	Issue Date	: 01-MAR-2013
Order number	: HU060213		
		No. of samples received	: 1
Quote number	: SY/471/12	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non -volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

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

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA055: Moisture Content							
Snap Lock Bag (EA055-103) W41386	**29-JAN-2013**	**----**	----	----	**28-FEB-2013**	12-FEB-2013	✗
EG005T: Total Metals by ICP-AES							
Snap Lock Bag (EG005T) W41386	**29-JAN-2013**	**28-FEB-2013**	28-JUL-2013	✓	**01-MAR-2013**	28-JUL-2013	✓
EG035T: Total Recoverable Mercury by FIMS							
Snap Lock Bag (EG035T) W41386	**29-JAN-2013**	**28-FEB-2013**	26-FEB-2013	✗	**01-MAR-2013**	26-FEB-2013	✗

Quality Control Parameter Frequency Compliance

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

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		*Count*		*Rate (%)*			*Quality Control Specification*
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Moisture Content	EA055-103	1	2	**50.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	2	14	**14.3**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	18	**11.1**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Total Mercury by FIMS	EG035T	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	18	**5.6**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Total Mercury by FIMS	EG035T	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	18	**5.6**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	14	**7.1**	**5.0**	✓	ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	18	**5.6**	**5.0**	✓	ALS QCS3 requirement

Brief Method Summaries

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

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Moisture Content	EA055-103	SOIL	A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2010 Draft) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Total Metals by ICP-AES	EG005T	SOIL	(APHA 21st ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3)

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **SOIL**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA055: Moisture Content						
Snap Lock Bag W41386	----	----	----	28-FEB-2013	12-FEB-2013	**16**
EG035T: Total Recoverable Mercury by FIMS						
Snap Lock Bag W41386	28-FEB-2013	26-FEB-2013	**2**	01-MAR-2013	26-FEB-2013	**3**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

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

Environmental Division

QUALITY CONTROL REPORT

Work Order : **ES1304501**

Client : **NETWORK GEOTECHNICS PTY LTD**
Contact : MR HARRY UBUNGEN
Address : UNIT 1, 140 INDUSTRIAL ROAD
OAK FLATS NSW, AUSTRALIA 2529

E-mail : hubungen@netgeo.com.au
Telephone : +61 02 4257 5548
Facsimile : +61 02 4257 4463

Project : W07 2163
Site : ----
C-O-C number : ----
Sampler : ----
Order number : HU060213

Quote number : SY/471/12

Page : 1 of 5

Laboratory : Environmental Division Sydney
Contact : Client Services
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164

E-mail : sydney@alsglobal.com
Telephone : +61-2-8784 8555
Facsimile : +61-2-8784 8500

QC Level : NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Date Samples Received : 27-FEB-2013
Issue Date : 01-MAR-2013

No. of samples received : 1
No. of samples analysed : 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

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

NATA
WORLD RECOGNISED
ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Inorganics

General Comments

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

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

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

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

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

Laboratory Duplicate (DUP) Report

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

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA055: Moisture Content (QC Lot: 2750701)									
ES1304501-001	W41386	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	4.2	4.2	0.0	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 2751324)									
ES1304107-018	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	18	16	12.3	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	9	9	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	11	11	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	19	18	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	53	56	4.8	0% - 50%
ES1304461-001	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	3	4	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	36	42	13.3	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	13	13	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	8	8	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2751325)									
ES1304107-018	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
ES1304461-001	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit

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

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

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 2751324)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	115	84	128
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	108	79	119
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	115	70	130
EG005T: Copper	7440-50-8	5	mg/kg	<5	32.0 mg/kg	116	83	127
EG005T: Lead	7439-92-1	5	mg/kg	<5	40.0 mg/kg	112	81	117
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55.0 mg/kg	109	79	127
EG005T: Zinc	7440-66-6	5	mg/kg	<5	60.8 mg/kg	105	78	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2751325)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.57 mg/kg	92.6	72	114

