Hillgrove Resources – Kanmantoo Copper Mines

Conversion of abandoned cropping land to *Eucalyptus odorata* open woodland using a topsoil prestrip and direct seeding establishment method.

1. The following photo illustrates the 2014 work area prior to topsoil stripping and highlights abandoned cropping land with rows of 2-year old *Eucalyptus odorata* seedlings.



2. Optimum pre-strip depth was investigated using a series of 10 soil pits distributed randomly over the patch. Soil samples were extracted at 25mm intervals to 100mm. The soil samples were spread over seedling flats, watered, placed in a glasshouse and seedling emergence from each depth interval was monitored and recorded.



3. Topsoil stripping was commenced with a Cat 12G grader to provide accurate depth control and mid-row windrowing of the topsoil for later removal by a Cat 623 scraper.



4. Topsoil was removed between *E. odorata* tree-rows along contours in alternating bands to create a landscape with areas of stripped land next to similar bands of undisturbed land. This provides erosion protection while stripped areas establish and reduces the potential for dust lift. Undisturbed areas will be stripped and direct-seeded next year, completing initial conversion of the whole area within a 12-month timeframe.



5. Depth control with the 12G grader was good, ranging between 50mm and 100mm in most cases. This resulted in a seed bed consisting mostly of sub-soil (lower A-horizon).



6. Following windrowing with the 12G grader, topsoil was picked up using a 623 scraper and was moved off-site to a stockpile for later use.



7. The planting rows were smoothed by the grader before deep-ripping to remove remnant ploughpans and other sources of soil compaction accumulated during previous cropping use (Photo shown is deep ripping during 2013 on KCM's 'Laydown Area' prior to soil preparation and sowing to native grass species).



8. Seed bed preparation was then completed with a turf power rake, which finely cultivates only the top 25-30mm of the soil surface.



9. The seed bed is then hand broadcast with a mix of local-provenance native plant species known as our 'Foundation Seed Mix. Seed was entirely sourced from within the Mining Lease or the near-mine region, or was grown in the Mine's purpose-built Seed Production Area. (The seed mix shown below excludes native grass species). One person can easily broadcast seed over a 1ha area in 7-hours. Hand broadcasting achieves random seed placement and will result in a sward which approximates a natural vegetation stand.



10. After hand-sowing, the turf power rake was used to incorporate the seed in the upper soil surface. The white bands in the photo below highlight Austrodanthonia and Austrostipa seed placement prior to incorporation, which further disperses seed placement.



11. Twelve months after sowing, native plant establishment within the prepared strips will be similar to the sward illustrated below. This area was established in 2013 within the ML on 'Smelter Road' using the same technique illustrated above.



12. Establishment of grasses and herbaceous species has been excellent with very little weed competition. Enchylaena and Mariana have seeded and 2nd-generation recruitment has commenced (see below).



13. Austrodanthonia, Chloris and Austrostipa on Smelter Rd are establishing well and are expected to seed during spring 2014. The vegetation in the foreground is a high-density stand of native grasses sown in 2013 using topsoil pre-stripping, resulting in good cover and low weed competition.



14. Hard-seeded canopy species are starting to emerge on Smelter Rd. These will be supplemented by tube-stock plantings of E. odorata and Allocasuarina verticillata during 2014.



A further 15ha of plantings are planned for 2015. Hillgrove plans to establish a total of 200ha of SEBquality native vegetation to provide offset for native vegetation disturbance within the ML during mining operations.

Seed Batch No.	Species	Seed Collection	Date	Location of direct	Amount per hectare (grams)	Total weight used/4.5 ha (grams)
EBSKAN73	Acacia acinacea	Kanmantoo mine site / surrounding area	Nov-13	NW corner - SEB	100	450
EBSKAN53	Acacia acinacea	Kanmantoo mine site / surrounding area	Spring / summer 2012	NW corner - SEB	18	80
EBSKAN12	Acacia pycnantha	Kanmantoo mine site	May-11	NW corner - SEB	178	800
EBSKAN58	Acacia pycnantha	Kanmantoo mine site / surrounding area	Dec-12	NW corner - SEB	667	3000
EBSKAN13	Allocasuarina verticillata	Kanmantoo mine site	May-11	NW corner - SEB	169	760

