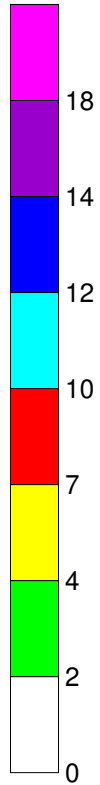
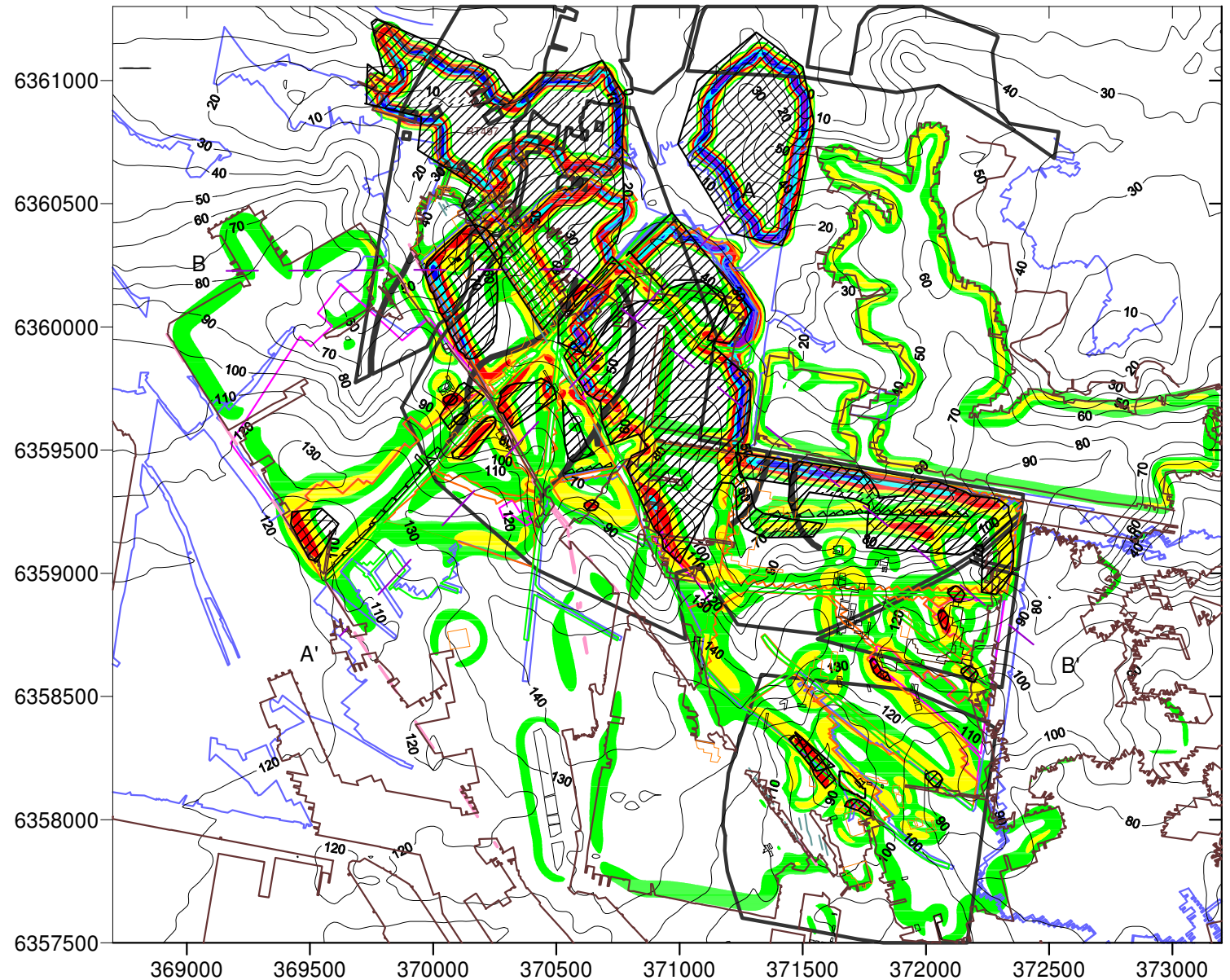


Tilt (mm/m)



Key

-  High Tilt Hazard Zones (>7mm/m)
-  Moderate Tilt Hazard Zones (4 - 7 mm/m)
-  Site Boundary
-  Normal Fault
-  Igneous Dyke (Very High Strength)
-  Extent of Browns-Minmi & Duckenfield Mines in Borehole Seam
-  Extent of Wallsend Borehole & Gretley Workings in Young Wallsend Seam
-  Depth of Cover above Borehole Seam

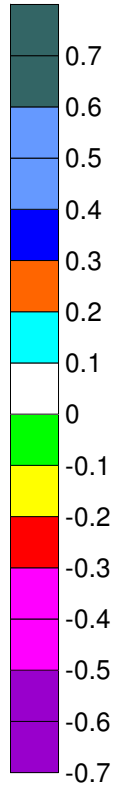


DgS

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	17.01.08
Ditton Geotechnical Services Pty Ltd	

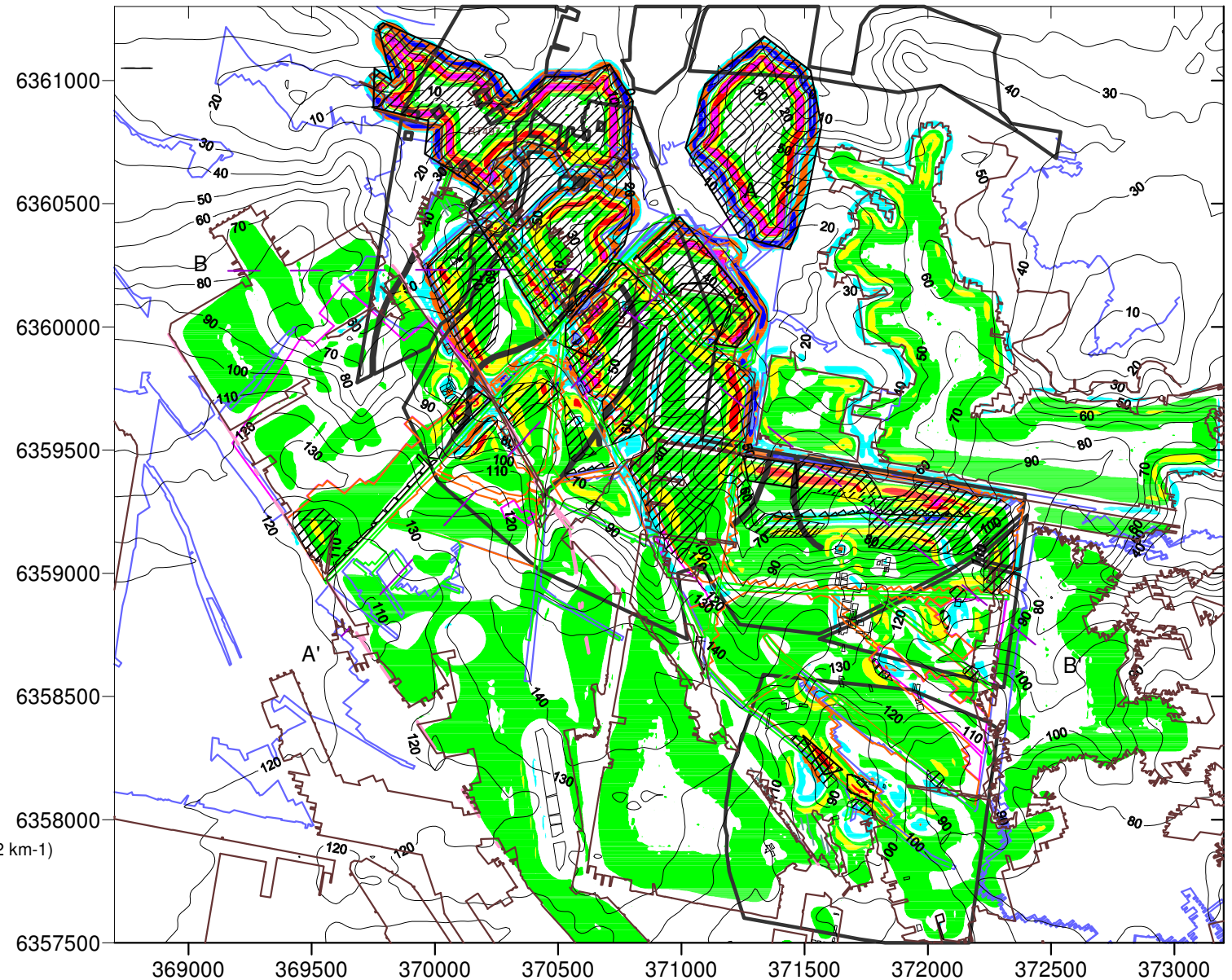
Client:	Douglas Partners DPS-002/1
Title:	Worst-case Future Tilt Contours above the Pillar Extraction Panels in the Borehole Seam and Young Wallsend Seams if Pillar FoS under FTA Load is Ignored
Scale:	1:25,000
Figure No:	10b

Curvature (1/km)



Key

-  High Curvature Hazard Zones (>0.2 km⁻¹)
-  Moderate Curvature Hazard Zones (0.1-0.2 km⁻¹)
-  Site Boundary
-  Normal Fault
-  Igneous Dyke (Very High Strength)
-  Extent of Browns-Minmi & Duckenfield Mines in Borehole Seam
-  Extent of Wallsend Borehole & Gretley Workings in Young Wallsend Seam
-  Depth of Cover above Borehole Seam



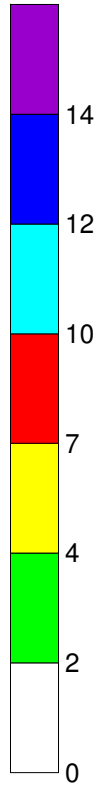
DgS



Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	17.07.08
Ditton Geotechnical Services Pty Ltd	

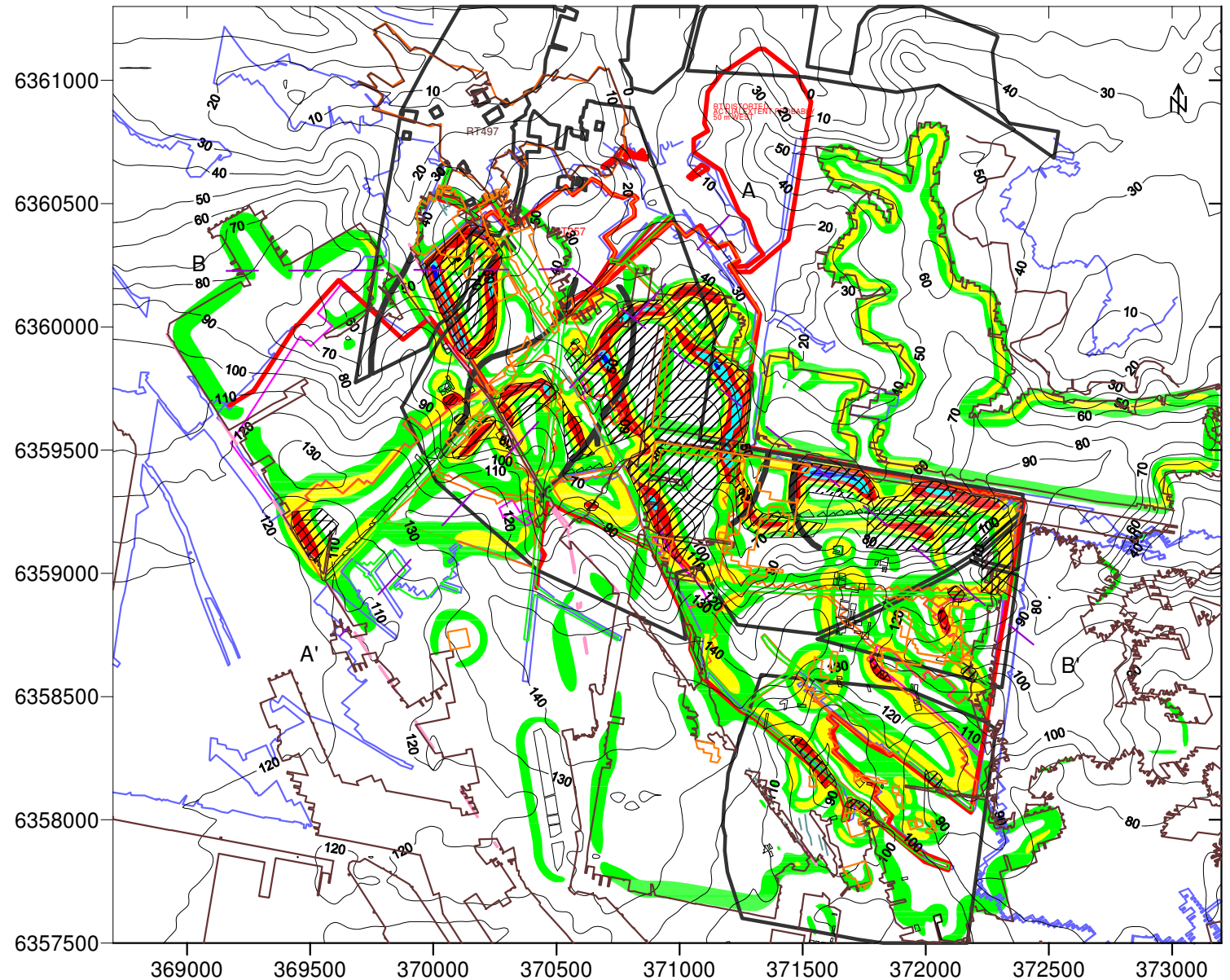
Client:	Douglas Partners DPS-002/1		
Title:	Worst-case Future Curvature Contours above the Pillar Extraction Panels in the Borehole Seam and Young Wallsend Seams with Pillar FoS > 2.11 Limits under FTA Load Case		
Scale:	1:25,000	Figure No:	10c

Tilt (mm/m)



Key

-  High Tilt Hazard Zones (>7mm/m)
-  Moderate Tilt Hazard Zones (4 - 7 mm/m)
-  Site Boundary
-  Normal Fault
-  Igneous Dyke (Very High Strength)
-  Extent of Browns-Minmi & Duckenfield Mines in Borehole Seam
-  Extent of Wallsend Borehole & Gretley Workings in Young Wallsend Seam
-  Depth of Cover above Borehole Seam



DgS

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	17.01.08
Ditton Geotechnical Services Pty Ltd	

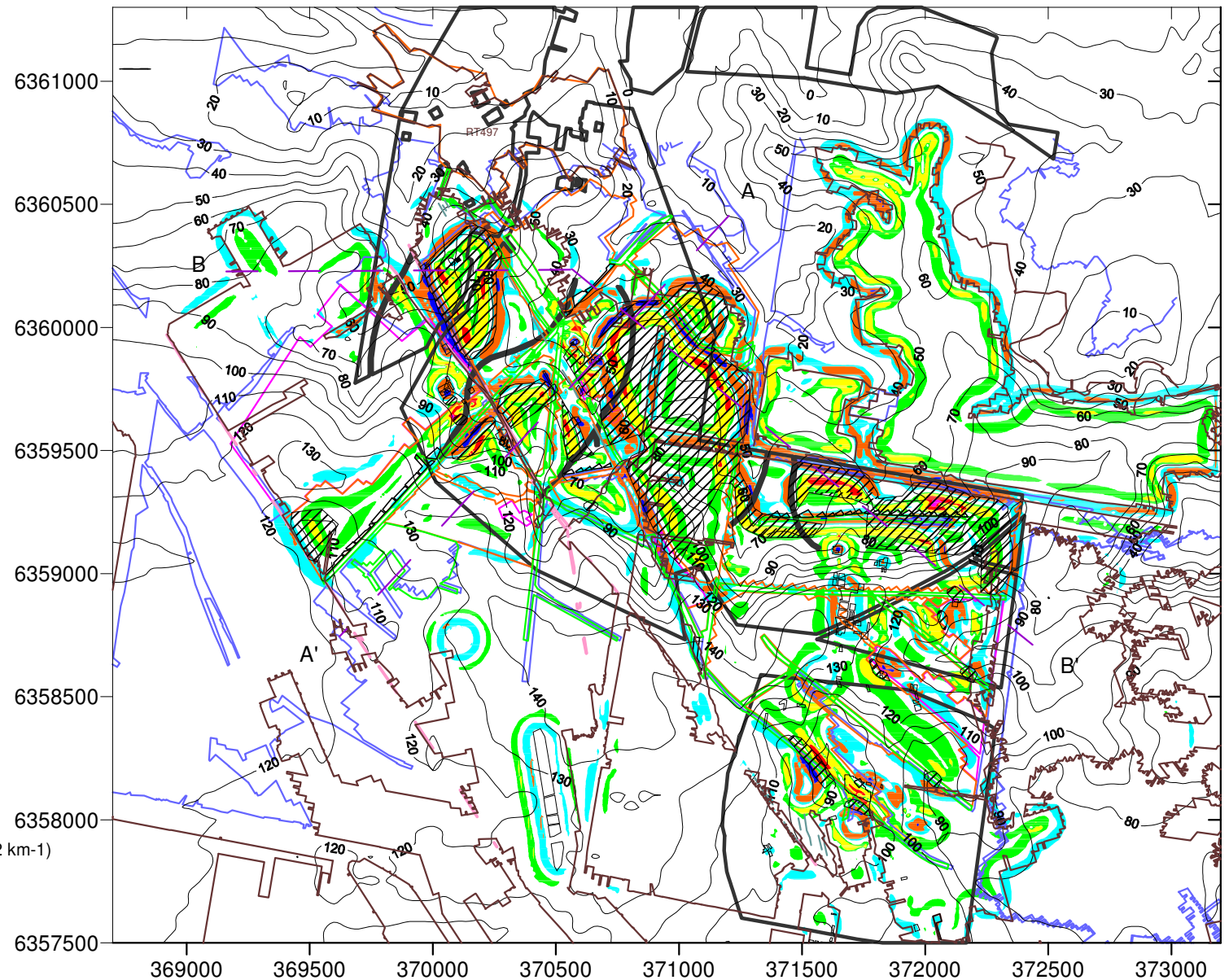
Client:	Douglas Partners DPS-002/1
Title:	Worst-case Future Tilt Contours above the Pillar Extraction Panels in the Borehole Seam & Young Wallsend Seams with FoS>2.11 Limits for FTA Load Case
Scale:	1:25,000
Figure No:	12b

Curvature (1/km)



Key

-  High Curvature Hazard Zones (>0.2 km-1)
-  Moderate Curvature Hazard Zones (0.1-0.2 km-1)
-  Site Boundary
-  Normal Fault
-  Igneous Dyke (Very High Strength)
-  Extent of Browns-Minmi & Duckenfield Mines in Borehole Seam
-  Extent of Wallsend Borehole & Gretley Workings in Young Wallsend Seam
-  Depth of Cover above Borehole Seam

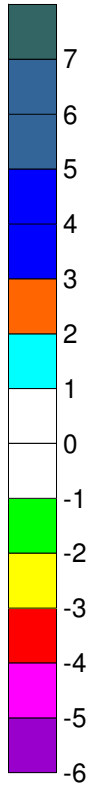


DgS

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	17.07.08
Ditton Geotechnical Services Pty Ltd	

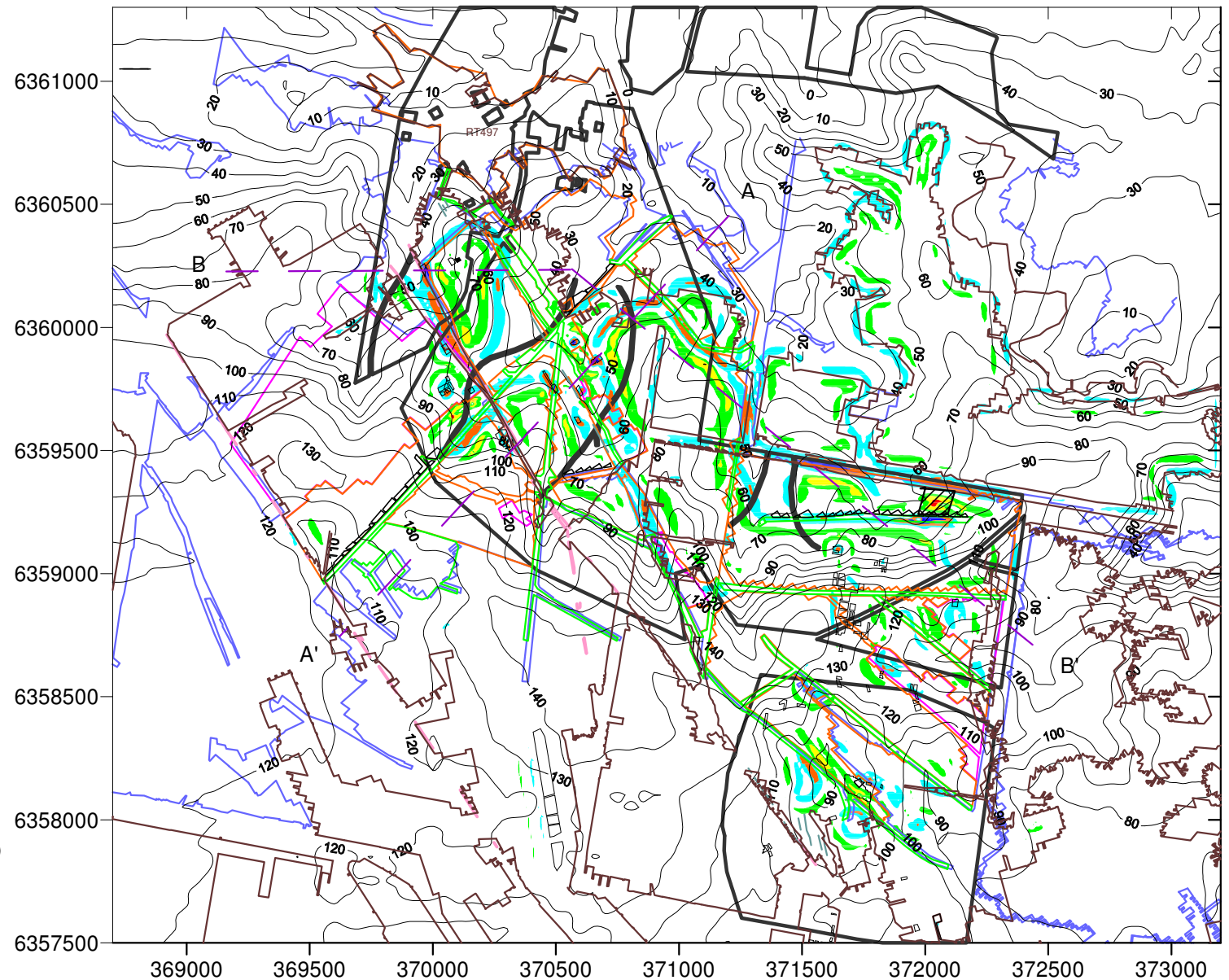
Client:	Douglas Partners DPS-002/1		
Title:	Worst-case Future Curvature Contours above the Pillar Extraction Panels in the Borehole Seam and Young Wallsend Seams with Pillar FoS >2.11 FTA Load Included		
Scale:	1:25,000	Figure No:	12c

Strain (mm/m)



Key

-  High Strain Hazard Zones (>3 mm/m)
-  Moderate Strain Hazard Zones (2-3 mm/m)
-  Site Boundary
-  Normal Fault
-  Igneous Dyke (Very High Strength)
-  Extent of Browns-Minmi & Duckenfield Mines in Borehole Seam
-  Extent of Wallsend Borehole & Gretley Workings in Young Wallsend Seam
-  Depth of Cover above Borehole Seam

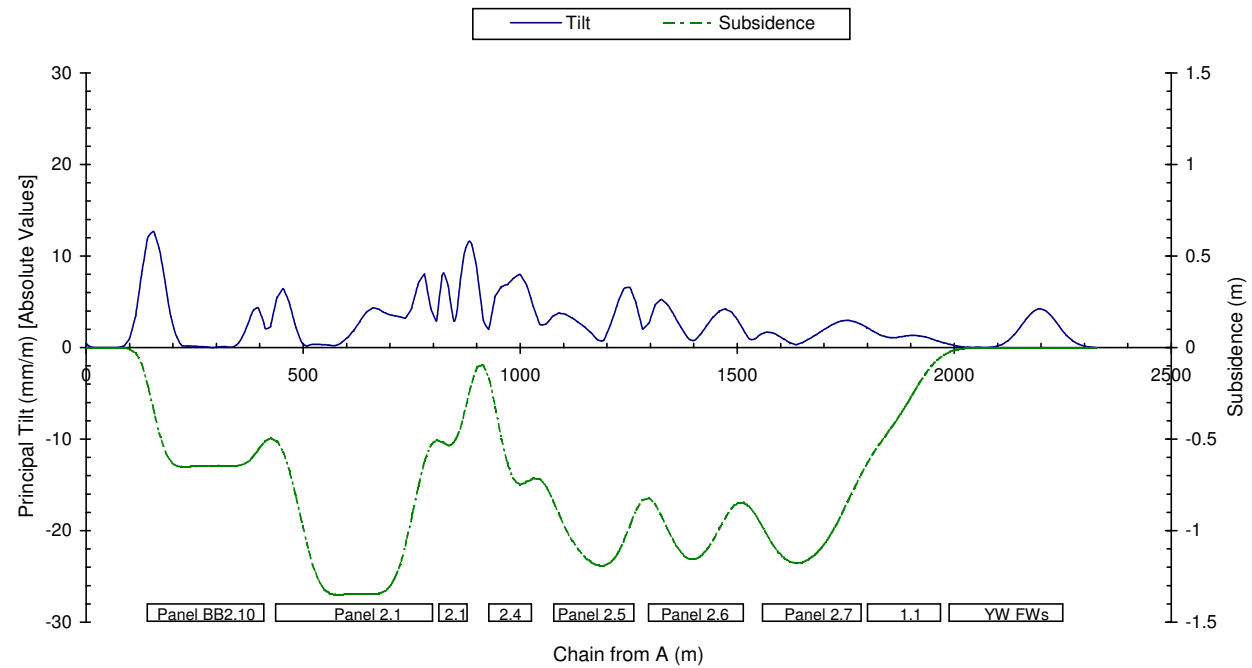


DgS

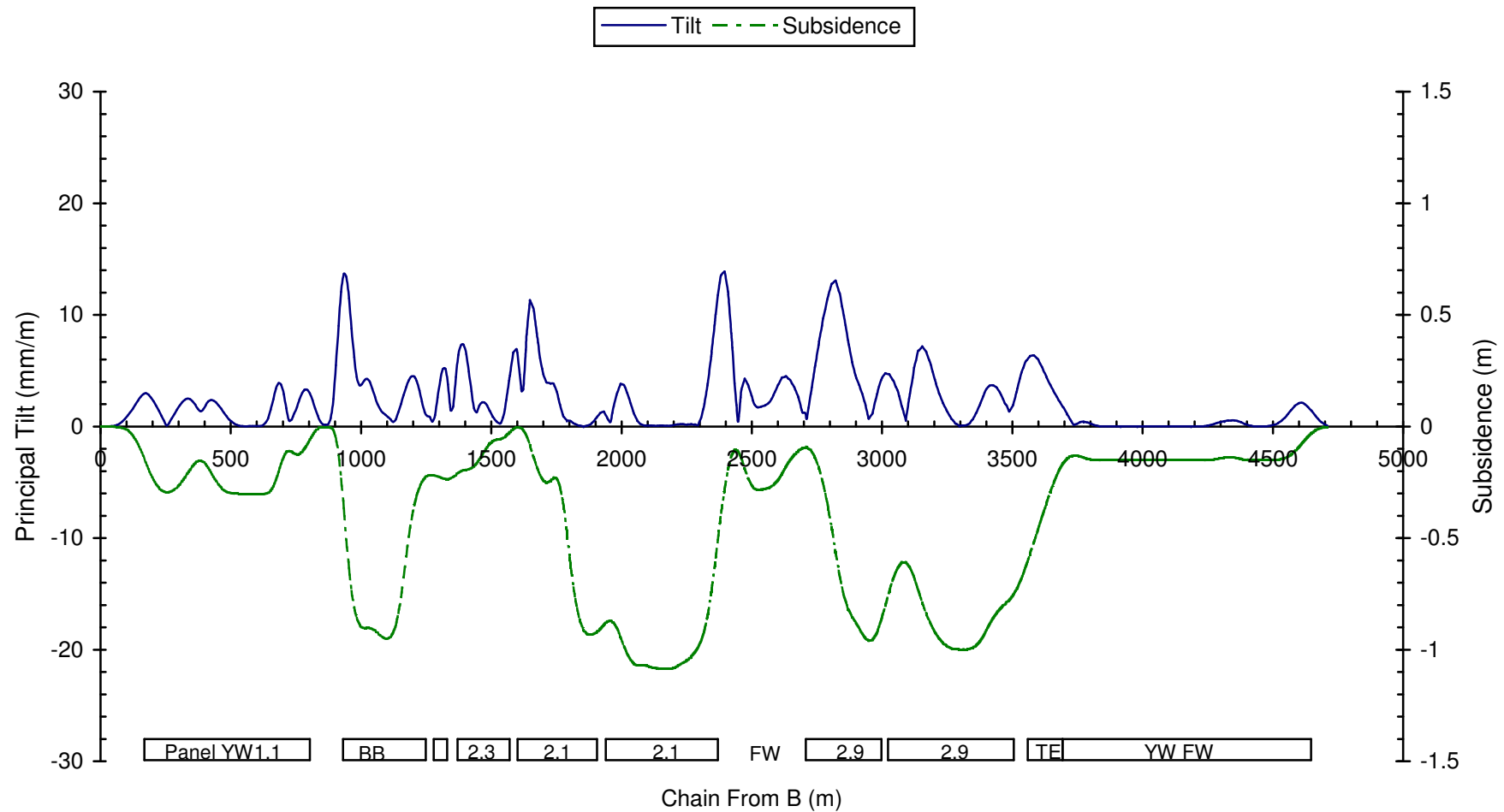


Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	17.07.08
Ditton Geotechnical Services Pty Ltd	

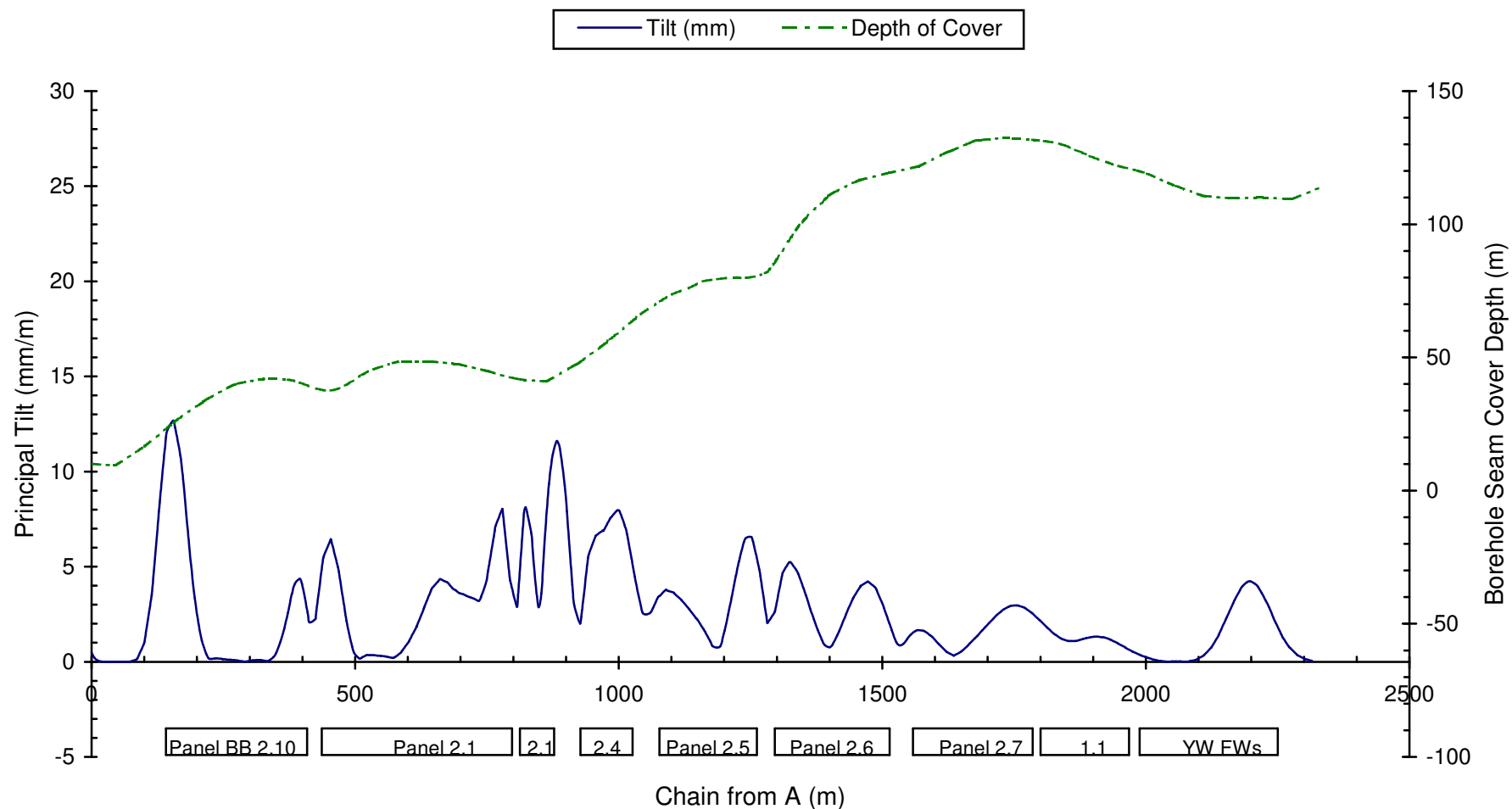
Client:	Douglas Partners DPS-002/1		
Title:	Worst-case Future Strain Contours above the Pillar Extraction Panels in the Borehole Seam and Young Wallsend Seams with Pillar FoS >2.11 FTA Load Included		
Scale:	1:25,000	Figure No:	12d



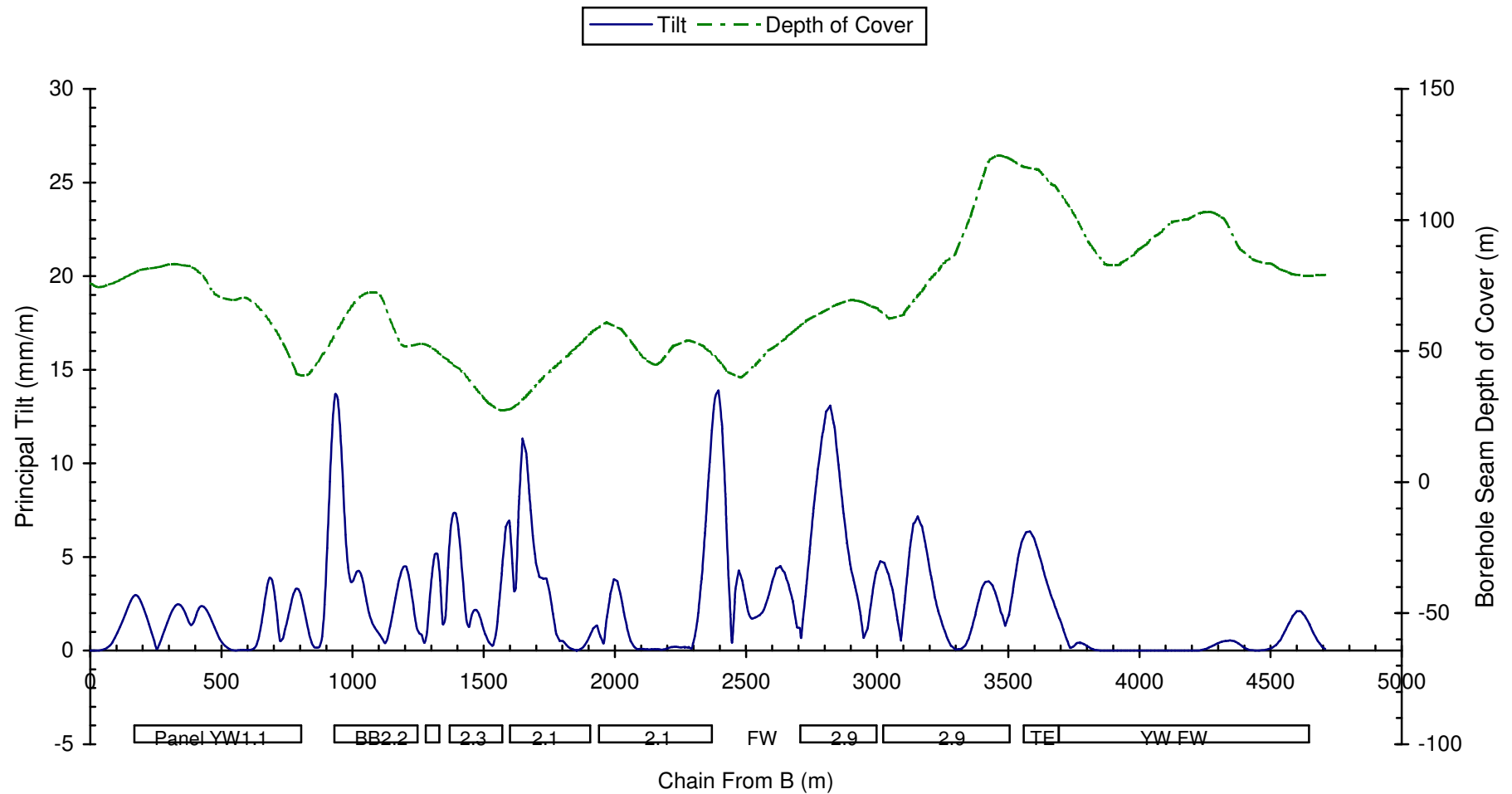
Engineer:	S.Ditton	Client:	Douglas Partners Pty Ltd
Drawn:	S.Ditton		DPS-002/1
Date:	31.07.08	Title:	Predicted Worst-Case Principal Tilt Profile v. Subsidence along Section AA' with
Ditton Geotechnical			Pillar FoS Ignored (see Figure 8a and 8b)
Services Pty Ltd		Scale:	NTS
		Figure No:	13a



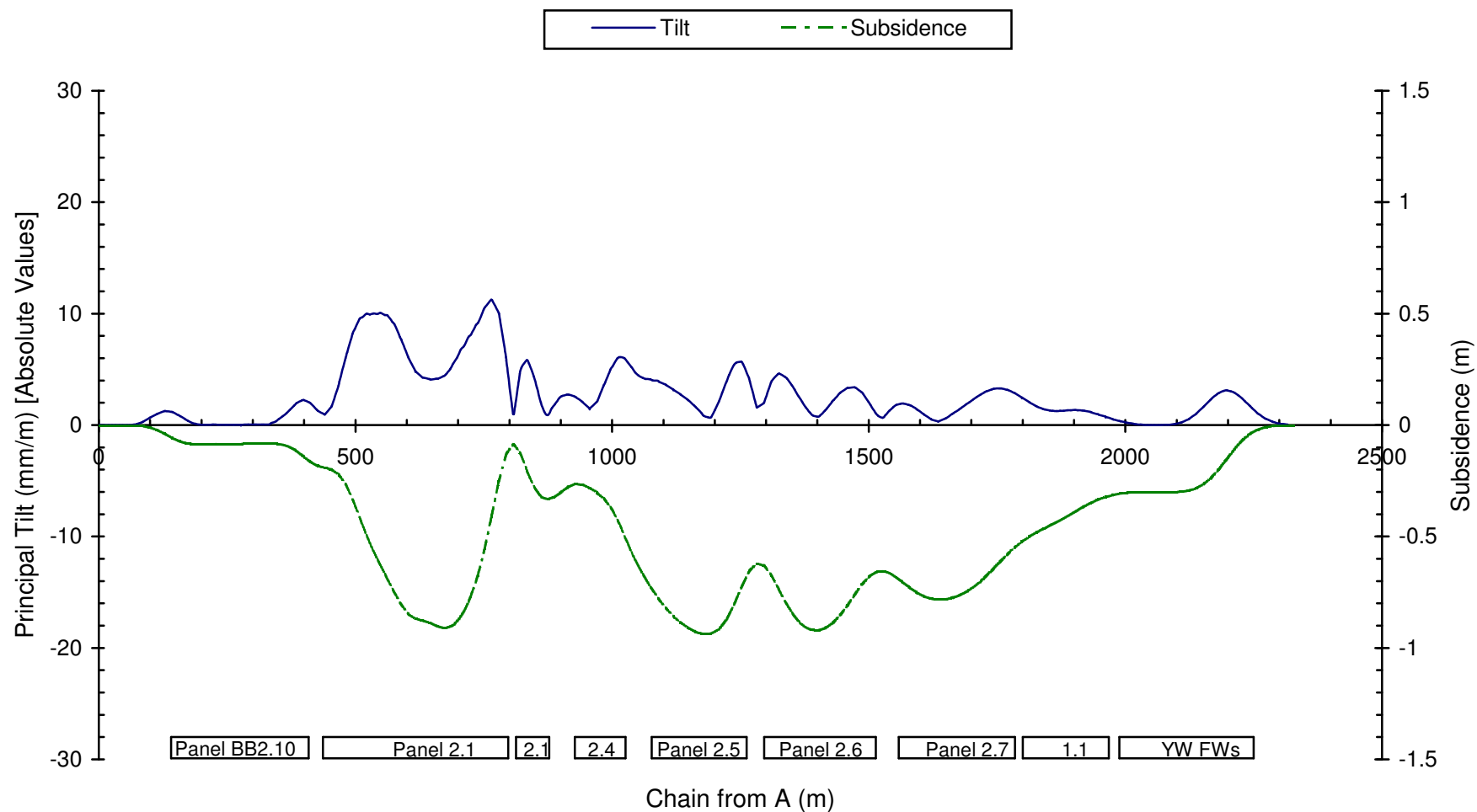
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	Drawn:	S.Ditton		DPS-002/1			
	Date:	31.01.08	Title:	Predicted Worst-Case Principal Tilt Profile v. Subsidence along Section BB'			
	Ditton Geotechnical Services Pty Ltd			(see Figures 8a and 8b)			
			Scale:	NTS		Figure No:	13b



