Vickery Coal Project

Environmental Impact Statement

SECTION 5

REHABILITATION AND MINE CLOSURE

Resource Strategies

WHITEHAVEN COAL

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5 REHABILITATION

This section summarises the approach to rehabilitation and landscape management for the Project. It describes how the Project would be progressively rehabilitated and integrated with adjoining landscapes, and the measures that would be put in place for the long-term protection and management of the site following the cessation of mining.

5.1 EXISTING REHABILITATION MONITORING AND MANAGEMENT IN THE PROJECT AREA

As described in Section 2.1, open cut and underground mining activities have previously been conducted in the Project area at both the Vickery and Canyon Coal Mines.

The areas previously disturbed for mining have been successfully rehabilitated such that the land is suitable for grazing (Figure 5-1).

Canyon Coal Mine

Whitehaven maintains the Canyon Coal Mine site (Figure 5-1), which ceased operations in 2009, in accordance with the *Canyon Open Cut Coal Mine Closure Plan* (Whitehaven, 2009), Development Consent (DA-8-1-2005) and EPL 10094.

The rehabilitation activities conducted at the Canyon Coal Mine site have included reshaping of the final void and overburden emplacements, topsoil placement, installation of water management control measures, establishment of a cover crop, planting of tube stock, and monitoring and maintenance of rehabilitated areas.

The Canyon Coal Mine site has been successfully returned to a mixture of open pasture areas and established woodland, and is the model on which all Whitehaven rehabilitation projects are currently based. Photographs showing the progressive implementation of several of the rehabilitation stages at the Canyon Coal Mine are provided in Plates 5-1 to 5-6.

Vickery Coal Mine

Three historical open cut areas (i.e. Shannon Hill, Blue Vale and Greenwood) and one underground mining area (i.e. Red Hill) associated with the historical Vickery Coal Mine are located within CL 316 (Figure 5-1).

Mining operations at the Vickery Coal Mine ceased in 1998, when approval from the DPI was granted to suspend operations and complete rehabilitation works on-site.

Rehabilitation of approximately 405 ha of mining areas was completed in 2000 and the site is currently in care and maintenance.

The areas previously disturbed for mining have been rehabilitated with ground cover suitable for grazing, with areas of woodland vegetation on the steeper slopes of the open cut mining landforms. Plate 5-7 shows rehabilitation at the Shannon Hill final void, and Plate 5-8 shows rehabilitation at the Blue Vale final void.

5.2 EXISTING REHABILITATION MONITORING AND MANAGEMENT AT OTHER WHITEHAVEN OPERATIONS

Tarrawonga Coal Mine

Rehabilitation activities at the Tarrawonga Coal Mine commenced in 2007 and have focused on the western slopes of the Northern Emplacement.

The objective of the current rehabilitation is to re-profile the available finalised Northern Emplacement batters to a stable overall slope of approximately 10^{o}, and to revegetate the completed landform to open native woodland with flora species characteristic of the local area. Fauna habitat features (e.g. tree trunks) are incorporated into the rehabilitation areas.

Rehabilitation monitoring results at the Tarrawonga Coal Mine indicate that the initial cover crop has been successful in stabilising the rehabilitation areas, with a 95% cover recorded (Geoff Cunningham Natural Resource Consultants Pty Ltd, 2010).

Tube stock establishment has also been largely successful to date with a survival rate of approximately 75% (TCPL, 2010). Several fauna species have been observed on the rehabilitated western slopes of the Northern Emplacement, including: the Nankeen Kestrel, Galah, Crested Pigeon, Australian Magpie, Australian Raven, Apostlebird, Black-shouldered Kite, Euro, House Mouse, Variegated Dtella and Tree-crevice Skink (Countrywide Ecological Services, 2009a; 2009b; 2010).

Photographs of the progressive rehabilitation of the Northern Emplacement at the Tarrawonga Coal Mine are provided in Plates 5-9 and 5-10.