Matrix Spike (MS) Report

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

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 2751324)							
ES1304107-018	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	124	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	130	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	122	70	130
		EG005T: Copper	7440-50-8	250 mg/kg	115	70	130
		EG005T: Lead	7439-92-1	250 mg/kg	111	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	101	70	130
		EG005T: Zinc	7440-66-6	250 mg/kg	129	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2751325)							
ES1304107-018	Anonymous	EG035T: Mercury	7439-97-6	5 mg/kg	97.1	70	130

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

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

Sub-Matrix: **SOIL**

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report			
Spike	Spike Recovery (%)	Recovery Limits (%)	RPDs (%)

Sub-Matrix: **SOIL**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	Spike Recovery (%)		Recovery Limits (%)		RPDs (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*MSD*	*Low*	*High*	*Value*	*Control Limit*
EG005T: Total Metals by ICP-AES (QCLot: 2751324)										
ES1304107-018	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	124	----	70	130	----	----
		EG005T: Cadmium	7440-43-9	50 mg/kg	130	----	70	130	----	----
		EG005T: Chromium	7440-47-3	50 mg/kg	122	----	70	130	----	----
		EG005T: Copper	7440-50-8	250 mg/kg	115	----	70	130	----	----
		EG005T: Lead	7439-92-1	250 mg/kg	111	----	70	130	----	----
		EG005T: Nickel	7440-02-0	50 mg/kg	101	----	70	130	----	----
		EG005T: Zinc	7440-66-6	250 mg/kg	129	----	70	130	----	----
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2751325)										
ES1304107-018	Anonymous	EG035T: Mercury	7439-97-6	5 mg/kg	97.1	----	70	130	----	----

CERTIFICATE OF ANALYSIS

Work Order : **ES1304501**
Client : **NETWORK GEOTECHNICS PTY LTD**
Contact : MR HARRY UBUNGEN
Address : UNIT 1, 140 INDUSTRIAL ROAD
OAK FLATS NSW, AUSTRALIA 2529
E-mail : hubungen@netgeo.com.au
Telephone : +61 02 4257 5548
Facsimile : +61 02 4257 4463
Project : W07 2163
Order number : HU060213
C-O-C number : ----
Sampler : ----
Site : ----
Quote number : SY/471/12

Page : 1 of 3
Laboratory : Environmental Division Sydney
Contact : Client Services
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail : sydney@alsglobal.com
Telephone : +61-2-8784 8555
Facsimile : +61-2-8784 8500
QC Level : NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Date Samples Received : 27-FEB-2013
Issue Date : 01-MAR-2013
No. of samples received : 1
No. of samples analysed : 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

WORLD RECOGNISED
ACCREDITATION

Signatories

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

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Inorganics

General Comments

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

			Client sample ID	**W41386**	----	----	----	----
			Client sampling date / time	29-JAN-2013 15:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES1304501-001**	**----**	**----**	**----**	**----**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**4.2**	----	----	----	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
Chromium	7440-47-3	2	mg/kg	**4**	----	----	----	----
Copper	7440-50-8	5	mg/kg	**22**	----	----	----	----
Lead	7439-92-1	5	mg/kg	**26**	----	----	----	----
Nickel	7440-02-0	2	mg/kg	**9**	----	----	----	----
Zinc	7440-66-6	5	mg/kg	**67**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	----	----	----	----

BORAL®

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TEST REPORT

CLIENT: Network Geotechnics Pty. Ltd.
Unit 1, 140 Industrial Road Oak Flats NSW 2529

FILE No.: 63 / 13

PROJECT: Job Number: W07/2163 - Testing of -53mm Coal

REQUEST No.: 51315

TEST PROCEDURE:

RMS T219 – Acid Soluble Sulfate content in Road Construction Materials

Laboratory Sample No.:	138205
Date Sampled:	29.1.13
Sample Description:	-53mm Coal Client Sample No. W41386
Field No.:	1

TEST RESULTS

Sulfate as SO_3 (%)	0.10

Sample submitted by the Client.

S.Thorley, H.Ubungen, Q.C.File, File.

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Approved Signatory S.Krishnamoorthy

Date 22.2./13. Serial No. 113075

NATA Accredited Laboratory Number: **547**

Appendix G. Coal washery rejects general waste exemption

Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A

The coal washery rejects general exemption 2009

Name

1. This exemption is to be known as 'The coal washery rejects general exemption 2009'.

Commencement

2. This exemption commences on 1 November 2009.

Duration

3. This exemption is valid until revoked by the Environment Protection Authority (EPA) by notice published in the Government Gazette.