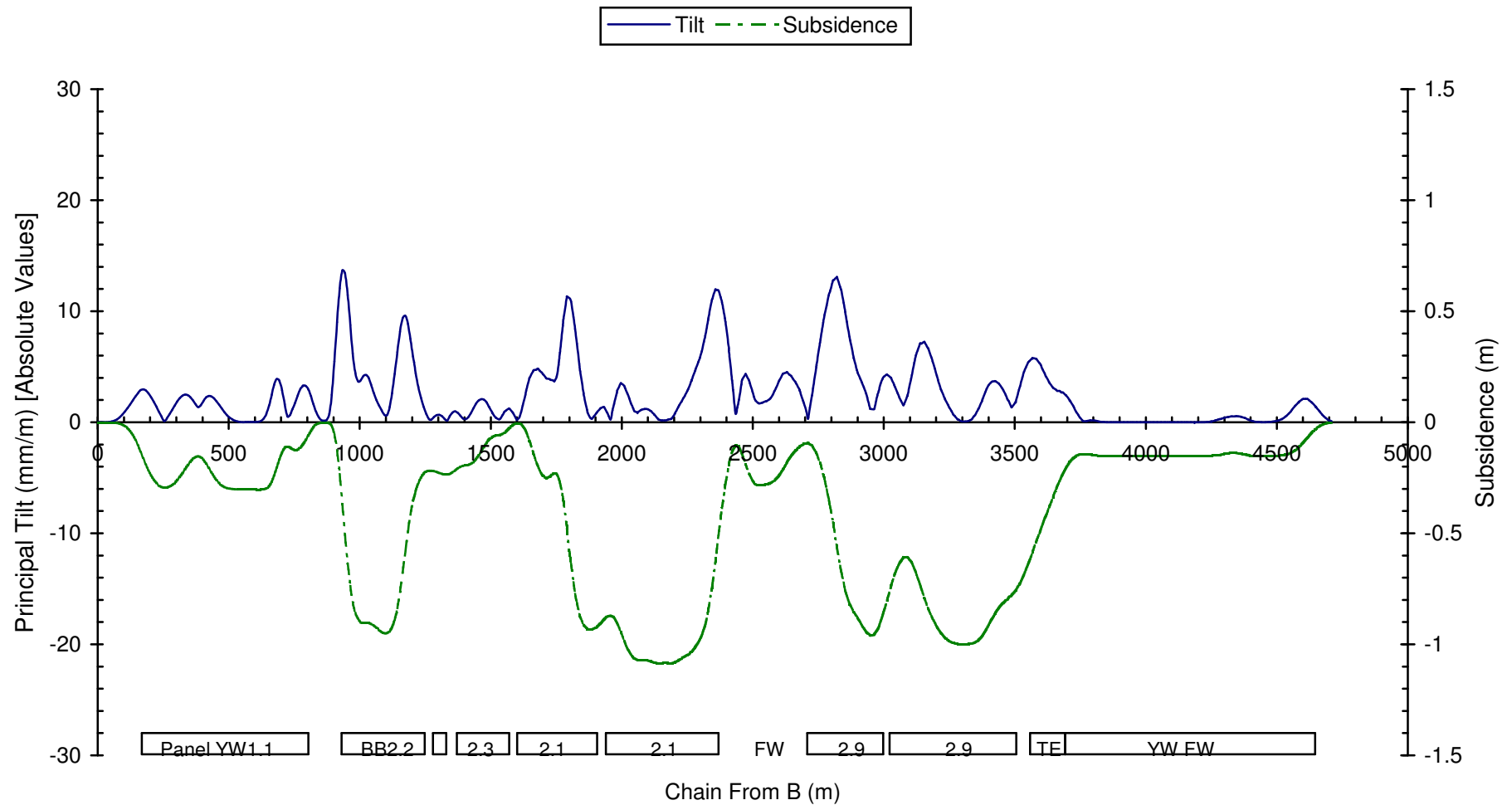
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	Drawn:	S.Ditton		DPS-002/1		
	Date:	31.01.08	Title:	Predicted Worst-Case Principal Tilt Profile v. Cover Depth along Section AA'		
	Ditton Geotechnical			(see Figure 8a)		
	Services Pty Ltd		Scale:	NTS		Figure No: 14a



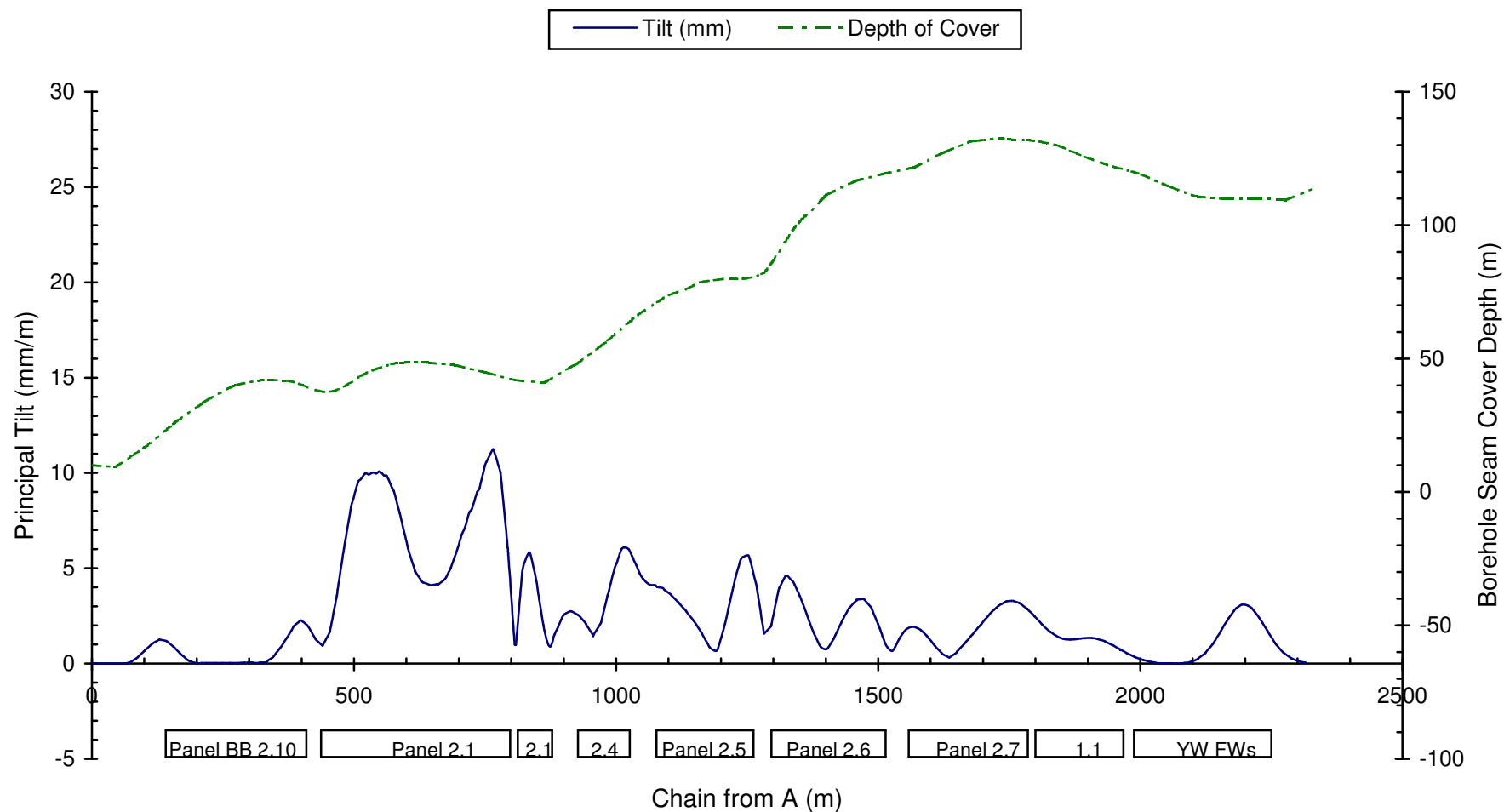
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	Date:	31.01.08	Title:	Predicted Worst-Case Principal Tilt Profile v. Cover Depth along Section BB'			
	Ditton Geotechnical			(see Figure 8a)			
	Services Pty Ltd		Scale:	NTS		Figure No:	14b



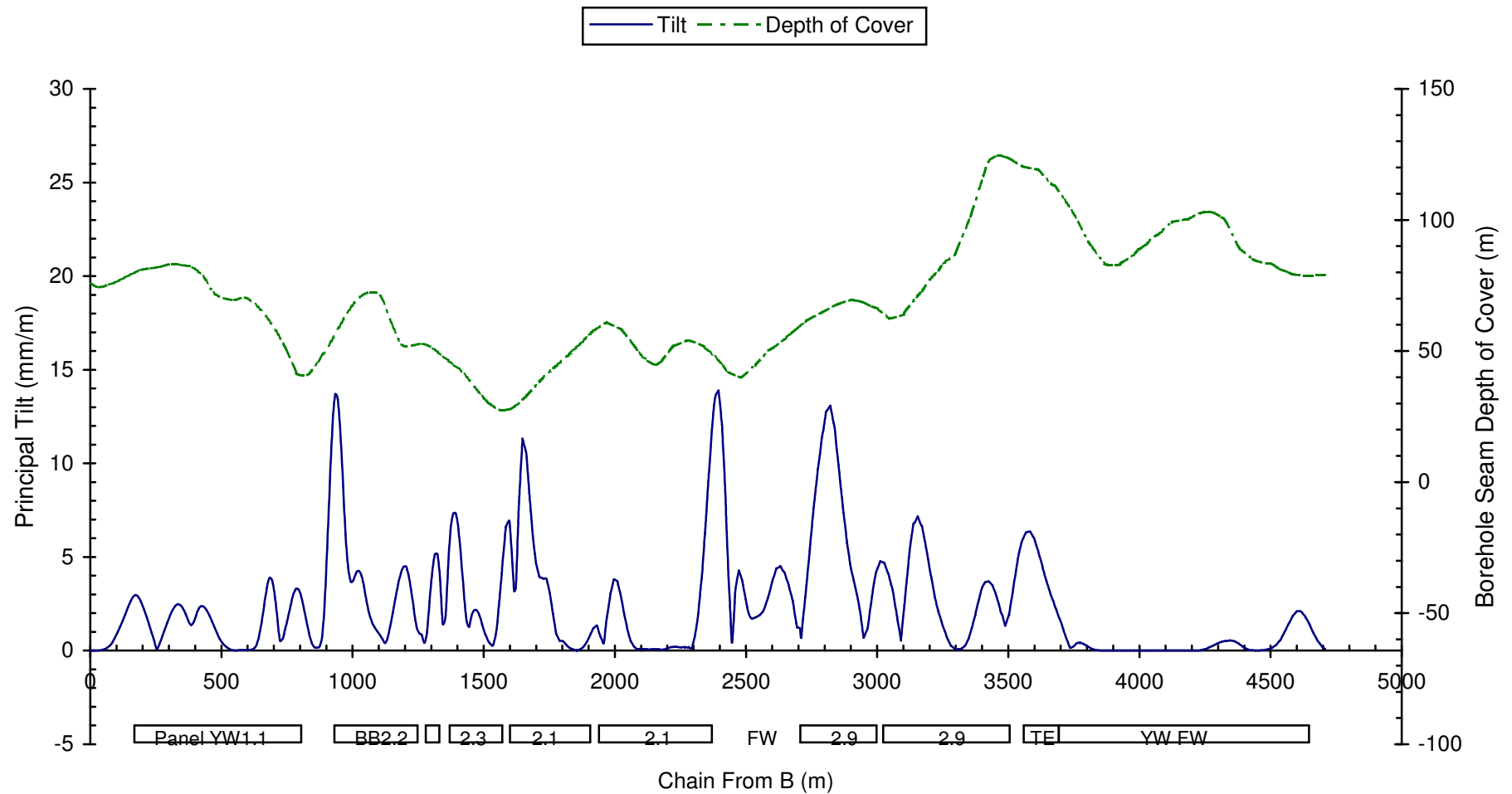
Engineer:	S.Ditton	Client:	Douglas Partners Pty Ltd			
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Date:	31.07.08	Title:	Predicted Worst-Case Principal Tilt Profile v. Subsidence along Section AA' with			
Ditton Geotechnical			FoS > 2.11 Limits Included for FTA Load Case (see Figures 12a and 12b)			
Services Pty Ltd		Scale:	NTS		Figure No:	15a



	Engineer:	S.Ditton	Client:	Douglas Partners Pty Ltd			
	Drawn:	S.Ditton		DPS-002/1			
	Date:	31.01.08	Title:	Predicted Future Worst-Case Principal Tilt Profile v. Subsidence along Section BB' with FoS >2.11 Limits due to FTA Loading Case (see Figures 12a and 12b)			
	Ditton Geotechnical Services Pty Ltd			Scale:		NTS	



Engineer:	S.Ditton	Client:	Douglas Partners Pty Ltd				
Drawn:	S.Ditton		DPS-002/1				
Date:	31.01.08	Title:	Predicted Worst-Case Principal Tilt Profile v. Cover Depth along Section AA'				
Ditton Geotechnical Services Pty Ltd			with FoS >2.11 Limits for FTA Loading Case (see Figure 12b)				
		Scale:	NTS			Figure No:	16a



	Engineer:	S.Ditton	Client:	Douglas Partners Pty Ltd			
	Drawn:	S.Ditton		DPS-002/1			
	Date:	31.01.08	Title:	Predicted Worst-Case Principal Tilt Profile v. Cover Depth along Section BB'			
	Ditton Geotechnical			with FoS>2.11 Limits for FTA Loading Case (see Figure 12b)			
	Services Pty Ltd		Scale:	NTS		Figure No:	16b

APPENDIX A - Pillar Factor of Safety and Subsidence Calculations

Pillar Panel	SPDS Panel#	Cover Depth	Pillar h	Pillar w/h	Panel ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	Max Subs Factor	Min Subs Factor	Net Subs Factor	Net Subs
Wallsend Borehole Mine's Zone 2 Panels														
YW2.1	34	20	3	6.3	40.0%	14.1	0.83	16.95	0.99	14.22	0.003	0.001	0.002	0.01
YW2.1	34	50	3	6.3	40.0%	14.1	2.08	6.78	2.99	4.72	0.006	0.001	0.004	0.01
YW2.2	36	50	3	6.3	43.8%	13.5	2.22	6.07	3.19	4.23	0.006	0.001	0.005	0.01
YW2.2	36	60	3	6.3	43.8%	13.5	2.67	5.06	4.01	3.36	0.007	0.002	0.006	0.02
YW2.3	36	40	3	6.3	43.8%	13.5	1.78	7.59	2.42	5.57	0.005	0.001	0.004	0.01
YW2.3	31	50	3	6.3	43.8%	13.5	2.22	6.07	3.19	4.23	0.006	0.001	0.005	0.01
YW2.4	31	20	3	5.0	44.8%	12.5	0.91	13.83	1.11	11.32	0.002	0.001	0.002	0.01
YW2.4	33	45	3	5.0	44.8%	12.5	2.04	6.15	2.94	4.26	0.006	0.001	0.004	0.01
YW2.5	33	40	3	5.8	43.1%	13.5	1.76	7.67	2.42	5.58	0.005	0.001	0.004	0.01
YW2.5	32	50	3	5.8	43.1%	13.5	2.20	6.14	3.18	4.23	0.006	0.001	0.005	0.01
YW2.6	32	30	3	4.2	47.8%	11.2	1.44	7.80	1.93	5.80	0.004	0.001	0.003	0.01
YW2.6	30	45	3	4.2	47.8%	11.2	2.16	5.20	3.17	3.53	0.006	0.001	0.005	0.01
YW2.6	30	30	3	7.1	39.5%	14.7	1.24	11.86	1.56	9.42	0.003	0.001	0.003	0.01
YW2.6	30	45	3	7.1	39.5%	14.7	1.86	7.91	2.56	5.76	0.005	0.001	0.004	0.01
YW2.7	29	50	3	5.8	41.1%	13.7	2.12	6.48	3.08	4.47	0.006	0.001	0.005	0.01
YW2.7	29	60	3	5.8	41.1%	13.7	2.54	5.40	3.87	3.55	0.007	0.002	0.005	0.02
YW2.8	28	45	3	4.2	47.2%	11.2	2.13	5.27	3.14	3.58	0.006	0.001	0.004	0.01
YW2.8	28	60	3	4.2	47.2%	11.2	2.84	3.95	4.50	2.50	0.008	0.002	0.006	0.02
YW2.9	35	50	3	3.3	56.6%	9.9	2.88	3.43	4.44	2.22	0.008	0.002	0.006	0.02
YW2.9	35	60	3	3.3	56.6%	9.9	3.45	2.86	5.58	1.77	0.009	0.002	0.007	0.02
YW2.10	27	50	3	5.4	42.2%	13.2	2.16	6.10	3.17	4.17	0.006	0.001	0.005	0.01
YW2.10	27	110	3	5.4	42.2%	13.2	4.76	2.77	8.70	1.52	0.222	0.003	0.219	0.66
mean		48		5.42	0.45	12.83	2.19	6.88	3.28	5.00	0.015	0.001	0.014	0.042
min		20		3.33	0.40	9.87	0.83	2.77	0.99	1.52	0.002	0.001	0.002	0.006
max		110		7.08	0.57	14.71	4.76	16.95	8.70	14.22	0.222	0.003	0.219	0.658
Wallsend Borehole Mine's Zone 1 Panels														
YW1.1	57	45	3	7.9	32.8%	17.28	1.67	10.32	2.26	7.64	0.005	0.001	0.004	0.01
YW1.1	57	50	3	7.9	32.8%	17.28	1.86	9.29	2.58	6.71	0.005	0.001	0.004	0.01
YW1.1	71	40	3	7.5	37.4%	15.54	1.60	9.73	1.41	10.99	0.004	0.001	0.003	0.01
YW1.1	71	80	3	7.5	37.4%	15.54	3.19	4.86	5.06	3.07	0.009	0.002	0.007	0.02
YW1.1	71	80	3	8.3	31.4%	18.15	2.92	6.22	4.54	4.00	0.008	0.002	0.006	0.02
YW1.1	71	120	3	8.3	31.4%	18.15	4.38	4.15	7.72	2.35	0.012	0.003	0.010	0.03
YW1.1	68	45	3	12.5	18.6%	33.72	1.38	24.40	1.72	19.57	0.004	0.001	0.003	0.01
YW1.1	68	120	3	12.5	18.6%	33.72	3.68	9.15	5.98	5.64	0.011	0.003	0.009	0.03
YW1.2	56	20	3	10.4	30.6%	21.10	0.72	29.31	0.81	25.90	0.002	0.000	0.002	0.00
YW1.2	56	60	3	10.4	30.6%	21.10	2.16	9.77	2.98	7.09	0.006	0.001	0.005	0.01
YW1.2	56	20	3	10.4	30.6%	21.10	0.72	29.31	0.81	25.90	0.002	0.000	0.002	0.00
YW1.2	56	60	3	10.4	30.6%	21.10	2.16	9.77	2.98	7.09	0.006	0.001	0.005	0.01

Pillar Panel	SPDS Panel#	Cover Depth	Pillar h	Pillar w/h	Panel ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	Max Subs Factor	Min Subs Factor	Net Subs Factor	Net Subs
YW1.3	54	20	3	4.2	46.7%	11.24	0.94	11.99	1.17	9.63	0.003	0.001	0.002	0.01
YW1.3	54	45	3	4.2	46.7%	11.24	2.11	5.33	3.11	3.62	0.006	0.001	0.004	0.01
YW1.4	53	20	3	7.1	40.3%	14.53	0.84	17.35	0.98	14.77	0.002	0.001	0.002	0.01
YW1.4	53	45	3	7.1	40.3%	14.53	1.88	7.71	2.59	5.61	0.005	0.001	0.004	0.01
YW1.5	52	45	3	5.8	45.7%	13.13	2.07	6.34	2.93	4.48	0.006	0.001	0.004	0.01
YW1.5	52	50	3	5.8	45.7%	13.13	2.30	5.70	3.34	3.93	0.006	0.001	0.005	0.01
YW1.6	55	45	3	6.3	43.8%	13.49	2.00	6.75	2.80	4.82	0.005	0.001	0.004	0.01
YW1.6	55	50	3	6.3	43.8%	13.49	2.22	6.07	3.19	4.23	0.006	0.001	0.005	0.01
YW1.7	58	20	3	10.4	30.6%	21.10	0.72	29.31	0.81	25.90	0.002	0.000	0.002	0.00
YW1.7	58	30	3	10.4	30.6%	21.10	1.08	19.54	1.29	16.39	0.003	0.001	0.002	0.01
YW1.8	59	20	3	2.9	66.0%	9.22	1.47	6.27	1.89	4.88	0.004	0.001	0.003	0.01
YW1.8	59	30	3	2.9	66.0%	9.22	2.20	4.18	3.06	3.01	0.005	0.001	0.004	0.01
YW1.9	60	20	3	7.9	36.7%	16.01	0.79	20.28	0.92	17.48	0.002	0.000	0.002	0.01
YW1.9	69	30	3	7.9	36.7%	16.01	1.18	13.52	1.47	10.91	0.003	0.001	0.003	0.01
mean		47		7.82	0.38	17.35	1.86	12.18	2.63	9.83	0.01	0.00	0.00	0.01
min		20		2.9	18.6%	9.22	0.72	4.15	0.81	2.35	0.00	0.00	0.00	0.00
max		120		12.5	66.0%	33.72	4.38	29.31	7.72	25.90	0.01	0.00	0.01	0.03

Wallsend Borehole Mine's Pillars in Zone 3 Panels-YW Seam

YW3.1.1	76	50	3	8.33	36.0%	16.53	1.95	8.47	2.68	6.17	0.005	0.001	0.004	0.01	1
YW3.1.1	76	60	3	8.33	36.0%	16.53	2.34	7.05	3.37	4.91	0.006	0.001	0.005	0.01	1
YW3.1.2	77	50	3	5.42	43.5%	13.08	2.21	5.91	3.24	4.04	0.006	0.001	0.005	0.01	2
YW3.1.2	77	60	3	5.42	43.5%	13.08	2.65	4.93	4.07	3.21	0.007	0.002	0.006	0.02	2
YW3.1.3	78	50	3	5.00	38.2%	12.99	2.02	6.42	2.99	4.34	0.006	0.001	0.004	0.01	2
YW3.1.3	78	60	3	5.00	38.2%	12.99	2.43	5.35	3.77	3.45	0.007	0.002	0.005	0.02	2
YW3.1.4	79	50	3	6.25	32.5%	15.49	1.85	8.36	2.66	5.82	0.005	0.001	0.004	0.01	2
YW3.1.4	79	60	3	6.25	32.5%	15.49	2.22	6.97	3.34	4.63	0.007	0.001	0.005	0.02	2
YW3.1.5	80	50	3	6.25	40.0%	14.12	2.08	6.78	2.99	4.72	0.006	0.001	0.004	0.01	2
YW3.1.5	80	60	3	6.25	40.0%	14.12	2.50	5.65	3.76	3.75	0.007	0.002	0.005	0.02	2
YW3.1.6	81	50	3	6.25	43.8%	13.49	2.22	6.07	3.19	4.23	0.006	0.001	0.005	0.01	1
YW3.1.6	81	60	3	6.25	43.8%	13.49	2.67	5.06	4.01	3.36	0.007	0.002	0.006	0.02	1
YW3.1.7	83	50	3	8.33	36.0%	16.53	1.95	8.47	2.68	6.17	0.005	0.001	0.004	0.01	4
YW3.1.7	83	60	3	8.33	36.0%	16.53	2.34	7.05	3.37	4.91	0.006	0.001	0.005	0.01	4
YW3.1.8	82	50	3	8.33	36.0%	16.53	1.95	8.47	2.68	6.17	0.005	0.001	0.004	0.01	4
YW3.1.8	82	60	3	8.33	36.0%	16.53	2.34	7.05	3.37	4.91	0.006	0.001	0.005	0.01	4
YW3.1.9	82	50	3	8.33	31.4%	18.15	1.82	9.95	2.50	7.25	0.005	0.001	0.004	0.01	3
YW3.1.9	82	60	3	8.33	31.4%	18.15	2.19	8.30	3.14	5.77	0.006	0.001	0.005	0.01	3
YW3.5.1	82	50	3	14.58	22.2%	36.13	1.61	22.48	1.99	18.13	0.005	0.001	0.004	0.01	1
YW3.5.1	82	60	3	14.58	22.2%	36.13	1.93	18.74	2.48	14.55	0.006	0.001	0.004	0.01	1

Pillar Panel	SPDS Panel#	Cover Depth	Pillar h	Pillar w/h	Panel ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	Max Subs Factor	Min Subs Factor	Net Subs Factor	Net Subs	
YW3.3.1	75	30	3	6.25	34.4%	15.13	1.14	13.24	1.46	10.33	0.003	0.001	0.003	0.01	3
YW3.3.1	75	40	3	6.25	34.4%	15.13	1.52	9.93	2.08	7.29	0.004	0.001	0.003	0.01	3
YW3.3.2	74	50	3	7.92	32.1%	17.52	1.84	9.51	2.55	6.87	0.005	0.001	0.004	0.01	2
YW3.3.2	74	60	3	7.92	32.1%	17.52	2.21	7.93	3.21	5.47	0.006	0.001	0.005	0.01	2
YW3.3.3	73	50	3	7.92	36.7%	16.01	1.97	8.11	2.73	5.86	0.005	0.001	0.004	0.01	2
YW3.3.3	73	60	3	7.92	36.7%	16.01	2.37	6.76	3.43	4.66	0.007	0.001	0.005	0.02	2
YW3.6.1	84	30	3	4.17	38.5%	11.40	1.22	9.36	1.64	6.96	0.004	0.001	0.003	0.01	2
YW3.6.1	84	40	3	4.17	38.5%	11.40	1.63	7.02	2.33	4.90	0.005	0.001	0.004	0.01	2
YW3.6.2	85	30	3	6.25	35.7%	14.88	1.17	12.76	1.49	9.96	0.003	0.001	0.003	0.01	2
YW3.6.2	85	40	3	6.25	35.7%	14.88	1.56	9.57	2.12	7.02	0.004	0.001	0.003	0.01	2
YW3.6.3	81	30	3	6.25	34.4%	15.13	1.14	13.24	1.46	10.33	0.003	0.001	0.003	0.01	4
YW3.6.3	81	40	3	6.25	34.4%	15.13	1.52	9.93	2.08	7.29	0.004	0.001	0.003	0.01	4
YW3.6.4	90	30	3	5.42	39.8%	13.45	1.25	10.80	1.63	8.27	0.003	0.001	0.003	0.01	4
YW3.6.4	90	40	3	5.42	39.8%	13.45	1.66	8.10	2.31	5.83	0.005	0.001	0.004	0.01	4
YW3.6.5	86	20	3	5.42	38.1%	13.63	0.81	16.88	0.98	13.94	0.002	0.001	0.002	0.01	4
YW3.6.5	86	30	3	5.42	38.1%	13.63	1.21	11.25	1.58	8.62	0.003	0.001	0.003	0.01	4
YW3.6.6	87	20	3	4.17	45.7%	11.26	0.92	12.23	1.15	9.82	0.003	0.001	0.002	0.01	2
YW3.6.6	87	30	3	4.17	45.7%	11.26	1.38	8.16	1.86	6.06	0.004	0.001	0.003	0.01	2
YW3.6.7	88	20	3	9.17	32.1%	18.76	0.74	25.48	0.84	22.29	0.002	0.000	0.002	0.00	3
YW3.6.7	88	30	3	9.17	32.1%	18.76	1.10	16.99	1.34	14.00	0.003	0.001	0.002	0.01	3
YW3.9.1		100	3	4.17	35.9%	11.45	3.90	2.94	7.12	1.61	0.189	0.003	0.186	0.56	2
YW3.9.1		115	3	4.17	35.9%	11.45	4.49	2.55	8.55	1.34	0.189	0.003	0.186	0.56	2
mean		48		6.87	36.3%	15.79	1.91	9.53	2.77	7.12	0.014	0.001	0.013	0.038	2
min		20		4.17	22.2%	11.26	0.74	2.55	0.84	1.34	0.002	0.000	0.002	0.005	1
max		115		14.58	45.7%	36.13	4.49	25.48	8.55	22.29	0.189	0.003	0.186	0.558	4

YW Seam Panel	SPDS Panel #	Cover Depth	Pillar w/h	Panel ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	Max Subs Factor	Min Subs Factor	Net Subs Factor	Net Subsidence
Gretley Mine's Zone 1 Panels													
GY1.1	70	50	5.0	49.0%	12.2	2.45	4.98	3.84	3.19	0.01	0.002	0.01	0.03
GY1.1	70	90	5.0	49.0%	12.2	4.41	2.77	8.90	1.37	0.26	0.004	0.25	0.76
GY1.1	70	50	5.0	42.5%	12.7	2.17	5.83	3.40	3.73	0.01	0.002	0.01	0.02
GY1.1	70	90	5.0	42.5%	12.7	3.91	3.24	7.89	1.61	0.02	0.004	0.01	0.04
GY1.1	72	30	4.2	46.7%	11.24	1.41	7.99	1.95	5.78	0.01	0.001	0.00	0.01
GY1.1	72	40	4.2	46.7%	11.24	1.88	6.00	2.83	3.97	0.01	0.002	0.01	0.02
GY1.2	51	60	4.2	43.1%	11.31	2.64	4.29	6.69	1.69	0.01	0.003	0.01	0.03
GY1.2	51	70	4.2	43.1%	11.31	3.08	3.68	8.59	1.32	0.01	0.003	0.01	0.03
GY1.3	66	50	2.9	48.6%	9.22	2.43	3.79	4.38	2.11	0.01	0.002	0.01	0.02
GY1.3	66	80	2.9	48.6%	9.22	3.89	2.37	8.87	1.04	0.01	0.003	0.01	0.03
GY1.4	na	90	8.3	33.3%	17.4	3.38	5.17	5.71	3.06	0.02	0.003	0.01	0.03
GY1.4	na	110	8.3	33.3%	17.4	4.13	4.23	7.61	2.29	0.02	0.004	0.01	0.04
GY1.5	64	70	2.1	58.3%	7.77	4.20	1.85	15.49	0.50	0.31	0.004	0.30	0.91
GY1.5	64	80	2.1	58.3%	7.77	4.80	1.62	19.54	0.40	0.31	0.004	0.30	0.91
GY1.5	64	70	8.3	34.8%	16.9	2.68	6.31	5.57	3.04	0.01	0.003	0.01	0.03
GY1.5	64	80	8.3	34.8%	16.9	3.07	5.52	6.84	2.48	0.01	0.003	0.01	0.03
GY1.6	65	80	6.3	37.5%	14.6	3.20	4.55	8.11	1.79	0.01	0.003	0.01	0.03
GY1.6	65	100	6.3	37.5%	14.6	4.00	3.64	11.68	1.25	0.02	0.004	0.01	0.04
GY1.7	63	60	2.9	51.4%	9.22	3.09	2.99	6.05	1.52	0.01	0.003	0.01	0.03
GY1.7	63	70	2.9	51.4%	9.22	3.60	2.56	7.63	1.21	0.27	0.003	0.27	0.80
GY1.8	61,62,67	60	10.4	30.6%	21.1	2.16	9.77	2.99	7.06	0.01	0.002	0.01	0.02
GY1.8	61,62,67	70	10.4	30.6%	21.1	2.52	8.37	3.65	5.78	0.01	0.003	0.01	0.03
mean		70	5.42	0.43	13.06	3.14	4.61	7.19	2.55	0.062	0.003	0.059	0.18
min		30	2.1	30.6%	7.8	1.41	1.62	1.95	0.40	0.006	0.001	0.005	0.01
max		110	10.4	58.3%	21.1	4.80	9.77	19.54	7.06	0.307	0.004	0.303	0.91
Gretley Mines Zone 2 Panels - YW Seam													
GY2.1	40	30	2.9	52.5%	9.22	1.58	5.84	2.34	3.95	0.01	0.001	0.005	0.02
GY2.1	40	50	2.9	52.5%	9.22	2.63	3.51	4.73	1.95	0.01	0.002	0.008	0.03
GY2.1	40	30	2.9	52.5%	9.22	1.58	5.84	3.09	2.98	0.01	0.001	0.005	0.02
GY2.1	40	50	2.9	52.5%	9.22	2.63	3.51	6.84	1.35	0.01	0.002	0.008	0.03
GY2.1	40	30	2.9	52.5%	9.22	1.58	5.84	3.85	2.40	0.01	0.001	0.005	0.02
GY2.1	40	50	2.9	52.5%	9.22	2.63	3.51	8.94	1.03	0.01	0.002	0.008	0.03
GY2.2	152	80	3.8	47.2%	10.48	3.79	2.77	7.94	1.32	0.02	0.004	0.012	0.04
GY2.2	152	100	3.8	47.2%	10.48	4.73	2.21	11.22	0.93	0.25	0.005	0.244	0.73
GY2.3	37	90	4.2	46.7%	11.24	4.22	2.66	9.08	1.24	0.25	0.004	0.242	0.72
GY2.3	37	110	4.2	46.7%	11.24	5.16	2.18	12.41	0.91	0.25	0.005	0.241	0.72
GY2.4	153	80	4.2	55.6%	11.06	4.50	2.46	9.11	1.21	0.29	0.004	0.288	0.87
GY2.4	153	100	4.2	55.6%	11.06	5.63	1.97	12.82	0.86	0.29	0.005	0.287	0.86
GY2.4	153	80	4.2	44.1%	11.29	3.58	3.16	7.24	1.56	0.02	0.004	0.012	0.04
GY2.4	153	100	4.2	44.1%	11.29	4.47	2.53	10.19	1.11	0.23	0.004	0.228	0.68

YW Seam	SPDS	Cover	Pillar	Panel	Pillar	FTA	FTA	SA	SA	Max	Min	Net	Net
Panel	Panel #	Depth	w/h	ER	Strength	Load	FoS	Load	FoS	Subs Factor	Subs Factor	Subs Factor	Subsidence
GY2.5	38	100	2.1	57.6%	7.77	5.89	1.32	17.20	0.45	0.30	0.005	0.298	0.89
GY2.5	38	120	2.1	57.6%	7.77	7.07	1.10	23.36	0.33	0.30	0.007	0.296	0.89
GY2.6	39	100	2.1	58.3%	7.77	6.00	1.29	17.52	0.44	0.31	0.005	0.302	0.90
GY2.6	39	120	2.1	58.3%	7.77	7.20	1.08	23.78	0.33	0.31	0.007	0.300	0.90
GY2.7	42	70	6.3	40.0%	14.12	2.92	4.84	4.88	2.90	0.01	0.003	0.010	0.03
GY2.7	42	80	6.3	40.0%	14.12	3.33	4.24	5.89	2.40	0.01	0.003	0.011	0.03
GY2.8	45	100	4.6	44.0%	11.99	4.46	2.69	9.82	1.22	0.23	0.004	0.227	0.68
GY2.8	45	120	4.6	44.0%	11.99	5.36	2.24	13.06	0.92	0.23	0.005	0.226	0.68
GY2.9	46	100	4.2	55.6%	11.06	5.63	1.97	12.82	0.86	0.29	0.005	0.287	0.86
GY2.9	46	120	4.2	55.6%	11.06	6.75	1.64	17.11	0.65	0.29	0.006	0.286	0.86
GY2.10	47	70	4.2	44.4%	11.28	3.15	3.58	5.97	1.89	0.01	0.003	0.011	0.03
GY2.10	47	80	4.2	44.4%	11.28	3.60	3.13	7.29	1.55	0.02	0.004	0.012	0.04
GY2.11	48	60	4.2	46.7%	11.24	2.81	4.00	4.97	2.26	0.01	0.003	0.009	0.03
GY2.11	48	70	4.2	46.7%	11.24	3.28	3.43	6.22	1.81	0.01	0.003	0.011	0.03
GY2.12	49	60	2.5	54.5%	8.52	3.30	2.58	6.75	1.26	0.29	0.003	0.284	0.85
GY2.12	49	70	2.5	54.5%	8.52	3.85	2.21	8.55	1.00	0.29	0.004	0.283	0.85
GY2.12	49	60	5.0	47.1%	12.36	2.83	4.36	8.59	1.44	0.01	0.003	0.009	0.03
GY2.12	49	70	5.0	47.1%	12.36	3.31	3.74	11.14	1.11	0.01	0.003	0.011	0.03
GY2.13	50	60	3.3	48.7%	9.87	2.93	3.37	10.70	0.92	0.01	0.003	0.010	0.03
GY2.13	50	70	3.3	48.7%	9.87	3.41	2.89	13.99	0.71	0.01	0.003	0.011	0.03
GY2.14	44	60	3.3	48.7%	9.87	2.93	3.37	5.52	1.79	0.01	0.003	0.010	0.03
GY2.14	44	70	3.3	48.7%	9.87	3.41	2.89	6.94	1.42	0.01	0.003	0.011	0.03
GY2.15	43	60	3.8	46.4%	10.48	2.80	3.74	5.10	2.05	0.01	0.003	0.009	0.03
GY2.15	43	70	3.8	46.4%	10.48	3.27	3.21	6.40	1.64	0.01	0.003	0.011	0.03
mean		77	3.7	49.6%	10.42	3.90	3.08	9.56	1.42	0.12	0.00	0.12	0.36
min		30	2.1	40.0%	7.77	1.58	1.08	2.34	0.33	0.01	0.00	0.01	0.02
max		120	6.3	58.3%	14.12	7.20	5.84	23.78	3.95	0.31	0.01	0.30	0.90

Gretley Mine's Pillars in Zone 3 Panels-YW Seam

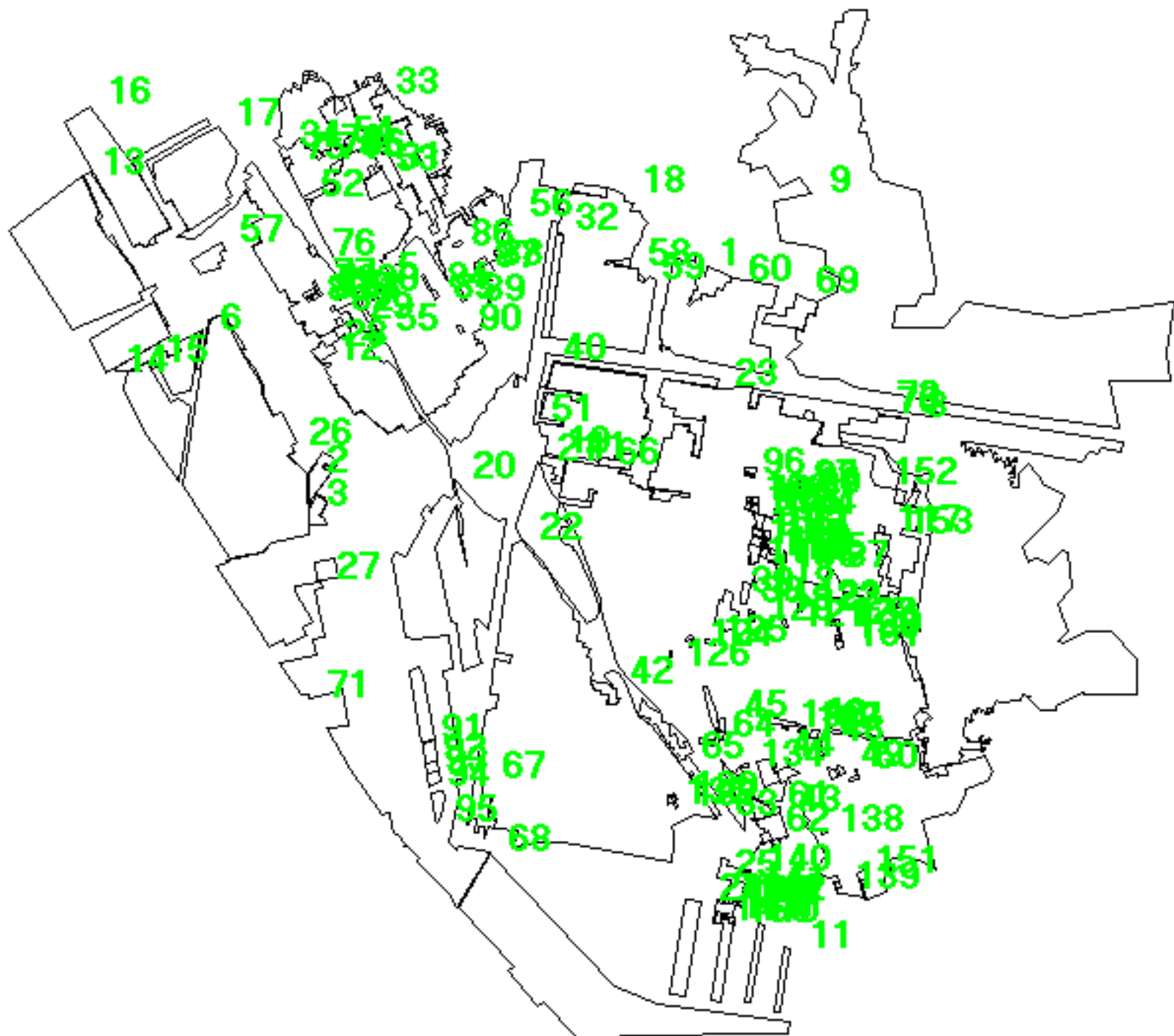
														n
GY3.1.1	na	60	4.17	34.3%	11.48	2.28	5.03	4.04	2.85	0.02	0.003	0.01	0.04	1
GY3.1.1	na	70	4.17	34.3%	11.48	2.66	4.31	5.05	2.27	0.02	0.004	0.01	0.04	1
GY3.1.2	131	90	9.17	33.6%	18.18	3.39	5.36	9.89	1.84	0.01	0.003	0.01	0.03	3
GY3.1.2	131	100	9.17	33.6%	18.18	3.77	4.83	11.80	1.54	0.02	0.004	0.01	0.04	3
GY3.1.3	130	90	4.17	44.4%	11.28	4.05	2.79	8.71	1.30	0.16	0.004	0.15	0.46	1
GY3.1.3	130	100	4.17	44.4%	11.28	4.50	2.51	10.26	1.10	0.16	0.004	0.15	0.45	1
GY3.1.4	129	90	4.17	43.8%	11.30	4.00	2.82	13.21	0.86	0.15	0.004	0.15	0.45	2
GY3.1.4	129	100	4.17	43.8%	11.30	4.44	2.54	15.82	0.71	0.15	0.004	0.15	0.45	2
GY3.1.5	128	90	5.42	39.4%	13.49	3.71	3.63	7.28	1.85	0.02	0.004	0.01	0.04	1
GY3.1.5	128	100	5.42	39.4%	13.49	4.13	3.27	8.53	1.58	0.02	0.004	0.01	0.04	1
GY3.1.6	127	90	4.17	44.1%	11.29	4.02	2.81	17.93	0.63	0.15	0.004	0.15	0.45	3