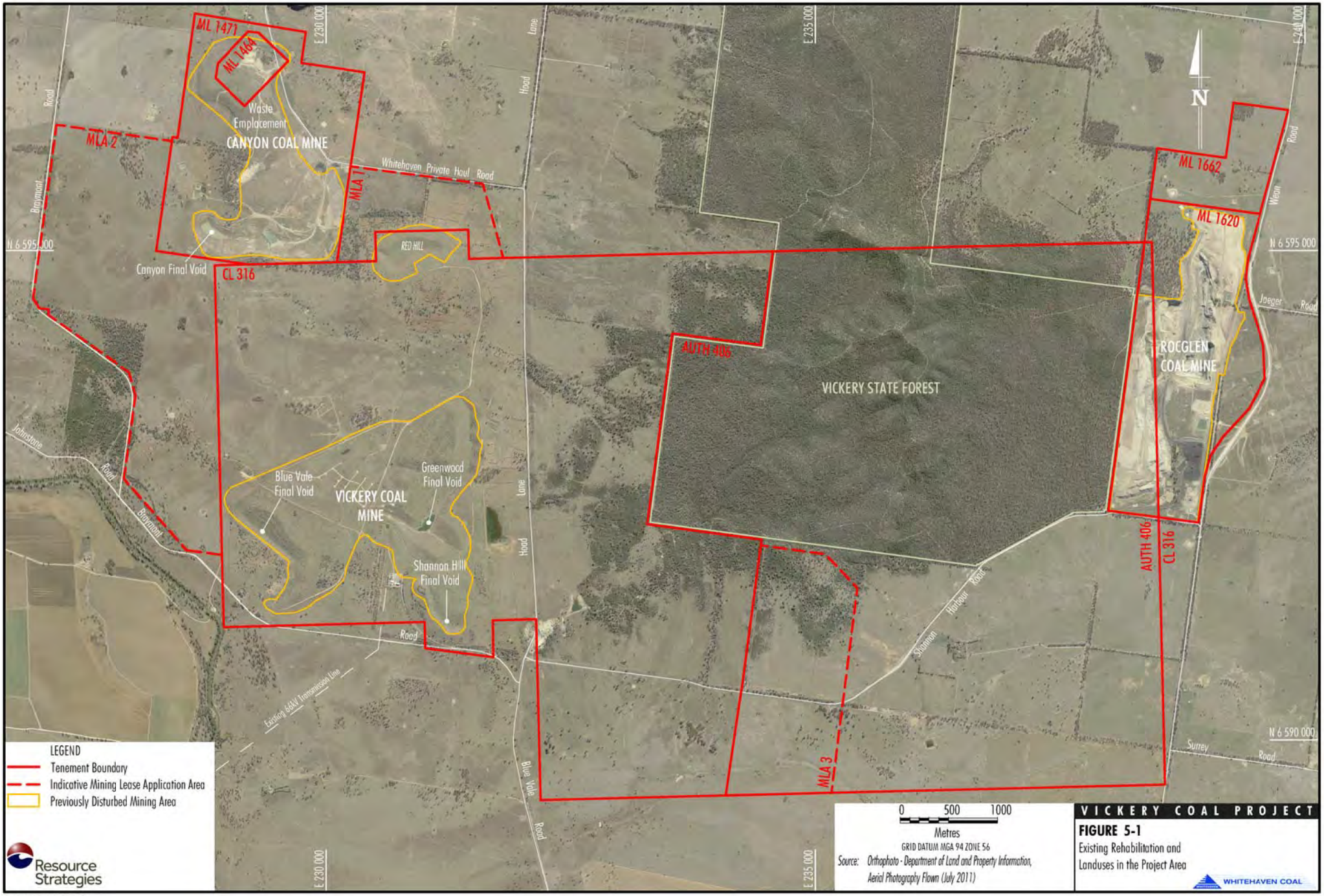

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Plate 5-1 Canyon Coal Mine - Prior to Reshaping

Plate 5-2 Canyon Coal Mine - Following Reshaping

Source: Whitehaven (2011)