Legislation

4. Under the *Protection of the Environment Operations (Waste) Regulation 2005* (the Regulation):

4.1. Clause 51 (2) authorises the EPA to grant an exemption in relation to any matter or thing including an activity or class of activities, and

4.2. Clause 51A authorises the EPA to exempt a person from any of the following provisions in relation to an activity or class of activities relating to certain waste that is to be land applied or used as a fuel:

- the provisions of sections 47 to 49 and 88 of the *Protection of the Environment Operations Act 1997* (the Act),
- the provisions of Schedule 1 to the Act, either in total or as they apply to a particular activity, and
- the provisions of Part 3 and clauses 45 and 47 of the Regulation.

Exemption

5. In this Notice of Exemption:

5.1. The responsible person listed in Column 1 of Table 1 is exempt from the provision/s listed in Column 2 of that table but only in relation to activities involving the relevant waste and only where the responsible person complies with the conditions referred to in Column 3 of the table.

However, this Notice of Exemption does not exempt the responsible person from the provisions specified in Column 2 where the relevant waste is received at premises that are, despite this exemption, required to be licensed for waste disposal (application to land) activities under the provisions of the Act.

5.2. Where a responsible person complies with the conditions of this Notice of Exemption, the activity referred to in Schedule 1 from which that person is exempt is taken to be a non-scheduled activity for the purposes of the Act.

Table 1

Column 1	Column 2	Column 3
Responsible person	**Provisions from which the responsible person is exempt**	**Conditions to be met by the responsible person**
Generator	section 48 of the Act in respect of clause 39 of Schedule 1 to the Act	all requirements specified in section 7 and 8
Consumer	section 48 of the Act in respect of clauses 39 and 42 of Schedule 1 to the Act section 88 of the Act clause 47 of the Regulation	all requirements specified in section 7 and 9

This Notice of Exemption is a general exemption for the purposes of clause 51(3) of the Regulation.

Definitions

6. In this Notice of Exemption:

Characterisation means sampling and testing that must be conducted on the coal washery rejects for the range of chemicals and other attributes listed in Column 1 of Table 2.
Coal washery rejects means the waste resulting from washing coal (including substances such as coal fines, soil, sand and rock resulting from that process).
Composite sample means a sample that combines 5 discrete sub-samples into a single sample for the purpose of analysis.
Consumer means a person who applies, causes, or permits the application to land of coal washery rejects within the definitions of "application to land" in accordance with the Act. The consumer may be the landholder responsible for the land to which coal washery rejects are applied.
Generator means a person who generates, supplies, causes, or permits the supply of coal washery rejects to a consumer.
Once-off sampling means sampling and testing that must be conducted only once on a batch, truckload or stockpile of coal washery rejects that is not repeated, reproduced and does not form part of a continuous process.
Relevant waste means coal washery rejects that meets the requirements of Section 7.
Routine sampling means sampling and testing that must be conducted on the coal washery rejects on an ongoing and regular basis.

General conditions

7. This Notice of Exemption is subject to the following conditions:

7.1. The chemical concentration or other attribute of the coal washery rejects listed in Column 1 of Table 2 must not exceed any of the following:
  7.1.1. the absolute maximum concentration or other value listed in Column 4 of Table 2,
  7.1.2. for characterisation or once-off tests, the maximum average (based on the arithmetic mean) concentration or other value listed in Column 2 of Table 2, and
  7.1.3. for routine tests, the maximum average (based on the arithmetic mean) concentration or other value listed in Column 3 of Table 2.

7.2. Coal washery rejects can only be applied to land in earthworks for civil engineering applications. This approval does not apply to any of the following applications:
  7.2.1. Mine site rehabilitation or other mine site uses,
  7.2.2. Quarry rehabilitation or the back-filling of quarry voids,
  7.2.3. Raising or reshaping of land used for agricultural purposes, and
  7.2.4. Construction of roads on private land unless:
    (a) the relevant waste is applied to land to the minimum extent necessary for the construction of a road, and
    (b) a development consent for the development has been granted under the relevant Environmental Planning Instrument (EPI), or
    (c) it is to provide access (temporary or permanent) to a development approved by a Council, or
    (d) the works undertaken are either exempt or complying development.