YW Seam Panel	SPDS Panel #	Cover Depth	Pillar w/h	Panel ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	Max Subs Factor	Min Subs Factor	Net Subs Factor	Net Subsidence	
GY3.1.6	127	100	4.17	44.1%	11.29	4.47	2.53	21.63	0.52	0.15	0.004	0.15	0.45	3
GY3.1.7	121	100	4.17	42.9%	11.32	4.38	2.59	26.77	0.42	0.15	0.004	0.15	0.44	4
GY3.1.7	121	110	4.17	42.9%	11.32	4.81	2.35	31.91	0.35	0.15	0.005	0.15	0.44	4
GY3.1.8	122	100	4.17	55.6%	11.06	5.63	1.97	27.22	0.41	0.19	0.005	0.19	0.57	3
GY3.1.8	122	110	4.17	55.6%	11.06	6.19	1.79	32.31	0.34	0.19	0.006	0.19	0.57	3
9	123	100	4.17	55.6%	11.06	5.63	1.97	27.22	0.41	0.19	0.005	0.19	0.57	3
9	123	110	4.17	55.6%	11.06	6.19	1.79	32.31	0.34	0.19	0.006	0.19	0.57	3
10	120	100	4.17	43.4%	11.30	4.42	2.56	21.39	0.53	0.15	0.004	0.15	0.44	3
10	120	110	4.17	43.4%	11.30	4.86	2.33	25.39	0.45	0.15	0.005	0.15	0.44	3
11	121	100	4.17	50.0%	11.17	5.00	2.23	24.19	0.46	0.18	0.005	0.17	0.51	3
11	121	110	4.17	50.0%	11.17	5.50	2.03	28.72	0.39	0.18	0.005	0.17	0.51	3
12	118	100	3.13	50.0%	9.55	5.00	1.91	28.03	0.34	0.18	0.005	0.17	0.51	3
12	118	110	3.13	50.0%	9.55	5.50	1.74	33.37	0.29	0.18	0.005	0.17	0.51	3
13	116	30	10.83	29.7%	22.20	1.07	20.83	1.66	13.37	0.00	0.001	0.00	0.01	3
13	116	50	10.83	29.7%	22.20	1.78	12.50	3.43	6.48	0.01	0.002	0.01	0.02	3
14	115	30	4.17	41.5%	11.34	1.28	8.85	2.76	4.11	0.01	0.001	0.00	0.01	3
14	115	50	4.17	41.5%	11.34	2.14	5.31	6.23	1.82	0.01	0.002	0.01	0.02	3
15	114	80	3.33	48.4%	9.87	3.88	2.55	17.61	0.56	0.17	0.004	0.17	0.50	3
15	114	100	3.33	48.4%	9.87	4.84	2.04	26.30	0.38	0.17	0.005	0.17	0.50	3
16	111	90	10.42	22.6%	25.46	2.91	8.76	6.26	4.07	0.01	0.003	0.01	0.03	2
16	111	110	10.42	22.6%	25.46	3.55	7.16	8.56	2.98	0.02	0.004	0.01	0.04	2
17	112	80	10.42	27.1%	22.83	2.74	8.32	5.55	4.11	0.01	0.003	0.01	0.03	2
17	112	100	10.42	27.1%	22.83	3.43	6.66	7.82	2.92	0.02	0.004	0.01	0.04	2
18	113	80	7.92	35.0%	16.55	3.08	5.38	8.98	1.84	0.01	0.003	0.01	0.03	3
18	113	100	7.92	35.0%	16.55	3.84	4.31	13.07	1.27	0.02	0.004	0.01	0.04	3
19	109	100	2.50	53.7%	8.52	5.40	1.58	14.83	0.57	0.19	0.005	0.18	0.55	1
19	109	120	2.50	53.7%	8.52	6.48	1.31	20.05	0.42	0.19	0.006	0.18	0.55	1
20	110	100	2.50	53.7%	8.52	5.40	1.58	14.83	0.57	0.19	0.005	0.18	0.55	1
20	110	120	2.50	53.7%	8.52	6.48	1.31	20.05	0.42	0.19	0.006	0.18	0.55	1
21	108	70	10.42	27.1%	22.83	2.40	9.51	3.47	6.57	0.01	0.003	0.01	0.03	1
21	108	80	10.42	27.1%	22.83	2.74	8.32	4.15	5.51	0.01	0.003	0.01	0.03	1
22	106	100	10.42	27.1%	22.83	3.43	6.66	5.62	4.06	0.02	0.004	0.01	0.04	1
22	106	120	10.42	27.1%	22.83	4.11	5.55	7.27	3.14	0.02	0.004	0.01	0.04	1
23	107	100	9.17	32.1%	18.76	3.68	5.10	8.92	2.10	0.02	0.004	0.01	0.04	2
23	107	120	9.17	32.1%	18.76	4.42	4.25	11.96	1.57	0.02	0.004	0.02	0.05	2
24	104	80	8.33	36.0%	16.53	3.13	5.29	10.80	1.53	0.01	0.003	0.01	0.03	4
24	104	100	8.33	32.5%	17.75	3.70	4.79	15.08	1.18	0.02	0.004	0.01	0.04	4
25	101	80	8.33	32.5%	17.75	2.96	5.99	6.60	2.69	0.01	0.003	0.01	0.03	2
25	101	100	8.33	32.5%	17.75	3.70	4.79	9.39	1.89	0.02	0.004	0.01	0.04	2
26	103	80	8.33	32.5%	17.75	2.96	5.99	6.60	2.69	0.01	0.003	0.01	0.03	2
26	103	100	8.33	32.5%	17.75	3.70	4.79	9.39	1.89	0.02	0.004	0.01	0.04	2
27	102	80	6.25	37.5%	14.56	3.20	4.55	8.11	1.79	0.01	0.003	0.01	0.03	2
27	102	100	6.25	37.5%	14.56	4.00	3.64	11.68	1.25	0.02	0.004	0.01	0.04	2

YW Seam	SPDS	Cover	Pillar	Panel	Pillar	FTA	FTA	SA	SA	Max	Min	Net	Net	
Panel	Panel #	Depth	w/h	ER	Strength	Load	FoS	Load	FoS	Subs Factor	Subs Factor	Subs Factor	Subsidence	
28	100	80	6.25	37.5%	14.56	3.20	4.55	8.11	1.79	0.01	0.003	0.01	0.03	2
28	100	100	6.25	37.5%	14.56	4.00	3.64	11.68	1.25	0.02	0.004	0.01	0.04	2
29	105	50	8.33	30.0%	18.70	1.79	10.47	4.53	4.13	0.01	0.002	0.01	0.02	4
29	105	60	8.33	30.0%	18.70	2.14	8.73	6.09	3.07	0.01	0.002	0.01	0.02	4
29	96	50	2.92	50.0%	9.22	2.50	3.69	4.50	2.05	0.01	0.002	0.01	0.02	1
29	96	60	2.92	50.0%	9.22	3.00	3.07	5.88	1.57	0.01	0.003	0.01	0.03	1
30	97	50	5.42	47.8%	12.64	2.40	5.28	3.67	3.44	0.01	0.002	0.01	0.02	1
30	97	60	5.42	47.8%	12.64	2.88	4.40	4.72	2.68	0.01	0.003	0.01	0.03	1
31	98	70	12.50	25.0%	28.28	2.33	12.12	5.02	5.63	0.01	0.002	0.01	0.02	3
31	98	80	12.50	25.0%	28.28	2.67	10.61	6.18	4.58	0.01	0.003	0.01	0.03	3
32	99	70	4.17	46.7%	11.24	3.28	3.43	6.22	1.81	0.01	0.003	0.01	0.03	1
32	99	80	4.17	46.7%	11.24	3.75	3.00	7.59	1.48	0.02	0.004	0.01	0.04	1
32	99	70	2.92	53.3%	9.22	3.75	2.46	7.95	1.16	0.19	0.004	0.18	0.55	1
32	99	80	2.92	53.3%	9.22	4.29	2.15	9.77	0.94	0.19	0.004	0.18	0.55	1
33	117	100	8.33	33.3%	17.45	3.75	4.65	12.39	1.41	0.02	0.004	0.01	0.04	3
33	117	110	8.33	33.3%	17.45	4.13	4.23	14.58	1.20	0.02	0.004	0.01	0.04	3
34	125	90	10.42	29.3%	21.71	3.18	6.82	10.51	2.07	0.01	0.003	0.01	0.03	4
34	125	100	10.42	29.3%	21.71	3.54	6.14	12.58	1.72	0.02	0.004	0.01	0.04	4
35	124	90	2.92	48.1%	9.22	4.34	2.12	29.32	0.31	0.17	0.004	0.16	0.49	4
35	124	100	2.92	48.1%	9.22	4.82	1.91	35.67	0.26	0.17	0.005	0.16	0.49	4
35	124	90	3.33	48.7%	9.87	4.39	2.25	16.05	0.62	0.17	0.004	0.17	0.50	2
35	124	100	3.33	48.7%	9.87	4.88	2.02	19.27	0.51	0.17	0.005	0.17	0.50	2
36	126	90	3.75	42.1%	10.48	3.89	2.69	23.08	0.45	0.15	0.004	0.14	0.43	4
36	126	100	3.75	42.1%	10.48	4.32	2.43	28.02	0.37	0.15	0.004	0.14	0.43	4
37	134	70	6.25	38.4%	14.40	2.84	5.07	8.57	1.68	0.01	0.003	0.01	0.03	3
37	134	80	6.25	38.4%	14.40	3.25	4.44	10.72	1.34	0.01	0.003	0.01	0.03	3
38	138	60	4.17	46.7%	11.24	2.81	4.00	11.45	0.98	0.01	0.003	0.01	0.03	4
38	138	70	4.17	46.7%	11.24	3.28	3.43	15.04	0.75	0.01	0.003	0.01	0.03	4
39	139	70	7.08	35.6%	15.72	2.72	5.78	7.70	2.04	0.01	0.003	0.01	0.03	3
39	139	80	7.08	35.6%	15.72	3.11	5.06	9.61	1.64	0.01	0.003	0.01	0.03	3
40	151,132	70	5.00	47.1%	12.36	3.31	3.74	5.92	2.09	0.01	0.003	0.01	0.03	1
40	151,132	80	5.00	47.1%	12.36	3.78	3.27	7.19	1.72	0.02	0.004	0.01	0.04	1
41	133	70	4.17	48.5%	11.20	3.40	3.30	6.44	1.74	0.01	0.003	0.01	0.03	1
41	133	80	4.17	48.5%	11.20	3.88	2.89	7.86	1.43	0.02	0.004	0.01	0.04	1
GY3.2.1	135	80	6.25	40.0%	14.12	3.33	4.24	11.01	1.28	0.01	0.003	0.01	0.03	3
GY3.2.1	135	100	6.25	40.0%	14.12	4.17	3.39	16.16	0.87	0.02	0.004	0.01	0.04	3
2	136	80	2.92	52.5%	9.22	4.21	2.19	20.36	0.45	0.18	0.004	0.18	0.54	3
2	136	100	2.92	52.5%	9.22	5.26	1.75	30.50	0.30	0.18	0.005	0.18	0.54	3
3	137	80	2.92	53.8%	9.22	4.33	2.13	20.96	0.44	0.19	0.004	0.18	0.55	3
3	137	100	2.92	53.8%	9.22	5.41	1.70	31.39	0.29	0.19	0.005	0.18	0.55	3
GY3.15.1	147	80	8.33	29.3%	18.98	2.83	6.71	6.30	3.01	0.01	0.003	0.01	0.03	2
GY3.15.1	147	90	8.33	29.3%	18.98	3.18	5.96	7.58	2.50	0.01	0.003	0.01	0.03	2
2	148	80	2.92	53.3%	9.22	4.29	2.15	9.77	0.94	0.19	0.004	0.18	0.55	1

YW Seam Panel	SPDS Panel #	Cover Depth	Pillar w/h	Panel ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	Max Subs Factor	Min Subs Factor	Net Subs Factor	Net Subsidence	
2	148	90	2.92	53.3%	9.22	4.82	1.91	11.76	0.78	0.19	0.005	0.18	0.55	1
3	150	80	7.08	35.6%	15.72	3.11	5.06	9.61	1.64	0.01	0.003	0.01	0.03	3
3	150	90	7.08	35.6%	15.72	3.49	4.50	11.72	1.34	0.02	0.004	0.01	0.04	3
4	149	80	4.17	46.7%	11.24	3.75	3.00	11.43	0.98	0.02	0.004	0.01	0.04	2
4	149	90	4.17	46.7%	11.24	4.22	2.66	13.94	0.81	0.16	0.004	0.16	0.48	2
5	146	80	3.33	51.8%	9.87	4.15	2.38	9.06	1.09	0.18	0.004	0.18	0.53	1
5	146	90	3.33	51.8%	9.87	4.67	2.11	10.88	0.91	0.18	0.004	0.18	0.53	1
6	145	80	3.33	51.8%	9.87	4.15	2.38	13.96	0.71	0.18	0.004	0.18	0.53	2
6	145	90	3.33	51.8%	9.87	4.67	2.11	17.09	0.58	0.18	0.004	0.18	0.53	2
7	144	80	3.33	51.8%	9.87	4.15	2.38	13.96	0.71	0.18	0.004	0.18	0.53	2
7	144	90	3.33	51.8%	9.87	4.67	2.11	17.09	0.58	0.18	0.004	0.18	0.53	2
8	142	80	3.33	53.8%	9.87	4.33	2.28	9.45	1.04	0.19	0.004	0.18	0.55	1
8	142	90	3.33	53.8%	9.87	4.88	2.02	11.35	0.87	0.19	0.005	0.18	0.55	1
9	143	80	3.33	51.8%	9.87	4.15	2.38	9.06	1.09	0.18	0.004	0.18	0.53	1
9	143	90	3.33	51.8%	9.87	4.67	2.11	10.88	0.91	0.18	0.004	0.18	0.53	1
10	141	70	3.33	47.3%	9.87	3.32	2.97	6.75	1.46	0.01	0.003	0.01	0.03	1
10	141	75	3.33	47.3%	9.87	3.55	2.78	7.49	1.32	0.02	0.003	0.01	0.04	1
11	140	65	3.33	47.3%	9.87	3.08	3.20	6.04	1.63	0.01	0.003	0.01	0.03	1
11	140	70	3.33	47.3%	9.87	3.32	2.97	6.75	1.46	0.01	0.003	0.01	0.03	1
mean		86	5.59	0.42	13.68	3.83	4.14	13.07	1.69	0.08	0.004	0.08	0.23	2.24
min		30	2.5	22.6%	8.52	1.07	1.31	1.66	0.26	0.00	0.001	0.00	0.01	1
max		120	12.5	55.6%	28.28	6.48	20.83	35.67	13.37	0.19	0.006	0.19	0.57	4

Young Wallsend Seam Workings Outline (SPDS Model)



BH Seam Panels	SPDS #	DoC	h	w	w/h	ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	FoS of Pillars Ignored		Net Subs Factor	Net Subs	FoS of Pillars Included		Net Subs Factor	Net Subs
												Max Subs Factor	Min Subs Factor			Max Subs Factor	Min Subs Factor		
Zone 2 Panels																			
BB2.1	12	40	2.1	4.1	1.95	72.4%	9.47	3.62	2.62	5.35	1.77	0.381	0.004	0.38	0.79	0.026	0.004	0.02	0.05
BB2.1	12	45	2.1	4.1	1.95	70.8%	9.47	3.86	2.45	5.89	1.61	0.373	0.005	0.37	0.77	0.027	0.005	0.02	0.05
BB2.1	31	100	2.1	4.1	1.95	70.8%	9.47	8.58	1.10	16.19	0.59	0.373	0.010	0.36	0.76	0.373	0.010	0.36	0.76
BB2.1	31	40	2.1	4.1	1.95	70.8%	9.47	3.43	2.76	5.10	1.86	0.373	0.004	0.37	0.77	0.373	0.004	0.37	0.77
BB2.1	31	50	2.1	4.1	1.95	70.8%	9.47	4.29	2.21	6.72	1.41	0.373	0.005	0.37	0.77	0.373	0.005	0.37	0.77
BB2.2	18	59	2.1	5.3	2.52	64.6%	10.79	4.16	2.59	6.73	1.60	0.340	0.005	0.33	0.70	0.340	0.005	0.33	0.70
BB2.2	18	80	2.1	5.3	2.52	64.6%	10.79	5.64	1.91	9.90	1.09	0.340	0.007	0.33	0.70	0.340	0.007	0.33	0.70
BB2.2	35	50	2.1	10.0	4.76	51.7%	16.48	2.59	6.37	3.83	4.31	0.272	0.003	0.27	0.56	0.020	0.003	0.02	0.04
BB2.2	35	80	2.1	10.0	4.76	51.7%	16.48	4.14	3.98	6.95	2.37	0.272	0.005	0.27	0.56	0.032	0.005	0.03	0.06
BB2.3	11,15,16	20	2.1	5.3	2.52	64.6%	10.79	1.41	7.65	1.80	5.99	0.340	0.002	0.34	0.71	0.010	0.002	0.01	0.02
BB2.3	11,15,17	59	2.1	5.3	2.52	64.6%	10.79	4.16	2.59	6.73	1.60	0.340	0.005	0.33	0.70	0.030	0.005	0.03	0.05
BB2.3	17	20	2.1	10.0	4.76	51.0%	16.60	1.02	16.28	1.25	13.32	0.268	0.001	0.27	0.56	0.008	0.001	0.01	0.01
BB2.3	17	60	2.1	10.0	4.76	51.0%	16.60	3.06	5.43	4.74	3.50	0.268	0.004	0.26	0.55	0.024	0.004	0.02	0.04
BB2.4	33	50	2.1	5.1	2.42	60.3%	10.90	4.42	2.47	7.95	1.37	0.317	0.005	0.31	0.66	0.030	0.005	0.02	0.05
BB2.4	33	80	2.1	5.1	2.42	60.3%	10.90	7.07	1.54	16.12	0.68	0.317	0.005	0.31	0.65	0.317	0.005	0.31	0.65
BB2.4	32	50	2.1	10.2	4.85	60.3%	10.90	2.86	3.81	4.57	2.38	0.317	0.004	0.31	0.66	0.023	0.004	0.02	0.04
BB2.4	32	80	2.1	10.2	4.85	60.3%	10.90	4.57	2.38	8.96	1.22	0.317	0.006	0.31	0.65	0.317	0.006	0.31	0.65
BB2.5	28	40	2.1	6.4	3.03	60.3%	10.90	3.12	3.49	4.96	2.20	0.317	0.003	0.31	0.66	0.018	0.003	0.02	0.03
BB2.5	28	90	2.1	7.6	3.64	60.3%	10.90	5.85	1.86	13.62	0.80	0.317	0.007	0.31	0.65	0.317	0.007	0.31	0.65
BB2.5	34	40	2.1	12.7	6.06	60.3%	10.90	2.16	5.05	3.08	3.54	0.317	0.003	0.31	0.66	0.018	0.003	0.02	0.03
BB2.5	34	90	2.1	12.7	6.06	60.3%	10.90	4.86	2.24	9.52	1.14	0.317	0.007	0.31	0.65	0.317	0.007	0.31	0.65
BB2.6	21,22	70	2.1	5.1	2.42	60.3%	10.90	6.30	1.73	13.35	0.82	0.317	0.005	0.31	0.65	0.317	0.005	0.31	0.65
BB2.6	21,23	79	2.1	5.1	2.42	60.3%	10.90	7.11	1.53	16.09	0.68	0.317	0.006	0.31	0.65	0.317	0.006	0.31	0.65
BB2.6	NA	70	2.1	8.9	4.24	60.3%	10.90	4.47	2.44	8.48	1.29	0.317	0.005	0.31	0.65	0.317	0.005	0.31	0.65
BB2.6	NA	120	2.1	8.9	4.24	60.3%	10.90	7.66	1.42	19.43	0.56	0.317	0.009	0.31	0.65	0.317	0.009	0.31	0.65
BB2.6	NA	120	2.1	5.1	2.42	60.3%	10.90	10.80	1.01	31.53	0.35	0.317	0.009	0.31	0.65	0.317	0.009	0.31	0.65
BB2.8	20	110	2.1	5.4	2.57	60.3%	10.90	6.92	1.58	13.39	0.81	0.317	0.010	0.31	0.65	0.317	0.010	0.31	0.65
BB2.8	20	85	2.1	5.4	2.57	60.3%	10.90	5.35	2.04	9.60	1.13	0.317	0.007	0.31	0.65	0.317	0.007	0.31	0.65
BB2.8	30	110	2.1	5.4	2.57	60.3%	10.90	6.92	1.58	13.39	0.81	0.317	0.010	0.31	0.65	0.317	0.010	0.31	0.65
BB2.8	30	124	2.1	5.4	2.57	60.3%	10.90	7.80	1.40	15.66	0.70	0.317	0.011	0.31	0.64	0.317	0.011	0.31	0.64
BB2.9	37	50	2.1	5.3	2.52	64.6%	10.79	4.16	2.59	6.73	1.60	0.340	0.006	0.33	0.70	0.034	0.006	0.03	0.06
BB2.9	37	80	2.1	5.3	2.52	64.6%	10.79	5.64	1.91	9.90	1.09	0.340	0.008	0.33	0.70	0.340	0.008	0.33	0.70
BB2.9	36	130	2.1	5.3	2.52	64.6%	10.79	9.17	1.18	18.57	0.58	0.340	0.013	0.33	0.69	0.340	0.013	0.33	0.69
BB2.9	36	80	2.1	5.3	2.52	64.6%	10.79	5.64	1.91	9.90	1.09	0.340	0.008	0.33	0.70	0.340	0.008	0.33	0.70
BB2.9	38	100	2.1	6.0	2.86	54.3%	11.50	5.47	2.10	10.28	1.12	0.286	0.007	0.28	0.59	0.286	0.007	0.28	0.59
BB2.9	38	130	2.1	6.0	2.86	54.3%	11.50	7.11	1.62	14.47	0.79	0.286	0.009	0.28	0.58	0.286	0.009	0.28	0.58
BB2.10	14	20	2.1	4.1	1.95	72.4%	9.47	1.81	5.23	2.33	4.07	0.381	0.002	0.38	0.79	0.015	0.002	0.01	0.03
BB2.10	14	55	2.1	4.1	1.95	72.4%	9.47	4.52	2.09	7.06	1.34	0.381	0.006	0.37	0.79	0.381	0.006	0.37	0.79
BB2.10	14	20	2.1	4.1	1.95	72.4%	9.47	1.81	5.23	2.33	4.07	0.381	0.002	0.38	0.79	0.015	0.002	0.01	0.03
BB2.10	14	55	2.1	4.1	1.95	72.4%	9.47	3.89	2.43	5.85	1.62	0.381	0.005	0.38	0.79	0.381	0.005	0.38	0.79
BB2.4	33	50	2.1	5.3	2.52	64.6%	10.79	3.53	3.06	5.47	1.97	0.340	0.005	0.33	0.70	0.029	0.005	0.02	0.05
BB2.4	33	61	2.1	5.3	2.52	64.6%	10.79	4.30	2.51	7.02	1.54	0.340	0.006	0.33	0.70	0.340	0.006	0.33	0.70
BB2.4	32	50	2.1	5.3	2.52	64.6%	10.79	3.53	3.06	5.47	1.97	0.340	0.005	0.33	0.70	0.029	0.005	0.02	0.05
BB2.4	32	80	2.1	5.3	2.52	64.6%	10.79	5.64	1.91	9.90	1.09	0.340	0.008	0.33	0.70	0.340	0.008	0.33	0.70
BB2.11	13	20	2.1	5.1	2.42	72.4%	9.47	1.30	7.27	1.80	5.26	0.368	0.002	0.37	0.77	0.013	0.002	0.01	0.02
BB2.11	13	20	2.1	5.1	2.42	72.4%	9.47	1.30	7.27	1.80	5.26	0.368	0.002	0.37	0.77	0.013	0.002	0.01	0.02
BB2.11	13	40	2.1	5.1	2.42	72.4%	9.47	2.60	3.64	4.60	2.06	0.368	0.004	0.36	0.76	0.026	0.004	0.02	0.05
BB2.11	13	20	2.1	5.1	2.42	72.4%	9.47	1.67	5.68	2.20	4.30	0.368	0.002	0.37	0.77	0.013	0.002	0.01	0.02

										<u>FoS of Pillars Ignored</u>				<u>FoS of Pillars Included</u>					
BH Seam							Pillar	FTA	FTA	SA	SA	Max	Min	Net	Net	Max	Min	Net	Net
Panels	SPDS #	DoC	h	w	w/h	ER	Strength	Load	FoS	Load	FoS	Subs Factor	Subs Factor	Subs Factor	Subs	Subs Factor	Subs Factor	Subs Factor	Subs
BB2.11	13	40	2.1	5.1	2.42	72.4%	9.47	3.33	2.84	5.47	1.73	0.368	0.004	0.36	0.76	0.026	0.004	0.02	0.05
BB2.12	48	90	2.1	6.4	3.03	60.3%	10.90	5.41	2.01	13.92	0.78	0.307	0.007	0.30	0.63	0.307	0.007	0.30	0.63
BB2.12	23	133	2.1	6.4	3.03	60.3%	10.90	8.00	1.36	26.57	0.41	0.307	0.010	0.30	0.62	0.307	0.010	0.30	0.62
BB2.12	25	90	2.1	7.6	3.64	60.3%	10.90	5.78	1.89	12.90	0.84	0.307	0.007	0.30	0.63	0.307	0.007	0.30	0.63
BB2.12	25	145	2.1	7.6	3.64	60.3%	10.90	9.30	1.17	27.80	0.39	0.307	0.011	0.30	0.62	0.307	0.011	0.30	0.62
BB2.13	19	70	2.1	7.6	3.64	60.3%	10.90	4.55	2.40	9.25	1.18	0.307	0.005	0.30	0.63	0.307	0.005	0.30	0.63
BB2.13	19	130	2.1	7.6	3.64	60.3%	10.90	8.45	1.29	24.67	0.44	0.307	0.010	0.30	0.62	0.307	0.010	0.30	0.62
BB2.13	19	70	2.1	10.2	4.85	60.3%	10.90	3.94	2.77	7.46	1.46	0.307	0.005	0.30	0.63	0.307	0.005	0.30	0.63
BB2.13	19	130	2.1	10.2	4.85	60.3%	10.90	7.31	1.49	19.48	0.56	0.307	0.010	0.30	0.62	0.307	0.010	0.30	0.62
BB2.14	13	50	2.1	10.2	4.85	60.3%	10.90	2.34	4.65	3.95	2.76	0.307	0.004	0.30	0.64	0.023	0.004	0.02	0.04
BB2.15	26	100	2.1	6.4	3.03	60.3%	10.90	5.91	1.84	16.23	0.67	0.307	0.008	0.30	0.63	0.307	0.008	0.30	0.63
BB2.15	27	130	2.1	6.4	3.03	60.3%	10.90	7.69	1.42	25.12	0.43	0.307	0.010	0.30	0.62	0.307	0.010	0.30	0.62
BB2.15	29	100	2.1	8.9	4.24	60.3%	10.90	4.99	2.18	12.36	0.88	0.307	0.008	0.30	0.63	0.307	0.008	0.30	0.63
BB2.15	29	130	2.1	8.9	4.24	60.3%	10.90	6.49	1.68	18.94	0.58	0.307	0.010	0.30	0.62	0.307	0.010	0.30	0.62
BB2.16	24	90	2.1	8.9	4.24	60.3%	10.90	4.49	2.43	10.46	1.04	0.307	0.007	0.30	0.63	0.307	0.007	0.30	0.63
BB2.16	24	140	2.1	8.9	4.24	60.3%	10.90	6.99	1.56	21.43	0.51	0.307	0.011	0.30	0.62	0.307	0.011	0.30	0.62
Zone 2 Pillar Statistics																			
Mean		75.16	2.10	6.6	3.16	0.63	10.94	4.94	2.96	10.51	1.83	0.33	0.01	0.32	0.67	0.21	0.01	0.21	0.44
Minimum		20.00	2.10	4.1	1.95	0.51	9.47	1.02	1.01	1.25	0.35	0.27	0.00	0.26	0.55	0.01	0.00	0.01	0.01
Maximum		145.00	2.10	12.7	6.06	0.72	16.60	10.80	16.28	31.53	13.32	0.38	0.01	0.38	0.79	0.38	0.01	0.38	0.79
Zone 1 Panels																			
BB1.1	1	120	2.1	10.2	4.85	42.8%	14.29	5.24	2.73	14.53	0.98	0.248	0.005	0.24	0.51	0.248	0.005	0.24	0.51
BB1.1	1	150	2.1	10.2	4.85	42.8%	14.29	6.55	2.18	21.06	0.68	0.218	0.006	0.21	0.44	0.218	0.006	0.21	0.44
BB1.1	1	120	2.1	19.1	9.09	38.6%	22.61	4.89	4.63	10.01	2.26	0.031	0.005	0.03	0.05	0.031	0.005	0.03	0.05
BB1.1	1	150	2.1	19.1	9.09	38.6%	22.61	6.11	3.70	14.11	1.60	0.039	0.006	0.03	0.07	0.039	0.006	0.03	0.07
BB1.2	8	30	2.1	10.2	4.85	36.0%	14.04	1.17	11.98	1.79	7.86	0.005	0.001	0.00	0.01	0.005	0.001	0.00	0.01
BB1.2	8	130	2.1	10.2	4.85	36.0%	14.04	5.08	2.76	16.60	0.85	0.183	0.003	0.18	0.38	0.183	0.003	0.18	0.38
BB1.2	54-65	30	2.1	16.5	7.88	28.5%	19.61	1.05	18.69	1.43	13.75	0.004	0.001	0.00	0.01	0.004	0.001	0.00	0.01
BB1.2	56-68	130	2.1	16.5	7.88	28.5%	19.61	4.55	4.31	11.63	1.69	0.018	0.003	0.02	0.03	0.018	0.003	0.02	0.03
BB1.3	7	30	2.1	5.1	2.42	65.5%	9.35	2.17	4.31	4.67	2.00	0.011	0.002	0.01	0.02	0.011	0.002	0.01	0.02
BB1.3	7	60	2.1	5.1	2.42	65.5%	9.35	4.34	2.15	14.34	0.65	0.333	0.003	0.33	0.69	0.333	0.003	0.33	0.69
BB1.4	7	30	2.1	5.1	2.42	65.5%	9.35	2.17	4.31	4.67	2.00	0.011	0.002	0.01	0.02	0.011	0.002	0.01	0.02
BB1.4	7	60	2.1	5.1	2.42	65.5%	9.35	4.34	2.15	14.34	0.65	0.333	0.003	0.33	0.69	0.333	0.003	0.33	0.69
BB1.5	6	55	2.1	10.2	4.85	44.6%	14.14	2.48	5.69	6.51	2.17	0.013	0.002	0.01	0.02	0.013	0.002	0.01	0.02
BB1.6	9,10	50	2.1	7.6	3.64	50.1%	11.50	2.51	4.59	4.69	2.45	0.013	0.002	0.01	0.02	0.013	0.002	0.01	0.02
BB1.6	9,10	100	2.1	8.9	4.24	47.0%	12.79	4.71	2.71	12.25	1.04	0.239	0.004	0.23	0.49	0.239	0.004	0.23	0.49
BB1.7	5	50	2.1	7.6	3.64	49.1%	11.50	2.46	4.68	4.60	2.50	0.013	0.002	0.01	0.02	0.013	0.002	0.01	0.02
BB1.7	5	70	2.1	7.6	3.64	49.1%	11.50	3.44	3.35	7.64	1.51	0.019	0.003	0.02	0.03	0.019	0.003	0.02	0.03
BB1.8	9	70	2.1	12.7	6.06	42.9%	16.93	3.06	5.53	5.63	3.00	0.018	0.003	0.02	0.03	0.018	0.003	0.02	0.03
BB1.9	2	50	2.1	20.4	9.70	33.5%	24.70	1.88	13.14	2.70	9.15	0.011	0.002	0.01	0.02	0.011	0.002	0.01	0.02
BB1.9	2	90	2.1	20.4	9.70	33.5%	24.70	3.38	7.30	6.04	4.09	0.021	0.003	0.02	0.04	0.021	0.003	0.02	0.04
BB1.9	2	50	2.1	7.6	3.64	54.3%	11.50	2.73	4.21	2.73	4.21	0.016	0.002	0.01	0.03	0.016	0.002	0.01	0.03
BB1.9	2	90	2.1	7.6	3.64	54.3%	11.50	4.92	2.34	4.92	2.34	0.276	0.004	0.27	0.57	0.276	0.004	0.27	0.57
BB1.10	4	90	2.1	7.6	3.64	60.0%	11.50	5.63	2.04	13.72	0.84	0.305	0.005	0.30	0.63	0.305	0.005	0.30	0.63
BB1.10	4	130	2.1	7.6	3.64	60.0%	11.50	8.13	1.42	25.02	0.46	0.305	0.007	0.30	0.63	0.305	0.007	0.30	0.63
BB1.11	3	60	2.1	10.2	4.85	48.1%	14.18	2.89	4.91	5.26	2.69	0.017	0.003	0.01	0.03	0.017	0.003	0.01	0.03
BB1.11	3	100	2.1	10.2	4.85	48.1%	14.18	4.81	2.95	11.41	1.24	0.244	0.004	0.24	0.50	0.244	0.004	0.24	0.50
BB1.11	69-87	60	2.1	20.4	9.70	33.9%	24.42	2.27	10.76	3.46	7.07	0.014	0.002	0.01	0.02	0.014	0.002	0.01	0.02
BB1.11	69-87	100	2.1	20.4	9.70	33.9%	24.42	3.78	6.46	7.08	3.45	0.023	0.004	0.02	0.04	0.023	0.004	0.02	0.04
BB1.12	NA	130	2.1	12.7	6.06	42.2%	17.10	5.62	3.04	14.39	1.19	0.215	0.006	0.21	0.44	0.215	0.006	0.21	0.44
BB1.12	NA	140	2.1	12.7	6.06	42.2%	17.10	6.05	2.82	16.06	1.06	0.215	0.006	0.21	0.44	0.215	0.006	0.21	0.44

BH Seam Panels	SPDS #	DoC	h	w	w/h	ER	Pillar Strength	FTA Load	FTA FoS	SA Load	SA FoS	FoS of Pillars Ignored		Net Subs Factor	Net Subs	FoS of Pillars Included		Net Subs Factor	Net Subs
												Max Subs Factor	Min Subs Factor			Max Subs Factor	Min Subs Factor		
BB1.13	27	100	2.1	10.2	4.85	48.1%	14.18	4.81	2.95	11.41	1.24	0.244	0.004	0.24	0.50	0.244	0.004	0.24	0.50
BB1.13	27	130	2.1	10.2	4.85	48.1%	14.18	6.26	2.27	17.41	0.81	0.244	0.006	0.24	0.50	0.244	0.006	0.24	0.50
BB1.14	NA	120	2.1	12.7	6.06	38.4%	18.10	4.87	3.71	11.89	1.52	0.040	0.006	0.03	0.07	0.040	0.006	0.03	0.07
BB1.14	NA	130	2.1	12.7	6.06	38.4%	18.10	5.28	3.43	13.51	1.34	0.044	0.007	0.04	0.08	0.044	0.007	0.04	0.08
BB1.15	10	100	2.1	7.6	3.64	53.5%	11.50	5.38	2.14	13.97	0.82	0.272	0.005	0.27	0.56	0.272	0.005	0.27	0.56
BB1.15	10	110	2.1	7.6	3.64	53.5%	11.50	5.91	1.95	16.31	0.70	0.272	0.006	0.27	0.56	0.272	0.006	0.27	0.56
BB1.16	10	110	2.1	11.5	5.45	40.4%	16.39	4.61	3.55	11.10	1.48	0.043	0.007	0.04	0.08	0.043	0.007	0.04	0.08
BB1.16	10	120	2.1	11.5	5.45	40.4%	16.39	5.03	3.26	12.75	1.29	0.047	0.008	0.04	0.08	0.047	0.008	0.04	0.08
BB1.17	10	130	2.1	11.5	5.45	44.7%	15.65	5.88	2.66	15.66	1.00	0.228	0.006	0.22	0.47	0.228	0.006	0.22	0.47
BB1.17	10	140	2.1	11.5	5.45	44.7%	15.65	6.33	2.47	17.68	0.89	0.228	0.006	0.22	0.47	0.228	0.006	0.22	0.47
BB1.18	NA	130	2.1	11.5	5.45	44.7%	15.65	5.88	2.66	15.66	1.00	0.228	0.006	0.22	0.47	0.228	0.006	0.22	0.47
BB1.18	NA	140	2.1	11.5	5.45	44.7%	15.65	6.33	2.47	17.68	0.89	0.228	0.006	0.22	0.47	0.228	0.006	0.22	0.47
Zone 1 Pillar Statistics																			
Mean		94.88	2.10	11.3	5.38	0.46	15.39	4.40	4.41	10.91	2.34	0.13	0.00	0.13	0.27	0.13	0.00	0.13	0.27
Minimum		30.00	2.10	5.1	2.42	0.29	9.35	1.05	1.42	1.43	0.46	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Maximum		150.00	2.10	20.4	9.70	0.65	24.70	8.13	18.69	25.02	13.75	0.33	0.01	0.33	0.69	0.33	0.01	0.33	0.69

Borehole Seam Workings Outline (SPDS Model)