VICKERY COAL PROJECT

PLATES 5-1 and 5-2

Canyon Coal Mine Rehabilitation

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Plates 5-3 Canyon Coal Mine - Cover Crop Establishment

Plate 5-4 Canyon Coal Mine - Cover Crop Establishment

Source: Whitehaven (2011)

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PLATES 5-3 and 5-4
Canyon Coal Mine Rehabilitation

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Plates 5-5 Canyon Coal Mine - Rehabilitation Under Maintenance

Plate 5-6 Canyon Coal Mine - Rehabilitation Under Maintenance

Source: Whitehaven (2011)

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PLATES 5-5 and 5-6
Canyon Coal Mine Rehabilitation

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Plates 5-7 Shannon Hill Final Void - Under Maintenance

Plate 5-8 Blue Vale Final Void - Under Maintenance

Source: Whitehaven (2011)

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PLATES 5-7 and 5-8
Vickery Coal Mine Rehabilitation

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Plates 5-9 Tarrawonga Coal Mine - Northern Emplacement Reshaping and Fauna Habitat Placement

Plate 5-10 Tarrawonga Coal Mine - Northern Emplacement Cover Crop Establishment

Source: Whitehaven (2011)

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PLATES 5-9 and 5-10
Tarrawonga Coal Mine Rehabilitation

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5.3 REHABILITATION AND MINE CLOSURE GOALS FOR THE PROJECT

The Project would disturb a total area of approximately 2,242 ha, consisting of approximately 1,284 of grassland, 464 ha native woodland/forest, 405 ha of rehabilitated land associated with the previous Vickery Coal Mine and approximately 89 ha of existing dams, tracks, roads and infrastructure areas.

Table 5-1 describes the rehabilitation and mine closure goals for the Project. The rehabilitation and revegetation concepts described within this section build upon, and are consistent with, these goals.

The existing rehabilitation in the Project area and other Whitehaven mines has been successful (Section 5.2), and the rehabilitation practices used by Whitehaven at these sites are contemporary and have been developed in consultation with, and to the satisfaction of, the relevant government agencies.

On this basis, the Project rehabilitation and mine closure goals (Table 5-1) have been developed in consideration of the methodology used at these sites (e.g. slope of the batters, topsoil thickness, revegetation techniques and plant selection).

The overall rehabilitation goal for the Project mining area is to enhance the cover and connectivity of native woodland across the Project area, while retaining areas of agricultural land capable of supporting cattle grazing and cropping in rotation with sown pastures.

Whitehaven's overall mine closure goal for the Project is that the status of the Vickery Coal Mine at relinquishment will be to the satisfaction of the relevant Minister(s), and that all relevant mining tenement and Development Consent conditions will have been met. Disturbed land would be considered suitable for surrender when the nominated standards and/or completion criteria for land use, landform reconstruction, landform stability, revegetation and beneficial water use have been met, unless the relevant Minister(s) otherwise accept the rehabilitation status.