Hillgrove Resources – Kanmantoo Copper Mines: 2014 Direct Seeding Species List

EBSKAN46	Allocasuarina verticillata	Kanmantoo mine site / surrounding area	Spring / summer 2012	NW corner - SEB	100	450
EBSKAN107	Atriplex semibaccata	SPA	2014		1000	4500
EBSKAN91	Austrodanthonia sp.	SPA	Nov-13	NW corner - SEB	10667	48000
EBSKAN36	Austrodanthonia sp.	Kanmantoo mine site / surrounding area	Spring / summer 2012	NW corner - SEB	956	4300
EBSKAN34	Austrostipa sp	Kanmantoo mine site / surrounding area	Spring / summer 2012	NW corner - SEB	8422	37900
EBSKAN65	Bothriochloa macra	SPA	Jan-13	NW corner - SEB	3311	14900
Seed Batch No.	Species	Seed Collection Location	Date collected	Location of direct seeding	Amount per hectare (grams)	Total weight used/4.5 ha (grams)
Seed Batch No. EBSKAN68	Species Bursaria spinosa	Seed Collection Location Kanmantoo mine site / surrounding area	Date collected Feb-13	Location of direct seeding NW corner - SEB	Amount per hectare (grams)	Total weight used/4.5 ha (grams) 170
Seed Batch No. EBSKAN68 EBSKAN101	Species Bursaria spinosa Callitris gracilis	Seed Collection Location Kanmantoo mine site / surrounding area Kanmantoo mine site / surrounding area	Date collected Feb-13 Dec-13	Location of direct seeding NW corner - SEB NW corner - SEB	Amount per hectare (grams) 38	Total weight used/4.5 ha (grams) 170 675
Seed Batch No. EBSKAN68 EBSKAN101 EBSKAN52	Species Bursaria spinosa Callitris gracilis Chloris truncata	Seed Collection Location Kanmantoo mine site / surrounding area Kanmantoo mine site / surrounding area Kanmantoo mine site / surrounding area	Date collected Feb-13 Dec-13 Jan-13	Location of direct seeding NW corner - SEB NW corner - SEB NW corner - SEB	Amount per hectare (grams) 38 150 2311	Total weight used/4.5 ha (grams) 170 675 10400
Seed Batch No. EBSKAN68 EBSKAN101 EBSKAN52 EBSKAN75	Species Bursaria spinosa Callitris gracilis Chloris truncata Chrysocephalum apiculatum	Seed Collection Location Kanmantoo mine site / surrounding area Kanmantoo mine site / surrounding area Kanmantoo mine site / surrounding area surrounding area	Date collected Feb-13 Dec-13 Jan-13 Nov-13	Location of direct seeding NW corner - SEB NW corner - SEB NW corner - SEB	Amount per hectare (grams) 38 150 2311 26	Total weight used/4.5 ha (grams) 170 675 10400 115

EBSKAN62	Convolvulus remotus	SPA	Spring / summer 2012	NW corner - SEB	164	740
EBSKAN92	Cymbopogon ambigus	SPA	Dec-13	NW corner - SEB	4000	18000
EBSKAN66	Diacanthium sericeum	SPA	Jan-13	NW corner - SEB	3244	14600
EBSKAN49	Dodonaea viscosa	Kanmantoo mine site / surrounding area	Spring / summer 2012	NW corner - SEB	189	850
EBSKAN67	Einadia nutans	SPA	Mar-13	NW corner - SEB	376	1693
EBSKAN103	Enchylaena tomentosa	SPA	2014		500	2250
	1					
Seed Batch No.	Species	Seed Collection Location	Date collected	Location of direct seeding	Amount per hectare (grams)	Total weight used/4.5 ha (grams)
Seed Batch No.	Species Eucalyptus odorata	Seed Collection Location Paringa site, Kanmantoo Mine	Date collected 2008	Location of direct seeding NW corner - SEB	Amount per hectare (grams) 86	Total weight used/4.5 ha (grams) 386
Seed Batch No. EBSKAN01 EBSKAN79	Species Eucalyptus odorata Hardenbergia violacea	Seed Collection Location Paringa site, Kanmantoo Mine SPA and mine site	Date collected 2008 Nov-13	Location of direct seeding NW corner - SEB NW corner - SEB	Amount per hectare (grams) 86	Total weight used/4.5 ha (grams) 386 320
Seed Batch No. EBSKAN01 EBSKAN79 EBSKAN108	Species Eucalyptus odorata Hardenbergia violacea Maireana brevifolia	Seed Collection Location Paringa site, Kanmantoo Mine SPA and mine site SPA	Date collected 2008 Nov-13 2014	Location of direct seeding NW corner - SEB NW corner - SEB	Amount per hectare (grams) 86 71 150	Total weight used/4.5 ha (grams) 386 320
Seed Batch No. EBSKAN01 EBSKAN79 EBSKAN108 EBSKAN90	Species Eucalyptus odorata Hardenbergia violacea Maireana brevifolia Themeda triandra	Seed Collection LocationParinga site, Kanmantoo MineSPA and mine siteSPA and mine siteSPASPA	Date collected 2008 Nov-13 2014 Nov - Dec 13	Location of direct seeding NW corner - SEB NW corner - SEB	Amount per hectare (grams) 86 71 150 4578	Total weight used/4.5 ha (grams) 386 320 675 20600

EBSKAN29	Vittadinia blackii	Kanmantoo mine site / surounding area	Spring / summer 2012	NW corner - SEB	111	500
			Totals (kg)		42.06	189.277