UNSW Pillar Design Spreadsheet

Wallsend Borehole - Young Wallsend Seam	Partial Extraction Panels - Split and Lifted Pillars																			
INPUT DATA	YW2.1	YW2.1	YW2.2	YW2.2	YW2.3	YW2.3	YW2.4	YW2.4	YW2.5	YW2.5	YW2.6	YW2.6	YW2.6	YW2.6	YW2.7	YW2.7	YW2.8	YW2.8	YW2.9	YW2.9
Depth of Cover (m)	20	50	50	50	40	50	20	45	40	50	30	45	30	45	50	60	45	50	30	60
Mining Height (m)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)	25	25	20	20	20	20	23	23	22	22	23	23	23	23	23	25	25	24	24	17
Pillar Width - centres (m)	20	20	20	20	20	20	17	17	19	19	15	15	22	22	19	19	15	15	13	13
Roadway Width for maximum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	120	120	100	100	200	200	100	100	350	350	300	300	300	300	180	180	250	250	250	250
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																				
Maximum Rib to Rib Pillar Length (w ₂)	20.0	20.0	15.0	15.0	15.0	15.0	18.0	18.0	17.0	17.0	18.0	18.0	18.0	18.0	20.0	20.0	19.0	19.0	12.0	12.0
Minimum Rib to Rib Pillar Width (w ₁)	15.0	15.0	15.0	15.0	15.0	15.0	12.0	12.0	14.0	14.0	10.0	10.0	17.0	17.0	14.0	14.0	10.0	10.0	8.0	8.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	15.0	15.0	15.0	15.0	15.0	15.0	12.0	12.0	14.0	14.0	10.0	10.0	17.0	17.0	14.0	14.0	10.0	10.0	8.0	8.0
Minimum Pillar Width/Height Ratio	5.0	5.0	5.0	5.0	5.0	5.0	4.0	4.0	4.7	4.7	3.3	3.3	5.7	5.7	4.7	4.7	3.3	3.3	2.7	2.7
Extraction Ratio (%)	40.0%	40.0%	43.8%	43.8%	43.8%	43.8%	44.8%	44.8%	43.1%	43.1%	47.8%	47.8%	39.5%	39.5%	41.1%	41.1%	47.2%	47.2%	56.6%	56.6%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	22.942	36.275	36.275	39.737	32.445	36.275	22.942	34.413	32.445	36.275	28.098	34.413	28.098	34.413	36.275	39.737	34.413	39.737	36.275	39.737
R (Pillar 2nd Abutment Component)	1.00	0.91	0.91	0.88	0.94	0.91	0.98	0.87	0.93	0.89	0.90	0.82	0.99	0.95	0.89	0.86	0.82	0.76	0.74	0.70
Dimensionless Pillar 'Rectangularity'	1.14	1.14	1.00	1.00	1.00	1.00	1.20	1.20	1.10	1.10	1.29	1.29	1.03	1.03	1.18	1.18	1.31	1.31	1.20	1.20
Width/Height Ratio Exponent	0.67	0.67	0.67	0.67	0.67	0.67	0.33	0.33	0.56	0.56	0.11	0.11	0.89	0.89	0.56	0.56	0.11	0.11	-0.11	-0.11
Effective Width Factor (Omega)	1.09	1.09	1.00	1.00	1.00	1.00	1.06	1.06	1.05	1.05	1.03	1.03	1.03	1.03	1.09	1.09	1.03	1.03	0.98	0.98
Effective Width Interim	16.40	16.40	15.00	15.00	15.00	15.00	12.75	12.75	14.74	14.74	10.28	10.28	17.43	17.43	15.32	15.32	10.30	10.30	7.84	7.84
Effective Pillar Width (m)	16.40	16.40	15.00	15.00	15.00	15.00	12.75	12.75	14.74	14.74	10.28	10.28	17.43	17.43	15.32	15.32	10.30	10.30	8.00	8.00
Effective Pillar Loading Height (m)	20.00	50.00	50.00	60.00	40.00	50.00	20.00	45.00	40.00	50.00	30.00	45.00	30.00	45.00	50.00	60.00	45.00	60.00	50.00	60.00
RESULTS																				
Tributary Area Loading (MPa)	0.83	2.08	2.22	2.67	1.78	2.22	0.91	2.04	1.76	2.20	1.44	2.16	1.24	1.86	2.12	2.54	2.13	2.84	2.88	3.45
Tributary Area Loading x 0.5 (MPa)	0.42	1.04	1.11	1.33	0.89	1.11	0.45	1.02	0.88	1.10	0.72	1.08	0.62	0.93	1.06	1.27	1.07	1.42	1.44	1.73
Pillar Strength (UNSW Squat Pillar 1999)	14.12	14.12	13.49	13.49	13.49	13.49	NA	NA	NA	NA	NA	NA	NA	14.71	14.71	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h-c5)	N/A	N/A	N/A	N/A	N/A	N/A	12.52	12.52	13.48	13.48	11.22	11.22	N/A	N/A	13.75	13.75	11.23	11.23	9.87	9.87
Safety Factor under FTA Loading (Squat Pillar)	14.12	14.12	13.49	13.49	13.49	13.49	12.52	12.52	13.48	13.48	11.22	11.22	14.71	14.71	13.75	13.75	11.23	11.23	9.87	9.87
Safety Factor under FTA Loading (w/h-c5)	16.95	6.78	6.07	5.06	7.59	6.07	N/A	N/A	N/A	N/A	N/A	N/A	11.86	7.91	N/A	N/A	N/A	N/A	N/A	N/A
No. SAs, n	N/A	N/A	N/A	N/A	N/A	N/A	13.83	6.15	7.67	6.14	7.80	5.20	N/A	N/A	6.48	5.40	5.27	3.95	3.43	2.86
Single Abutment Loading (3D) - full	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Single Abutment Loading (3D) - pillar	0.16	0.91	0.97	1.35	0.64	0.97	0.20	0.90	0.66	0.99	0.50	1.02	0.32	0.70	0.96	1.32	1.01	1.66	1.56	2.13
Single Abutment Loading (3D) - solid	0.00	0.09	0.10	0.19	0.04	0.10	0.00	0.13	0.05	0.12	0.06	0.22	0.00	0.03	0.12	0.22	0.22	0.53	0.56	0.93
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	0.99	2.99	3.19	4.01	2.42	3.19	1.11	2.94	2.42	3.18	1.93	3.17	1.56	2.56	3.08	3.87	3.14	4.50	4.44	5.58
Safety Factor (under Single Abutment Loading)	14.22	4.72	4.23	3.36	5.57	4.23	11.32	4.26	5.58	4.23	5.80	3.53	9.42	5.76	4.47	3.55	3.58	2.50	2.22	1.77
Total Pillar Loading @ nA	0.99	3.08	3.29	4.20	2.46	3.29	1.11	3.07	2.47	3.30	1.99	3.40	1.56	2.59	3.19	4.09	3.36	5.02	5.00	6.51
Safety Factor @ nA	14.22	4.58	4.10	3.21	5.49	4.10	11.28	4.08	5.47	4.08	5.64	3.30	9.40	5.68	4.31	3.36	3.34	2.24	1.97	1.52
Total Pillar Loading under Double Abutment Loading	1.15	4.08	4.35	5.74	3.14	4.35	1.31	4.11	3.18	4.41	2.54	4.64	1.89	3.32	4.26	5.63	4.59	7.21	7.13	9.57
Safety Factor (under Double Abutment Loading)	12.25	3.46	3.10	2.35	4.29	3.10	9.53	3.05	4.24	3.05	4.41	2.42	7.79	4.43	3.23	2.44	2.45	1.56	1.38	1.03
Notes:																				
FTA Sp/T	0.009	0.011	0.011	0.012	0.011	0.011	0.010	0.011	0.011	0.011	0.010	0.011	0.010	0.011	0.011	0.012	0.011	0.012	0.012	0.013
FTA Sp(m)	0.028	0.033	0.034	0.036	0.032	0.034	0.029	0.033	0.032	0.034	0.031	0.033	0.030	0.032	0.033	0.035	0.033	0.036	0.036	0.039
FTA Sp/T (U95%)	0.063	0.065	0.065	0.066	0.065	0.065	0.064	0.065	0.065	0.065	0.064	0.065	0.064	0.065	0.065	0.066	0.065	0.066	0.066	0.067
FTA Sp (U95%)	0.190	0.195	0.196	0.198	0.194	0.196	0.191	0.195	0.194	0.196	0.193	0.195	0.192	0.194	0.195	0.197	0.195	0.198	0.198	0.201
nA Sp/T	0.010	0.012	0.013	0.014	0.012	0.013	0.010	0.012	0.012	0.013	0.011	0.013	0.010	0.012	0.013	0.014	0.013	0.016	0.016	0.019
nA Sp(m)	0.029	0.037	0.038	0.043	0.035	0.038	0.029	0.037	0.035	0.038	0.033	0.039	0.031	0.035	0.038	0.042	0.039	0.047	0.047	0.057
nA Sp/T (U95%)	0.064	0.066	0.067	0.068	0.066	0.067	0.064	0.066	0.066	0.067	0.065	0.067	0.064	0.066	0.067	0.068	0.067	0.070	0.070	0.073
nA Sp (U95%)	0.191	0.199	0.200	0.205	0.197	0.200	0.191	0.199	0.197	0.200	0.195	0.201	0.193	0.197	0.200	0.204	0.201	0.209	0.209	0.219
Max Subs	0.72	0.72	0.73	0.79	0.79	0.79	0.81	0.81	0.78	0.86	0.86	0.86	0.71	0.74	0.85	0.85	0.85	1.02	1.02	1.02
Ecoot(GPa)	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Efloor(GPa)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Eroof(GPa)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	0.50	1.25	1.25	1.50	1.00	1.25	0.50	1.13	1.00	1.25	0.75	1.13	0.75	1.13	1.25	1.50	1.13	1.50	1.25	1.50
Increase in vertical stress (MPa)	0.33	0.83	0.97	1.17	0.78	0.97	0.41	0.91	0.76	0.95	0.69	1.03	0.49	0.74	0.87	1.04	1.01	1.34	1.63	1.95
Pillar Compression (m)	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002
Roof Compression (m)	0.00																			

UNSW Pillar Design Spreadsheet

Wallsend Borehole - Young Wallsend Seam				FWs Panels																		
INPUT DATA				YW2.10	YW2.10	YW1.1	YW1.1	YW1.1	YW1.1	YW1.1	YW1.1	YW1.1	YW1.2	YW1.2	YW1.2	YW1.2	YW1.3	YW1.3	YW1.4	YW1.4	YW1.5	YW1.5
Depth of Cover (m)		50	110	45	50	40	80	80	120	45	120	45	20	60	20	60	20	45	20	45	50	50
Mining Height (m)		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)		25	25	33	33	25	25	35	35	100	100	30	30	30	30	30	25	25	22	22	19	19
Pillar Width - centres (m)		18	18	24	24	23	23	25	25	35	35	30	30	30	30	30	15	15	22	22	19	19
Roadway Width for maximum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)		250	250	250	250	200	200	200	200	200	200	200	150	150	150	300	300	220	220	145	145	145
SG (tonnes/m ³)		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)		10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																						
Maximum Rib to Rib Pillar Length (w ₂)		20.0	20.0	28.0	28.0	20.0	20.0	30.0	30.0	95.0	95.0	25.0	25.0	25.0	25.0	25.0	20.0	20.0	17.0	17.0	14.0	14.0
Minimum Rib to Rib Pillar Width (w ₁)		13.0	13.0	19.0	19.0	18.0	18.0	20.0	20.0	30.0	30.0	25.0	25.0	25.0	25.0	10.0	10.0	17.0	17.0	14.0	14.0	14.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)		13.0	13.0	19.0	19.0	18.0	18.0	20.0	20.0	30.0	30.0	25.0	25.0	25.0	25.0	10.0	10.0	17.0	17.0	14.0	14.0	14.0
Minimum Pillar Width/Height Ratio		4.3	4.3	6.3	6.3	6.0	6.0	6.7	6.7	10.0	10.0	8.3	8.3	8.3	8.3	3.3	3.3	5.7	5.7	4.7	4.7	4.7
Extraction Ratio (%)		42.2%	42.2%	32.8%	32.8%	37.4%	37.4%	31.4%	31.4%	18.6%	18.6%	30.6%	30.6%	30.6%	30.6%	46.7%	46.7%	40.3%	40.3%	45.7%	45.7%	45.7%
Abutment Angle (Radians)		0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)		1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?		Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)		36.275	53.804	34.413	36.275	32.445	45.884	45.884	56.196	34.413	56.196	22.942	39.737	22.942	39.737	22.942	34.413	22.942	34.413	34.413	36.275	36.275
R (Pillar 2nd Abutment Component)		0.87	0.71	0.97	0.96	0.98	0.88	0.91	0.83	1.00	0.95	1.03	0.99	1.03	0.99	0.96	0.82	1.00	0.95	0.91	0.89	0.89
Dimensionless Pillar 'Rectangularity'		1.21	1.21	1.19	1.19	1.05	1.05	1.20	1.20	1.52	1.52	1.00	1.00	1.00	1.00	1.33	1.33	1.00	1.00	1.00	1.00	1.00
Width/Height Ratio Exponent		0.44	0.44	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.11	0.11	0.89	0.89	0.56	0.56	0.56
Effective Width Factor (Omega)		1.09	1.09	1.19	1.19	1.05	1.05	1.20	1.20	1.52	1.52	1.00	1.00	1.00	1.00	1.00	1.03	1.03	1.00	1.00	1.00	1.00
Effective Width Interim		14.16	14.16	22.64	22.64	18.95	18.95	24.00	24.00	45.60	45.60	25.00	25.00	25.00	25.00	10.32	10.32	17.00	17.00	14.00	14.00	14.00
Effective Pillar Width (m)		14.16	14.16	22.64	22.64	18.95	18.95	24.00	24.00	45.60	45.60	25.00	25.00	25.00	25.00	10.32	10.32	17.00	17.00	14.00	14.00	14.00
Effective Pillar Loading Height (m)		50.00	110.00	45.00	50.00	40.00	80.00	80.00	120.00	45.00	120.00	20.00	60.00	20.00	60.00	20.00	45.00	20.00	45.00	50.00	50.00	50.00
RESULTS																						
Tributary Area Loading (MPa)		2.16	4.76	1.67	1.86	1.60	3.19	2.92	4.38	1.38	3.68	0.72	2.16	0.72	2.16	0.94	2.11	0.84	1.88	2.07	2.30	2.30
Tributary Area Loading x 0.5 (MPa)		1.08	2.38	0.84	0.93	0.80	1.60	1.46	2.19	0.69	1.84	0.36	1.08	0.36	1.08	0.47	1.05	0.42	0.94	1.04	1.15	1.15
Pillar Strength (UNSW Squat Pillar 1999)		NA	NA	17.28	17.28	15.54	15.54	18.15	18.15	33.72	33.72	21.10	21.10	21.10	21.10	NA	NA	14.53	14.53	NA	NA	NA
Pillar Strength (UNSW w/h<5)		13.21	13.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.24	11.24	NA	N/A	13.13	13.13
Safety Factor under FTA Loading (Squat Pillar)		13.21	13.21	17.28	17.28	15.54	15.54	18.15	18.15	33.72	33.72	21.10	21.10	21.10	21.10	11.24	11.24	14.53	14.53	13.13	13.13	13.13
Safety Factor under FTA Loading (w/h<5)		N/A	N/A	10.32	9.29	9.73	4.86	6.22	4.15	24.40	9.15	29.31	9.77	29.31	9.77	N/A	N/A	17.35	7.71	N/A	N/A	N/A
No. SAs, n		6.10	2.77	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.99	5.33	N/A	N/A	6.34	5.70	5.70
Single Abutment Loading (3D) - full		1.15	5.58	0.60	0.74	-0.19	2.13	1.79	4.03	0.34	2.42	0.09	0.83	0.09	0.83	0.24	1.21	0.15	0.74	0.94	1.16	1.16
Single Abutment Loading (3D) - pillar		1.01	3.94	0.59	0.72	-0.18	1.87	1.62	3.34	0.34	2.29	0.09	0.82	0.09	0.82	0.23	1.00	0.15	0.70	0.86	1.04	1.04
Single Abutment Loading (3D) - solid		0.15	1.65	0.02	0.03	0.00	0.26	0.17	0.69	0.00	0.13	0.00	0.01	0.00	0.01	0.01	0.22	0.00	0.03	0.08	0.13	0.13
Cell Sensitivity (MPa)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading		3.17	8.70	2.26	2.58	1.41	5.06	4.54	7.72	1.72	5.98	0.81	2.98	0.81	2.98	1.17	3.11	0.98	2.59	2.93	3.34	3.34
Safety Factor (under Single Abutment Loading)		4.17	1.52	7.64	6.71	10.99	3.07	4.00	2.35	19.57	5.64	25.90	7.09	25.90	7.09	9.63	3.62	14.77	5.61	4.48	3.93	3.93
Total Pillar Loading @ nA		3.32	10.34	2.28	2.60	1.41	5.33	4.71	8.41	1.72	6.11	0.81	2.99	0.81	2.99	1.18	3.32	0.98	2.62	3.01	3.47	3.47
Safety Factor @ nA		3.98	1.28	7.59	6.63	11.02	2.92	3.85	2.16	19.57	5.52	25.99	7.06	25.99	7.06	9.55	3.38	14.77	5.54	4.39	3.79	3.79
Total Pillar Loading under Double Abutment Loading		4.47	15.92	2.88	3.35	1.22	7.46	6.50	12.44	2.06	8.53	0.90	3.82	0.90	3.82	1.42	4.54	1.13	3.36	3.96	4.63	4.63
Safety Factor (under Double Abutment Loading)		2.95	0.83	6.00	5.16	12.72	2.08	2.79	1.46	16.34	3.95	23.34	5.53	23.34	5.53	7.93	2.48	12.86	4.32	3.32	2.84	2.84
Notes:																						
FTA Sp/T		0.011	0.015	0.010	0.011	0.010	0.013	0.012	0.015	0.010	0.013	0.009	0.011	0.009	0.011	0.010	0.011	0.009	0.011	0.011	0.011	0.011
FTA Sp(m)		0.033	0.046	0.031	0.032	0.031	0.038	0.037	0.044	0.030	0.040	0.028	0.033	0.028	0.033	0.029	0.033	0.028	0.032	0.033	0.034	0.034
FTA Sp/T (U95%)		0.065	0.069	0.064	0.065	0.064	0.067	0.066	0.069	0.064	0.067	0.063	0.065	0.063	0.065	0.064	0.065	0.063	0.065	0.065	0.065	0.065
FTA Sp (U95%)		0.195	0.208	0.193	0.194	0.193	0.200	0.199	0.206	0.192	0.202	0.190	0.195	0.190	0.195	0.191	0.195	0.190	0.194	0.195	0.196	0.196
nA Sp/T		0.013	0.029	0.011	0.012	0.010	0.016	0.015	0.024	0.011	0.018	0.009	0.012	0.009	0.012	0.010	0.013	0.010	0.012	0.012	0.013	
nA Sp(m)		0.039	0.088	0.034	0.035	0.030																

UNSW Pillar Design Spreadsheet

Wallsend Borehole - Young Wallsend Seam										Pillars in High Extraction Panels									
INPUT DATA																			
Depth of Cover (m)	45	50	20	30	20	30	20	30	20	50	60	50	60	50	60	50	60	50	60
Mining Height (m)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)	20	20	30	30	12	12	25	25	25	25	23	23	40	40	50	50	25	25	20
Pillar Width - centres (m)	20	20	30	30	12	12	24	24	25	25	18	18	17	17	20	20	20	20	20
Roadway Width for maximum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	150	150	250	250	250	250	200	200	170	170	170	170	170	170	170	170	170	170	170
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																			
Maximum Rib to Rib Pillar Length (w ₂)	15.0	15.0	25.0	25.0	7.0	7.0	20.0	20.0	20.0	20.0	18.0	18.0	35.0	35.0	45.0	45.0	20.0	20.0	15.0
Minimum Rib to Rib Pillar Width (w ₁)	15.0	15.0	25.0	25.0	7.0	7.0	19.0	19.0	20.0	20.0	13.0	13.0	12.0	12.0	15.0	15.0	15.0	15.0	15.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	15.0	15.0	25.0	25.0	7.0	7.0	19.0	19.0	20.0	20.0	13.0	13.0	12.0	12.0	15.0	15.0	15.0	15.0	15.0
Minimum Pillar Width/Height Ratio	5.0	5.0	8.3	8.3	2.3	2.3	6.3	6.3	6.7	6.7	4.3	4.3	4.0	4.0	5.0	5.0	5.0	5.0	5.0
Extraction Ratio (%)	43.8%	43.8%	30.6%	30.6%	66.0%	66.0%	36.7%	36.7%	36.0%	36.0%	43.5%	43.5%	38.2%	38.2%	32.5%	32.5%	40.0%	40.0%	43.8%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	34.413	36.275	22.942	28.098	22.942	28.098	22.942	28.098	36.275	39.737	36.275	39.737	36.275	39.737	36.275	39.737	36.275	39.737	39.737
R (Pillar 2nd Abutment Component)	0.93	0.91	1.03	1.00	0.89	0.81	1.00	1.00	0.97	0.95	0.87	0.84	0.85	0.81	0.91	0.88	0.91	0.88	0.91
Dimensionless Pillar 'Rectangularity'	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.03	1.00	1.00	1.16	1.16	1.49	1.49	1.50	1.50	1.14	1.14	1.00
Width/Height Ratio Exponent	0.67	0.67	1.00	1.00	-0.22	-0.22	1.00	1.00	1.00	1.00	0.44	0.44	0.33	0.33	0.67	0.67	0.67	0.67	1.00
Effective Width Factor (Omega)	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.03	1.00	1.00	1.07	1.07	1.14	1.14	1.31	1.31	1.09	1.09	1.00
Effective Width Interim	15.00	15.00	25.00	25.00	7.00	7.00	19.49	19.49	20.00	20.00	13.89	13.89	13.70	13.70	19.66	19.66	16.40	16.40	15.00
Effective Pillar Width (m)	15.00	15.00	25.00	25.00	7.00	7.00	19.49	19.49	20.00	20.00	13.89	13.89	13.70	13.70	19.66	19.66	16.40	16.40	15.00
Effective Pillar Loading Height (m)	45.00	50.00	20.00	30.00	20.00	30.00	20.00	30.00	50.00	60.00	50.00	60.00	50.00	60.00	50.00	60.00	50.00	60.00	60.00
RESULTS																			
Tributary Area Loading (MPa)	2.00	2.22	0.72	1.08	1.47	2.20	0.79	1.18	1.95	2.34	2.21	2.65	2.02	2.43	1.85	2.22	2.08	2.50	2.22
Tributary Area Loading x 0.5 (MPa)	1.00	1.11	0.36	0.54	0.73	1.10	0.39	0.59	0.98	1.17	1.11	1.33	1.01	1.21	0.93	1.11	1.04	1.25	1.11
Pillar Strength (UNSW Squat Pillar 1999)	13.49	13.49	21.10	21.10	NA	NA	16.01	16.01	16.53	16.53	NA	NA	NA	NA	15.49	15.49	14.12	14.12	13.49
Pillar Strength (UNSW w/h-c5)	N/A	N/A	N/A	N/A	9.22	9.22	N/A	N/A	N/A	N/A	13.08	13.08	12.99	12.99	N/A	N/A	N/A	N/A	N/A
Safety Factor under FTA Loading (Squat Pillar)	13.49	13.49	21.10	21.10	9.22	9.22	16.01	16.01	16.53	16.53	13.08	13.08	12.99	12.99	15.49	15.49	14.12	14.12	13.49
Safety Factor under FTA Loading (w/h-c5)	6.75	6.07	29.31	19.54	N/A	N/A	20.28	13.52	8.47	7.05	N/A	N/A	N/A	N/A	8.36	6.97	6.78	5.65	6.07
No. SAs, n	N/A	N/A	N/A	N/A	6.27	4.18	N/A	N/A	N/A	N/A	5.91	4.93	6.42	5.35	N/A	N/A	N/A	N/A	N/A
Single Abutment Loading (3D) - full	0.86	1.07	0.09	0.21	0.47	1.06	0.13	0.28	0.75	1.08	1.18	1.70	1.14	1.65	0.89	1.28	1.00	1.44	1.07
Single Abutment Loading (3D) - pillar	0.80	0.97	0.09	0.21	0.42	0.86	0.13	0.28	0.73	1.02	1.03	1.42	0.97	1.34	0.81	1.12	0.91	1.26	0.97
Single Abutment Loading (3D) - solid	0.06	0.10	0.00	0.00	0.05	0.20	0.00	0.00	0.02	0.06	0.15	0.28	0.17	0.31	0.08	0.16	0.09	0.18	0.10
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	2.80	3.19	0.81	1.29	1.89	3.06	0.92	1.47	2.68	3.37	3.24	4.07	2.99	3.77	2.66	3.34	2.99	3.76	3.19
Safety Factor (under Single Abutment Loading)	4.82	4.23	25.90	16.39	4.88	3.01	17.48	10.91	6.17	4.91	4.04	3.21	4.34	3.45	5.82	4.63	4.72	3.75	4.23
Total Pillar Loading @ nA	2.86	3.29	0.81	1.29	1.94	3.26	0.92	1.47	3.45	4.50	4.57	6.05	4.31	5.72	3.63	4.78	4.08	5.38	4.35
Safety Factor @ nA	4.71	4.10	25.99	16.39	4.75	2.83	17.48	10.90	4.79	3.67	2.86	2.16	3.01	2.27	4.27	3.24	3.46	2.63	3.10
Total Pillar Loading under Double Abutment Loading	3.73	4.35	0.90	1.49	2.41	4.32	1.04	1.75	3.45	4.50	4.57	6.05	4.31	5.72	3.63	4.78	4.08	5.38	4.35
Safety Factor (under Double Abutment Loading)	3.62	3.10	23.34	14.12	3.83	2.13	15.36	9.14	4.79	3.67	2.86	2.16	3.01	2.27	4.27	3.24	3.46	2.63	3.10
Notes:																			
FTA Sp/T	0.011	0.011	0.009	0.010	0.010	0.011	0.009	0.010	0.011	0.011	0.011	0.012	0.011	0.012	0.011	0.011	0.011	0.012	0.012
FTA Sp(m)	0.033	0.034	0.028	0.029	0.031	0.034	0.028	0.030	0.033	0.034	0.034	0.035	0.033	0.035	0.032	0.034	0.033	0.035	0.034
FTA Sp/T (U95%)	0.065	0.065	0.063	0.064	0.064	0.065	0.063	0.064	0.065	0.065	0.065	0.066	0.065	0.066	0.065	0.065	0.066	0.065	0.066
FTA Sp (U95%)	0.195	0.196	0.190	0.191	0.193	0.196	0.190	0.192	0.195	0.196	0.196	0.197	0.195	0.197	0.194	0.196	0.195	0.197	0.196
nA Sp/T	0.012	0.013	0.009	0.010	0.011	0.013	0.010	0.010	0.013	0.015	0.015	0.018	0.014	0.017	0.013	0.015	0.014	0.016	0.015
nA Sp(m)	0.036	0.038	0.028	0.030	0.033	0.038	0.029	0.031	0.039	0.044	0.045	0.054	0.043	0.052	0.040	0.046	0.042	0.049	0.044
nA Sp/T (U95%)	0.066	0.067	0.063	0.064	0.065	0.067	0.064	0.067	0.069	0.069	0.072	0.068	0.071	0.067	0.069	0.068	0.070	0.069	0.071
nA Sp (U95%)	0.198	0.200	0.190	0.192	0.195	0.200	0.191	0.193	0.201	0.206	0.207	0.216	0.205	0.214	0.202	0.208	0.204	0.211	0.206
Max Subs	0.79	0.79	0.55	0.55	1.19	1.19	0.66	0.65	0.65	0.78	0.78	0.69	0.59	0.72	0.69	0.69	0.72	0.79	0.79
Ecoatl(GPa)	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Efloor(GPa)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Eroof(GPa)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	1.13	1.25	0.50	0.75	0.50	0.75	0.50	0.75	1.25	1.50	1.25	1.50	1.25	1.50	1.25	1.50	1.25	1.50	1.50
Increase in vertical stress (MPa)	0.88	0.97	0.22	0.33	0.97	1.45	0.29	0.43	0.70	0.84	0.96	1.15	0.77	0.93	0.60	0.72	0.83	1.00	0.97
Pillar Compression (m)	0.001	0.001	0.000	0.000	0.001	0.002	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Roof Compression (m)	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Floor Compression (m)	0.001																		

UNSW Pillar Design Spreadsheet

Wallsend Borehole - Young Wallsend Seam																					
INPUT DATA		YW3.1.7	YW3.1.7	YW3.1.8	YW3.1.8	YW3.1.9	YW3.1.9	YW3.5.1	YW3.5.1	YW3.3.1	YW3.3.1	YW3.3.2	YW3.3.2	YW3.3.3	YW3.3.3	YW3.6.1	YW3.6.1	YW3.6.2	YW3.6.2	YW3.6.3	YW3.6.3
Depth of Cover (m)		50	50	50	50	50	50	50	50	30	30	40	40	50	50	30	30	40	40	30	30
Mining Height (m)		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)		25	25	25	25	35	35	45	45	40	40	40	35	25	25	65	65	35	35	40	40
Pillar Width - centres (m)		25	25	25	25	25	25	40	40	20	20	24	24	24	24	15	15	20	20	20	20
Roadway Width for maximum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)		170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170
SG (tonnes/m ³)		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)		10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																					
Maximum Rib to Rib Pillar Length (w ₂)		20.0	20.0	20.0	20.0	30.0	30.0	40.0	40.0	35.0	35.0	30.0	30.0	20.0	20.0	60.0	60.0	30.0	30.0	35.0	35.0
Minimum Rib to Rib Pillar Width (w ₁)		20.0	20.0	20.0	20.0	20.0	20.0	35.0	35.0	15.0	15.0	19.0	19.0	19.0	19.0	10.0	10.0	15.0	15.0	15.0	15.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)		20.0	20.0	20.0	20.0	20.0	20.0	35.0	35.0	15.0	15.0	19.0	19.0	19.0	19.0	10.0	10.0	15.0	15.0	15.0	15.0
Minimum Pillar Width/Height Ratio		6.7	6.7	6.7	6.7	6.7	6.7	11.7	11.7	5.0	5.0	6.3	6.3	6.3	6.3	3.3	3.3	5.0	5.0	5.0	5.0
Extraction Ratio (%)		36.0%	36.0%	36.0%	36.0%	31.4%	31.4%	22.2%	22.2%	34.4%	34.4%	32.1%	32.1%	36.7%	36.7%	38.5%	38.5%	35.7%	35.7%	34.4%	34.4%
Abutment Angle (Radians)		0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)		1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)		36.275	39.737	36.275	39.737	36.275	39.737	36.275	39.737	28.098	32.445	36.275	39.737	36.275	39.737	28.098	32.445	28.098	32.445	28.098	32.445
R (Pillar 2nd Abutment Component)		0.97	0.95	0.97	0.95	0.97	0.95	1.00	1.00	0.98	0.94	0.96	0.94	0.96	0.94	0.98	0.94	0.98	0.94	0.98	0.94
Dimensionless Pillar 'Rectangularity'		1.00	1.00	1.00	1.00	1.20	1.20	1.07	1.07	1.40	1.40	1.22	1.22	1.03	1.03	1.71	1.71	1.33	1.33	1.40	1.40
Width/Height Ratio Exponent		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.67	0.67	1.00	1.00	1.00	1.00	0.11	0.11	0.67	0.67	0.67	0.67
Effective Width Factor (Omega)		1.00	1.00	1.00	1.00	1.20	1.20	1.07	1.07	1.25	1.25	1.22	1.22	1.03	1.03	1.06	1.06	1.21	1.21	1.25	1.25
Effective Width Interim		20.00	20.00	20.00	20.00	24.00	24.00	37.33	37.33	18.77	18.77	23.27	23.27	19.49	19.49	10.62	10.62	18.17	18.17	18.77	18.77
Effective Pillar Width (m)		20.00	20.00	20.00	20.00	24.00	24.00	37.33	37.33	18.77	18.77	23.27	23.27	19.49	19.49	10.62	10.62	18.17	18.17	18.77	18.77
Effective Pillar Loading Height (m)		50.00	60.00	50.00	60.00	50.00	60.00	50.00	60.00	30.00	40.00	50.00	60.00	50.00	60.00	30.00	40.00	30.00	40.00	30.00	40.00
RESULTS																					
Tributary Area Loading (MPa)		1.95	2.34	1.95	2.34	1.82	2.19	1.61	1.93	1.14	1.52	1.84	2.21	1.97	2.37	1.22	1.63	1.17	1.56	1.14	1.52
Tributary Area Loading x 0.5 (MPa)		0.98	1.17	0.98	1.17	0.91	1.09	0.80	0.96	0.57	0.76	0.92	1.11	0.99	1.18	0.61	0.81	0.58	0.78	0.57	0.76
Pillar Strength (UNSW Squat Pillar 1999)		16.53	16.53	16.53	16.53	18.15	18.15	36.13	36.13	15.13	15.13	17.52	17.52	16.01	16.01	NA	NA	14.88	14.88	15.13	15.13
Pillar Strength (UNSW w/h<5)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.40	11.40	NA	NA	N/A	N/A
Safety Factor under FTA Loading (Squat Pillar)		16.53	16.53	16.53	16.53	18.15	18.15	36.13	36.13	15.13	15.13	17.52	17.52	16.01	16.01	11.40	11.40	14.88	14.88	15.13	15.13
Safety Factor under FTA Loading (w/h<5)		8.47	7.05	8.47	7.05	9.95	8.30	22.48	18.74	9.93	9.93	7.93	8.11	6.76	6.76	N/A	N/A	12.76	9.57	13.24	9.93
No. SAs, n		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.36	7.02	N/A	N/A	N/A	N/A
Single Abutment Loading (3D) - full		4	4	4	4	3	3	2	2	3	3	2	2	2	2	2	2	2	2	4	4
Single Abutment Loading (3D) - pillar		0.75	1.08	0.75	1.08	0.70	1.01	0.39	0.56	0.33	0.58	0.74	1.06	0.79	1.14	0.47	0.83	0.34	0.60	0.33	0.58
Single Abutment Loading (3D) - solid		0.73	1.02	0.73	1.02	0.68	0.96	0.39	0.56	0.32	0.55	0.71	0.99	0.76	1.07	0.42	0.70	0.33	0.56	0.32	0.55
Cell Sensitivity (MPa)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading		2.68	3.37	2.68	3.37	2.50	3.14	1.99	2.48	1.46	2.08	2.55	3.21	2.73	3.43	1.64	2.33	1.49	2.12	1.46	2.08
Safety Factor (under Single Abutment Loading)		6.17	4.91	6.17	4.91	7.25	5.77	18.13	14.55	10.33	7.29	6.87	5.47	5.86	4.66	6.96	4.90	9.96	7.02	10.33	7.29
Total Pillar Loading @ nA		4.95	6.66	4.95	6.66	3.92	5.21	2.38	3.04	2.13	3.28	3.32	4.33	3.55	4.64	2.15	3.29	1.84	2.75	2.46	3.58
Safety Factor @ nA		3.34	2.48	3.34	2.48	4.63	3.48	15.19	11.89	7.10	4.61	5.29	4.05	4.51	3.45	5.29	3.47	8.09	5.41	6.15	3.92
Total Pillar Loading under Double Abutment Loading		3.45	4.50	3.45	4.50	3.22	4.20	2.38	3.04	1.80	2.69	3.32	4.33	3.55	4.64	2.15	3.29	1.84	2.75	1.80	2.69
Safety Factor (under Double Abutment Loading)		4.79	3.67	4.79	3.67	5.63	4.32	15.19	11.89	8.40	5.62	5.29	4.05	4.51	3.45	5.29	3.47	8.09	5.41	8.40	5.62
Notes:																					
FTA Sp/T		0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.011	0.010	0.010	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010
FTA Sp(m)		0.033	0.034	0.033	0.034	0.032	0.034	0.031	0.032	0.029	0.031	0.032	0.034	0.033	0.034	0.030	0.031	0.030	0.031	0.029	0.031
FTA Sp/T (U95%)		0.065	0.065	0.065	0.065	0.065	0.065	0.064	0.065	0.064	0.064	0.065	0.065	0.065	0.065	0.064	0.064	0.064	0.064	0.064	0.064
FTA Sp (U95%)		0.195	0.196	0.195	0.196	0.194	0.196	0.193	0.194	0.191	0.193	0.194	0.196	0.195	0.196	0.192	0.193	0.192	0.193	0.191	0.193
nA Sp/T		0.016	0.019	0.016	0.019	0.014	0.016	0.011	0.012	0.011	0.013	0.013	0.015	0.013	0.015	0.011	0.013	0.011	0.012	0.012	0.014
nA Sp(m)		0.047	0.058	0.047	0.058	0.041	0.048	0.034	0.037	0.033	0.038	0.038	0.044	0.040	0.045	0.033	0.038	0.032	0.036	0.035	0.041
nA Sp/T (U95%)		0.070	0.073	0.070	0.073	0.068	0.070	0.065	0.066	0.065	0.067	0.067	0.069	0.067	0.069	0.065	0.067	0.065	0.066	0.066	0.068
nA Sp (U95%)		0.209	0.220	0.209	0.220	0.203	0.210	0.196	0.199	0.195	0.200	0.200	0.206	0.202	0.207	0.195	0.200	0.194	0.196	0.197	0.203
Max Subs		0.65	0.65	0.65	0.65	0.57	0.57	0.40	0.40	0.62	0.62	0.58	0.58	0.66	0.66	0.64	0.64	0.62	0.62	0.62	0.62
Ecoatl(GPa)		2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Efloor(GPa)		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Eroof(GPa)		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Poissons Ratio floor/roof		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)		1.25	1.50</																		

UNSW Pillar Design Spreadsheet

Wallsend Borehole - Young Wallsend Seam										
INPUT DATA										
Depth of Cover (m)	30	40	20	30	20	30	20	30	100	115
Mining Height (m)	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)	30	30	35	35	27	30	30	130	130	130
Pillar Width - centres (m)	18	18	18	18	15	15	27	15	15	15
Roadway Width for maximum pillar dimension	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	170	170	170	170	170	170	170	120	120	120
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS										
Maximum Rib to Rib Pillar Length (w ₂)	25.0	25.0	30.0	30.0	22.0	22.0	25.0	25.0	125.0	125.0
Minimum Rib to Rib Pillar Width (w ₁)	13.0	13.0	13.0	13.0	10.0	10.0	22.0	22.0	10.0	10.0
w, Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	13.0	13.0	13.0	13.0	10.0	10.0	22.0	22.0	10.0	10.0
Minimum Pillar Width/Height Ratio	4.3	4.3	4.3	4.3	3.3	3.3	7.3	7.3	3.3	3.3
Extraction Ratio (%)	39.8%	39.8%	38.1%	38.1%	45.7%	45.7%	32.1%	32.1%	35.9%	35.9%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	28.098	32.445	22.942	28.098	22.942	28.098	22.942	28.098	51.300	55.013
R (Pillar 2nd Abutment Component)	0.95	0.91	0.99	0.95	0.96	0.90	1.01	1.00	0.65	0.62
Dimensionless Pillar 'Rectangularity'	1.32	1.32	1.40	1.40	1.38	1.38	1.06	1.06	1.85	1.85
Width/Height Ratio Exponent	0.44	0.44	0.44	0.44	0.11	0.11	1.00	1.00	0.11	0.11
Effective Width Factor (Omega)	1.13	1.13	1.16	1.16	1.04	1.04	1.06	1.06	1.07	1.07
Effective Width Interim	14.69	14.69	15.07	15.07	10.36	10.36	23.40	23.40	10.71	10.71
Effective Pillar Width (m)	14.69	14.69	15.07	15.07	10.36	10.36	23.40	23.40	10.71	10.71
Effective Pillar Loading Height (m)	30.00	40.00	20.00	30.00	20.00	30.00	20.00	30.00	100.00	115.00
RESULTS										
Tributary Area Loading (MPa)	1.25	1.66	0.81	1.21	0.92	1.38	0.74	1.10	3.90	4.49
Tributary Area Loading x 0.5 (MPa)	0.62	0.83	0.40	0.61	0.46	0.69	0.37	0.55	1.95	2.24
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	NA	NA	NA	NA	18.76	18.76	NA	NA
Pillar Strength (UNSW w/h<5)	13.45	13.45	13.63	13.63	11.26	11.26	N/A	N/A	11.45	11.45
Safety Factor under FTA Loading (Squat Pillar)	13.45	13.45	13.63	13.63	11.26	11.26	18.76	18.76	11.45	11.45
Safety Factor under FTA Loading (w/h<5)	N/A	N/A	N/A	N/A	N/A	N/A	25.48	16.99	N/A	N/A
No. SAs, n	10.80	8.10	16.58	11.25	12.23	8.16	N/A	N/A	2.94	2.55
Single Abutment Loading (3D) - full	0.40	0.71	0.17	0.39	0.24	0.53	0.10	0.24	4.99	6.60
Single Abutment Loading (3D) - pillar	0.38	0.65	0.17	0.37	0.23	0.48	0.11	0.24	3.22	4.06
Single Abutment Loading (3D) - solid	0.02	0.06	0.00	0.02	0.01	0.05	0.00	0.00	1.77	2.54
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	1.63	2.31	0.98	1.58	1.15	1.86	0.84	1.34	7.12	8.55
Safety Factor (under Single Abutment Loading)	8.27	5.83	13.94	8.62	9.82	6.06	22.29	14.00	1.61	1.34
Total Pillar Loading @ nA	2.84	4.50	1.50	2.76	1.39	2.44	1.05	1.81	13.88	17.68
Safety Factor @ nA	4.74	2.99	9.11	4.94	8.09	4.61	17.86	10.36	0.83	0.65
Total Pillar Loading under Double Abutment Loading	2.04	3.08	1.15	1.99	1.39	2.44	0.95	1.58	13.88	17.68
Safety Factor (under Double Abutment Loading)	6.58	4.37	11.83	6.86	8.09	4.61	19.84	11.91	0.83	0.65
Notes:										
FTA Sp/T	0.010	0.010	0.009	0.010	0.010	0.010	0.009	0.010	0.014	0.015
FTA Sp(m)	0.030	0.031	0.028	0.030	0.029	0.030	0.028	0.029	0.041	0.044
FTA Sp/T (U95%)	0.064	0.064	0.063	0.064	0.064	0.064	0.063	0.064	0.068	0.069
FTA Sp (U95%)	0.192	0.193	0.190	0.192	0.191	0.192	0.190	0.191	0.203	0.206
nA Sp/T	0.012	0.015	0.010	0.012	0.010	0.012	0.010	0.011	0.043	0.064
nA Sp(m)	0.036	0.044	0.031	0.036	0.030	0.035	0.029	0.032	0.130	0.191
nA Sp/T (U95%)	0.066	0.069	0.064	0.066	0.064	0.066	0.064	0.065	0.097	0.118
nA Sp (U95%)	0.198	0.206	0.193	0.198	0.192	0.197	0.191	0.194	0.292	0.353
Max Subs	0.72	0.72	0.69	0.69	0.82	0.58	0.82	0.58	0.65	0.65
Ecoal(GPa)	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Etfloor(GPa)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Eeroof(GPa)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	0.75	1.00	0.50	0.75	0.50	0.75	0.50	0.75	2.50	2.88
increase in vertical stress (MPa)	0.50	0.66	0.31	0.46	0.42	0.63	0.24	0.35	1.40	1.61
Pillar Compression (m)	0.001	0.001	0.000	0.001	0.000	0.001	0.000	0.000	0.002	0.002
Roof Compression (m)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.004
Floor Compression (m)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.004
Total Elastic Compression (m)	0.002	0.003	0.002	0.002	0.002	0.003	0.001	0.002	0.009	0.010
Yielded Pillars (m)	0.012	0.016	0.008	0.012	0.009	0.013	0.007	0.011	0.646	0.646
Smax/T	0.003	0.005	0.002	0.003	0.003	0.004	0.002	0.003	0.189	0.189
Smin/T	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.003	0.003