Table 5-1
Rehabilitation and Mine Closure Goals for the Project

Short-term	Medium to Long-term
• Minimise active disturbance areas by progressively rehabilitating, and by restricting clearing to the minimum required for operations. • Recover vegetation and habitat resources during clearing activities and re-use in rehabilitated areas to provide habitat resources for fauna (e.g. trees, hollows). • Use soil resources stripped from disturbance areas directly for rehabilitation, but if this is not possible, minimise the time soil is stored in temporary stockpiles before being re-used. • Install erosion and sediment control measures prior to the commencement of soil stripping and rehabilitation activities. • Plant cover crops on newly rehabilitated mine landform areas (and topsoil stockpiles) as soon as possible after completing earthworks (e.g. within 1 year), to minimise the potential for soil erosion. • Stabilise new infrastructure disturbance areas (e.g. road and dam embankments) as soon as possible by topsoiling and seeding. • Plant vegetation screens in key areas ahead of Project disturbance activities, to allow growth and screening to occur prior to the commencement of disturbance activities. • Progressively backfill the open cut with overburden and interburden and reshape completed areas to their final landform shape so that they can be progressively rehabilitated.	• Provide self maintaining, geo-technically stable and safe landforms that complement existing surrounding landforms in terms of vegetation/land use. • Revegetate the mine landforms to a combination of native woodland/forest and agricultural land uses that meet community and regulatory expectations in consideration of existing land uses and conservation values. • Establish native woodland/forest on the northern section of the Western Emplacement (and all of the Eastern Emplacement), creating a continuous corridor of native vegetation from the Vickery State Forest to the Namoi River. • Rehabilitate the southern section of the Western Emplacement and the MIA with groundcover (i.e. native grass species) and scattered trees that would return these areas to land suitable for grazing and cropping in rotation with sown pastures. • Construct the final top surface of the Western Emplacement so that rainfall runoff drains in a stable manner, including the use of swale drains and rock armoured chutes. • Create final voids that do not impact the groundwater systems and receiving surface waters surrounding the Project.

5.4 REHABILITATION OF THE PROJECT

This section describes the rehabilitation concepts for each of the key final landforms. At the completion of mining, the key final landforms and features at the Project would include the:

- Western Emplacement and open cut infill area;
- Eastern Emplacement;
- open cut final voids;
- water management infrastructure;
- MIA; and
- the private haul road and Kamilaroi Highway overpass.

The Project final landform and revegetation program would provide for a combination of approximately 1,360 ha of native woodland/forest and some 780 ha of agricultural land (i.e. native grassland).

5.4.1 Western Emplacement and Open Cut Infill Area

The Western Emplacement and open cut infill area would be constructed predominantly with batter slopes of 10^{o} or shallower. The design angle of the batter slopes is based on the design of successful rehabilitation at other Whitehaven sites (i.e. the Canyon and Tarrawonga Coal Mines).

The northern, western and southern sides of the Western Emplacement would be designed to gradually slope up from the natural surface to the maximum elevation of 375 m AHD.

The top surface of the Western Emplacement would be approximately 4 km long and between 0.6 and 1.7 km wide, and would be designed with a slight dish shape so that incident rainfall could drain from it via wide vegetated swale drains that gradually slope to the north, to sediment basins and rock armored chutes, before being directed to the north-west drainage line (Figure 5-2).

A terrace with elevation of approximately 270 m AHD would be constructed to the east of the top surface of the Western Emplacement (i.e. where it merges into the open cut infill area) and would run parallel to the Western Emplacement in a north-south direction (Figure 5-2). Rainfall runoff would drain in a southerly direction through a vegetated swale drain before being directed to Stratford Creek (Figure 5-2).

The sediment dams constructed as part of the Project to the north, west and south of the Western Emplacement would be retained until the rehabilitated surface is stable and runoff water quality is similar to runoff from similar landforms outside the Project area (Section 5.4.4).

A conceptual cross-section of the Western Emplacement is shown on Figure 5-3. Figure 5-4 is a simulation of the rehabilitated Project area.

Vegetation Corridor

To the east of the Project is the Vickery State Forest, which contains native woodland vegetation, and to the west of the Project is a patch of remnant vegetation along Braymont Road that is contiguous with the Namoi River.

The northern section of the Western Emplacement would be revegetated with native tree, shrub and grass species, creating a native woodland/forest corridor that would connect the existing native vegetation in the Vickery State Forest with the Namoi River (Figure 5-4).

Revegetation would extend slightly beyond the western extent of the Western Emplacement to connect with the vegetation to the west of the Project (Figure 5-4).