Generator responsibilities

8. The following conditions must be met by the generator for this exemption to apply:

8.1. Sampling must be undertaken in accordance with Australian Standard 1141 Methods for sampling and testing aggregates (or equivalent). Sampling and information on sample storage and preparation must be detailed in a written sampling plan.
8.2. Where the coal washery rejects are generated as part of a continuous process, the generator must undertake characterisation and routine sampling according to the requirements listed in Column 1 and Column 2 of Table 3.
8.3. Where the coal washery rejects are not generated as part of a continuous process, the generator may undertake once-off sampling of a batch, truckload or stockpile of coal washery rejects according to the requirements listed in Column 3 of Table 3, for the range of chemicals and other attributes listed in Column 1 of Table 2.
8.4. Where there is a change in inputs that is likely to affect the properties in the coal washery rejects, characterisation must be repeated. Characterisation samples can be used for routine testing and subsequent calculations.
8.5. Generators must keep a written record of all characterisation routine and/or once-off test results for a period of three years.
8.6. Records of the quantity of coal washery rejects supplied to the consumer and the consumer's name and address must be kept for a period of three years.
8.7. The generator of coal washery rejects must provide a written statement of compliance to the consumer with each transaction, certifying that the coal washery rejects comply with the relevant conditions of this exemption.
8.8. The generator of coal washery rejects must make information on the latest characterisation, routine test or once-off results available to the consumer or the EPA upon request.

Consumer responsibilities

9. The following conditions must be met by the consumer for this exemption to apply:

9.1. Records of the quantity of coal washery rejects received by the consumer and the suppliers' name and address must be kept for a period of three years from the date the coal washery rejects are received.

9.2. The coal washery rejects must not be applied in or beneath water including groundwater.

9.3. The consumer must land apply the relevant waste within a reasonable period of time.

Chemical and other material property requirements

10. This Notice of Exemption only applies to coal washery rejects where the chemical and other attributes listed in Column 1 of Table 2 comply with the chemical concentrations and other values listed in Column 2, Column 3 and Column 4 of Table 2, when analysed according to test methods specified in Column 5 of Table 2.

Table 2

Column 1	Column 2	Column 3	Column 4	Column 5
Chemicals and other attributes	**Maximum average concentration for characterisation** (mg/kg 'dry weight' unless otherwise specified)	**Maximum average concentration for routine testing** (mg/kg 'dry weight' unless otherwise specified)	**Absolute maximum concentration** (mg/kg 'dry weight' unless otherwise specified)	**Test method specified within Section**
1. Mercury	0.5	Not required	1	12.1
2. Cadmium	0.5	Not required	1	12.2
3. Lead	50	50	100	12.2
4. Arsenic	10	Not required	20	12.2
5. Chromium (total)	75	75	150	12.2
6. Copper	50	50	100	12.2
7. Nickel	40	40	80	12.2
8. Selenium	2	Not required	5	12.2
9. Zinc	100	100	200	12.2
10. Electrical Conductivity	1 dS/m	1dS/m	2 dS/m	12.3
11. pH*	8 to 11	Not required	7 to 12	12.3
12. Combustible content	30%	30%	40%	12.4
13. Sulphur %	0.5%	0.5%	1%	12.4

*Note: The ranges given for pH are for the minimum and maximum acceptable pH values in the coal washery rejects.

Sampling and testing requirements

11. This Notice of Exemption only applies to coal washery rejects sampled according to the requirements in Table 3.

Table 3

Column 1	Column 2	Column 3
Characterisation frequency	**Routine sampling frequency**	**Once-off sampling frequency**
20 composite samples, by taking 1 composite sample from a different batch, truckload or stockpile. This must be repeated every 2 years.	5 composite samples per 10,000 tonnes or 5 composite samples per 6 months.	10 composite samples per 4,000 tonnes.