UNSW Pillar Design Spreadsheet

Gretley - Young Wallsend Seam		FWs Panels																			
INPUT DATA		GY1.1	GY1.1	GY1.1	GY1.1	GY1.1	GY1.1	GY1.2	GY1.2	GY1.3	GY1.3	GY1.4	GY1.4	GY1.5	GY1.5	GY1.5	GY1.5	GY1.6	GY1.6	GY1.7	GY1.7
Depth of Cover (m)	50	50	50	50	50	50	50	60	70	50	60	90	110	70	80	70	80	80	100	60	70
Mining Height (m)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)	18	18	27	27	25	25	34	34	42	42	30	30	30	30	30	27	27	30	30	30	30
Pillar Width - centres (m)	17	17	17	17	15	15	15	15	15	12	12	25	25	10	10	25	25	20	20	12	12
Roadway Width for maximum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																					
Maximum Rib to Rib Pillar Length (w ₂)	13.0	13.0	22.0	22.0	20.0	20.0	29.0	29.0	37.0	37.0	25.0	25.0	25.0	25.0	22.0	22.0	25.0	25.0	25.0	25.0	25.0
Minimum Rib to Rib Pillar Width (w ₁)	12.0	12.0	12.0	12.0	10.0	10.0	10.0	10.0	7.0	7.0	20.0	20.0	5.0	5.0	20.0	20.0	15.0	15.0	7.0	7.0	7.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	12.0	12.0	12.0	12.0	10.0	10.0	10.0	10.0	7.0	7.0	20.0	20.0	5.0	5.0	20.0	20.0	15.0	15.0	7.0	7.0	7.0
Minimum Pillar Width/Height Ratio	4.0	4.0	4.0	4.0	3.3	3.3	3.3	3.3	2.3	2.3	6.7	6.7	1.7	1.7	6.7	6.7	5.0	5.0	2.3	2.3	2.3
Extraction Ratio (%)	49.0%	49.0%	42.5%	42.5%	46.7%	46.7%	43.1%	43.1%	48.6%	48.6%	33.3%	33.3%	58.3%	58.3%	34.8%	34.8%	37.5%	37.5%	51.4%	51.4%	51.4%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	36.275	48.667	36.275	48.667	28.098	32.445	39.737	42.921	36.275	42.303	48.667	53.804	42.921	45.884	42.921	45.884	51.300	39.737	42.921	42.921	42.921
R (Pillar 2nd Abutment Component)	0.85	0.72	0.85	0.72	0.90	0.84	0.76	0.72	0.70	0.63	0.88	0.85	0.55	0.52	0.93	0.91	0.82	0.77	0.66	0.63	0.63
Dimensionless Pillar 'Rectangularity'	1.04	1.04	1.29	1.29	1.33	1.33	1.49	1.49	1.68	1.68	1.11	1.11	1.67	1.67	1.05	1.05	1.25	1.25	1.56	1.56	1.56
Width/Height Ratio Exponent	0.33	0.33	0.33	0.33	0.11	0.11	0.11	0.11	-0.22	-0.22	1.00	1.00	-0.44	-0.44	1.00	1.00	0.67	0.67	-0.22	-0.22	-0.22
Effective Width Factor (Omega)	1.01	1.01	1.09	1.09	1.03	1.03	1.05	1.05	0.89	0.89	1.11	1.11	0.80	0.80	1.05	1.05	1.16	1.16	0.91	0.91	0.91
Effective Width Interim	12.16	12.16	13.08	13.08	10.32	10.32	10.45	10.45	6.24	6.24	22.22	22.22	3.98	3.98	20.95	20.95	17.41	17.41	6.34	6.34	6.34
Effective Pillar Width (m)	12.16	12.16	13.08	13.08	10.32	10.32	10.45	10.45	7.00	7.00	22.22	22.22	5.00	5.00	20.95	20.95	17.41	17.41	7.00	7.00	7.00
Effective Pillar Loading Height (m)	50.00	90.00	50.00	90.00	30.00	40.00	60.00	70.00	50.00	68.00	90.00	110.00	70.00	80.00	70.00	80.00	80.00	100.00	60.00	70.00	70.00
RESULTS																					
Tributary Area Loading (MPa)	2.45	4.41	2.17	3.91	1.41	1.88	2.64	3.08	2.43	3.31	3.38	4.13	4.20	4.80	2.68	3.07	3.20	4.00	3.09	3.60	3.60
Tributary Area Loading x 0.5 (MPa)	1.23	2.21	1.09	1.96	0.70	0.94	1.32	1.54	1.22	1.65	1.69	2.06	2.10	2.40	1.34	1.53	1.60	2.00	1.54	1.80	1.80
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17.45	17.45	NA	NA	16.93	16.93	14.56	14.56	NA	NA	NA
Pillar Strength (UNSW w/h<5)	12.22	12.22	12.68	12.68	11.24	11.24	11.31	11.31	9.22	9.22	NA	NA	7.77	7.77	NA	NA	NA	NA	9.22	9.22	9.22
Safety Factor under FTA Loading (Squat Pillar)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.17	4.23	NA	NA	6.31	5.52	4.55	3.64	NA	NA	NA
Safety Factor under FTA Loading (w/h<5)	4.98	2.77	5.83	3.24	7.99	6.00	4.29	3.68	3.79	2.79	NA	NA	1.85	1.62	NA	NA	NA	NA	2.99	2.56	2.56
No. SAs, n	1	1	1	1	1	1	2	2	1	1	1	1	2	2	3	3	2	2	1	1	1
Single Abutment Loading (3D) - full	1.38	4.48	1.23	3.97	0.54	0.96	2.03	2.76	1.95	3.60	2.33	3.48	5.64	7.37	1.44	1.88	2.46	3.84	2.96	4.03	4.03
Single Abutment Loading (3D) - pillar	1.18	3.25	1.04	2.88	0.49	0.81	1.54	2.00	1.36	2.28	2.06	2.95	3.10	3.84	1.34	1.71	2.02	2.97	1.95	2.52	2.52
Single Abutment Loading (3D) - solid	0.21	1.24	0.18	1.10	0.05	0.15	0.49	0.76	0.58	1.32	0.27	0.53	2.55	3.53	0.11	0.18	0.44	0.87	1.01	1.51	1.51
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	3.63	7.66	3.22	6.79	1.89	2.69	4.17	5.08	3.79	5.58	5.44	7.07	7.30	8.64	4.02	4.77	5.22	6.97	5.04	6.12	6.12
Safety Factor (under Single Abutment Loading)	3.37	1.59	3.94	1.87	5.94	4.19	2.71	2.23	2.43	1.65	3.21	2.47	1.06	0.90	4.21	3.55	2.79	2.09	1.83	1.51	1.51
Total Pillar Loading @ nA	3.84	8.90	3.40	7.89	1.95	2.83	6.69	8.59	4.38	6.91	5.71	7.61	15.49	19.54	7.01	8.72	8.11	11.68	6.05	7.63	7.63
Safety Factor @ nA	3.19	1.37	3.73	1.61	5.78	3.97	1.69	1.32	2.11	1.34	3.06	2.29	0.50	0.40	2.41	1.94	1.79	1.25	1.52	1.21	1.21
Total Pillar Loading under Double Abutment Loading	5.22	13.38	4.63	11.86	2.49	3.79	6.69	8.59	6.32	10.50	8.04	11.09	15.49	19.54	5.57	6.84	8.11	11.68	9.01	11.66	11.66
Safety Factor (under Double Abutment Loading)	2.34	0.91	2.74	1.07	4.52	2.96	1.69	1.32	1.46	0.88	2.17	1.57	0.50	0.40	3.04	2.48	1.79	1.25	1.02	0.79	0.79
Notes:																					
FTA Sp/T	0.012	0.015	0.011	0.014	0.010	0.011	0.012	0.012	0.012	0.013	0.013	0.014	0.014	0.015	0.012	0.012	0.013	0.014	0.012	0.013	0.013
FTA Sp(m)	0.035	0.044	0.033	0.041	0.030	0.032	0.035	0.037	0.035	0.038	0.039	0.042	0.043	0.046	0.036	0.037	0.038	0.042	0.037	0.040	0.040
FTA Sp/T (U95%)	0.066	0.069	0.065	0.068	0.064	0.065	0.066	0.066	0.066	0.067	0.067	0.068	0.068	0.069	0.066	0.066	0.067	0.068	0.066	0.067	0.067
FTA Sp (U95%)	0.197	0.206	0.195	0.203	0.192	0.194	0.197	0.199	0.197	0.200	0.201	0.204	0.205	0.208	0.198	0.199	0.200	0.204	0.199	0.202	0.202
nA Sp/T	0.014	0.025	0.013	0.022	0.011	0.012	0.019	0.024	0.015	0.020	0.017	0.021	0.051	0.075	0.020	0.024	0.023	0.034	0.018	0.022	0.022
nA Sp(m)	0.041	0.075	0.039	0.067	0.033	0.036	0.058	0.072	0.044	0.059	0.051	0.064	0.154	0.226	0.060	0.073	0.068	0.103	0.054	0.065	0.065
nA Sp/T (U95%)	0.068	0.079	0.067	0.076	0.065	0.066	0.073	0.078	0.069	0.074	0.071	0.075	0.105	0.129	0.074	0.078	0.077	0.088	0.072		

UNSW Pillar Design Spreadsheet

Gretley - Young Walsend Seam	Partial Extraction Panels - Split and Lifted Pillars																											
INPUT DATA			G1Y1.8						G1Y1.9						G1Y2.0													
Depth of Cover (m)	60	70	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30								
Mining Height (m)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3								
Pillar Length - centres (m)	30	30	27	27	27	27	27	27	27	28	28	25	25	15	15	31	31	33	33	30								
Pillar Width - centres (m)	30	30	12	12	12	12	12	12	12	14	14	15	15	15	15	15	15	10	10	10								
Roadway Width for maximum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5								
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5								
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90								
Average Panel Span (m) [rib-rib width]	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300								
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5								
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000								
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21								
INTERMEDIATE CALCULATIONS																												
Maximum Rib to Rib Pillar Length (w_2)	25.0	25.0	22.0	22.0	22.0	22.0	22.0	22.0	23.0	23.0	20.0	20.0	10.0	10.0	26.0	26.0	28.0	28.0	25.0	25.0								
Minimum Rib to Rib Pillar Width (w_1)	25.0	25.0	7.0	7.0	7.0	7.0	7.0	7.0	9.0	9.0	10.0	10.0	10.0	10.0	10.0	5.0	5.0	5.0	5.0	5.0								
$w_1 \text{ Minimum Rib to Rib Pillar Width } (ie w_1 sin\theta)$	25.0	25.0	7.0	7.0	7.0	7.0	7.0	7.0	9.0	9.0	10.0	10.0	10.0	10.0	10.0	5.0	5.0	5.0	5.0	5.0								
Minimum Pillar Width/Height Ratio	8.3	8.3	2.3	2.3	2.3	2.3	2.3	2.3	3.0	3.0	3.3	3.3	3.3	3.3	3.3	1.7	1.7	1.7	1.7	1.7								
Extraction Ratio (%)	30.6%	30.6%	52.5%	52.5%	52.5%	52.5%	52.5%	52.5%	47.2%	47.2%	46.7%	46.7%	55.6%	55.6%	44.1%	57.6%	57.6%	58.3%	58.3%	58.3%								
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367								
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571								
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes								
D (Peng & Chiang Loading Factor)	39.737	42.921	28.098	36.275	28.098	36.275	28.098	36.275	45.884	51.300	48.667	53.804	45.884	51.300	45.884	51.300	56.196	51.300	56.196	51.300								
R (Pillar 2nd Abutment Component)	0.99	0.97	0.81	0.70	0.81	0.70	0.81	0.70	0.66	0.62	0.67	0.62	0.70	0.65	0.70	0.65	0.48	0.44	0.48	0.44								
Dimensionless Pillar 'Rectangularity'	1.00	1.00	1.52	1.52	1.52	1.52	1.52	1.52	1.44	1.33	1.32	1.33	1.00	1.00	1.44	1.44	1.40	1.70	1.67	1.67								
Width/Height Ratio Exponent	1.00	1.00	-0.22	-0.22	-0.2																							

UNSW Pillar Design Spreadsheet

[illegible]

INTERMEDIATE CALCULATIONS																			
Maximum Rib to Rib Pillar Length (w_2)	20.0	20.0	22.0	22.0	10.0	10.0	25.0	25.0	20.0	20.0	25.0	25.0	15.0	15.0	25.0	25.0	25.0	25.0	25.0
Minimum Rib to Rib Pillar Width (w_1)	15.0	15.0	11.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0	6.0	6.0	12.0	12.0	8.0	8.0	8.0	8.0	9.0
w_1 , Minimum Rib to Rib Pillar Width (ie $w_1 \sin\theta$)	15.0	15.0	11.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0	6.0	6.0	12.0	12.0	8.0	8.0	8.0	8.0	9.0
Minimum Pillar Width/Height Ratio	5.0	5.0	3.7	3.7	3.3	3.3	3.3	3.3	3.3	3.3	2.0	2.0	4.0	4.0	2.7	2.7	2.7	2.7	3.0
Extraction Ratio (%)	40.0%	40.0%	44.0%	44.0%	55.6%	55.6%	44.4%	44.4%	46.7%	46.7%	54.5%	54.5%	47.1%	47.1%	48.7%	48.7%	48.7%	48.7%	46.4%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	42.921	45.884	51.300	56.196	51.300	56.196	42.921	45.884	39.737	42.921	39.737	42.921	39.737	42.921	39.737	42.921	39.737	42.921	42.921
R (Pillar 2nd Abutment Component)	0.85	0.82	0.67	0.63	0.65	0.61	0.72	0.70	0.76	0.72	0.62	0.59	0.81	0.78	0.70	0.66	0.70	0.66	0.69
Dimensionless Pillar 'Rectangularity'	1.14	1.14	1.33	1.33	1.00	1.00	1.43	1.43	1.33	1.33	1.61	1.61	1.11	1.11	1.52	1.52	1.52	1.52	1.47
Width/Height Ratio Exponent	0.67	0.67	0.22	0.22	1.00	1.11	0.11	0.11	0.11	0.11	-0.33	-0.33	0.33	0.33	-0.11	-0.11	-0.11	-0.11	0.00
Effective Width Factor (Omega)	1.09	1.09	1.07	1.07	1.00	1.00	1.04	1.04	1.03	1.03	0.85	0.85	1.04	1.04	0.95	0.95	0.95	0.95	1.00
Effective Width Interim	16.40	16.40	11.73	11.73	10.00	10.00	10.40	10.40	10.32	10.32	5.12	5.12	12.43	12.43	7.64	7.64	7.64	7.64	9.00
Effective Pillar Width (m)	16.40	16.40	11.73	11.73	10.00	10.00	10.40	10.40	10.32	10.32	6.00	6.00	12.43	12.43	8.00	8.00	8.00	8.00	9.00
Effective Pillar Loading Height (m)	70.00	80.00	100.00	120.00	100.00	120.00	70.00	80.00	60.00	70.00	60.00	70.00	60.00	70.00	60.00	70.00	60.00	70.00	70.00

RESULTS																				
Tributary Area Loading (MPa)	2.92	3.33	4.46	5.36	5.63	6.75	3.15	3.60	2.81	3.28	3.30	3.85	2.83	3.31	2.93	3.41	2.93	3.41	2.80	3.27
Tributary Area Loading x 0.5 (MPa)	1.46	1.67	2.23	2.68	2.81	3.38	1.58	1.80	1.41	1.64	1.65	1.93	1.42	1.65	1.46	1.71	1.46	1.71	1.40	1.63
Pillar Strength (UNSW Squat Pillar 1999)	14.12	14.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h<5)	N/A	N/A	11.99	11.99	11.06	11.06	11.28	11.28	11.24	11.24	8.52	8.52	12.36	12.36	9.87	9.87	9.87	9.87	10.48	10.48
Safety Factor under FTA Loading (Squat Pillar)	14.12	14.12	11.99	11.99	11.06	11.06	11.28	11.28	11.24	11.24	8.52	8.52	12.36	12.36	9.87	9.87	9.87	9.87	10.48	10.48
Safety Factor under FTA Loading (w/h<5)	4.84	4.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No. SAs, n	N/A	N/A	2.69	2.24	1.97	1.64	3.58	3.13	4.00	3.43	2.58	2.21	4.36	3.74	3.37	2.89	3.37	2.89	3.74	3.21
Single Abutment Loading (3D) - full	1	1	1	1	1	1	1	1	1	1	1	1	3	3	3	3	1	1	1	1
Single Abutment Loading (3D) - pillar	1.96	2.56	5.35	7.71	7.20	10.36	2.82	3.69	2.16	2.94	3.45	4.70	1.92	2.61	2.59	3.53	2.59	3.53	2.30	3.13
Single Abutment Loading (3D) - solid	1.66	2.10	3.61	4.89	4.65	6.28	2.04	2.56	1.64	2.13	2.15	2.77	1.56	2.04	1.80	2.33	1.80	2.33	1.68	2.18
Cell Sensitivity (MPa)	0.30	0.46	1.74	2.82	2.55	4.08	0.78	1.12	0.52	0.81	1.31	1.93	0.36	0.58	0.79	1.19	0.79	1.19	0.63	0.96
Total Pillar Loading with Single Abutment Loading	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Safety Factor (under Single Abutment Loading)	4.58	5.43	8.07	10.24	10.27	13.03	5.19	6.16	4.45	5.41	5.45	6.62	4.39	5.34	4.73	5.74	4.73	5.74	4.48	5.44
Total Pillar Loading @ nA	3.08	2.60	1.49	1.17	1.08	0.85	2.17	1.83	2.53	2.08	1.56	1.29	2.81	2.31	2.09	1.72	2.09	1.72	2.34	1.93
Safety Factor @ nA	4.88	5.89	9.82	13.06	12.82	17.11	5.97	7.29	4.97	6.22	6.25	8.55	8.59	11.14	10.70	13.99	10.70	13.99	5.10	6.40
Total Pillar Loading under Double Abutment Loading	2.90	2.40	1.22	0.92	0.86	0.65	1.89	1.55	2.26	1.81	1.26	1.00	1.44	1.11	0.92	0.71	0.92	0.71	1.42	1.64
Safety Factor (under Double Abutment Loading)	6.84	8.45	15.17	20.77	20.02	27.48	8.79	10.97	7.13	9.16	10.21	13.25	6.67	8.53	8.11	10.47	8.11	10.47	7.41	9.54
	2.07	1.67	0.79	0.58	0.55	0.40	1.28	1.03	1.58	1.23	0.83	0.64	1.85	1.45	1.22	0.94	1.22	0.94	1.42	1.10

Notes:

Smax/T	FTA Sp/T	0.012	0.013	0.015	0.016	0.017	0.019	0.013	0.013	0.012	0.013	0.013	0.014	0.012	0.013	0.012	0.013	0.012	0.013	0.012	0.013
	FTA Sp(m)	0.037	0.039	0.044	0.049	0.051	0.058	0.038	0.040	0.036	0.038	0.038	0.041	0.036	0.038	0.037	0.039	0.037	0.039	0.036	0.038
	FTA Sp/T (U95%)	0.066	0.067	0.069	0.070	0.071	0.073	0.067	0.067	0.066	0.067	0.067	0.068	0.066	0.067	0.066	0.067	0.066	0.067	0.066	0.067
	FTA Sp (U95%)	0.199	0.201	0.206	0.211	0.213	0.220	0.200	0.202	0.198	0.200	0.200	0.203	0.198	0.200	0.199	0.201	0.199	0.201	0.198	0.200
	nA Sp/T	0.016	0.018	0.028	0.040	0.039	0.060	0.018	0.021	0.016	0.018	0.019	0.024	0.024	0.032	0.031	0.044	0.017	0.020	0.016	0.019
	nA Sp(m)	0.047	0.053	0.083	0.119	0.116	0.181	0.053	0.062	0.047	0.055	0.058	0.072	0.072	0.097	0.092	0.132	0.050	0.060	0.048	0.056
	nA Sp/T (U95%)	0.070	0.072	0.082	0.094	0.093	0.114	0.072	0.075	0.070	0.072	0.073	0.078	0.078	0.086	0.085	0.098	0.071	0.074	0.070	0.073
	nA Sp (U95%)	0.209	0.215	0.245	0.281	0.278	0.343	0.215	0.224	0.209	0.217	0.220	0.224	0.234	0.259	0.254	0.294	0.212	0.222	0.210	0.218
	Max Subs	0.72	0.72	0.79	0.79	1.00	1.00	0.80	0.80	0.84	0.84	0.98	0.98	0.85	0.85	0.88	0.88	0.88	0.88	0.84	0.84
	Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Initial vertical stress (MPa)	1.75	2.00	2.50	3.00	2.50	3.00	1.75	2.00	1.50	1.75	1.50	1.75	1.50	1.75	1.50	1.75	1.50	1.75	1.50	1.75
	Increase in vertical stress (MPa)	1.17	1.33	1.96	2.36	1.17	1.33	0.75	1.40	1.50	1.31	1.53	1.80	2.10	1.33	1.56	1.43	1.66	1.30	1.52	1.50
Pillar Compression (m)	0.002	0.002	0.003	0.003	0.005	0.005	0.004	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	
Roof Compression (m)	0.004	0.004	0.005	0.006	0.005	0.006	0.004	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	
Floor Compression (m)	0.004	0.004	0.005	0.006	0.005	0.006	0.004	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	
Total Elastic Compression (m)	0.009	0.010	0.013	0.016	0.015	0.018	0.009	0.011	0.008	0.010	0.009	0.011	0.008	0.009	0.008	0.010	0.008	0.010	0.008	0.010	
Yielded Pillars (m)	0.043	0.049	0.792	0.792	1.000	1.000	0.047	0.053	0.041	0.048	0.982	0.982	0.040	0.047	0.042	0.049	0.042	0.049	0.041	0.048	
	0.013	0.014	0.231	0.231	0.292	0.292	0.014	0.016	0.012	0.014	0.287	0.287	0.012	0.014	0.012	0.014	0.012	0.014	0.012	0.014	
Smin/T		0.003	0.003	0.004	0.005	0.005	0.006	0.003	0.004	0.003	0.003	0.003	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	

UNSW Pillar Design Spreadsheet

Gretley - Young Wallsend Seam		Pillars in High Extraction Panels																			
INPUT DATA		GY3.1.1	GY3.1.1	GY3.1.2	GY3.1.2	GY3.1.3	GY3.1.3	GY3.1.4	GY3.1.4	GY3.1.5	GY3.1.5	GY3.1.6	GY3.1.6	GY3.1.7	GY3.1.7	GY3.1.8	GY3.1.8	9	9	10	10
Depth of Cover (m)	60	70	90	100	90	100	90	100	90	100	90	100	90	100	90	100	90	100	100	100	
Mining Height (m)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Pillar Length - centres (m)	350	350	27	27	30	30	32	32	31	31	31	31	35	35	15	15	15	15	33	33	
Pillar Width - centres (m)	15	15	27	27	15	15	15	15	18	18	15	15	15	15	15	15	15	15	15	15	
Roadway Width for maximum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	
Average Panel Span (m) (rib-rib width)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
SG (tonnes/m²)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
INTERMEDIATE CALCULATIONS																					
Maximum Rib to Rib Pillar Length (w₂)	345.0	345.0	22.0	22.0	25.0	25.0	27.0	27.0	26.0	26.0	26.0	26.0	30.0	30.0	10.0	10.0	10.0	10.0	28.0	28.0	
Minimum Rib to Rib Pillar Width (w₁)	10.0	10.0	22.0	22.0	10.0	10.0	10.0	10.0	13.0	13.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	
w₁ Minimum Rib to Rib Pillar Width (ie w₁sinθ)	10.0	10.0	22.0	22.0	10.0	10.0	10.0	10.0	13.0	13.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	
Minimum Pillar Width/Height Ratio	3.3	3.3	7.3	7.3	3.3	3.3	3.3	3.3	4.3	4.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
Extraction Ratio (%)	34.3%	34.3%	33.6%	33.6%	44.4%	44.4%	43.8%	43.8%	39.4%	39.4%	44.1%	44.1%	42.9%	42.9%	55.6%	55.6%	55.6%	55.6%	43.4%	43.4%	
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
D (Peng & Chiang Loading Factor)	39.737	42.921	48.667	51.300	48.667	51.300	48.667	51.300	48.667	51.300	48.667	51.300	51.300	53.804	51.300	53.804	51.300	53.804	51.300	53.804	
R (Pillar 2nd Abutment Component)	0.76	0.72	0.91	0.89	0.67	0.65	0.67	0.65	0.73	0.67	0.65	0.65	0.62	0.65	0.62	0.65	0.62	0.65	0.62	0.62	
Dimensionless Pillar 'Rectangularity'	1.94	1.94	1.00	1.00	1.43	1.43	1.46	1.46	1.33	1.33	1.44	1.44	1.50	1.50	1.00	1.00	1.00	1.00	1.47	1.47	
Width/Height Ratio Exponent	0.11	0.11	1.00	1.00	0.11	0.11	0.11	0.11	0.44	0.44	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
Effective Width Factor (Omega)	1.08	1.08	1.00	1.00	1.04	1.04	1.04	1.04	1.14	1.14	1.04	1.04	1.05	1.05	1.00	1.00	1.00	1.00	1.04	1.04	
Effective Width Interim	10.77	10.77	22.00	22.00	10.40	10.40	10.43	10.43	14.77	14.77	10.42	10.42	10.46	10.46	10.00	10.00	10.00	10.00	10.44	10.44	
Effective Pillar Width (m)	10.77	10.77	22.00	22.00	10.40	10.40	10.43	10.43	14.77	14.77	10.42	10.42	10.46	10.46	10.00	10.00	10.00	10.00	10.44	10.44	
Effective Pillar Loading Height (m)	60.00	70.00	90.00	100.00	90.00	100.00	90.00	100.00	90.00	100.00	90.00	100.00	100.00	110.00	100.00	110.00	100.00	110.00	100.00	110.00	
RESULTS																					
Tributary Area Loading (MPa)	2.28	2.66	3.39	3.77	4.05	4.50	4.00	4.44	3.71	4.13	4.02	4.47	4.38	4.81	5.63	6.19	5.63	6.19	4.42	4.86	
Tributary Area Loading x 0.5 (MPa)	1.14	1.33	1.69	1.88	2.03	2.25	2.00	2.22	1.86	2.06	2.01	2.24	2.19	2.41	2.81	3.09	2.81	3.09	2.21	2.43	
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	18.18	18.18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Pillar Strength (UNSW w/h<5)	11.48	11.48	N/A	N/A	11.28	11.28	11.30	11.30	13.49	13.49	11.29	11.29	11.32	11.32	11.06	11.06	11.06	11.06	11.30	11.30	
Safety Factor under FTA Loading (Squat Pillar)	N/A	N/A	5.36	4.83	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Safety Factor under FTA Loading (w/h<5)	5.03	4.31	N/A	N/A	2.79	2.51	2.82	2.54	3.63	3.27	2.81	2.53	2.59	2.35	1.97	1.79	1.97	1.79	2.56	2.33	
No. SAs, n	1	3	3	3	1	1	2	2	3	3	3	3	4	3	3	3	3	3	3	3	
Single Abutment Loading (3D) - full	1.75	2.39	2.17	2.68	4.66	5.76	4.61	5.69	3.56	4.40	4.63	5.72	5.60	6.77	7.20	8.71	7.20	8.71	5.66	6.84	
Single Abutment Loading (3D) - pillar	1.33	1.73	1.98	2.39	3.12	3.72	3.08	3.67	2.67	3.20	3.10	3.69	3.61	4.23	4.65	5.44	4.65	5.44	3.65	4.28	
Single Abutment Loading (3D) - solid	0.42	0.66	0.19	0.28	1.54	2.04	1.53	2.01	0.89	1.20	1.53	2.03	1.98	2.54	2.55	3.27	2.55	3.27	2.00	2.57	
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total Pillar Loading with Single Abutment Loading	3.61	4.39	5.37	6.16	7.17	8.22	7.08	8.12	6.39	7.32	7.12	8.17	7.99	9.05	10.27	11.63	10.27	11.63	8.07	9.14	
Safety Factor (under Single Abutment Loading)	3.18	2.61	3.39	2.95	1.57	1.37	1.60	1.39	2.11	1.84	1.59	1.38	1.42	1.25	1.08	0.95	1.08	0.95	1.40	1.24	
Total Pillar Loading @ nA	4.04	5.05	9.89	11.80	8.71	10.26	13.21	15.82	7.28	8.53	17.93	21.63	26.77	31.91	27.22	32.31	27.22	32.31	21.39	25.39	
Safety Factor @ nA	2.85	2.27	1.84	1.54	1.30	1.10	0.86	0.71	1.85	1.58	0.63	0.52	0.42	0.35	0.41	0.34	0.41	0.34	0.53	0.45	
Total Pillar Loading under Double Abutment Loading	5.79	7.43	7.73	9.12	13.38	16.02	13.21	15.82	10.84	12.93	13.29	15.91	15.57	18.36	20.02	23.61	20.02	23.61	15.73	18.55	
Safety Factor (under Double Abutment Loading)	1.98	1.54	2.35	1.99	0.84	0.70	0.86	0.71	1.24	1.04	0.85	0.71	0.73	0.62	0.55	0.47	0.55	0.47	0.72	0.61	
Notes:																					
FTA Sp/T	0.011	0.012	0.013	0.014	0.014	0.015	0.014	0.015	0.013	0.014	0.014	0.015	0.015	0.015	0.017	0.018	0.017	0.018	0.015	0.015	
FTA Sp(m)	0.034	0.036	0.039	0.041	0.042	0.044	0.042	0.044	0.040	0.043	0.042	0.044	0.044	0.046	0.051	0.054	0.051	0.054	0.044	0.046	
FTA Sp/T (U95%)	0.065	0.066	0.067	0.068	0.068	0.069	0.068	0.069	0.067	0.068	0.068	0.069	0.069	0.069	0.071	0.072	0.071	0.072	0.069	0.069	
FTA Sp (U95%)	0.196	0.198	0.201	0.203	0.204	0.206	0.204	0.206	0.202	0.204	0.204	0.206	0.206	0.208	0.213	0.216	0.213	0.216	0.206	0.208	
nA Sp/T	0.014	0.016	0.028	0.035	0.024	0.029	0.040	0.053	0.021	0.024	0.065	0.090	0.129	0.166	0.132	0.168	0.132	0.168	0.088	0.118	
nA Sp(m)	0.042	0.048	0.084	0.104	0.073	0.088	0.121	0.159	0.062	0.072	0.195	0.270	0.387	0.498	0.397	0.505	0.397	0.505	0.265	0.355	
nA Sp/T (U95%)	0.068	0.070	0.082	0.089	0.078	0.083	0.094	0.107	0.075	0.078	0.119	0.144	0.183	0.220	0.186	0.222	0.186	0.222	0.142	0.172	
nA Sp (U95%)	0.204	0.210	0.246	0.286	0.235	0.250	0.283	0.321	0.224	0.234	0.357	0.432	0.549	0.660	0.559	0.667	0.559	0.667	0.427	0.517	
Max Subs	0.41	0.41	0.40	0.40	0.53</																

UNSW Pillar Design Spreadsheet

Gretley - Young Wallsend Seam

INPUT DATA		11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20
Depth of Cover (m)		100	110	100	110	30	50	30	50	80	100	90	110	80	100	80	100	100	120	100	120
Mining Height (m)		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)		20	20	30	30	31	31	41	41	31	31	70	70	40	40	28	28	33	33	33	33
Pillar Width - centres (m)		15	15	12.5	12.5	31	31	15	15	13	13	30	30	30	30	24	24	11	11	11	11
Roadway Width for maximum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
SG (tonnes/m ³)		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)		10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21

INTERMEDIATE CALCULATIONS		11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20
Maximum Rib to Rib Pillar Length (w ₂)		15.0	15.0	25.0	25.0	26.0	26.0	36.0	36.0	26.0	26.0	65.0	65.0	35.0	35.0	23.0	23.0	28.0	28.0	28.0	28.0
Minimum Rib to Rib Pillar Width (w ₁)		10.0	10.0	7.5	7.5	26.0	26.0	10.0	10.0	8.0	8.0	25.0	25.0	25.0	25.0	19.0	19.0	6.0	6.0	6.0	6.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)		10.0	10.0	7.5	7.5	26.0	26.0	10.0	10.0	8.0	8.0	25.0	25.0	25.0	25.0	19.0	19.0	6.0	6.0	6.0	6.0
Minimum Pillar Width/Height Ratio		3.3	3.3	2.5	2.5	8.7	8.7	3.3	3.3	2.7	2.7	8.3	8.3	8.3	8.3	6.3	6.3	2.0	2.0	2.0	2.0
Extraction Ratio (%)		50.0%	50.0%	50.0%	50.0%	29.7%	29.7%	41.5%	41.5%	48.4%	48.4%	22.6%	22.6%	27.1%	27.1%	35.0%	35.0%	53.7%	53.7%	53.7%	53.7%
Abutment Angle (Radians)		0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)		1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)		51.300	53.804	51.300	53.804	28.098	36.275	28.098	36.275	45.884	51.300	48.667	53.804	45.884	51.300	45.884	51.300	56.196	51.300	56.196	56.196
R (Pillar 2nd Abutment Component)		0.65	0.62	0.57	0.55	1.00	1.00	0.90	0.80	0.63	0.58	0.94	0.91	0.96	0.93	0.89	0.85	0.52	0.48	0.52	0.48
Dimensionless Pillar 'Rectangularity'		1.20	1.20	1.54	1.54	1.00	1.00	1.57	1.57	1.53	1.53	1.44	1.44	1.17	1.17	1.10	1.10	1.65	1.65	1.65	1.65
Width/Height Ratio Exponent		0.11	0.11	-0.17	-0.17	1.00	1.00	0.11	0.11	-0.11	-0.11	1.00	1.00	1.00	1.00	1.00	1.00	-0.33	-0.33	-0.33	-0.33
Effective Width Factor (Omega)		1.02	1.02	0.93	0.93	1.00	1.00	1.05	1.05	0.95	0.95	1.44	1.44	1.17	1.17	1.10	1.10	0.85	0.85	0.85	0.85
Effective Width Interim		10.20	10.20	6.98	6.98	26.00	26.00	10.51	10.51	7.63	7.63	36.11	36.11	29.17	29.17	20.81	20.81	5.08	5.08	5.08	5.08
Effective Pillar Width (m)		10.20	10.20	7.50	7.50	26.00	26.00	10.51	10.51	8.00	8.00	36.11	36.11	29.17	29.17	20.81	20.81	6.00	6.00	6.00	6.00
Effective Pillar Loading Height (m)		100.00	110.00	100.00	110.00	30.00	50.00	30.00	50.00	80.00	100.00	90.00	110.00	80.00	100.00	80.00	100.00	100.00	120.00	100.00	120.00

RESULTS		11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20
Tributary Area Loading (MPa)		5.00	5.50	5.00	5.50	1.07	1.78	1.28	2.14	3.88	4.84	2.91	3.55	2.74	3.43	3.08	3.84	5.40	6.48	5.40	6.48
Tributary Area Loading x 0.5 (MPa)		2.50	2.75	2.50	2.75	0.53	0.89	0.64	1.07	1.94	2.42	1.45	1.78	1.37	1.71	1.54	1.92	2.70	3.24	2.70	3.24
Pillar Strength (UNSW Squat Pillar 1999)		NA	NA	NA	NA	22.20	22.20	NA	NA	NA	NA	25.46	25.46	22.83	22.83	16.55	16.55	NA	NA	NA	NA
Pillar Strength (UNSW w/h-c5)		11.17	11.17	9.55	9.55	N/A	N/A	11.34	11.34	9.87	9.87	N/A	N/A	N/A	N/A	N/A	N/A	8.52	8.52	8.52	8.52
Safety Factor under FTA Loading (Squat Pillar)		11.17	11.17	9.55	9.55	22.20	22.20	11.34	11.34	9.87	9.87	25.46	25.46	22.83	22.83	16.55	16.55	8.52	8.52	8.52	8.52
Safety Factor under FTA Loading (w/h-c5)		N/A	N/A	N/A	N/A	20.63	12.50	N/A	N/A	N/A	N/A	8.76	7.16	8.32	6.66	5.38	4.31	N/A	N/A	N/A	N/A
No. SAs, n		2.23	2.03	1.91	1.74	N/A	N/A	8.55	5.31	2.55	2.04	N/A	N/A	N/A	N/A	N/A	N/A	1.58	1.31	1.58	1.31
Single Abutment Loading (3D) - full		6.40	7.74	7.68	9.29	0.20	0.55	0.49	1.37	4.58	7.15	1.67	2.50	1.40	2.19	1.97	3.07	9.43	13.57	9.43	13.57
Single Abutment Loading (3D) - pillar		4.13	4.84	4.36	5.09	0.20	0.55	0.44	1.09	2.89	4.18	1.58	2.28	1.35	2.04	1.75	2.61	4.86	6.51	4.86	6.51
Single Abutment Loading (3D) - solid		2.27	2.90	3.32	4.20	0.00	0.00	0.05	0.28	1.68	2.98	0.09	0.22	0.06	0.16	0.21	0.46	4.57	7.06	4.57	7.06
Cell Sensitivity (MPa)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading		9.13	10.34	9.36	10.59	1.26	2.33	1.72	3.23	6.77	9.02	4.49	5.84	4.09	5.47	4.83	6.46	10.26	12.99	10.26	12.99
Safety Factor (under Single Abutment Loading)		1.22	1.08	1.02	0.90	17.56	9.55	6.58	3.52	1.46	1.09	5.67	4.36	5.58	4.18	3.43	2.56	0.83	0.66	0.83	0.66
Total Pillar Loading @ nA		24.19	28.72	28.03	33.37	1.66	3.43	2.76	6.23	17.61	26.30	6.26	8.98	5.55	8.98	13.07	14.83	20.05	14.83	20.05	20.05
Safety Factor @ nA		0.46	0.39	0.34	0.29	13.37	6.48	4.11	1.82	0.56	0.38	4.07	2.98	4.11	2.92	1.84	1.27	0.57	0.42	0.57	0.42
Total Pillar Loading under Double Abutment Loading		17.80	20.98	20.35	24.08	1.46	2.88	2.26	4.87	13.03	19.15	6.26	8.56	5.55	7.82	7.01	9.99	24.25	33.63	24.25	33.63
Safety Factor (under Double Abutment Loading)		0.63	0.53	0.47	0.40	15.18	7.72	5.01	2.33	0.76	0.52	4.07	2.98	4.11	2.92	2.36	1.66	0.35	0.25	0.35	0.25

Notes:

	FTA Sp/T	0.016	0.017	0.016	0.017	0.010	0.011	0.010	0.011	0.014	0.015	0.012	0.013	0.012	0.013	0.012	0.014	0.017	0.019	0.017	0.019
	FTA Sp(m)	0.047	0.050	0.047	0.050	0.029	0.032	0.030	0.033	0.041	0.046	0.037	0.040	0.036	0.039	0.037	0.041	0.050	0.056	0.050	0.056
	FTA Sp/T (U95%)	0.070	0.071	0.070	0.071	0.064	0.065	0.064	0.065	0.068	0.069	0.066	0.067	0.066	0.067	0.066	0.068	0.071	0.073	0.071	0.073
	FTA Sp (U95%)	0.209	0.212	0.209	0.212	0.191	0.194	0.192	0.195	0.203	0.208	0.199	0.202	0.198	0.201	0.199	0.203	0.212	0.218	0.212	0.218
	nA Sp/T	0.109	0.144	0.138	0.175	0.010	0.013	0.012	0.018	0.063	0.125	0.018	0.024	0.017	0.022	0.025	0.040	0.048	0.079	0.048	0.079
	nA Sp(m)	0.327	0.431	0.415	0.525	0.031	0.039	0.036	0.055	0.189	0.376	0.055	0.072	0.050	0.066	0.076	0.119	0.144	0.237	0.144	0.237
	nA Sp/T (U95%)	0.163	0.198	0.192	0.229	0.064	0.067	0.066	0.072	0.117	0.179	0.072	0.078	0.071	0.076	0.079	0.094	0.102	0.133	0.102	0.133
	nA Sp (U95%)	0.489	0.593	0.577	0.687	0.193	0.201	0.198	0.217	0.351	0.538	0.217	0.234	0.212	0.228	0.238	0.281	0.306	0.399	0.306	0.399
	Max Subs	0.60	0.60	0.60	0.60	0.36	0.36	0.50	0.50	0.58	0.58	0.27	0.27	0.33	0.33	0.42	0.42	0.64	0.64	0.64	0.64
	Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	initial vertical stress (MPa)	2.50	2.75	2.50	2.75	1.25	1.25	0.75	0.75	2.25	2.25	2.25	2.25	2.00	2.50	2.00	2.50	3.00	2.50	3.00	2.50
increase in vertical stress (MPa)		2.50	2.75	2.50	2.75	0.32	0.53	0.53	0.89	1.88	2.34	0.66	0.80	0.74	0.93	1.08	1.34	2.90	3.48	2.90	3.48
	Pillar Compression (m)	0.004	0.004	0.004	0.004	0.000	0.001	0.001	0.001	0.003	0.003	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.005	0.004	0.005
	Roof Compression (m)	0.005	0.006	0.005	0.006	0.001	0.002	0.002	0.003	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.006	0.007	0.006	0.007
	Floor Compression (m)	0.005	0.006	0.005	0.006	0.001	0.002	0.002	0.003	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.006	0.007	0.006	0.007
Total Elastic Compression (m)		0.014	0.016	0.014	0.016	0.003	0.005	0.004	0.007	0.011	0.014	0.010	0.012	0.009	0.011	0.009	0.012	0.015	0.018	0.015	0.018
	Yielded Pillars (m)	0.600	0.600	0.600	0.600	0.016	0.027	0.020	0.033	0.581	0.581	0.048	0.059	0.043	0.054	0.046	0.058	0.645	0.645	0.645	0.645
		0.175	0.175	0.175	0.175	0.005	0.008	0.006	0.010	0.170	0.170	0.014	0.017	0.013	0.016	0.014	0.017	0.188	0.188	0.188	0.188
		0.005	0.005	0.005	0.005	0.001	0.002	0.001	0.002	0.004	0.005	0.003	0.004	0.003	0.004	0.003	0.004	0.005	0.006	0.005	0.006

UNSW Pillar Design Spreadsheet

Gretley - Young Wallsend Seam

INPUT DATA	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	29	29
Depth of Cover (m)	70	80	100	100	100	120	80	100	80	100	80	100	80	100	80	100	50	60	50	60
Mining Height (m)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)	40	40	40	40	30	30	25	32	32	32	32	32	30	30	30	30	40	40	35	35
Pillar Width - centres (m)	30	30	30	30	27	27	25	25	25	25	25	25	20	20	20	20	25	25	12	12
Roadway Width for maximum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21

INTERMEDIATE CALCULATIONS	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	29	29
Maximum Rib to Rib Pillar Length (w ₂)	35.0	35.0	35.0	35.0	25.0	25.0	20.0	27.0	27.0	27.0	27.0	27.0	25.0	25.0	25.0	25.0	35.0	35.0	30.0	30.0
Minimum Rib to Rib Pillar Width (w ₁)	25.0	25.0	25.0	25.0	22.0	22.0	20.0	20.0	20.0	20.0	20.0	20.0	15.0	15.0	15.0	15.0	20.0	20.0	7.0	7.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	25.0	25.0	25.0	25.0	22.0	22.0	20.0	20.0	20.0	20.0	20.0	20.0	15.0	15.0	15.0	15.0	20.0	20.0	7.0	7.0
Minimum Pillar Width/Height Ratio	8.3	8.3	8.3	8.3	7.3	7.3	6.7	6.7	6.7	6.7	6.7	6.7	5.0	5.0	5.0	5.0	6.7	6.7	2.3	2.3
Extraction Ratio (%)	27.1%	27.1%	27.1%	27.1%	32.1%	32.1%	36.0%	32.5%	32.5%	32.5%	32.5%	32.5%	37.5%	37.5%	37.5%	37.5%	30.0%	30.0%	50.0%	50.0%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	42.921	45.884	51.300	56.196	51.300	56.196	45.884	51.300	45.884	51.300	45.884	51.300	45.884	51.300	45.884	51.300	36.275	39.737	36.275	39.737
R (Pillar 2nd Abutment Component)	0.97	0.96	0.93	0.90	0.89	0.86	0.91	0.87	0.91	0.87	0.91	0.87	0.82	0.77	0.82	0.77	0.97	0.95	0.70	0.66
Dimensionless Pillar 'Rectangularity'	1.17	1.17	1.17	1.17	1.06	1.06	1.00	1.15	1.15	1.15	1.15	1.15	1.25	1.25	1.25	1.25	1.27	1.27	1.62	1.62
Width/Height Ratio Exponent	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.67	0.67	0.67	1.00	1.00	-0.22	-0.22
Effective Width Factor (Omega)	1.17	1.17	1.17	1.17	1.06	1.06	1.00	1.15	1.15	1.15	1.15	1.15	1.16	1.16	1.16	1.16	1.27	1.27	0.90	0.90
Effective Width Interim	29.17	29.17	29.17	29.17	23.40	23.40	20.00	22.98	22.98	22.98	22.98	22.98	17.41	17.41	17.41	17.41	25.45	25.45	6.29	6.29
Effective Pillar Width (m)	29.17	29.17	29.17	29.17	23.40	23.40	20.00	22.98	22.98	22.98	22.98	22.98	17.41	17.41	17.41	17.41	25.45	25.45	7.00	7.00
Effective Pillar Loading Height (m)	70.00	80.00	100.00	120.00	100.00	120.00	80.00	100.00	80.00	100.00	80.00	100.00	80.00	100.00	80.00	100.00	50.00	60.00	50.00	60.00