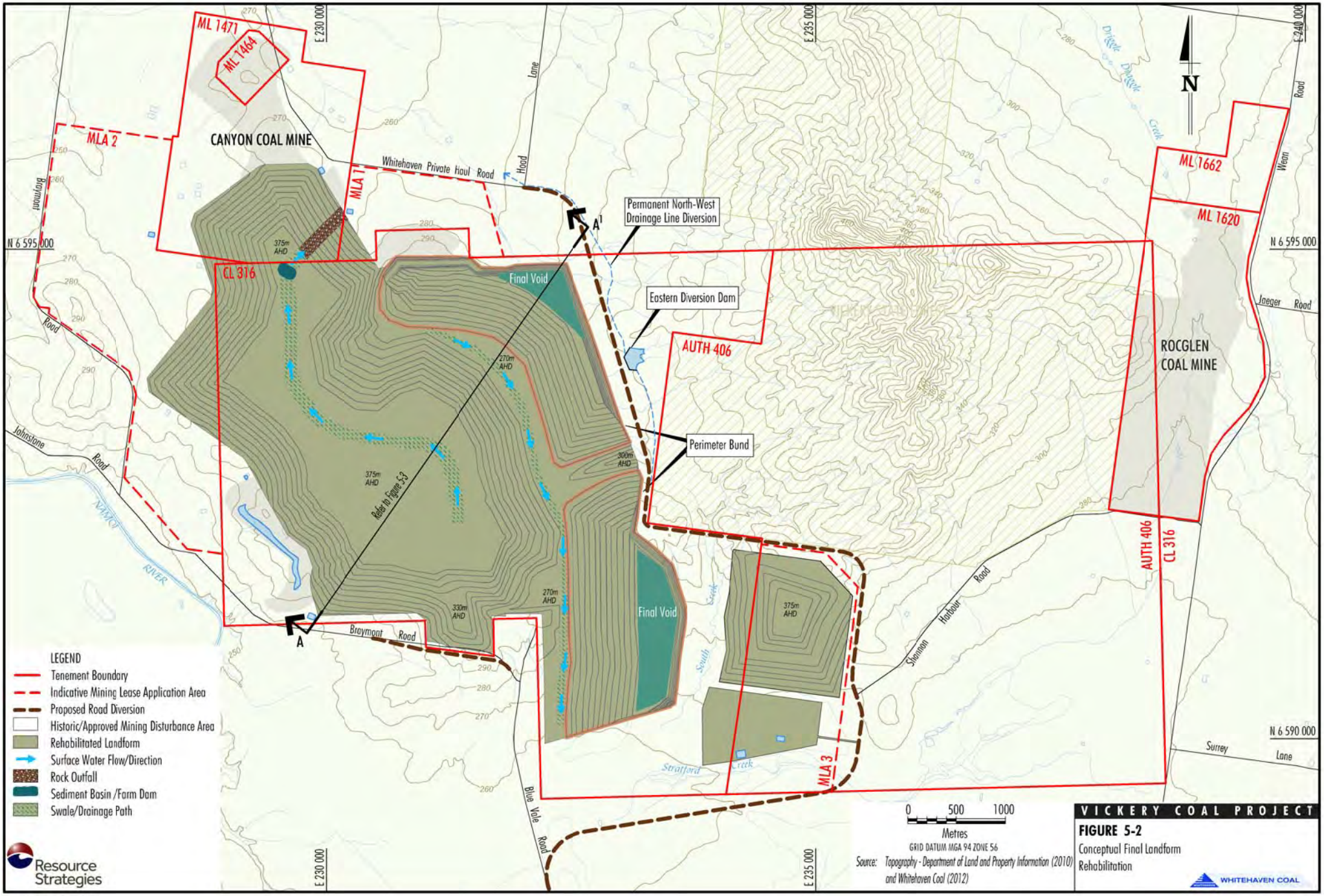
Areas Suitable for Agriculture

The land immediately to the south of the Project area, and the majority of land within the Project area, has been cleared for grazing purposes (Section 4.3.1).

The southern section of the Western Emplacement would be rehabilitated with native grass species to return it to land suitable for cattle grazing and cropping in rotation with sown pastures.

The southern half of the top surface of the Western Emplacement would be rehabilitated to Class 3 Agricultural Suitability land. The batters of the southern half of the Western Emplacement would be rehabilitated to Class 4 Agricultural Suitability land. Figure 5-5 shows the planned post-mining Agricultural Suitability classes for the Project mining area.