Test methods

12. All testing must be undertaken by analytical laboratories accredited by the National Association of Testing Authorities, or equivalent. All chemicals and other attributes listed in Column 1 of Table 2 must be measured in accordance with the test methods specified below:

12.1. Test methods for measuring the mercury concentration in coal washery rejects:
  12.1.1. Particle size reduction & sample splitting may be required.
  12.1.1. Analysis using USEPA SW-846 Method 7471B Mercury in solid or semisolid waste (manual cold vapour technique), or an equivalent analytical method with a detection limit < 20% of the stated absolute maximum concentration in Table 2, Column 4 (i.e. 0.2 mg/kg dry weight).
  12.1.2. Report as mg/kg dry weight.

12.2. Test methods for measuring chemicals 2 - 9 in coal washery rejects:
  12.2.1. Particle size reduction & sample splitting may be required.
  12.2.2. Sample preparation by digesting using USEPA SW-846 Method 3051A Microwave assisted acid digestion of sediments, sludges, soils, and oils.
  12.2.3. Analysis using USEPA SW-846 Method 6010C Inductively coupled plasma - atomic emission spectrometry, or an equivalent analytical method with a detection limit < 10% of the stated absolute maximum concentration in Table 2, Column 4 (i.e. 10 mg/kg dry weight for lead).
  12.2.4. Report as mg/kg dry weight.

12.3. Test methods for measuring the electrical conductivity and pH in coal washery rejects:
  12.3.1. Sample preparation by mixing 1 part coal washery rejects with 5 parts distilled water.
  12.3.2. Analysis using Method 103 (pH) and Method 104 (Electrical Conductivity). *In* Schedule B (3): Guideline on Laboratory Analysis of Potentially Contaminated Soils, National Environment Protection (Assessment of Site Contamination) Measure 1999 (or equivalent method).
  12.3.3. Report electrical conductivity in deciSiemens per metre (dS/m), and pH as pH.

12.4. Test methods for measuring the combustible content and sulphur content of coal washery rejects:
  12.4.1. Australian Standard 1038 Coal and coke (or an equivalent analytical method).
  12.4.2. Report combustible content as %.
  12.4.3. Report Sulphur Content as %.

Exemption Granted

Mark Gorta
Manager, Waste Management Section
Environment Protection Authority
by delegation

Notes

The EPA may amend or revoke this exemption at any time. It is the responsibility of the generator, processor and consumer to ensure that they comply with all relevant requirements of the most current exemption. The current version of an exemption will be available on the EPA website: www.environment.nsw.gov.au

In gazetting this general exemption, the EPA is exempting the relevant waste from the specific requirements of the Act and Regulations as stated in this exemption. The EPA is not in any way endorsing the use of this substance or guaranteeing that the substance will confer benefit.

The use of exempted material remains subject to other relevant environmental regulations within the Act and Regulations. For example, a person who pollutes land (s142A) or water (s120), or does not meet the special requirements for asbestos waste (clause 42), regardless of having an exemption, is guilty of an offence and subject to prosecution.

For the purposes of arrangements between a generator, a processor and a consumer, a 'transaction' is taken to mean the contractual agreement between the two parties which specifies the exchange of waste material from one party to another. A 'statement of compliance' must be in writing and be provided with each transaction.

The conditions set out in this exemption are designed to minimise the risk of potential harm to the environment, human health or agriculture, however, neither this exemption nor these conditions guarantee that the environment, human health or agriculture will not be harmed.

The consumer should assess whether or not the exempted material is fit for the purpose the material is proposed to be used and whether this use will cause harm. The consumer may need to seek expert engineering or technical advice.

This exemption does not apply to any material received at a premises that is required to be licensed for waste disposal (application to land) activities under the provisions of the Act. This exemption does not remove the need for a site at which processing occurs to be licensed, if required under Schedule 1 of the Act.

This exemption does not alter the requirements of any other relevant legislation that must be met in utilising this material, including for example, the need to prepare a Material Safety Data Sheet (MSDS).

Regardless of any exemption provided by the EPA, the person who causes or permits the application of the substance to land must ensure that the action is lawful and consistent with the development consent requirements of the land.

All records required to be kept under this exemption must be made available to authorised officers of the EPA upon request.

Failure to comply with the conditions of this Notice of Exemption may constitute an offence under clause 51 of the Regulation and the responsible person will be required to comply with the normal regulatory provisions.