RESULTS																				
Tributary Area Loading (MPa)	2.40	2.74	3.43	4.11	3.68	4.42	3.13	3.70	2.96	3.70	2.96	3.70	3.20	4.00	3.20	4.00	1.79	2.14	2.50	3.00
Tributary Area Loading x 0.5 (MPa)	1.20	1.37	1.71	2.06	1.84	2.21	1.56	1.85	1.48	1.85	1.48	1.85	1.60	2.00	1.60	2.00	0.89	1.07	1.25	1.50
Pillar Strength (UNSW Squat Pillar 1999)	22.83	22.83	22.83	22.83	18.76	18.76	16.53	17.75	17.75	17.75	17.75	17.75	14.56	14.56	14.56	14.56	18.70	18.70	NA	NA
Pillar Strength (UNSW w/h-c5)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.22
	22.83	22.83	22.83	22.83	18.76	18.76	16.53	17.75	17.75	17.75	17.75	17.75	14.56	14.56	14.56	14.56	18.70	18.70	9.22	9.22
Safety Factor under FTA Loading (Squat Pillar)	9.51	8.32	6.66	5.55	5.10	4.25	5.29	4.79	5.99	4.79	5.99	4.79	4.55	3.64	4.55	3.64	10.47	8.73	N/A	N/A
Safety Factor under FTA Loading (w/h-c5)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.69
No. SAs, n	1	1	1	1	2	2	4	2	2	2	2	2	2	2	2	2	2	4	4	1
Single Abutment Loading (3D) - full	1.07	1.40	2.19	3.16	2.62	3.77	1.92	2.84	1.82	2.84	1.82	2.84	2.46	3.84	2.46	3.84	0.69	0.99	2.00	2.88
Single Abutment Loading (3D) - pillar	1.05	1.35	2.04	2.84	2.34	3.24	1.74	2.46	1.65	2.46	1.65	2.46	2.02	2.97	2.02	2.97	0.66	0.94	1.40	1.90
Single Abutment Loading (3D) - solid	0.03	0.06	0.16	0.32	0.28	0.53	0.18	0.38	0.17	0.38	0.17	0.38	0.44	0.87	0.44	0.87	0.02	0.05	0.60	0.98
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	3.45	4.09	5.47	6.95	6.02	7.66	4.86	6.16	4.61	6.16	4.61	6.16	5.22	6.97	5.22	6.97	2.45	3.08	3.90	4.90
Safety Factor (under Single Abutment Loading)	6.63	5.58	4.18	3.28	3.12	2.45	3.40	2.88	3.85	2.88	3.85	2.88	2.79	2.09	2.79	2.09	7.63	6.07	2.36	1.88
Total Pillar Loading @ nA	3.47	4.15	5.62	7.27	8.92	11.96	10.80	15.08	6.60	9.39	6.60	9.39	8.11	11.68	8.11	11.68	4.53	6.09	4.50	5.88
Safety Factor @ nA	6.57	5.51	4.06	3.14	2.10	1.57	1.53	1.18	2.69	1.89	2.69	1.89	1.79	1.25	1.79	1.25	4.13	3.07	2.05	1.57
Total Pillar Loading under Double Abutment Loading	4.55	5.55	7.82	10.43	8.92	11.96	6.96	9.39	6.60	9.39	6.60	9.39	8.11	11.68	8.11	11.68	3.16	4.12	6.50	8.76
Safety Factor (under Double Abutment Loading)	5.02	4.11	2.92	2.19	2.10	1.57	2.37	1.89	2.69	1.89	2.69	1.89	1.79	1.25	1.79	1.25	5.92	4.54	1.42	1.05

Notes:

FTA Sp/T	0.011	0.012	0.013	0.014	0.013	0.015	0.013	0.013	0.012	0.013	0.012	0.013	0.013	0.014	0.013	0.014	0.011	0.011	0.012	0.012
FTA Sp(m)	0.034	0.036	0.039	0.042	0.040	0.044	0.038	0.040	0.037	0.040	0.037	0.040	0.038	0.042	0.038	0.042	0.032	0.033	0.035	0.037
FTA Sp/T (U95%)	0.065	0.066	0.067	0.068	0.067	0.069	0.067	0.067	0.066	0.067	0.066	0.067	0.066	0.067	0.066	0.067	0.065	0.065	0.066	0.066
FTA Sp (U95%)	0.196	0.198	0.201	0.204	0.202	0.206	0.200	0.202	0.199	0.202	0.199	0.202	0.199	0.200	0.200	0.204	0.194	0.195	0.197	0.199
nA Sp/T	0.013	0.014	0.017	0.021	0.025	0.035	0.031	0.049	0.019	0.026	0.019	0.026	0.023	0.034	0.023	0.034	0.015	0.018	0.015	0.017
nA Sp(m)	0.039	0.043	0.051	0.062	0.075	0.106	0.093	0.148	0.057	0.079	0.057	0.079	0.068	0.103	0.068	0.103	0.045	0.054	0.044	0.052
nA Sp/T (U95%)	0.067	0.068	0.071	0.075	0.079	0.089	0.085	0.103	0.073	0.080	0.073	0.080	0.077	0.088	0.077	0.088	0.069	0.072	0.069	0.071
nA Sp (U95%)	0.201	0.205	0.213	0.224	0.237	0.268	0.255	0.310	0.219	0.241	0.219	0.241	0.230	0.265	0.230	0.265	0.207	0.216	0.206	0.214
Max Subs	0.33	0.33	0.33	0.33	0.39	0.39	0.43	0.39	0.39	0.39	0.39	0.39	0.45	0.45	0.45	0.45	0.36	0.36	0.36	0.36
Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	1.75	2.00	2.50	3.00	2.50	3.00	2.00	2.50	2.00	2.50	2.00	2.50	2.00	2.50	2.00	2.50	1.25	1.50	1.25	1.50
increase in vertical stress (MPa)	0.65	0.74	0.93	1.11	1.18	1.42	1.13	1.20	0.96	1.20	0.96	1.20	1.20	1.50	1.20	1.50	0.54	0.64	1.25	1.50
Pillar Compression (m)	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.002	0.002

UNSW Pillar Design Spreadsheet

Gretley - Young Wallsend Seam																			
INPUT DATA		30	30	31	31	32	32	32	32	33	33	34	34	35	35	35	35	36	36
Depth of Cover (m)		50	60	70	80	70	80	70	80	100	110	90	100	90	100	90	100	90	100
Mining Height (m)		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)		18	18	40	40	25	25	25	25	30	30	33	33	45	45	30	30	50	50
Pillar Width - centres (m)		18	18	35	35	15	15	12	12	25	25	30	30	12	12	13	13	14	14
Roadway Width for maximum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)		150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
SG (tonnes/m ³)		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)		10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																			
Maximum Rib to Rib Pillar Length (w ₂)		13.0	13.0	35.0	35.0	20.0	20.0	20.0	20.0	25.0	25.0	28.0	28.0	40.0	40.0	25.0	25.0	45.0	45.0
Minimum Rib to Rib Pillar Width (w ₁)		13.0	13.0	30.0	30.0	10.0	10.0	7.0	7.0	20.0	20.0	25.0	25.0	7.0	7.0	8.0	8.0	9.0	9.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ .sinθ)		13.0	13.0	30.0	30.0	10.0	10.0	7.0	7.0	20.0	20.0	25.0	25.0	7.0	7.0	8.0	8.0	9.0	9.0
Minimum Pillar Width/Height Ratio		4.3	4.3	10.0	10.0	3.3	3.3	2.3	2.3	6.7	6.7	8.3	8.3	2.3	2.3	2.7	2.7	3.0	3.0
Extraction Ratio (%)		47.8%	47.8%	25.0%	25.0%	46.7%	46.7%	53.3%	53.3%	33.3%	33.3%	29.3%	29.3%	48.1%	48.1%	48.7%	48.7%	42.1%	42.1%
Abutment Angle (Radians)		0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)		1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)		36.275	39.737	42.921	45.884	42.921	45.884	42.921	45.884	51.300	53.804	48.667	51.300	48.667	51.300	48.667	51.300	48.667	51.300
R (Pillar 2nd Abutment Component)		0.87	0.84	0.99	0.99	0.72	0.70	0.63	0.60	0.87	0.85	0.94	0.93	0.57	0.55	0.61	0.58	0.64	0.62
Dimensionless Pillar 'Rectangularity'		1.00	1.00	1.08	1.08	1.33	1.33	1.48	1.48	1.11	1.11	1.06	1.06	1.70	1.70	1.52	1.52	1.67	1.67
Width/Height Ratio Exponent		0.44	0.44	1.00	1.00	0.11	0.11	-0.22	-0.22	1.00	1.00	1.00	1.00	-0.22	-0.22	-0.11	-0.11	0.00	0.00
Effective Width Factor (Omega)		1.00	1.00	1.08	1.08	1.03	1.03	0.92	0.92	1.11	1.11	1.06	1.06	0.89	0.89	0.95	0.95	1.00	1.00
Effective Width Interim		13.00	13.00	32.31	32.31	10.32	10.32	6.41	6.41	22.22	22.22	26.42	26.42	6.22	6.22	7.64	7.64	9.00	9.00
Effective Pillar Width (m)		13.00	13.00	32.31	32.31	10.32	10.32	7.00	7.00	22.22	22.22	26.42	26.42	7.00	7.00	8.00	8.00	9.00	9.00
Effective Pillar Loading Height (m)		50.00	60.00	70.00	80.00	70.00	80.00	70.00	80.00	100.00	110.00	90.00	100.00	90.00	100.00	90.00	100.00	90.00	100.00
RESULTS																			
Tributary Area Loading (MPa)		2.40	2.88	2.33	2.67	3.28	3.75	3.75	4.29	3.75	4.13	3.18	3.54	4.34	4.82	4.39	4.88	3.89	4.32
Tributary Area Loading x 0.5 (MPa)		1.20	1.44	1.17	1.33	1.64	1.88	1.88	2.14	1.88	2.06	1.59	1.77	2.17	2.41	2.19	2.44	1.94	2.16
Pillar Strength (UNSW Squat Pillar 1999)		NA	NA	28.28	28.28	NA	NA	NA	NA	17.45	17.45	21.71	21.71	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h<5)		12.64	12.64	N/A	N/A	11.24	11.24	9.22	9.22	N/A	N/A	N/A	N/A	9.22	9.22	9.87	9.87	10.48	10.48
Safety Factor under FTA Loading (Squat Pillar)		NA	NA	12.12	10.61	N/A	N/A	N/A	4.65	4.23	6.82	6.14	N/A	9.22	9.87	9.87	10.48	10.48	14.40
Safety Factor under FTA Loading (w/h<5)		5.28	4.40	N/A	N/A	3.43	3.00	2.46	2.15	N/A	N/A	N/A	N/A	2.12	1.91	2.25	2.02	2.69	2.43
No. SAs, n		1	1	3	3	1	1	3	3	4	4	3	4	4	4	4	4	3	3
Single Abutment Loading (3D) - full		1.28	1.84	0.90	1.17	2.94	3.84	4.20	2.88	3.48	1.83	2.26	6.25	7.71	5.83	7.20	4.80	5.92	1.91
Single Abutment Loading (3D) - pillar		1.11	1.54	0.89	1.15	2.13	2.67	3.28	2.49	2.95	1.73	2.10	3.57	4.24	3.54	4.20	3.06	3.65	1.62
Single Abutment Loading (3D) - solid		0.16	0.30	0.01	0.02	0.81	1.17	1.57	2.21	0.39	0.53	0.10	0.16	2.67	3.47	2.29	3.00	1.73	2.28
Cell Sensitivity (MPa)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading		3.51	4.41	3.22	3.82	5.41	6.42	6.38	7.56	6.24	7.07	4.91	5.64	7.91	9.07	7.92	9.08	6.95	7.97
Safety Factor (under Single Abutment Loading)		3.60	2.86	8.77	7.40	2.08	1.75	1.45	1.22	2.80	2.47	4.42	3.85	1.16	1.02	1.25	1.09	1.51	1.32
Total Pillar Loading @ nA		3.67	4.72	5.02	6.18	6.22	7.59	7.95	9.77	12.39	14.58	10.51	12.58	29.32	35.67	16.05	19.27	23.08	28.02
Safety Factor @ nA		3.44	2.68	5.63	4.58	1.81	1.48	1.16	0.94	1.41	1.20	2.07	1.72	0.31	0.26	0.62	0.51	0.45	0.37
Total Pillar Loading under Double Abutment Loading		4.95	6.56	4.12	5.01	9.16	11.43	12.15	15.25	9.51	11.09	6.85	8.06	16.83	20.24	16.05	19.27	13.49	16.17
Safety Factor (under Double Abutment Loading)		2.55	1.93	6.86	5.65	1.23	0.98	0.76	0.60	1.83	1.57	3.17	2.69	0.55	0.46	0.62	0.51	0.78	0.65
Notes:																			
FTA Sp/T		0.011	0.012	0.011	0.012	0.013	0.014	0.014	0.014	0.014	0.014	0.013	0.013	0.015	0.015	0.015	0.016	0.014	0.012
FTA Sp(m)		0.034	0.036	0.034	0.036	0.038	0.041	0.041	0.043	0.041	0.042	0.038	0.040	0.044	0.044	0.044	0.047	0.041	0.044
FTA Sp/T (U95%)		0.065	0.066	0.065	0.066	0.067	0.068	0.068	0.068	0.068	0.068	0.067	0.067	0.069	0.069	0.069	0.070	0.068	0.066
FTA Sp (U95%)		0.196	0.198	0.196	0.198	0.200	0.203	0.203	0.205	0.203	0.204	0.200	0.202	0.206	0.206	0.206	0.209	0.203	0.198
nA Sp/T		0.013	0.015	0.016	0.018	0.018	0.021	0.022	0.028	0.037	0.047	0.030	0.038	0.148	0.188	0.054	0.074	0.101	0.138
nA Sp(m)		0.040	0.046	0.047	0.054	0.055	0.064	0.067	0.083	0.111	0.140	0.090	0.113	0.444	0.564	0.163	0.221	0.302	0.415
nA Sp/T (U95%)		0.067	0.069	0.070	0.072	0.072	0.075	0.076	0.082	0.091	0.101	0.084	0.092	0.202	0.242	0.108	0.128	0.155	0.192
nA Sp (U95%)		0.202	0.208	0.209	0.216	0.217	0.226	0.229	0.245	0.273	0.302	0.252	0.275	0.606	0.726	0.235	0.383	0.464	0.577
Max Subs		0.57	0.57	0.30	0.36	0.56	0.64	0.64	0.64	0.40	0.40	0.35	0.35	0.58	0.68	0.58	0.58	0.51	0.46
Ecoal(GPa)		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Etfloor(GPa)		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eroof(GPa)		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Poissons Ratio floor/roof		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)		1.25	1.50	1.75	2.00	1.75	2.00	2.00	2.50	2.75	2.25	2.50	2.25	2.50	2.25	2.50	2.25	2.50	1.75
increase in vertical stress (MPa)		1.15	1.38	0.58	0.67	1.53	1.75	2.00	2.29	1.25	1.38	0.93	1.04	2.09	2.32	2.14	2.38	1.64	1.82
Pillar Compression (m)		0.002	0.002	0.001	0.001	0.002	0.002	0.003	0.003	0.002	0.002	0.001	0.001	0.003	0.003	0.003	0.003	0.002	0.002
Roof Compression (m)		0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.004	0.005	0.005	0.006	0.005	0.005	0.005	0.004
Floor Compression (m)		0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.004	0.005	0.005	0.006	0.005	0.005	0.005	0.004
Total Elastic Compression (m)		0.007	0.008	0.007	0.008	0.010	0.011	0.012	0.011	0.012	0.011	0.010	0.011	0.013	0.014	0.014	0.012	0.013	0.009
Yielded Pillars (m)		0.034	0.040	0.037	0.042	0.048	0.054	0.040	0.040	0.057	0.063	0.049	0.055	0.078	0.078	0.058	0.058	0.506	0.043

UNSW Pillar Design Spreadsheet

Gretley - Young Wallsend Seam

INPUT DATA		38	38	39	39	40	40	41	41	GY3.2.1	GY3.2.1	2	2	3	3	GY3.15.1	GY3.15.1	2	2	3	3
Depth of Cover (m)		60	70	70	80	70	80	70	80	80	100	80	100	80	100	80	100	80	90	80	90
Mining Height (m)		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Length - centres (m)		25	25	30	30	20	20	22	22	25	25	27	27	24	24	43	43	25	25	30	30
Pillar Width - centres (m)		15	15	22	22	17	17	15	15	20	20	12	12	12	12	25	25	12	12	22	22
Roadway Width for maximum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Roadway Width for minimum pillar dimension		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)		200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
SG (tonnes/m ³)		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)		10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21

INTERMEDIATE CALCULATIONS		20.0	20.0	25.0	25.0	15.0	15.0	17.0	17.0	20.0	20.0	22.0	22.0	19.0	19.0	38.0	38.0	20.0	20.0	25.0	25.0
Maximum Rib to Rib Pillar Length (w ₂)		20.0	20.0	25.0	25.0	15.0	15.0	17.0	17.0	20.0	20.0	22.0	22.0	19.0	19.0	38.0	38.0	20.0	20.0	25.0	25.0
Minimum Rib to Rib Pillar Width (w ₁)		10.0	10.0	17.0	17.0	12.0	12.0	10.0	10.0	15.0	15.0	7.0	7.0	7.0	7.0	20.0	20.0	7.0	7.0	17.0	17.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)		10.0	10.0	17.0	17.0	12.0	12.0	10.0	10.0	15.0	15.0	7.0	7.0	7.0	7.0	20.0	20.0	7.0	7.0	17.0	17.0
Minimum Pillar Width/Height Ratio		3.3	3.3	5.7	5.7	4.0	4.0	3.3	3.3	5.0	5.0	2.3	2.3	2.3	2.3	6.7	6.7	2.3	2.3	5.7	5.7
Extraction Ratio (%)		46.7%	46.7%	35.6%	35.6%	47.1%	47.1%	48.5%	48.5%	40.0%	40.0%	52.5%	52.5%	53.8%	53.8%	29.3%	29.3%	53.3%	53.3%	35.6%	35.6%
Abutment Angle (Radians)		0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)		1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)		39.737	42.921	42.921	45.884	42.921	45.884	42.921	45.884	51.300	45.884	51.300	45.884	51.300	45.884	48.667	48.667	45.884	48.667	45.884	48.667
R (Pillar 2nd Abutment Component)		0.76	0.72	0.88	0.86	0.78	0.75	0.72	0.70	0.82	0.77	0.60	0.55	0.60	0.55	0.91	0.88	0.60	0.57	0.86	0.84
Dimensionless Pillar 'Rectangularity'		1.33	1.33	1.19	1.19	1.11	1.11	1.26	1.26	1.14	1.14	1.52	1.52	1.46	1.46	1.31	1.31	1.48	1.48	1.19	1.19
Width/Height Ratio Exponent		0.11	0.11	0.89	0.89	0.33	0.33	0.11	0.11	0.67	0.67	-0.22	-0.22	-0.22	-0.22	1.00	1.00	-0.22	-0.22	0.89	0.89
Effective Width Factor (Omega)		1.03	1.03	1.17	1.17	1.04	1.04	1.03	1.03	1.09	1.09	0.91	0.91	0.92	0.92	1.31	1.31	0.92	0.92	1.17	1.17
Effective Width Interim		10.32	10.32	19.85	19.85	12.43	12.43	10.26	10.26	16.40	16.40	6.38	6.38	6.43	6.43	26.21	26.21	6.41	6.41	19.85	19.85
Effective Pillar Width (m)		10.32	10.32	19.85	19.85	12.43	12.43	10.26	10.26	16.40	16.40	7.00	7.00	7.00	7.00	26.21	26.21	7.00	7.00	19.85	19.85
Effective Pillar Loading Height (m)		60.00	70.00	70.00	80.00	70.00	80.00	70.00	80.00	80.00	100.00	80.00	100.00	80.00	100.00	80.00	90.00	80.00	90.00	80.00	90.00

RESULTS																					
Tributary Area Loading (MPa)	2.81	3.28	2.72	3.11	3.31	3.78	3.40	3.88	3.33	4.17	4.21	5.26	4.33	5.41	2.83	3.18	4.29	4.82	3.11	3.49	
Tributary Area Loading x 0.5 (MPa)	1.41	1.64	1.36	1.55	1.65	1.89	1.70	1.94	1.67	2.08	2.10	2.63	2.17	2.71	1.41	1.59	2.14	2.41	1.55	1.75	
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	15.72	15.72	NA	NA	NA	NA	14.12	14.12	NA	NA	NA	NA	18.98	18.98	NA	NA	15.72	15.72	
Pillar Strength (UNSW w/h<5)	11.24	11.24	N/A	N/A	12.36	12.36	11.20	11.20	N/A	N/A	9.22	9.22	9.22	9.22	N/A	N/A	9.22	9.22	N/A	N/A	
	11.24	11.24	15.72	15.72	12.36	12.36	11.20	11.20	14.12	14.12	9.22	9.22	9.22	9.22	18.98	18.98	9.22	9.22	15.72	15.72	
Safety Factor under FTA Loading (Squat Pillar)	N/A	N/A	5.78	5.06	N/A	N/A	N/A	N/A	4.24	3.39	N/A	N/A	N/A	N/A	6.71	5.96	N/A	N/A	5.06	4.50	
Safety Factor under FTA Loading (w/h<5)	4.00	3.43	N/A	N/A	3.74	3.27	3.30	2.89	N/A	N/A	2.19	1.75	2.13	1.70	N/A	N/A	2.15	1.91	N/A	N/A	
No. SAs, n	4	4	3	3	1	1	1	1	3	3	3	3	3	3	2	2	2	1	3	3	
Single Abutment Loading (3D) - full	2.16	2.94	1.66	2.17	2.61	3.41	3.04	3.97	2.56	4.00	5.38	8.41	5.54	8.66	1.74	2.20	5.48	6.94	2.17	2.74	
Single Abutment Loading (3D) - pillar	1.64	2.13	1.47	1.86	2.04	2.56	2.21	2.76	2.10	3.09	3.22	4.63	3.31	4.77	1.57	1.95	3.28	3.97	1.86	2.29	
Single Abutment Loading (3D) - solid	0.52	0.81	0.19	0.31	0.58	0.85	0.84	1.21	0.46	0.91	2.17	3.78	2.23	3.89	0.16	0.25	2.21	2.97	0.31	0.45	
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total Pillar Loading with Single Abutment Loading	4.45	5.41	4.19	4.97	5.34	6.34	5.60	6.64	5.43	7.26	7.42	9.89	7.64	10.18	4.40	5.13	7.56	8.79	4.97	5.79	
Safety Factor (under Single Abutment Loading)	2.53	2.08	3.76	3.16	2.31	1.95	2.00	1.69	2.60	1.95	1.24	0.93	1.21	0.91	4.31	3.70	1.22	1.05	3.16	2.72	
Total Pillar Loading @ nA	11.45	15.04	7.70	9.61	5.92	7.19	6.44	7.86	11.01	16.16	20.36	30.50	20.96	31.39	6.30	7.58	9.77	11.76	9.61	11.72	
Safety Factor @ nA	0.98	0.75	2.04	1.64	2.09	1.72	1.74	1.43	1.28	0.87	0.45	0.30	0.44	0.29	3.01	2.50	0.94	0.78	1.64	1.34	
Total Pillar Loading under Double Abutment Loading	7.13	9.16	6.04	7.44	8.53	10.60	9.48	11.83	8.45	12.16	14.98	22.08	15.41	22.73	6.30	7.58	15.25	18.70	7.44	8.98	
Safety Factor (under Double Abutment Loading)	1.58	1.23	2.60	2.11	1.45	1.17	1.18	0.95	1.67	1.16	0.62	0.42	0.60	0.41	3.01	2.50	0.60	0.49	2.11	1.75	

Notes:

	FTA Sp/T	0.012	0.013	0.012	0.013	0.013	0.014	0.013	0.014	0.013	0.014	0.014	0.016	0.015	0.017	0.012	0.013	0.014	0.015	0.013	0.013
	FTA Sp(m)	0.036	0.038	0.036	0.038	0.038	0.041	0.039	0.041	0.039	0.043	0.043	0.049	0.044	0.050	0.036	0.038	0.043	0.046	0.038	0.039
	FTA Sp/T (U95%)	0.066	0.067	0.066	0.067	0.067	0.068	0.067	0.068	0.067	0.068	0.068	0.070	0.069	0.071	0.066	0.067	0.068	0.069	0.067	0.067
	FTA Sp (U95%)	0.198	0.200	0.198	0.200	0.200	0.203	0.201	0.203	0.201	0.205	0.205	0.211	0.206	0.212	0.198	0.200	0.205	0.208	0.200	0.201
	nA Sp/T	0.033	0.049	0.022	0.027	0.018	0.020	0.019	0.022	0.032	0.055	0.081	0.156	0.085	0.162	0.018	0.021	0.028	0.035	0.027	0.034
	nA Sp(m)	0.100	0.147	0.065	0.081	0.053	0.061	0.056	0.066	0.095	0.165	0.243	0.469	0.255	0.487	0.055	0.064	0.083	0.104	0.081	0.103
	nA Sp/T (U95%)	0.087	0.103	0.076	0.081	0.072	0.074	0.073	0.076	0.086	0.109	0.135	0.210	0.139	0.216	0.072	0.075	0.082	0.089	0.081	0.088
	nA Sp (U95%)	0.262	0.309	0.227	0.243	0.215	0.223	0.218	0.228	0.257	0.327	0.405	0.631	0.417	0.649	0.217	0.226	0.245	0.266	0.243	0.265
	Max Subs	0.56	0.56	0.43	0.43	0.56	0.56	0.58	0.58	0.48	0.48	0.63	0.63	0.65	0.65	0.35	0.35	0.64	0.64	0.43	0.43
	Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Initial vertical stress (MPa)	1.50	1.75	1.75	2.00	1.75	2.00	1.75	2.00	2.00	2.50	2.00	2.50	2.00	2.50	2.00	2.00	2.25	2.00	2.25	2.25
increase in vertical stress (MPa)		1.31	1.53	0.97	1.11	1.56	1.78	1.65	1.88	1.33	1.67	2.26	2.91	2.83	2.91	2.57	2.83	2.29	2.57	1.11	1.24
	Pillar Compression (m)	0.002	0.002	0.001	0.002	0.002	0.003	0.002	0.003	0.002	0.002	0.003	0.004	0.003	0.004	0.001	0.001	0.003	0.004	0.002	0.002
	Roof Compression (m)	0.003	0.004	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.005	0.004	0.006	0.004	0.004	0.004	0.005	0.004	0.004
	Floor Compression (m)	0.003	0.004	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.005	0.004	0.006	0.004	0.004	0.004	0.005	0.004
Total Elastic Compression (m)		0.008	0.010	0.008	0.009	0.009	0.011	0.010	0.011	0.010	0.012	0.012	0.015	0.012	0.015	0.009	0.010	0.012	0.014	0.009	0.011
	Yielded Pillars (m)	0.041	0.048	0.041	0.047	0.047	0.054	0.048	0.055	0.049	0.062	0.630	0.630	0.646	0.646	0.045	0.050	0.640	0.640	0.047	0.053
		0.012	0.014	0.012	0.014	0.014	0.016	0.014	0.016	0.014	0.018	0.184	0.184	0.184	0.189	0.189	0.013	0.015	0.187	0.187	0.016
		0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.004	0.003	0.004	0.004	0.005	0.004	0.005	0.003	0.003	0.004	0.005	0.003	0.004

UNSW Pillar Design Spreadsheet

Gretley - Young Wallsend Seam																
INPUT DATA																
Depth of Cover (m)	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11
Mining Height (m)	80	90	80	90	80	90	80	90	80	90	80	90	70	75	65	70
Pillar Length - centres (m)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pillar Width - centres (m)	25	25	23	23	23	23	23	23	20	20	23	23	35	35	35	35
Roadway Width for maximum pillar dimension	15	15	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Roadway Width for minimum pillar dimension	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cut-Through Angle (degrees)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Average Panel Span (m) (rib-rib width)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
SG (tonnes/m ³)	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Conversion (tonnes to N)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Abutment Angle (°)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																
Maximum Rib to Rib Pillar Length (w ₂)	20.0	20.0	18.0	18.0	18.0	18.0	18.0	18.0	15.0	15.0	18.0	18.0	30.0	30.0	30.0	30.0
Minimum Rib to Rib Pillar Width (w ₁)	10.0	10.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	10.0	10.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Minimum Pillar Width/Height Ratio	3.3	3.3	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Extraction Ratio (%)	46.7%	46.7%	51.8%	51.8%	51.8%	51.8%	51.8%	51.8%	53.8%	53.8%	51.8%	51.8%	47.3%	47.3%	47.3%	47.3%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	45.884	48.667	45.884	48.667	45.884	48.667	45.884	48.667	45.884	48.667	45.884	48.667	42.921	44.427	41.359	42.921
R (Pillar 2nd Abutment Component)	0.70	0.67	0.63	0.61	0.63	0.61	0.63	0.61	0.63	0.61	0.63	0.61	0.66	0.65	0.68	0.66
Dimensionless Pillar 'Rectangularity'	1.33	1.33	1.38	1.38	1.38	1.38	1.38	1.38	1.30	1.30	1.38	1.38	1.58	1.58	1.58	1.58
Width/Height Ratio Exponent	0.11	0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
Effective Width Factor (Omega)	1.03	1.03	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.96	0.96	0.95	0.95	0.95	0.95
Effective Width Interim	10.32	10.32	7.72	7.72	7.72	7.72	7.72	7.72	7.77	7.77	7.72	7.72	7.60	7.60	7.60	7.60
Effective Pillar Width (m)	10.32	10.32	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Effective Pillar Loading Height (m)	80.00	90.00	80.00	90.00	80.00	90.00	80.00	90.00	80.00	90.00	80.00	90.00	70.00	75.00	65.00	70.00
RESULTS																
Tributary Area Loading (MPa)	3.75	4.22	4.15	4.67	4.15	4.67	4.15	4.67	4.33	4.88	4.15	4.67	3.32	3.55	3.08	3.32
Tributary Area Loading x 0.5 (MPa)	1.88	2.11	2.08	2.34	2.08	2.34	2.08	2.34	2.17	2.44	2.08	2.34	1.66	1.78	1.54	1.66
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h-c5)	11.24	11.24	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87	9.87
Safety Factor under FTA Loading (Squat Pillar)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Safety Factor under FTA Loading (w/h-c5)	3.00	2.66	2.38	2.11	2.38	2.11	2.38	2.11	2.28	2.02	2.38	2.11	2.97	2.78	3.20	2.97
No. SAs, n	2	2	1	1	2	2	2	2	1	1	2	1	1	1	1	1
Single Abutment Loading (3D) - full	3.84	4.86	4.90	6.21	4.90	6.21	4.90	6.21	5.12	6.48	4.90	6.21	3.43	3.94	2.96	3.43
Single Abutment Loading (3D) - pillar	2.67	3.25	3.10	3.76	3.10	3.76	3.10	3.76	3.23	3.93	3.10	3.76	2.27	2.54	2.00	2.27
Single Abutment Loading (3D) - solid	1.17	1.61	1.81	2.44	1.81	2.44	1.81	2.44	1.88	2.55	1.81	2.44	1.16	1.39	0.95	1.16
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	6.42	7.47	7.25	8.44	7.25	8.44	7.25	8.44	7.57	8.80	7.25	8.44	5.58	6.10	5.08	5.58
Safety Factor (under Single Abutment Loading)	1.75	1.51	1.36	1.17	1.36	1.17	1.36	1.17	1.30	1.12	1.36	1.17	1.77	1.62	1.94	1.77
Total Pillar Loading @ nA	11.43	13.94	9.06	10.88	13.96	17.09	13.96	17.09	9.45	11.35	9.06	10.88	6.75	7.49	6.04	6.75
Safety Factor @ nA	0.98	0.81	1.09	0.91	0.71	0.58	0.71	0.58	1.04	0.87	1.09	0.91	1.46	1.32	1.63	1.46
Total Pillar Loading under Double Abutment Loading	11.43	13.94	13.96	17.09	13.96	17.09	13.96	17.09	14.57	17.83	13.96	17.09	10.18	11.43	8.99	10.18
Safety Factor (under Double Abutment Loading)	0.98	0.81	0.71	0.58	0.71	0.58	0.71	0.58	0.68	0.55	0.71	0.58	0.97	0.86	1.10	0.97
Notes:																
FTA Sp/T	0.014	0.014	0.014	0.015	0.014	0.015	0.014	0.015	0.015	0.016	0.014	0.015	0.013	0.013	0.012	0.013
FTA Sp(m)	0.041	0.043	0.043	0.045	0.043	0.045	0.043	0.045	0.044	0.047	0.043	0.045	0.039	0.040	0.037	0.039
FTA Sp/T (U95%)	0.068	0.068	0.068	0.069	0.068	0.069	0.068	0.069	0.069	0.070	0.068	0.069	0.067	0.067	0.066	0.067
FTA Sp (U95%)	0.203	0.205	0.205	0.207	0.205	0.207	0.205	0.207	0.206	0.209	0.205	0.207	0.201	0.202	0.199	0.201
nA Sp/T	0.033	0.044	0.025	0.031	0.044	0.060	0.044	0.060	0.027	0.033	0.025	0.031	0.019	0.021	0.018	0.019
nA Sp(m)	0.100	0.131	0.076	0.094	0.131	0.180	0.131	0.180	0.080	0.099	0.076	0.094	0.058	0.064	0.054	0.058
nA Sp/T (U95%)	0.087	0.098	0.079	0.085	0.098	0.114	0.098	0.114	0.081	0.087	0.079	0.085	0.073	0.075	0.072	0.073
nA Sp (U95%)	0.262	0.293	0.236	0.256	0.293	0.342	0.293	0.342	0.242	0.261	0.236	0.256	0.220	0.226	0.216	0.220
Max Subs	0.56	0.56	0.62	0.62	0.62	0.62	0.62	0.62	0.65	0.65	0.62	0.62	0.57	0.57	0.57	0.57
Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Etfloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	2.00	2.25	2.00	2.25	2.00	2.25	2.00	2.25	2.00	2.25	2.00	2.25	1.75	1.88	1.63	1.75
increase in vertical stress (MPa)	1.75	1.97	2.15	2.42	2.15	2.42	2.15	2.42	2.33	2.63	2.15	2.42	1.57	1.68	1.46	1.57
Pillar Compression (m)	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.003	0.002	0.002	0.002	0.002
Roof Compression (m)	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.004	0.004	0.004
Floor Compression (m)	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.004	0.004	0.004
Total Elastic Compression (m)	0.011	0.012	0.012	0.012	0.012	0.013	0.012	0.013	0.012	0.014	0.012	0.013	0.010	0.010	0.009	0.010
Yielded Pillars (m)	0.054	0.560	0.622	0.622	0.622	0.622	0.622	0.622	0.646	0.646	0.622	0.622	0.049	0.052	0.045	0.049
Smax/T	0.016	0.164	0.182	0.182	0.182	0.182	0.182	0.182	0.189	0.189	0.182	0.182	0.014	0.015	0.013	0.014
Smin/T	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.003	0.003	0.003	0.003

UNSW Pillar Design Spreadsheet

Minmi - Pillar Extraction Panels		Partial Extraction Panels - Welsh Bords - min FoS = 1.6													
INPUT DATA		B82.1	B82.1	B82.1	B82.1	B82.1	B82.2	B82.2	B82.2	B82.2	B82.2	B82.3	B82.3	B82.3	B82.3
Depth of Cover (m)	30	40	45	100	40	50	59	80	50	80	20	59	20	59	60
Mining Height (m)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Pillar Length - centres (m)	34	36.1	35.4	35.4	35.4	35.4	31.7	28	28	31.7	31.7	30	30	30	30
Pillar Width - centres (m)	15	12	11.6	11.6	11.6	11.6	12.5	12.5	17	17	12.5	12.5	17	17	17
Roadway Width for maximum pillar dimension	5	6.9	6.2	6.2	6.2	6.2	5.2	5.2	5	5	5.2	5.2	5	5	5
Roadway Width for minimum pillar dimension	10	7.9	7.5	7.5	7.5	7.5	7.2	7.2	7	7	7.2	7.2	7	7	7
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
SG (tonnes/m ²)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS															
Maximum Rib to Rib Pillar Length (w ₂)	29.0	29.2	29.2	29.2	29.2	29.2	26.5	26.5	23.0	23.0	26.5	26.5	25.0	25.0	25.0
Minimum Rib to Rib Pillar Width (w ₁)	5.0	4.1	4.1	4.1	4.1	4.1	5.3	5.3	10.0	10.0	5.3	5.3	10.0	10.0	10.0
w, Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	5.0	4.1	4.1	4.1	4.1	4.1	5.3	5.3	10.0	10.0	5.3	5.3	10.0	10.0	10.0
Minimum Pillar Width/Height Ratio	2.4	2.0	2.0	2.0	2.0	2.0	2.5	2.5	4.8	4.8	2.5	2.5	4.8	4.8	4.8
Extraction Ratio (%)	71.6%	72.4%	70.8%	70.8%	70.8%	70.8%	64.6%	64.6%	51.7%	51.7%	64.6%	64.6%	51.0%	51.0%	51.0%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	28.098	32.445	34.413	51.300	32.445	36.275	39.404	45.884	36.275	45.884	22.942	39.404	22.942	39.737	39.737
R (Pillar 2nd Abutment Component)	0.90	0.75	0.71	0.54	0.73	0.69	0.68	0.61	0.85	0.75	0.91	0.68	0.98	0.81	0.81
Dimensionless Pillar 'Rectangularity'	1.71	1.75	1.75	1.75	1.75	1.75	1.67	1.67	1.39	1.39	1.67	1.67	1.43	1.43	1.43
Width/Height Ratio Exponent	-0.21	-0.35	-0.35	-0.35	-0.35	-0.35	-0.16	-0.16	0.59	0.59	-0.16	-0.16	0.59	0.59	0.59
Effective Width Factor (Omega)	0.90	0.82	0.82	0.82	0.82	0.82	0.92	0.92	1.22	1.22	0.92	0.92	1.23	1.23	1.23
Effective Width Interim	4.48	3.37	3.37	3.37	3.37	3.37	4.89	4.89	12.15	12.15	4.89	4.89	12.33	12.33	12.33
Effective Pillar Width (m)	5.00	4.10	4.10	4.10	4.10	4.10	5.30	5.30	12.15	12.15	5.30	5.30	12.33	12.33	12.33
Effective Pillar Loading Height (m)	30.00	40.00	45.00	100.00	40.00	50.00	59.00	80.00	50.00	80.00	20.00	59.00	20.00	60.00	60.00
RESULTS															
Tributary Area Loading (MPa)	2.64	3.62	3.86	8.58	3.43	4.29	4.16	5.64	2.59	4.14	1.41	4.16	1.02	3.06	3.06
Tributary Area Loading x 0.5 (MPa)	1.32	1.81	1.93	4.29	1.72	2.14	2.08	2.82	1.29	2.07	0.71	2.08	0.51	1.53	1.53
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h=5)	10.48	9.47	9.47	9.47	9.47	9.47	10.79	10.79	16.48	16.48	10.79	10.79	16.60	16.60	16.60
Safety Factor under FTA Loading (Squat Pillar)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Safety Factor under FTA Loading (w/h=5)	3.97	2.62	2.45	1.10	2.76	2.21	2.59	1.91	6.37	3.98	7.65	2.59	16.28	5.43	5.43
No. SAs, n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Single Abutment Loading (3D) - full	1.01	2.31	2.87	14.19	2.27	3.55	3.77	6.93	1.46	3.74	0.43	3.77	0.23	2.07	2.07
Single Abutment Loading (3D) - pillar	0.91	1.74	2.04	7.61	1.67	2.43	2.57	4.26	1.24	2.81	0.39	2.57	0.23	1.68	1.68
Single Abutment Loading (3D) - solid	0.10	0.58	0.84	6.58	0.60	1.12	1.20	2.67	0.22	0.93	0.04	1.20	0.00	0.39	0.39
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	3.55	5.35	5.89	16.19	5.10	6.72	6.73	9.90	3.83	6.95	1.80	6.73	1.25	4.74	4.74
Safety Factor (under Single Abutment Loading)	2.95	1.77	1.61	0.59	1.86	1.41	1.60	1.09	4.31	2.37	5.99	1.60	13.32	3.50	3.50
Total Pillar Loading @ nA	3.65	5.93	6.73	22.76	5.70	7.83	7.93	12.57	4.05	7.88	1.84	7.93	1.25	5.13	5.13
Safety Factor @ nA	2.87	1.60	1.41	0.42	1.66	1.21	1.36	0.86	4.07	2.09	5.85	1.36	13.28	3.23	3.23
Total Pillar Loading under Double Abutment Loading	4.66	8.25	9.60	36.95	7.97	11.38	11.70	19.50	5.51	11.62	2.28	11.70	1.48	7.21	7.21
Safety Factor (under Double Abutment Loading)	2.25	1.15	0.99	0.26	1.19	0.83	0.92	0.55	2.99	1.42	4.74	0.92	11.21	2.30	2.30
Notes:															
FTA Sp/T	0.012	0.013	0.014	0.024	0.013	0.014	0.014	0.017	0.012	0.014	0.010	0.014	0.010	0.012	0.012
FTA Sp(m)	0.025	0.028	0.029	0.051	0.027	0.030	0.030	0.036	0.025	0.030	0.021	0.030	0.020	0.026	0.026
FTA Sp/T (U95%)	0.066	0.067	0.068	0.078	0.067	0.068	0.068	0.071	0.066	0.068	0.064	0.068	0.064	0.066	0.066
FTA Sp (U95%)	0.138	0.141	0.142	0.164	0.141	0.144	0.143	0.149	0.138	0.143	0.135	0.143	0.134	0.140	0.140
nA Sp/T	0.013	0.018	0.019	0.098	0.017	0.022	0.022	0.038	0.014	0.022	0.011	0.022	0.010	0.016	0.016
nA Sp(m)	0.028	0.037	0.041	0.206	0.036	0.046	0.047	0.079	0.029	0.047	0.022	0.047	0.021	0.034	0.034
nA Sp/T (U95%)	0.067	0.072	0.073	0.152	0.071	0.076	0.076	0.092	0.068	0.076	0.065	0.076	0.064	0.070	0.070
nA Sp (U95%)	0.141	0.150	0.150	0.320	0.149	0.160	0.160	0.193	0.143	0.160	0.136	0.160	0.134	0.147	0.147
Max Subs	0.90	0.91	0.89	0.89	0.89	0.89	0.81	0.81	0.65	0.81	0.81	0.81	0.64	0.64	0.64
Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	0.75	1.00	1.13	2.50	1.00	1.25	1.48	2.00	1.25	2.00	0.50	1.48	0.50	1.50	1.50
increase in vertical stress (MPa)	1.89	2.62	2.73	6.08	2.43	3.04	2.69	3.64	1.34	2.14	0.91	2.69	0.52	1.56	1.56
Pillar Compression (m)	0.002	0.003	0.003	0.006	0.002	0.003	0.003	0.004	0.001	0.002	0.001	0.003	0.001	0.002	0.002
Roof Compression (m)	0.003	0.004	0.004	0.009	0.004	0.005	0.005	0.006	0.003	0.005	0.002	0.005	0.001	0.004	0.004
Floor Compression (m)	0.003	0.004	0.004	0.009	0.004	0.005	0.005	0.006	0.003	0.005	0.002	0.005	0.001	0.004	0.004
Total Elastic Compression (m)	0.008	0.010	0.011	0.024	0.010	0.012	0.012	0.016	0.008	0.013	0.004	0.012	0.003	0.010	0.010
Yielded Pillars (m)	0.90	0.91	0.89	0.89	0.89	0.89	0.81	0.81	0.65	0.81	0.81	0.81	0.64	0.64	0.64
Smax/T	0.38	0.38	0.37	0.37	0.37	0.37	0.34	0.34	0.27	0.34	0.34	0.34	0.27	0.27	0.27
Smin/T	0.003	0.004	0.005	0.010	0.004	0.005	0.005	0.007	0.003	0.005	0.002	0.005	0.001	0.004	0.004