Existing rehabilitation in the Project area has demonstrated that disturbed areas can be successfully returned to land suitable for livestock production.



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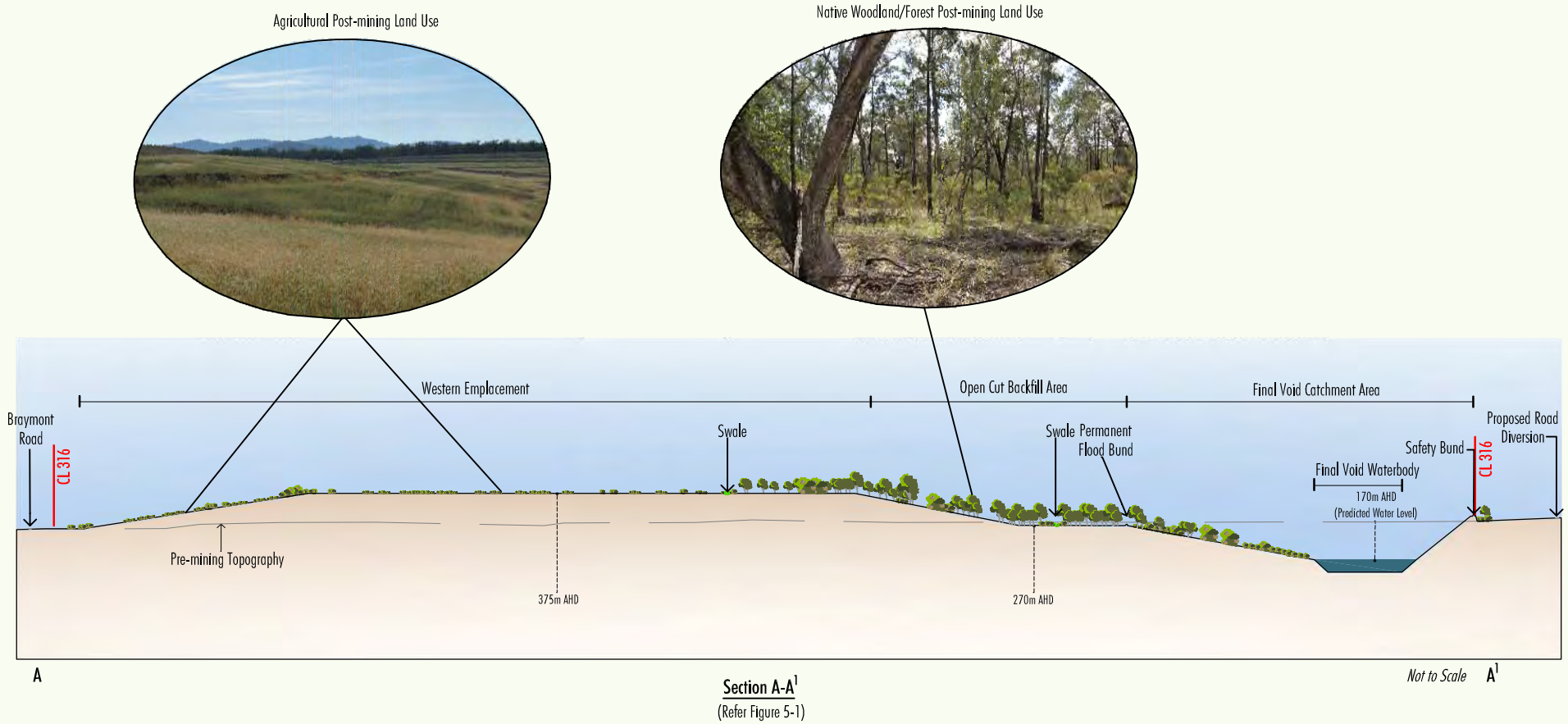

Section A-A[1]
(Refer Figure 5-1)

Source: Whitehaven (2012)