UNSW Pillar Design Spreadsheet

Minimi - Pillar Extraction Panels		Partial Extraction Panels - Welsh Bords - Min FoS = 1.6													
INPUT DATA		B82.4	B82.4	B82.4	B82.4	B82.5	B82.5	B82.5	B82.5	B82.5	B82.6	B82.6	B82.6	B82.6	B82.6
Depth of Cover (m)	30	65	70	50	80	40	90	40	80	70	120	120	120	120	120
Mining Height (m)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Pillar Length - centres (m)	34	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Pillar Width - centres (m)	11	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
Roadway Width for maximum pillar dimension	5	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Roadway Width for minimum pillar dimension	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	250	180	180	180	1180	110	110	110	150	150	150	150	150	150	150
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS															
Maximum Rib to Rib Pillar Length (w ₂)	29.0	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9
Minimum Rib to Rib Pillar Width (w ₁)	4.0	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
w, Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	4.0	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Minimum Pillar Width/Height Ratio	1.9	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Extraction Ratio (%)	69.0%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	28.098	41.359	42.921	36.275	45.884	32.445	48.667	32.445	48.667	42.921	45.596	42.921	56.196	56.196	56.196
R (Pillar 2nd Abutment Component)	0.77	0.64	0.62	0.70	0.59	0.75	0.57	0.75	0.57	0.62	0.60	0.62	0.51	0.51	0.51
Dimensionless Pillar 'Rectangularity'	1.76	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Width/Height Ratio Exponent	-0.37	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
Effective Width Factor (Omega)	0.81	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Effective Width Interim	3.26	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Effective Pillar Width (m)	4.00	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40
Effective Pillar Loading Height (m)	30.00	65.00	70.00	50.00	80.00	40.00	90.00	40.00	90.00	70.00	79.00	70.00	120.00	120.00	120.00
RESULTS															
Tributary Area Loading (MPa)	2.42	4.09	4.40	3.14	5.03	2.52	5.66	2.52	5.66	4.40	4.97	4.40	7.55	7.55	7.55
Tributary Area Loading x 0.5 (MPa)	1.21	2.04	2.20	1.57	2.52	1.26	2.83	1.26	2.83	2.20	2.48	2.20	3.77	3.77	3.77
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h-5)	9.35	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90
Safety Factor under FTA Loading (Squat Pillar)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Safety Factor under FTA Loading (w/h-5)	3.87	2.67	2.48	3.47	2.17	4.33	1.93	4.33	1.93	2.48	2.19	2.48	1.44	1.44	1.44
No. SAs, n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Single Abutment Loading (3D) - full	1.27	4.29	4.97	2.54	6.49	1.62	8.22	1.62	8.22	4.97	6.33	4.97	14.61	14.61	14.61
Single Abutment Loading (3D) - pillar	0.98	2.74	3.09	1.77	3.85	1.21	4.67	1.21	4.67	3.09	3.78	3.09	7.45	7.45	7.45
Single Abutment Loading (3D) - solid	0.29	1.55	1.88	0.77	2.64	0.41	3.54	0.41	3.54	1.88	2.56	1.88	7.15	7.15	7.15
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	3.40	6.83	7.50	4.91	8.89	3.73	10.33	3.73	10.33	7.50	8.74	7.50	15.00	15.00	15.00
Safety Factor (under Single Abutment Loading)	2.75	1.60	1.45	2.22	1.23	2.92	1.05	2.92	1.05	1.45	1.25	1.45	0.73	0.73	0.73
Total Pillar Loading @ nA	3.68	8.37	9.37	5.68	11.52	4.14	13.88	4.14	13.88	9.37	11.30	9.37	22.15	22.15	22.15
Safety Factor @ nA	2.54	1.30	1.16	1.92	0.95	2.63	0.79	2.63	0.79	1.16	0.96	1.16	0.49	0.49	0.49
Total Pillar Loading under Double Abutment Loading	4.95	12.66	14.34	8.22	18.02	5.76	22.09	5.76	22.09	14.34	17.63	14.34	36.76	36.76	36.76
Safety Factor (under Double Abutment Loading)	1.89	0.86	0.76	1.33	0.60	1.89	0.49	1.89	0.49	0.76	0.62	0.76	0.30	0.30	0.30
Notes:															
FTA Sp/T	0.011	0.014	0.015	0.013	0.016	0.012	0.017	0.012	0.017	0.015	0.016	0.015	0.021	0.021	0.021
FTA Sp(m)	0.024	0.030	0.031	0.026	0.033	0.024	0.036	0.024	0.036	0.031	0.033	0.031	0.045	0.045	0.045
FTA Sp/T (U95%)	0.065	0.068	0.069	0.067	0.070	0.066	0.071	0.066	0.071	0.069	0.070	0.069	0.075	0.075	0.075
FTA Sp (U95%)	0.138	0.143	0.144	0.140	0.147	0.138	0.149	0.138	0.149	0.144	0.146	0.144	0.158	0.158	0.158
nA Sp/T	0.013	0.023	0.026	0.017	0.034	0.014	0.043	0.014	0.043	0.026	0.033	0.026	0.094	0.094	0.094
nA Sp(m)	0.028	0.049	0.055	0.036	0.071	0.030	0.091	0.030	0.091	0.055	0.069	0.055	0.197	0.197	0.197
nA Sp/T (U95%)	0.067	0.077	0.080	0.071	0.088	0.068	0.097	0.068	0.097	0.080	0.087	0.080	0.148	0.148	0.148
nA Sp (U95%)	0.142	0.163	0.169	0.149	0.184	0.143	0.205	0.143	0.205	0.169	0.169	0.169	0.310	0.310	0.310
Max Subs	0.87	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	0.75	1.63	1.75	1.25	2.00	1.00	2.25	1.00	2.25	1.75	1.98	1.75	3.00	3.00	3.00
increase in vertical stress (MPa)	1.67	2.46	2.65	1.89	3.03	1.52	3.41	1.52	3.41	2.65	2.99	2.65	4.55	4.55	4.55
Pillar Compression (m)	0.002	0.002	0.003	0.002	0.003	0.001	0.003	0.001	0.003	0.003	0.003	0.003	0.004	0.004	0.004
Roof Compression (m)	0.002	0.005	0.005	0.004	0.006	0.003	0.006	0.003	0.006	0.005	0.006	0.005	0.009	0.009	0.009
Floor Compression (m)	0.002	0.005	0.005	0.004	0.006	0.003	0.006	0.003	0.006	0.005	0.006	0.005	0.009	0.009	0.009
Total Elastic Compression (m)	0.007	0.012	0.013	0.009	0.015	0.007	0.016	0.007	0.016	0.013	0.014	0.013	0.022	0.022	0.022
Yielded Pillars (m)	0.87	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Smax/T	0.36	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Smin/T	0.003	0.005	0.005	0.004	0.006	0.003	0.007	0.003	0.007	0.005	0.006	0.005	0.009	0.009	0.009

UNSW Pillar Design Spreadsheet

Minimi - Pillar Extraction Panels																		
Partial Extraction Panels - Welsh Bords - Min FoS = 1.6																		
INPUT DATA																		
Depth of Cover (m)	B82.8	B82.8	B82.8	B82.8	B82.9	B82.9	B82.9	B82.9	B82.9	B82.9	B82.9	B82.10	B82.10	B82.10	B82.10	B82.4	B82.4	B82.4
Mining Height (m)	110	85	110	124	59	80	130	80	130	20	50	20	43	50	61	50	80	80
Pillar Length - centres (m)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Pillar Width - centres (m)	38.7	38.7	38.7	38.7	31.7	31.7	31.7	35	35	36.1	36.1	36.1	36.1	31.7	31.7	31.7	31.7	31.7
Roadway Width for maximum pillar dimension	11.9	11.9	11.9	11.9	12.5	12.5	12.5	12	12	12	12	12	12	12	12.5	12.5	12.5	12.5
Roadway Width for minimum pillar dimension	4.8	4.8	4.8	4.8	5.2	5.2	5.2	3	3	6.9	6.9	6.9	6.9	5.2	5.2	5.2	5.2	5.2
Cut-Through Angle (degrees)	6.5	6.5	6.5	6.5	7.2	7.2	7.2	6	6	7.9	7.9	7.9	7.9	7.2	7.2	7.2	7.2	7.2
Average Panel Span (m) (rib-rib width)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
SG (tonnes/m ³)	200	200	200	200	180	180	180	180	250	270	270	270	270	180	180	180	180	1180
Conversion (tonnes to N)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Abutment Angle (°)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS																		
Maximum Rib to Rib Pillar Length (w ₂)	33.9	33.9	33.9	33.9	26.5	26.5	26.5	26.5	32.0	32.0	29.2	29.2	29.2	29.2	26.5	26.5	26.5	26.5
Minimum Rib to Rib Pillar Width (w ₁)	5.4	5.4	5.4	5.4	5.3	5.3	5.3	5.3	6.0	6.0	4.1	4.1	4.1	4.1	5.3	5.3	5.3	5.3
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	5.4	5.4	5.4	5.4	5.3	5.3	5.3	5.3	6.0	6.0	4.1	4.1	4.1	4.1	5.3	5.3	5.3	5.3
Minimum Pillar Width/Height Ratio	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.9	2.9	2.0	2.0	2.0	2.0	2.5	2.5	2.5	2.5
Extraction Ratio (%)	60.3%	60.3%	60.3%	60.3%	64.6%	64.6%	64.6%	64.6%	54.3%	54.3%	72.4%	72.4%	72.4%	72.4%	64.6%	64.6%	64.6%	64.6%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	53.804	47.296	53.804	57.125	39.404	45.884	58.491	45.884	51.300	58.491	22.942	36.275	22.942	33.640	36.275	40.067	36.275	45.884
R (Pillar 2nd Abutment Component)	0.53	0.58	0.53	0.50	0.68	0.61	0.51	0.61	0.55	0.50	0.89	0.70	0.89	0.73	0.72	0.67	0.72	0.61
Dimensionless Pillar 'Rectangularity'	1.73	1.73	1.73	1.73	1.67	1.67	1.67	1.67	1.68	1.68	1.75	1.75	1.75	1.75	1.67	1.67	1.67	1.67
Width/Height Ratio Exponent	-0.14	-0.14	-0.14	-0.14	-0.16	-0.16	-0.16	-0.16	-0.05	-0.05	-0.35	-0.35	-0.35	-0.35	-0.16	-0.16	-0.16	-0.16
Effective Width Factor (Omega)	0.93	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.98	0.98	0.82	0.82	0.82	0.82	0.92	0.92	0.92	0.92
Effective Width Interim	5.00	5.00	5.00	5.00	4.89	4.89	4.89	4.89	5.85	5.85	3.37	3.37	3.37	3.37	4.89	4.89	4.89	4.89
Effective Pillar Width (m)	5.40	5.40	5.40	5.40	5.30	5.30	5.30	5.30	6.00	6.00	4.10	4.10	4.10	4.10	5.30	5.30	5.30	5.30
Effective Pillar Loading Height (m)	110.00	85.00	110.00	124.00	59.00	80.00	130.00	80.00	100.00	130.00	20.00	50.00	20.00	43.00	50.00	61.00	50.00	80.00
RESULTS																		
Tributary Area Loading (MPa)	6.92	5.35	6.92	7.80	4.16	5.64	9.17	5.64	5.47	7.11	1.81	4.52	1.81	3.89	3.53	4.30	3.53	5.64
Tributary Area Loading x 0.5 (MPa)	3.46	2.67	3.46	3.90	2.08	2.82	4.58	2.82	2.73	3.55	0.90	2.26	0.90	1.94	1.76	2.15	1.76	2.82
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h<5)	10.90	10.90	10.90	10.90	10.79	10.79	10.79	10.79	11.50	11.50	9.47	9.47	9.47	9.47	10.79	10.79	10.79	10.79
Safety Factor under FTA Loading (Squat Pillar)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Safety Factor under FTA Loading (w/h<5)	1.58	2.04	1.58	1.40	2.59	1.91	1.18	1.91	2.10	1.62	5.23	2.09	5.23	2.43	3.06	2.51	3.06	1.91
No. SAs, n	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
Single Abutment Loading (3D) - full	12.27	7.33	12.27	15.60	3.77	6.93	18.30	6.93	8.75	14.78	0.58	3.62	0.58	2.68	2.71	4.03	2.71	6.93
Single Abutment Loading (3D) - pillar	6.48	4.26	6.48	7.86	2.57	4.26	9.41	4.26	4.81	7.36	0.52	2.53	0.52	1.96	1.95	2.72	1.95	4.26
Single Abutment Loading (3D) - solid	5.80	3.07	5.80	7.74	1.20	2.67	8.90	2.67	3.93	7.42	0.06	1.08	0.06	0.71	0.76	1.31	0.76	2.67
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	13.39	9.60	13.39	15.66	6.73	9.90	18.57	9.90	10.28	14.47	2.33	7.06	2.33	5.85	5.47	7.02	5.47	9.90
Safety Factor (under Single Abutment Loading)	0.81	1.13	0.81	0.70	1.60	1.09	0.58	1.09	1.12	0.79	4.07	1.34	4.07	1.62	1.97	1.54	1.97	1.09
Total Pillar Loading @ nA	19.19	12.67	19.19	23.40	7.93	12.57	27.47	12.57	14.22	7.11	2.39	8.14	2.39	6.57	6.23	8.33	6.23	12.57
Safety Factor @ nA	0.57	0.86	0.57	0.47	1.36	0.86	0.39	0.86	0.81	1.62	3.97	1.16	3.97	1.44	1.73	1.30	1.73	0.86
Total Pillar Loading under Double Abutment Loading	31.47	20.00	31.47	38.99	11.70	19.50	45.77	19.50	22.96	36.67	2.97	11.76	2.97	9.24	8.94	12.36	8.94	19.50
Safety Factor (under Double Abutment Loading)	0.35	0.54	0.35	0.28	0.92	0.55	0.24	0.55	0.50	0.31	3.19	0.81	3.19	1.02	1.21	0.87	1.21	0.55
Notes:																		
FTA Sp/T	0.020	0.016	0.020	0.022	0.014	0.017	0.026	0.017	0.017	0.020	0.011	0.015	0.011	0.014	0.013	0.014	0.013	0.017
FTA Sp(m)	0.042	0.034	0.042	0.046	0.030	0.036	0.054	0.036	0.035	0.043	0.022	0.031	0.022	0.029	0.028	0.030	0.028	0.036
FTA Sp/T (U95%)	0.074	0.070	0.074	0.076	0.068	0.071	0.080	0.071	0.071	0.074	0.065	0.069	0.065	0.068	0.067	0.068	0.067	0.071
FTA Sp (U95%)	0.155	0.148	0.155	0.160	0.143	0.149	0.168	0.149	0.148	0.156	0.136	0.145	0.136	0.142	0.141	0.144	0.141	0.149
nA Sp/T	0.073	0.038	0.073	0.103	0.022	0.038	0.134	0.038	0.045	0.020	0.011	0.023	0.011	0.019	0.018	0.023	0.018	0.038
nA Sp(m)	0.154	0.080	0.154	0.216	0.047	0.079	0.282	0.079	0.094	0.043	0.024	0.048	0.024	0.040	0.038	0.049	0.038	0.079
nA Sp/T (U95%)	0.127	0.092	0.127	0.157	0.076	0.092	0.188	0.092	0.099	0.074	0.065	0.077	0.065	0.073	0.072	0.077	0.072	0.092
nA Sp (U95%)	0.267	0.194	0.267	0.330	0.160	0.193	0.395	0.193	0.208	0.156	0.137	0.161	0.137	0.153	0.152	0.163	0.152	0.193
Max Subs	0.76	0.76	0.76	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
Ecoal(GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)	2.75	2.13	2.75	3.10	1.48	2.00	3.25	2.00	2.50	3.25	0.50	1.25	0.50	1.08	1.25	1.53	1.25	2.00
increase in vertical stress (MPa)	4.17	3.22	4.17	4.70	2.69	3.64	5.92	3.64	2.97	3.86	1.31	3.27	1.31	2.81	2.28	2.78	2.28	3.64
Pillar Compression (m)	0.004	0.003	0.004	0.005	0.003	0.004	0.006	0.004	0.003	0.004	0.001	0.003	0.001	0.003	0.002	0.003	0.002	0.004
Roof Compression (m)	0.008	0.006	0.008	0.009	0.005	0.006	0.010	0.006	0.006	0.008	0.002	0.005	0.002	0.004	0.004	0.005	0.004	0.006
Floor Compression (m)	0.008	0.006	0.008	0.009	0.005	0.006	0.010	0.006	0.006	0.008	0.002	0.005	0.002	0.004	0.004	0.005	0.004	0.006
Total Elastic Compression (m)	0.020	0.015	0.020	0.023	0.012	0.016												

UNSW Pillar Design Spreadsheet

Minimi - Pillar Extraction Panels		Partial Extraction Panels - Welsh Bords - Min FoS = 1.6																	
INPUT DATA		BB2.11	BB2.11	BB2.11	BB2.11	BB2.11	BB2.12	BB2.12	BB2.12	BB2.12	BB2.12	BB2.13	BB2.13	BB2.13	BB2.13	BB2.14	BB2.15	BB2.15	BB2.15
Depth of Cover (m)		20	20	40	20	40	90	133	90	145	70	130	70	130	50	100	130	100	130
Mining Height (m)		2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Pillar Length - centres (m)		36.1	36.1	36.1	36.1	36.1	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Pillar Width - centres (m)		12	12	12	12	12	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
Roadway Width for maximum pillar dimension		6.9	6.9	6.9	6.9	6.9	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Roadway Width for minimum pillar dimension		7.9	7.9	7.9	7.9	7.9	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Cut-Through Angle (degrees)		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)		70	70	150	70	150	200	200	200	200	400	400	400	400	250	230	230	230	230
SG (tonnes/m ³)		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Abutment (tonnes to N)		10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
INTERMEDIATE CALCULATIONS		29.2	29.2	29.2	29.2	29.2	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9
Maximum Rib to Rib Pillar Length (w ₂)		29.2	29.2	29.2	29.2	29.2	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33.9
Minimum Rib to Rib Pillar Width (w ₁)		4.1	4.1	4.1	4.1	4.1	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
w, Minimum Rib to Rib Pillar Width (ie w, sinθ)		4.1	4.1	4.1	4.1	4.1	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Minimum Pillar Width/Height Ratio		2.0	2.0	2.0	2.0	2.0	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Extraction Ratio (%)		72.4%	72.4%	72.4%	72.4%	72.4%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%	60.3%
Abutment Angle (Radians)		0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)		1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)		22.942	22.942	32.445	22.942	32.445	48.667	58.162	48.667	58.162	42.921	58.491	42.921	58.491	36.275	51.300	58.491	51.300	58.491
R (Pillar 2nd Abutment Component)		0.89	0.89	0.75	0.89	0.75	0.57	0.49	0.57	0.47	0.62	0.49	0.62	0.49	0.70	0.55	0.49	0.55	0.49
Dimensionless Pillar 'Rectangularity'		1.75	1.75	1.75	1.75	1.75	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Width/Height Ratio Exponent		-0.35	-0.35	-0.35	-0.35	-0.35	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
Effective Width Factor (Omega)		0.82	0.82	0.82	0.82	0.82	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Effective Width Interim		3.37	3.37	3.37	3.37	3.37	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Effective Pillar Width (m)		4.10	4.10	4.10	4.10	4.10	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40
Effective Pillar Loading Height (m)		20.00	20.00	40.00	20.00	40.00	90.00	133.00	90.00	145.00	70.00	130.00	70.00	130.00	50.00	100.00	130.00	100.00	130.00
RESULTS		1.81	1.81	3.62	1.81	3.62	5.66	8.36	5.66	9.12	4.40	8.18	4.40	8.18	3.14	6.29	8.18	6.29	8.18
Tributary Area Loading (MPa)		0.90	0.90	1.81	0.90	1.81	2.83	4.18	2.83	4.56	2.20	4.09	2.20	4.09	1.57	3.14	4.09	3.14	4.09
Tributary Area Loading x 0.5 (MPa)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW Squat Pillar 1999)		9.47	9.47	9.47	9.47	9.47	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90
Pillar Strength (UNSW w/h=5)		9.47	9.47	9.47	9.47	9.47	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90	10.90
Safety Factor under FTA Loading (Squat Pillar)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Safety Factor under FTA Loading (w/h=5)		5.23	5.23	2.62	5.23	2.62	1.93	1.30	1.93	1.20	2.48	1.33	2.48	1.33	3.47	1.73	1.33	1.73	1.33
No. SAs, n		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Single Abutment Loading (3D) - full		0.58	0.58	2.31	0.58	2.31	8.22	17.94	8.22	21.33	4.97	17.14	4.97	17.14	2.54	10.14	17.14	10.14	17.14
Single Abutment Loading (3D) - pillar		0.52	0.52	1.74	0.52	1.74	4.67	8.80	4.67	10.10	3.09	8.48	3.09	8.48	1.77	5.55	8.48	5.55	8.48
Single Abutment Loading (3D) - solid		0.06	0.06	0.58	0.06	0.58	3.54	9.15	3.54	11.22	1.88	8.66	1.88	8.66	0.77	4.60	8.66	4.60	8.66
Cell Sensitivity (MPa)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading		2.33	2.33	5.35	2.33	5.35	10.33	17.16	10.33	19.22	7.50	16.66	7.50	16.66	4.91	11.84	16.66	11.84	16.66
Safety Factor (under Single Abutment Loading)		4.07	4.07	1.77	4.07	1.77	1.05	0.64	1.05	0.57	1.45	0.65	1.45	0.65	2.22	0.92	0.65	0.92	0.65
Total Pillar Loading @ nA		2.39	2.39	5.93	2.39	5.93	13.88	26.31	13.88	30.45	9.37	25.32	9.37	25.32	5.68	16.43	25.32	16.43	25.32
Safety Factor @ nA		3.97	3.97	1.60	3.97	1.60	0.79	0.41	0.79	0.36	1.16	0.43	1.16	0.43	1.92	0.66	0.43	0.66	0.43
Total Pillar Loading under Double Abutment Loading		2.97	2.97	8.25	2.97	8.25	22.09	44.25	22.09	51.77	14.34	42.46	14.34	42.46	8.22	26.58	42.46	26.58	42.46
Safety Factor (under Double Abutment Loading)		3.19	3.19	1.15	3.19	1.15	0.49	0.25	0.49	0.21	0.76	0.26	0.76	0.26	1.33	0.41	0.26	0.41	0.26
Notes:																			
FTA Sp/T		0.011	0.011	0.013	0.011	0.013	0.017	0.023	0.017	0.026	0.015	0.023	0.015	0.023	0.013	0.018	0.023	0.018	0.023
FTA Sp(m)		0.022	0.022	0.028	0.022	0.028	0.036	0.049	0.036	0.054	0.031	0.048	0.031	0.048	0.026	0.039	0.048	0.039	0.048
FTA Sp/T (U95%)		0.065	0.065	0.067	0.065	0.067	0.071	0.077	0.071	0.080	0.069	0.077	0.069	0.077	0.067	0.072	0.077	0.072	0.077
FTA Sp (U95%)		0.136	0.136	0.141	0.136	0.141	0.149	0.163	0.149	0.167	0.144	0.162	0.144	0.162	0.140	0.152	0.162	0.152	0.162
nA Sp/T		0.011	0.011	0.018	0.011	0.018	0.043	0.125	0.043	0.156	0.026	0.118	0.026	0.118	0.017	0.056	0.118	0.056	0.118
nA Sp(m)		0.024	0.024	0.037	0.024	0.037	0.091	0.263	0.091	0.328	0.055	0.247	0.055	0.247	0.036	0.118	0.247	0.118	0.247
nA Sp/T (U95%)		0.065	0.065	0.072	0.065	0.072	0.097	0.179	0.097	0.210	0.080	0.172	0.080	0.172	0.071	0.110	0.172	0.110	0.172
nA Sp (U95%)		0.137	0.137	0.150	0.137	0.150	0.205	0.377	0.205	0.441	0.169	0.361	0.169	0.361	0.149	0.232	0.361	0.232	0.361
Max Subs		0.88	0.88	0.88	0.88	0.88	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Ecoal(2GPa)		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Efloor(GPa)		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eroof(GPa)		6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Poissons Ratio floor/roof		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
initial vertical stress (MPa)		0.50	0.50	1.00	0.50	1.00	2.25	3.33	2.25	3.63	1.75	3.25	1.75	3.25	1.25	2.50	3.25	2.50	3.25
increase in vertical stress (MPa)		1.31	1.31	2.62	1.31	2.62	3.41	5.04	3.41	5.49	2.65	4.93	2.65	4.93	1.89	3.79	4.93	3.79	4.93
Pillar Compression (m)		0.001	0.001	0.003	0.001	0.003	0.003	0.005	0.003	0.005	0.003	0.005	0.003	0.005	0.002	0.004	0.005	0.004	0.005
Roof Compression (m)		0.002	0.002	0.004	0.002	0.004	0.006	0.010	0.006	0.010	0.005	0.009	0.005	0.009	0.004	0.007	0.009	0.007	0.009
Floor Compression (m)		0.002	0.002	0.004	0.002	0.004	0.006	0.010	0.006	0.010	0.005	0.009	0.005	0.009	0.004	0.007	0.009	0.007	0.009
Total Elastic Compression (m)		0.005	0.005	0.010	0.005	0.010	0.016	0.024	0.016	0.026	0.013	0.024	0.013	0.024					

UNSW Pillar Design Spreadsheet

Minmi - Pillar Extraction Panels		
INPUT DATA		
Depth of Cover (m)	BB2.16	BB2.16
Mining Height (m)	90	140
Pillar Length - centres (m)	2.1	2.1
Pillar Width - centres (m)	38.7	38.7
Pillar Width for <u>maximum</u> pillar dimension	11.9	11.9
Roadway Width for <u>minimum</u> pillar dimension	4.8	4.8
Cut-Through Angle (degrees)	6.5	6.5
Average Panel Span (m) (rib-rib width)	90	90
SG (tonnes/m ³)	180	180
Conversion (tonnes to N)	2.5	2.5
Abutment Angle (°)	10000	10000
	21	21

INTERMEDIATE CALCULATIONS		
Maximum Rib to Rib Pillar Length (w ₂)	33.9	33.9
Minimum Rib to Rib Pillar Width (w ₁)	5.4	5.4
w, Minimum Rib to Rib Pillar Width (ie w, sinθ)	5.4	5.4
Minimum Pillar Width/Height Ratio	2.6	2.6
Extraction Ratio (%)	60.3%	60.3%
Abutment Angle (Radians)	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes
D (Peng & Chiang Loading Factor)	48.667	60.699
R (Pillar 2nd Abutment Component)	0.57	0.48
Dimensionless Pillar 'Rectangularity'	1.73	1.73
Width/Height Ratio Exponent	-0.14	-0.14
Effective Width Factor (Omega)	0.93	0.93
Effective Width Interim	5.00	5.00
Effective Pillar Width (m)	5.40	5.40
Effective Pillar Loading Height (m)	90.00	140.00

RESULTS		
Tributary Area Loading (MPa)	5.66	8.81
Tributary Area Loading x 0.5 (MPa)	2.83	4.40
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA
Pillar Strength (UNSW w/h<5)	10.90	10.90
Safety Factor under FTA Loading (Squat Pillar)	N/A	N/A
Safety Factor under FTA Loading (w/h<5)	1.93	1.24
No. SAs, n	1	1
Single Abutment Loading (3D) - full	8.22	19.88
Single Abutment Loading (3D) - pillar	4.67	9.55
Single Abutment Loading (3D) - solid	3.54	10.33
Cell Sensitivity (MPa)	0	0
Total Pillar Loading with Single Abutment Loading	10.33	18.36
Safety Factor (under Single Abutment Loading)	1.05	0.59
Total Pillar Loading @ nA	13.88	28.69
Safety Factor @ nA	0.79	0.38
Total Pillar Loading under Double Abutment Loading	22.09	48.57
Safety Factor (under Double Abutment Loading)	0.49	0.22

Notes:

FTA Sp/T	0.017	0.025
FTA Sp(m)	0.036	0.052
FTA Sp/T (U95%)	0.071	0.079
FTA Sp (U95%)	0.149	0.165
nA Sp/T	0.043	0.143
nA Sp(m)	0.091	0.301
nA Sp/T (U95%)	0.097	0.197
nA Sp (U95%)	0.205	0.414
Max Subs	0.73	0.73
Ecoal(2GPa)	2.00	2.00
Efloor(GPa)	6.00	6.00
Eroof(GPa)	6.00	6.00
Poissons Ratio floor/roof	0.25	0.25
initial vertical stress (MPa)	2.25	3.50
increase in vertical stress (MPa)	3.41	5.31
Pillar Compression (m)	0.003	0.005
Roof Compression (m)	0.006	0.010
Floor Compression (m)	0.006	0.010
Total Elastic Compression (m)	0.016	0.025
Yielded Pillars (m)	0.73	0.73
Smax/T	0.31	0.31

Smin/T 0.007 0.011

Notes:

- Based on Galvin et al, NIOSH Pillar Workshop, 1999, & ALTI
- Abutment Loading Model is 3D (allows for cut-throughs)
- Model incorporates sub and super-critical panel effects

UNSW Pillar Design Spreadsheet

Minimi - Pillar Extraction Panels	FW Panels - Welsh Bords - Min FoS = 1.6																				FW Panels - Welsh Bords - Min FoS = 1.6							
INPUT DATA	BB1.1	BB1.1	BB1.1	BB1.1	BB1.2	BB1.2	BB1.2	BB1.2	BB1.3	BB1.3	BB1.4	BB1.4	BB1.5	BB1.6	BB1.6	BB1.7	BB1.7	BB1.8	BB1.9	BB1.9	BB1.9	BB1.9	BB1.10	BB1.10				
Depth of Cover (m)	120	150	120	150	30	130	30	130	30	60	30	60	55	50	100	50	70	70	50	90	50	90	90	90				
Mining Height (m)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1				
Pillar Length - centres (m)	43	43	30	30	25	25	25	25	22	22	22	22	30	35	33	45	45	35	35	35	35	35	25	25				
Pillar Width - centres (m)	13	13	22	22	11	11	16	16	10	10	10	10	13	11	12	11	11	16	22	22	12	12	12	12				
Roadway Width for <u>maximum</u> pillar dimension	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5				
Roadway Width for <u>minimum</u> pillar dimension	5	5	7	7	3	3	3	3	3	6	6	6	5	5	5	5	5	6	6	6	6	6	6	6				
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90				
Average Panel Span (m) (rib-rib width)	120	120	120	200	200	200	200	200	310	310	400	400	280	180	180	180	180	180	150	150	150	150	250	250				
SG (tonnes/m ²)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5				
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000				
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21				
INTERMEDIATE CALCULATIONS																												
Maximum Rib to Rib Pillar Length (w ₂)	40.0	40.0	27.0	27.0	22.0	22.0	22.0	22.0	19.0	19.0	19.0	19.0	27.0	32.0	30.0	42.0	42.0	32.0	32.0	32.0	32.0	32.0	20.0	20.0				
Minimum Rib to Rib Pillar Width (w ₁)	8.0	8.0	15.0	15.0	8.0	8.0	13.0	13.0	4.0	4.0	4.0	4.0	8.0	6.0	7.0	6.0	6.0	10.0	16.0	16.0	6.0	6.0	6.0	6.0				
w ₁ Minimum Rib to Rib Pillar Width (ie w ₁ sinθ)	8.0	8.0	15.0	15.0	8.0	8.0	13.0	13.0	4.0	4.0	4.0	4.0	8.0	6.0	7.0	6.0	6.0	10.0	16.0	16.0	6.0	6.0	6.0	6.0				
Minimum Pillar Width/Height Ratio	3.8	3.8	7.1	7.1	3.8	3.8	6.2	6.2	1.9	1.9	1.9	1.9	3.8	2.9	3.3	2.9	2.9	4.8	7.6	7.6	2.9	2.9	2.9	2.9				
Extraction Ratio (%)	42.8%	42.8%	38.6%	38.6%	36.0%	36.0%	28.5%	28.5%	65.5%	65.5%	65.5%	65.5%	44.6%	50.1%	47.0%	49.1%	49.1%	42.9%	33.5%	33.5%	54.3%	54.3%	60.0%	60.0%				
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367				
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571				
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
D (Peng & Chiang Loading Factor)	56.196	62.829	56.196	62.829	28.098	58.491	28.098	58.491	28.098	39.737	28.098	39.737	38.045	36.275	51.300	36.275	42.921	42.921	36.275	48.667	36.275	48.667	48.667	48.667				
R (Pillar 2nd Abutment Component)	0.55	0.55	0.77	0.73	0.77	0.46	0.92	0.62	0.73	0.58	0.73	0.58	0.71	0.66	0.55	0.66	0.59	0.75	0.94	0.84	0.70	0.57	0.57	0.57				
Dimensionless Pillar 'Rectangularity'	1.67	1.67	1.29	1.29	1.47	1.47	1.26	1.26	1.65	1.65	1.65	1.65	1.54	1.68	1.62	1.75	1.75	1.52	1.33	1.33	1.68	1.68	1.54	1.54				
Width/Height Ratio Exponent	0.27	0.27	1.00	1.00	0.27	0.27	1.00	1.00	-0.37	-0.37	-0.37	-0.37	0.27	-0.05	0.11	-0.05	-0.05	0.59	1.00	1.00	-0.05	-0.05	-0.05	-0.05				
Effective Width Factor (Omega)	1.15	1.15	1.29	1.29	1.11	1.11	1.26	1.26	0.83	0.83	0.83	0.83	1.12	0.98	1.06	0.97	0.97	1.28	1.33	1.33	0.98	0.98	0.98	0.98				
Effective Width Interim	9.18	9.18	19.29	19.29	8.87	8.87	16.34	16.34	3.33	3.33	3.33	3.33	8.99	5.85	7.39	5.84	5.84	12.81	21.33	21.33	5.85	5.85	5.88	5.88				
Effective Pillar Width (m)	9.18	9.18	19.29	19.29	8.87	8.87	16.34	16.34	4.00	4.00	4.00	4.00	8.99	6.00	7.39	6.00	6.00	12.81	21.33	21.33	6.00	6.00	6.00	6.00				
Effective Pillar Loading Height (m)	120.00	150.00	120.00	150.00	30.00	130.00	30.00	130.00	30.00	60.00	30.00	60.00	55.00	50.00	100.00	50.00	70.00	70.00	50.00	90.00	50.00	90.00	90.00	90.00				
RESULTS																												
Tributary Area Loading (MPa)	5.24	6.55	4.89	6.11	1.17	5.08	1.05	4.55	2.17	4.34	2.17	4.34	2.48	2.51	4.71	2.46	3.44	3.06	1.88	3.38	2.73	4.92	5.63	5.63				
Tributary Area Loading x 0.5 (MPa)	2.62	3.28	2.44	3.06	0.59	2.54	0.52	2.27	1.09	2.17	1.09	2.17	1.24	1.25	2.36	1.23	1.72	1.53	0.94	1.69	1.37	2.46	2.81	2.81				
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	22.61	22.61	NA	NA	19.61	19.61	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.70	24.70	NA	NA	NA	NA				
Pillar Strength (UNSW w/h<5)	14.29	14.29	N/A	N/A	14.04	14.04	N/A	N/A	9.35	9.35	9.35	9.35	14.14	11.50	12.79	11.50	11.50	16.93	N/A	N/A	11.50	11.50	11.50	11.50				
Safety Factor under FTA Loading (Squat Pillar)	14.29	14.29	22.61	22.61	14.04	14.04	19.61	19.61	9.35	9.35	9.35	9.35	14.14	11.50	12.79	11.50	11.50	16.93	24.70	24.70	11.50	11.50	11.50	11.50				
Safety Factor under FTA Loading (w/h<5)	N/A	N/A	4.63	3.70	N/A	N/A	18.69	4.31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.14	7.30	N/A	N/A	N/A	N/A				
No. SAs, n	2.73	2.18	N/A	N/A	11.98	2.76	N/A	4.31	2.15	4.31	2.15	4.31	5.69	4.59	2.71	4.68	3.35	5.53	N/A	N/A	4.21	2.34	2.04	2.04				
Single Abutment Loading (3D) - full	1	1	1	1	1	1	1	1	1	2	2	2	2	1	1	1	1	1	1	1	0	0	1	1				
Single Abutment Loading (3D) - pillar	9.28	14.51	5.12	8.00	0.61	11.52	0.38	7.09	1.25	5.00	1.25	5.00	2.02	2.19	7.54	2.14	4.20	2.57	0.82	2.66	2.19	7.08	8.10	8.10				
Single Abutment Loading (3D) - solid	5.07	7.27	3.96	5.80	0.48	5.35	0.35	4.37	0.92	2.90	0.92	2.90	1.44	1.45	4.15	1.42	2.47	1.94	0.77	2.22	1.53	4.05	4.63	4.63				
Cell Sensitivity (MPa)	4.22	7.24	1.15	2.19	0.14	6.17	0.03	2.72	0.33	2.10	0.33	2.10	0.58	0.74	3.39	0.72	1.73	0.63	0.05	0.44	0.66	3.03	3.46	3.46				
Total Pillar Loading with Single Abutment Loading	10.31	13.82	8.85	11.91	1.65	10.43	1.40	8.92	3.09	7.25	3.09	7.25	3.92	3.95	8.86	3.87	5.91	5.00	2.65	5.60	4.27	8.98	10.26	10.26				
Safety Factor (under Single Abutment Loading)	1.39	1.03	2.55	1.90	8.52	1.35	14.04	2.20	3.03	1.29	3.03	1.29	3.60	2.91	1.44	2.97	1.95	3.39	9.32	4.41	2.70	1.28	1.12	1.12				
Total Pillar Loading @ nA	14.53	21.06	10.01	14.11	1.79	16.60	1.43	11.63	4.67	14.34	4.67	14.34	6.51	4.69	12.25	4.60	7.64	5.63	2.70	6.04	2.73	4.92	13.72	13.72				
Safety Factor @ nA	0.98	0.68	2.26	1.60	7.86	0.85	13.75	1.69	2.00	0.65	2.00	0.65	2.17	2.45	1.04	2.50	1.51	3.00	9.15	4.09	4.21	2.34	0.84	0.84				
Total Pillar Loading under Double Abutment Loading	23.81	35.57	15.13	22.11	2.40	28.12	1.80	18.72	4.67	14.34	4.67	14.34	6.51	6.88	19.79	6.74	11.83	8.21	3.52	8.70	7.11	19.09	21.82	21.82				
Safety Factor (under Double Abutment Loading)	0.60	0.40	1.50	1.02	5.85	0.50	10.87	1.05	2.00	0.65	2.00	0.65	2.17	1.67	0.65	1.71	0.97	2.06	7.02	2.84	1.62	0.60	0.53	0.53				
Notes:																												
FTA Sp/T	0.016	0.019	0.016	0.018	0.010	0.016	0.010	0.015	0.011	0.015	0.011	0.015	0.012	0.012	0.015	0.012	0.013	0.012	0.011	0.013	0.012	0.016	0.017	0.017				
FTA Sp(m) F																												

UNSW Pillar Design Spreadsheet

Minni - Pillar Extraction Panels																				
INPUT DATA																				
Depth of Cover (m)	130	60	100	60	100	130	140	100	130	120	130	100	110	120	130	140	100	130	140	130
Mining Height (m)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Pillar Length - centres (m)	25	33	33	33	33	40	40	33	33	203	203	43	43	500	500	38	38	38	38	38
Pillar Width - centres (m)	12	14	14	22	22	16	16	14	14	16	16	12	12	15	15	15	15	15	15	15
Roadway Width for <u>maximum</u> pillar dimension	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Roadway Width for <u>minimum</u> pillar dimension	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Cut-Through Angle (degrees)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average Panel Span (m) (rib-rib width)	250	150	150	100	100	100	230	230	230	230	200	200	200	200	200	240	240	240	240	240
SG (tonnes/m ³)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion (tonnes to N)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Abutment Angle (°)	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21

INTERMEDIATE CALCULATIONS																				
Maximum Rib to Rib Pillar Length (w ₂)	20.0	30.0	30.0	30.0	30.0	37.0	37.0	30.0	30.0	200.0	200.0	40.0	40.0	497.0	497.0	35.0	35.0	35.0	35.0	35.0
Minimum Rib to Rib Pillar Width (w ₁)	6.0	8.0	8.0	16.0	16.0	10.0	10.0	8.0	8.0	10.0	10.0	6.0	6.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
w, Minimum Rib to Rib Pillar Width (ie w, sinθ)	6.0	8.0	8.0	16.0	16.0	10.0	10.0	8.0	8.0	10.0	10.0	6.0	6.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Minimum Pillar Width/Height Ratio	2.9	3.8	3.8	7.6	7.6	4.8	4.8	3.8	3.8	4.8	4.8	2.9	2.9	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Extraction Ratio (%)	60.0%	48.1%	48.1%	33.9%	33.9%	42.2%	42.2%	48.1%	48.1%	38.4%	38.4%	53.5%	53.5%	40.4%	40.4%	44.7%	44.7%	44.7%	44.7%	44.7%
Abutment Angle (Radians)	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Cut-Through Angle (Radians)	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571	1.571
Is the Panel Super-Critical?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D (Peng & Chiang Loading Factor)	58.491	39.737	51.300	39.737	51.300	58.491	60.699	51.300	58.491	58.196	58.491	51.300	53.804	53.804	58.196	58.491	60.699	58.491	60.699	60.699
R (Pillar 2nd Abutment Component)	0.50	0.73	0.62	0.91	0.81	0.62	0.60	0.62	0.55	0.63	0.62	0.55	0.53	0.62	0.61	0.59	0.57	0.59	0.57	0.57
Dimensionless Pillar 'Rectangularity'	1.54	1.58	1.58	1.30	1.30	1.57	1.57	1.58	1.58	1.90	1.90	1.74	1.74	1.96	1.96	1.59	1.59	1.59	1.59	1.59
Width/Height Ratio Exponent	-0.05	0.27	0.27	1.00	1.00	0.59	0.59	0.27	0.27	0.59	0.59	-0.05	-0.05	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Effective Width Factor (Omega)	0.98	1.13	1.13	1.30	1.30	1.31	1.31	1.13	1.13	1.46	1.46	0.97	0.97	1.34	1.34	1.22	1.22	1.22	1.22	1.22
Effective Width Interim	5.88	9.05	9.05	20.87	20.87	13.06	13.06	9.05	9.05	14.60	14.60	5.84	5.84	12.02	12.02	10.98	10.98	10.98	10.98	10.98
Effective Pillar Width (m)	6.00	9.05	9.05	20.87	20.87	13.06	13.06	9.05	9.05	14.60	14.60	6.00	6.00	12.02	12.02	10.98	10.98	10.98	10.98	10.98
Effective Pillar Loading Height (m)	130.00	60.00	100.00	60.00	100.00	130.00	140.00	100.00	130.00	120.00	130.00	100.00	110.00	110.00	120.00	130.00	140.00	130.00	140.00	140.00

RESULTS																				
Tributary Area Loading (MPa)	8.13	2.89	4.81	2.27	3.78	5.62	6.05	4.81	6.26	4.87	5.28	5.38	5.91	4.61	5.03	5.88	6.33	5.88	6.33	6.33
Tributary Area Loading x 0.5 (MPa)	4.06	1.44	2.41	1.13	1.89	2.81	3.03	2.41	3.13	2.44	2.64	2.69	2.96	2.31	2.52	2.94	3.17	2.94	3.17	3.17
Pillar Strength (UNSW Squat Pillar 1999)	NA	NA	NA	24.42	24.42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pillar Strength (UNSW w/h<5)	11.50	14.18	14.18	N/A	N/A	17.10	17.10	14.18	14.18	18.10	18.10	11.50	11.50	16.39	16.39	15.65	15.65	15.65	15.65	15.65
Safety Factor under FTA Loading (Squat Pillar)	N/A	N/A	N/A	10.76	6.46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Safety Factor under FTA Loading (w/h<5)	1.42	4.91	2.95	N/A	N/A	3.04	2.82	2.95	2.27	3.71	3.43	2.14	1.95	3.55	3.26	2.66	2.47	2.66	2.47	2.47
No. SAs, n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Single Abutment Loading (3D) - full	16.89	2.38	6.60	1.19	3.30	8.77	10.01	6.60	11.15	7.01	8.23	8.60	10.40	6.49	7.72	9.78	11.35	9.78	11.35	11.35
Single Abutment Loading (3D) - pillar	8.41	1.73	4.06	1.08	2.68	5.41	6.01	4.06	6.24	4.45	5.08	4.73	5.52	4.06	4.68	5.76	6.50	5.76	6.50	6.50
Single Abutment Loading (3D) - solid	8.48	0.65	2.54	0.11	0.61	3.36	4.00	2.54	4.91	2.57	3.16	3.87	4.88	2.43	3.04	4.02	4.84	4.02	4.84	4.84
Cell Sensitivity (MPa)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pillar Loading with Single Abutment Loading	16.54	4.62	8.87	3.35	6.47	11.03	12.06	8.87	12.50	9.32	10.35	10.11	11.44	8.67	9.71	11.64	12.84	11.64	12.84	12.84
Safety Factor (under Single Abutment Loading)	0.70	3.07	1.60	7.29	3.78	1.55	1.42	1.60	1.13	1.94	1.75	1.14	1.01	1.89	1.69	1.34	1.22	1.34	1.22	1.22
Total Pillar Loading @ nA	25.02	5.26	11.41	3.46	7.08	14.39	16.06	11.41	17.41	11.89	13.51	13.97	16.31	11.10	12.75	15.66	17.68	15.66	17.68	17.68
Safety Factor @ nA	0.46	2.69	1.24	7.07	3.45	1.19	1.06	1.24	0.81	1.52	1.34	0.82	0.70	1.48	1.29	1.00	0.89	1.00	0.89	0.89
Total Pillar Loading under Double Abutment Loading	41.91	7.64	18.01	4.64	10.38	23.15	26.07	18.01	28.56	18.90	21.74	22.57	26.72	17.59	20.48	25.45	29.02	25.45	29.02	29.02
Safety Factor (under Double Abutment Loading)	0.27	1.86	0.79	5.26	2.35	0.74	0.66	0.79	0.50	0.96	0.83	0.51	0.43	0.93	0.80	0.62	0.54	0.62	0.54	0.54

Notes:																				
	FTA Sp/T	0.023	0.012	0.015	0.011	0.014	0.017	0.018	0.015	0.018	0.016	0.016	0.016	0.018	0.015	0.016	0.018	0.018	0.018	0.018
	FTA Sp(m)	0.048	0.026	0.032	0.024	0.029	0.036	0.038	0.032	0.038	0.033	0.034	0.035	0.037	0.032	0.033	0.037	0.039	0.037	0.039
	FTA Sp/T (U95%)	0.067	0.067	0.069	0.065	0.068	0.071	0.072	0.069	0.072	0.070	0.070	0.070	0.072	0.069	0.070	0.072	0.072	0.072	0.072
	FTA Sp (U95%)	0.161	0.139	0.146	0.137	0.142	0.149	0.151	0.146	0.152	0.146	0.148	0.148	0.150	0.145	0.147	0.150	0.152	0.150	0.152
	nA Sp/T	0.115	0.016	0.033	0.013	0.020	0.046	0.054	0.033	0.062	0.035	0.042	0.044	0.056	0.032	0.038	0.052	0.064	0.052	0.064
	nA Sp(m)	0.242	0.034	0.070	0.027	0.042	0.096	0.114	0.070	0.130	0.074	0.088	0.092	0.117	0.067	0.081	0.110	0.134	0.110	0.134
	nA Sp/T (U95%)	0.169	0.070	0.087	0.067	0.074	0.100	0.108	0.087	0.116	0.089	0.096	0.098	0.110	0.086	0.092	0.106	0.118	0.106	0.118
	nA Sp (U95%)	0.356	0.148	0.183	0.141	0.156	0.210	0.227	0.183	0.244	0.187	0.201	0.205	0.230	0.181	0.194	0.223	0.247	0.223	0.247
	Max Subs	0.73	0.59	0.59	0.41	0.41	0.51	0.51	0.47	0.47	0.59	0.65	0.65	0.49	0.49	0.54	0.54	0.54	0.54	0.54
	Ecoal(2GPa)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	Efloor(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Eroof(GPa)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	Poissons Ratio floor/roof	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	initial vertical stress (MPa)	3.25	1.50	2.50	1.50	2.50	3.25	3.50	2.50	3.25	3.00	3.25	2.50	2.75	2.75	3.00	3.25	3.50	3.25	3.50
	Increase in vertical stress (MPa)	4.88	1.39	2.31	0.77	1.28	2.37	2.55	2.31	3.01	1.87	2.03	2.88	3.16	1.86	2.03	2.63	2.83	2.63	2.83
	Pillar Compression (m)	0.005	0.001	0.002	0.001	0.001	0.002	0.003	0.002	0.003	0.002	0.002	0.003	0.003	0.002	0.002	0.003	0.003	0.003	0.003
	Roof Compression (m)	0.008	0.003	0.006	0.003	0.005	0.007	0.008	0.006	0.007	0.009	0.009	0.006	0.007	0.009	0.010	0.007	0.008	0.007	0.008
	Floor Compression (m)	0.008	0.003	0.006	0.003	0.005	0.007	0.008	0.006	0.007	0.009	0.009	0.006	0.007	0.009	0.010	0.007	0.008	0.007	0.008
	Total Elastic Compression (m)	0.022	0.008	0.013	0.007	0.011	0.017	0.018	0.013	0.017	0.019	0.021	0.015	0.021	0.021	0.023	0.017	0.021	0.017	0.018
	Yielded Pillars (m)	0.731	0.040	0.595	0.053	0.054	0.214	0.214	0.595	0.595	0.097	0.105	0.114	0.551	0.545	0.545	0.545	0.545	0.545	0.545
	Smax/T	0.005	0.017	0.244	0.014	0.023	0.015	0.215	0.244	0.244	0.040	0.044	0.272	0.272	0.272	0.272	0.228	0.228	0.228	0.228
	Smin/T	0.307	0.003	0.004	0.002	0.004	0.006	0.006	0.004	0.006	0.006	0.007	0.005	0.006	0.007	0.006	0.006	0.006	0.006	0.006



APPENDIX B - SPDS[®] Program Details (User Manual Extracts)

SDPS

**Surface Deformation Prediction System
for Windows
version 5.2**

Quick Reference Guide and Working Examples

by

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February 2002

List of Symbols

w	the panel width; the minimum dimension of a panel
h	panel depth; the vertical distance between the mining horizon and the surface; also known as the overburden thickness
m	the seam thickness; the extraction thickness (note that the extraction thickness may be different than the seam thickness)
R	the extraction ratio
R*	the adjusted extraction ratio
d	the distance of the inflection point from the rib (a positive value indicates that the position of the inflectionpoint is inby); also referred to as the “edge effect”
β	the influence angle
r	the influence radius
Smax	the maximum subsidence
a	the maximum subsidence factor
Bs	the strain coefficient
%HR	the percent hardrock in the overburden
Wp	the pillar width
Hp	the pillar height
Wo	the opening width

1.7 Overview of Subsidence Parameters

Maximum Subsidence Factor

The values of maximum subsidence factor, as function of the width-to-depth ratio and the percent hardrock in the overburden, are shown in the supercritical subsidence factor tables for longwall panels and for room-and-pillar panels respectively. When using the profile function method, the subsidence factor is calculated for the actual width-to-depth ratio of the panel. For example, for a panel with $W/h = 0.8$ (subcritical) and %HR = 50% the subsidence factor is equal to 0.38.

When using the influence function method, the technique requires knowledge of the supercritical subsidence factor, which will subsequently be adjusted through the superposition concept by the program itself. For example, for a panel with $W/h = 0.8$ (subcritical) and %HR = 50% the subsidence factor is found for $W/h = 1.5$ (supercritical) and equal to 0.40.

Notes:

A panel is considered supercritical for W/h greater than 1.2. Due to numerical approximations there may be slight variations to the supercritical subsidence factors presented in the supercritical subsidence factor tables.

Inflection Point

The location of the inflection point from the rib, with respect to overburden depth (d/h), can be estimated based on two empirical curves (see the Inflection Point Diagram). Both curves were statistically generated from the available field data. The first is an average curve based on a least squares estimator, while the second is considered an envelope or conservative curve in the sense that it tends to overpredict the surface impact of a given excavation area. In essence, this means that for average data the predicted subsidence profile could be either inside or outside of the measured subsidence line, whereas for conservative (envelope) data, an attempt is made to keep the prediction lines outside the measured ones, i.e. overestimate the influence of the mined area to the surface.

From experience and constant validation of the programs, the authors recommend that, for Appalachian predictions, improved accuracy is obtained by using the following rule: determine the d/h ratio using the conservative curve for subcritical panels ($W/h < 1.2$) determine the d/h ratio using the average curve for supercritical panels ($W/h \geq 1.2$).

Notes:

Always use the actual width-to-depth ratio.

Angle of Influence

The angle of principal influence (β , beta) is one of the basic parameters used in the influence function method since it has a major impact on the distribution of the deformations on the surface. It is measured in degrees from the horizontal and the

average value determined for the Appalachian coalfields is $\beta=67$ deg. The parameter required for these calculations is the tangent of this angle (i.e. $\tan\beta = 2.31$). The angle of influence is related to the radius of influence as shown in the equation:

$$\tan\beta = \frac{h}{r}$$

where

h = the overburden depth

r = the radius of influence

This value should be determined for each site by fitting a calculated subsidence profile to a measured subsidence profile. If this is not possible, the influence angle can be approximately set as the complementary angle to the angle of draw.

Supercritical Subsidence Factor Tables

The supercritical subsidence factors used in the calculations are presented in Tables 1.7.1 and 1.7.2.

Table 1.7.1: Calculation of maximum subsidence factors (S_{max}/m) for longwall panels

W/h	Percent Hardrock in the Overburden							
	10%	20%	30%	40%	50%	60%	70%	80%
0.6	0.64	0.59	0.51	0.42	0.34	0.26	0.21	0.16
0.7	0.69	0.63	0.55	0.46	0.36	0.28	0.22	0.18
0.8	0.71	0.65	0.57	0.47	0.38	0.29	0.23	0.18
0.9	0.72	0.66	0.58	0.48	0.38	0.30	0.23	0.19
1.0	0.73	0.67	0.58	0.49	0.39	0.30	0.24	0.19
1.1	0.74	0.68	0.59	0.49	0.39	0.31	0.24	0.19
1.2	0.74	0.68	0.59	0.49	0.39	0.31	0.24	0.19
1.3	0.74	0.68	0.60	0.49	0.40	0.31	0.24	0.19
1.4	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.5	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.6	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.7	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.8	0.75	0.69	0.60	0.50	0.40	0.31	0.24	0.19
1.9	0.76	0.69	0.60	0.50	0.40	0.31	0.24	0.19
2.0	0.76	0.69	0.60	0.50	0.40	0.31	0.24	0.19

Table 1.7.2: Calculation of maximum subsidence factors ($S_{max}/(m R^*)$) for high extraction room-and-pillar panels

W/h	Percent Hardrock in the Overburden							
	10%	20%	30%	40%	50%	60%	70%	80%
0.6	0.52	0.48	0.42	0.35	0.28	0.22	0.17	0.13
0.7	0.57	0.53	0.46	0.38	0.30	0.24	0.19	0.15
0.8	0.60	0.55	0.48	0.40	0.32	0.25	0.19	0.15
0.9	0.61	0.56	0.49	0.41	0.32	0.25	0.20	0.16
1.0	0.62	0.57	0.49	0.41	0.33	0.26	0.20	0.16
1.1	0.62	0.57	0.50	0.41	0.33	0.26	0.20	0.16
1.2	0.63	0.58	0.50	0.42	0.33	0.26	0.20	0.16
1.3	0.63	0.58	0.51	0.42	0.34	0.26	0.20	0.16
1.4	0.64	0.58	0.51	0.42	0.34	0.26	0.21	0.16
1.5	0.64	0.59	0.51	0.42	0.34	0.26	0.21	0.16
1.6	0.64	0.59	0.51	0.42	0.34	0.26	0.21	0.16
1.7	0.64	0.59	0.51	0.43	0.34	0.27	0.21	0.16
1.8	0.64	0.59	0.51	0.43	0.34	0.27	0.21	0.17
1.9	0.64	0.59	0.51	0.43	0.34	0.27	0.21	0.17
2.0	0.64	0.59	0.52	0.43	0.34	0.27	0.21	0.17

Horizontal Strain Factor

The value of this factor is directly related to the magnitude of the calculated strains and curvatures over an undermined area. It can be empirically estimated by the average ratio of measured strain and curvature over a set of surface points.

The average value determined for the Appalachian coalfields is:

$$Bs = (0.35 \pm 0.05) \frac{h}{\tan\beta}$$

where h is the excavation depth and $\tan\beta$ is the influence angle. The horizontal strain factor is expressed in units of length. The horizontal strain coefficient is unitless and its default value is 0.35.

Note: The higher the value for this coefficient, the larger the predicted strains and displacements.

Chapter 3: The Influence Function Method

3.1 Overview of the Influence Function Method

Influence function methods for subsidence prediction have the ability to consider any mining geometry, to negotiate superposition of the influence from a number of excavated areas having different mining characteristics and, also, to calculate horizontal strains as well as other related deformation indices. The function utilized in SDPS is the bell-shaped Gaussian function. This method assumes that the influence function for the two-dimensional case is given by:

$$g(x, s) = \frac{S_o(x)}{r} \exp \left[-\pi \frac{(x - s)^2}{r^2} \right]$$

where:

r = the radius of principal influence = $h / \tan(\text{beta})$;
 h = the overburden depth;
 beta = the angle of principal influence;
 s = coordinate of the point P, where subsidence is considered;
 x = coordinate of the infinitesimal excavated element; and
 $S_o(x)$ = convergence of the roof of the infinitesimal excavated element.

Subsidence at any point P(s), therefore, can be expressed by the following equation:

$$S(x, s) = \frac{1}{r} \int_{-\infty}^{+\infty} s_o(x) \exp \left[-\pi \frac{(x - r)^2}{r^2} \right]$$

where:

$S_o(x)$ = $m(x) a(x)$;
 $m(s)$ = extraction thickness; and
 $a(x)$ = roof convergence (subsidence) factor.

The influence function formulation can thus be applied to calculate surface deformations (subsidence, strain, slope, curvature, displacements) above longwall and room-and-pillar panels, given the geometry of the excavation, information on the overburden geology, as well as the location of the prediction points on the surface.

More specifically, the required data include:

- the geometry of the mine plan and the associated properties (extraction thickness, subsidence factor for supercritical conditions)

- the location (coordinates) of the points on the surface for which prediction of the deformation indices (subsidence, strain, slope, curvature, horizontal displacement) is to be performed
- the empirical parameters that numerically represent the behavior of the overburden

The typical steps required to calculate surface deformations using the influence function method, are shown below. The corresponding flowchart is also shown in Figure 3.1.1. Figure 3.1.2 presents a schematic diagram for creating the input data. Figure 3.1.3 presents typical distributions for the deformation indices that can be calculated by the influence function method. Table 3.1.1 shows all the indices that can be calculated by the influence function method.

- ✓ Load the Influence Function Program
- ✓ Input Data
- ✓ Mine Plan Data
 - Prediction Point Data
 - Empirical Parameters
- ✓ Select calculation options
 - Subsidence
 - Horizontal Strain
 - Horizontal Displacement
 - Slope
 - Curvature
- ✓ Save Project File
- ✓ Calculate Surface Deformations
- ✓ Load Graphing Program
- ✓ View Calculated Deformations

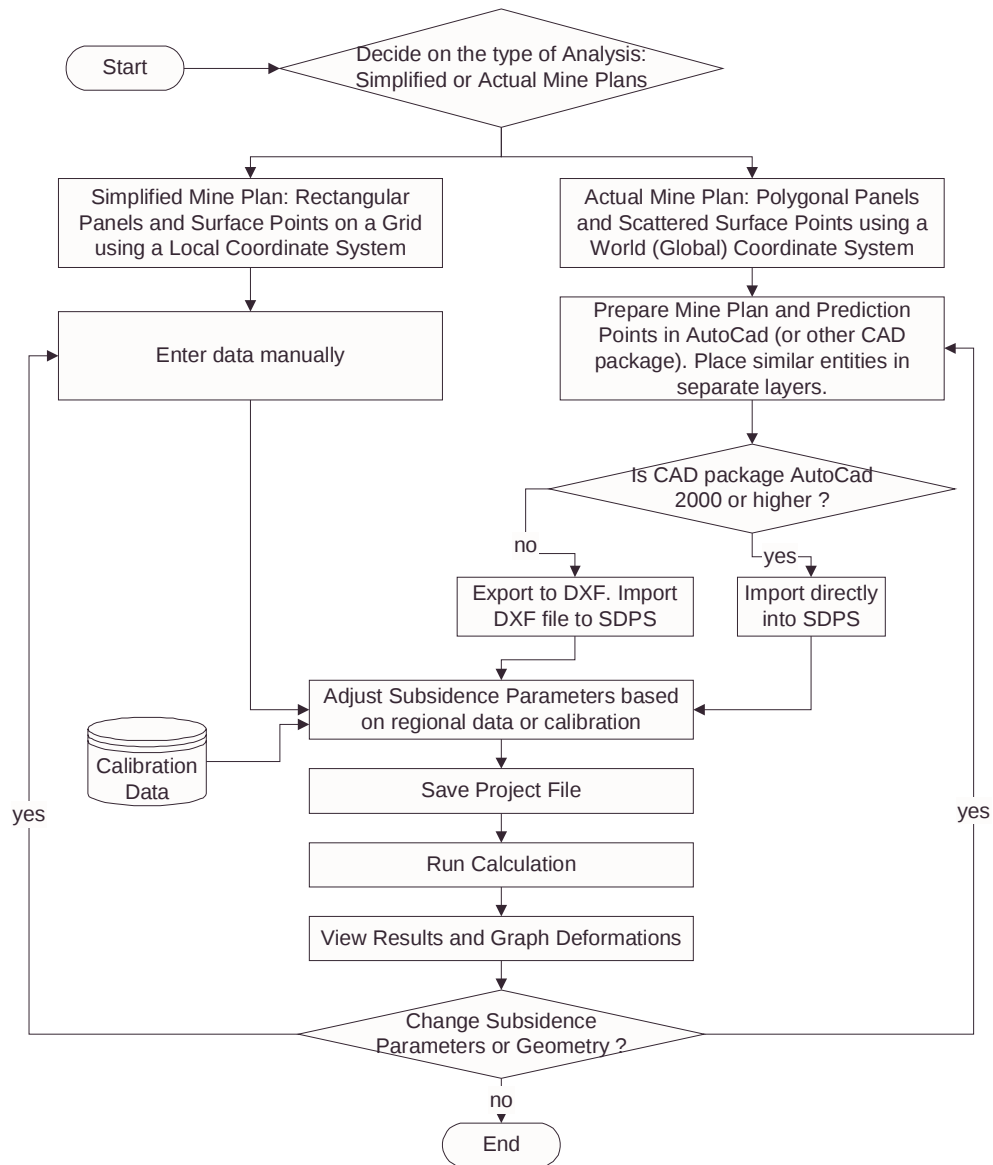


Figure 3.1.1: Flowchart diagram for using the influence function module

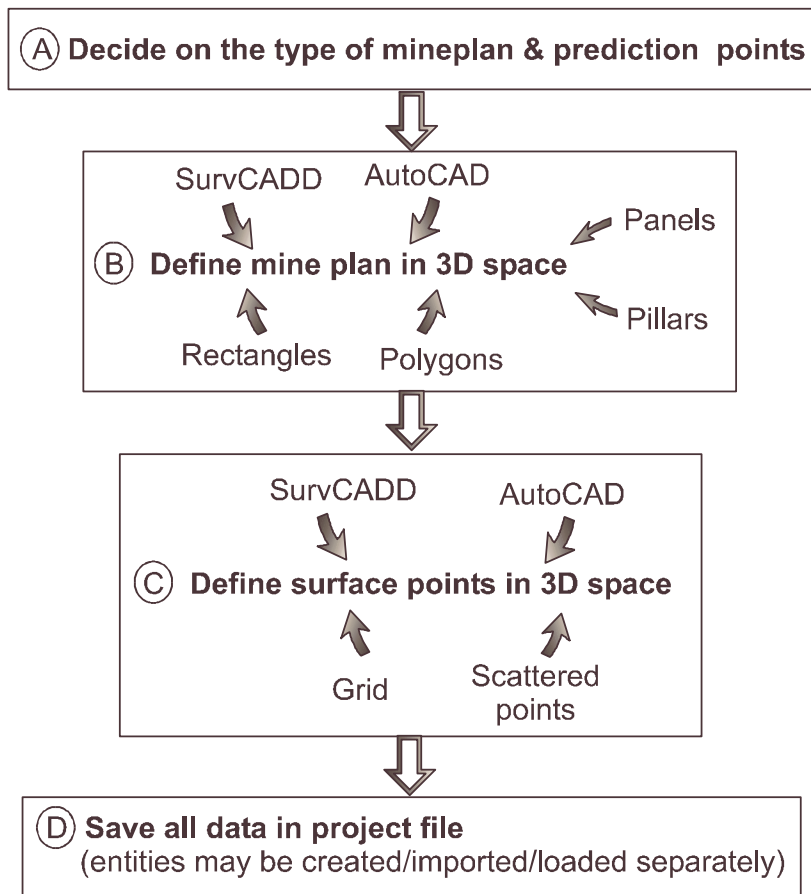
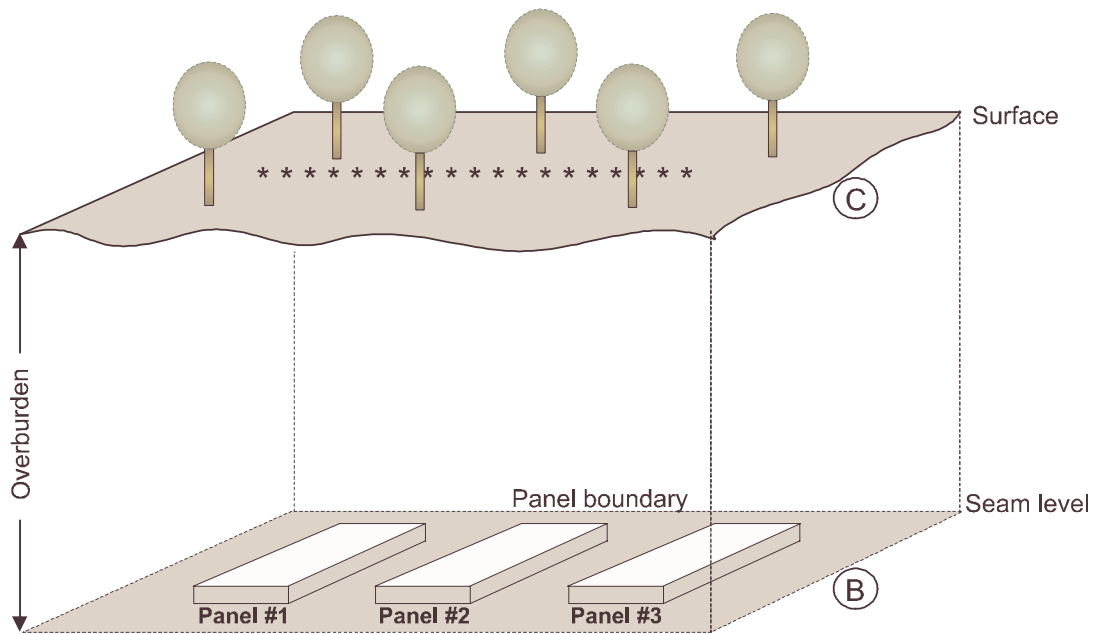


Figure 3.1.2: Steps in defining a project file

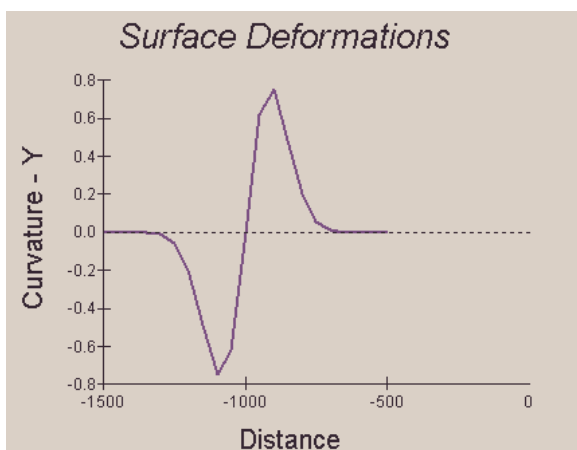
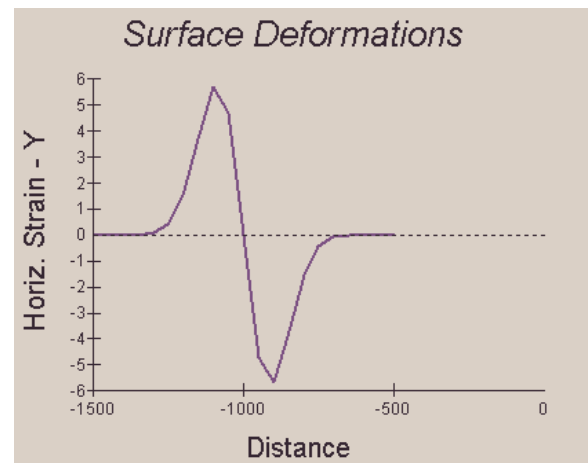
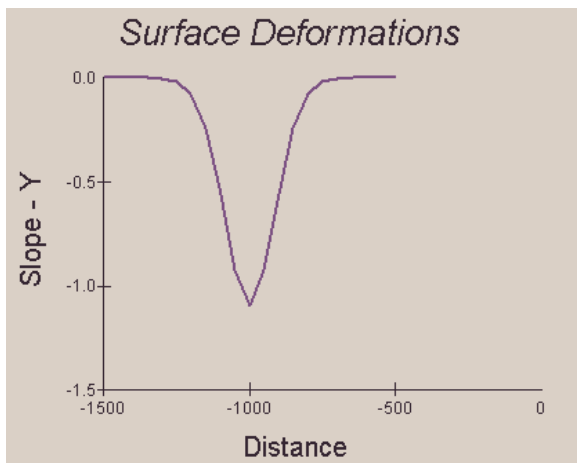
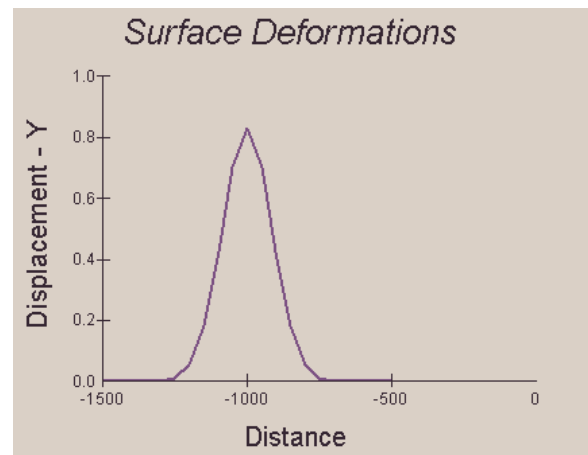
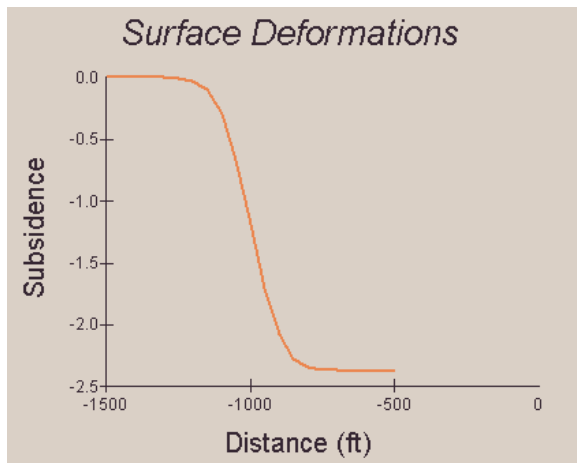


Figure 3.1.3: Typical deformation distributions

Table 3.1.1: Identification codes for deformation indices

Number	Deformation Index Name	Code	Units
1	Subsidence	SU	ft or m
2	Slope in the X-direction	TX	%
3	Slope in the Y-direction	TY	%
4	Directional Slope	TA	%
5	Maximum (Total) Slope	TM	%
6	Angle ¹ of Maximum Slope	TE	deg
7	Horizontal Displacement in the X-direction	VX	ft or m
8	Horizontal Displacement in the Y-direction	VY	ft or m
9	Directional Horizontal Displacement	VA	ft or m
10	Maximum (Total) Horizontal Displacement	VM	ft or m
11	Angle ¹ of Maximum Horizontal Displacement	VE	deg
12	Curvature in the X-direction	KX	1/ft or 1/m ²
13	Curvature in the Y-direction	KY	1/ft or 1/m ²
14	Directional Curvature	KA	1/ft or 1/m ²
15	Maximum Principal Curvature	K1	1/ft or 1/m ²
16	Minimum Principal Curvature	K2	1/ft or 1/m ²
17	Maximum Curvature	KM	1/ft or 1/m ²
18	Angle ¹ of Maximum Principal Curvature	KE	deg
19	Horizontal Strain in the X-direction	EX	- ³
20	Horizontal Strain in the Y-direction	EY	- ³
21	Directional Horizontal Strain	EA	- ³
22	Maximum Strain	EM	- ³
23	Maximum Principal Strain	E1	- ³
24	Minimum Principal Strain	E2	- ³
25	Angle ¹ of Maximum Principal Strain	EE	deg

¹ This angle is calculated in degrees from the positive x-axis in a counter-clockwise direction. It gives the direction of the maximum value of the corresponding index on the x-y plane.

² expressed in tenths of ppm (divide by 10.000 to obtain result)

³ expressed in millistrains (divide by 1000 to obtain result)

3.2 Definition of the Mine Plan in the Influence Function Program

Mine plan data describe the extraction area under consideration using various conventions. An extraction area is always defined in three-dimensional space by specifying the X,Y,Z coordinates of the points defining that area. Mine panels and pillars are referred to as excavation parcels. A parcel can be either active or not active. A parcel, which is not active, is not deleted from the file, but it does not participate in the calculations.

Geometry and Boundary Adjustment:

The geometry of a mine plan is determined by the geometry of the excavation panels adjusted by the edge effect. This parameter represents the distance between the actual rib of the excavation and the position of the inflection point, as determined by panel geometry and site characteristics. The location of the inflection point, which defines the transition between horizontal tensile and compressive strain zones, is very important for the application of the influence function method. The distance of the inflection point from the rib using either an average and a conservative estimate as a function of the width-to-depth ratio of a panel can be estimated using this graph.

Thus, the magnitude of the edge effect can be determined as follows:

- ✓ from the graph estimating the location of the inflection point for the conservative or average estimate (Figure 3.1.1),
- ✓ by clicking on the *Subs.Parm* button in the rectangular mine plan form of the influence function program,
- ✓ by analyzing subsidence curves measured at a specific site or region.

Panel Representation:

- ✓ Simple mine layouts can usually be approximated using sets of rectangular extraction areas. In this case, the input required for every parcel includes the parcel number; the coordinates of the west, east, south, and north borders; the seam elevation; the extraction thickness (mining height); and the average supercritical subsidence factor (in percent) associated with it. These coordinates can be specified in a local or a global coordinate system with axes parallel to the parcel sides. In the Influence function module, this option is implemented as **Rectangular Mine Plans**.
- ✓ Complex mine layouts can usually be approximated by a closed polygon (i.e. a piece-wise linear shape). In this case, the input required for every point within a parcel includes the point reference number; the northing (Y), easting (X), and elevation (Z); the extraction thickness (mining height); and the supercritical subsidence factor (in percent) associated with it. The mine plan editor can

provide access to all points in a parcel, add new points, and add new parcels provided that the current parcel is defined by three or more points. The points should be entered in a counter-clockwise fashion. The location of each point should be adjusted to reflect the edge effect, or the relative position of the inflection point. The maximum number of parcels and points per parcel can be adjusted within the limits of the available memory. In the Influence function module, this option is implemented as Polygonal Mine Plans.

Warning:

Pillars can not exist outside extracted areas. If a pillar is defined outside an extracted area the results are unpredictable. Currently, the parcel definition module of the program can not check for such inconsistencies. Examples of erroneous panel definitions are given in Appendix 3.

Notes:

- ✓ If no adjustments are made to the geometry of the mine plan, the program assumes that the inflection point is over the rib of the excavation.
- ✓ The user must specify whether each parcel represents an extracted panel or a pillar within an extracted panel. A pillar is mathematically represented as a parcel with a negative subsidence factor. Setting the pillar option on a parcel will reset the subsidence factor associated with this parcel. In that sense, an extraction area can be either positive (i.e. longwall panel) or negative (i.e. pillar in the middle of a panel). Thus, a mine plan that consists only of pillars (without an extraction boundary) will produce a mathematically positive! subsidence.
- ✓ It should be emphasized that the subsidence factor used here is the subsidence factor for supercritical conditions.
- ✓ The reason for supporting more than one format for input data is for the user's convenience. For example, certain panels or pillars can be easily represented as rectangles and can be entered as single entities, compared to four or more entries required if these panels are digitized point by point. Additionally, calculations for rectangular parcels are much faster compared to calculations for parcels defined by individual points.

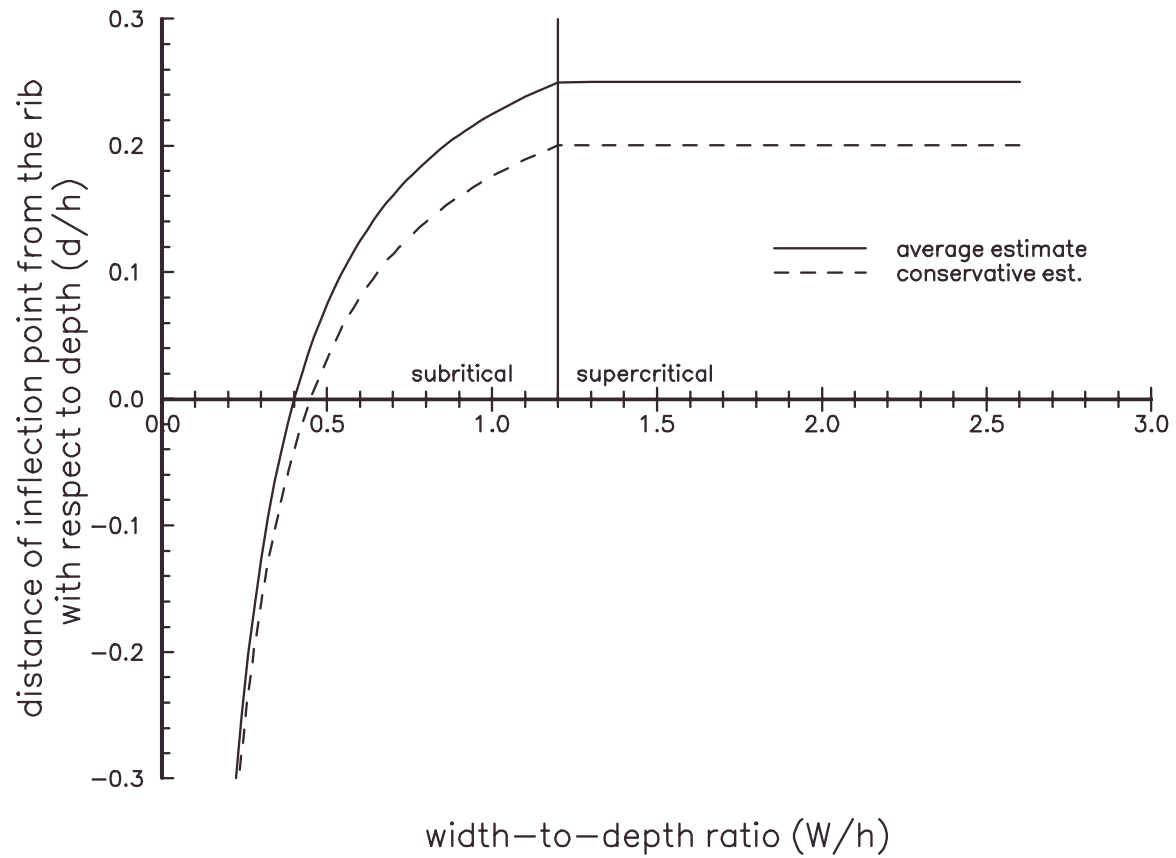


Figure 3.2.1: Determination of the offset of the inflection point.

3.3 Definition of the Prediction Points in the Influence Function Program

Prediction point data describe the surface points where the deformation indices will be calculated. Prediction points are always defined in three-dimensional space, by specifying the X,Y,Z coordinates of these points. A point can be either active or not active. A point which is not active is not deleted from the file but will not be included in the calculations.

Scattered Points

A scattered point set may consist of any number of points that are randomly located on the surface. If such points can be specified as part of a grid, then the Grid Points option should be used. Required parameters for each point include:

- ✓ the point reference code which can be any alphanumeric string,
- ✓ the easting, northing and elevation of each point,
- ✓ the point status, i.e. active or not active (an inactive point will not be displayed in the View option and will not participate in any of the calculations)

Grid Points

A grid point set may consist of any number of points in a window. This window is defined by minima and maxima in the X- and Y- directions as well as the cell size in each direction.

The grid can only be oriented parallel to the current coordinate system. If the grid needs to be oriented at an angle to the current coordinate system, the grid points should be generated by a different tool and imported as scattered points into the Influence Function module.

The user has two options regarding grid elevations.

- ✓ to consider a flat surface and specify a uniform elevation for all points, and
- ✓ to consider each point on an individual basis and specify individual point elevations.