VICKERY COAL PROJECT

FIGURE 5-3

Cross-section of the Rehabilitated Project Mine Landform

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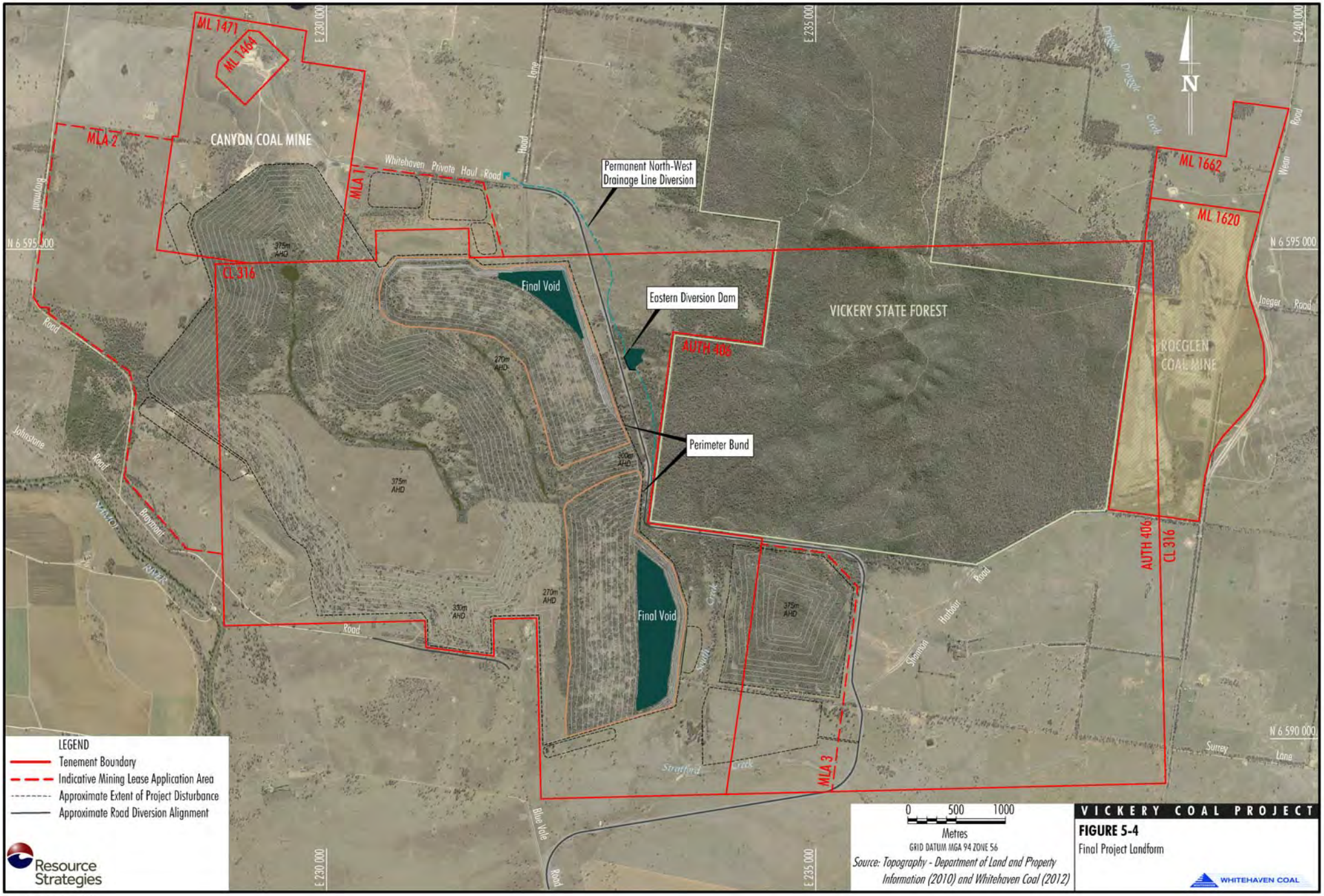

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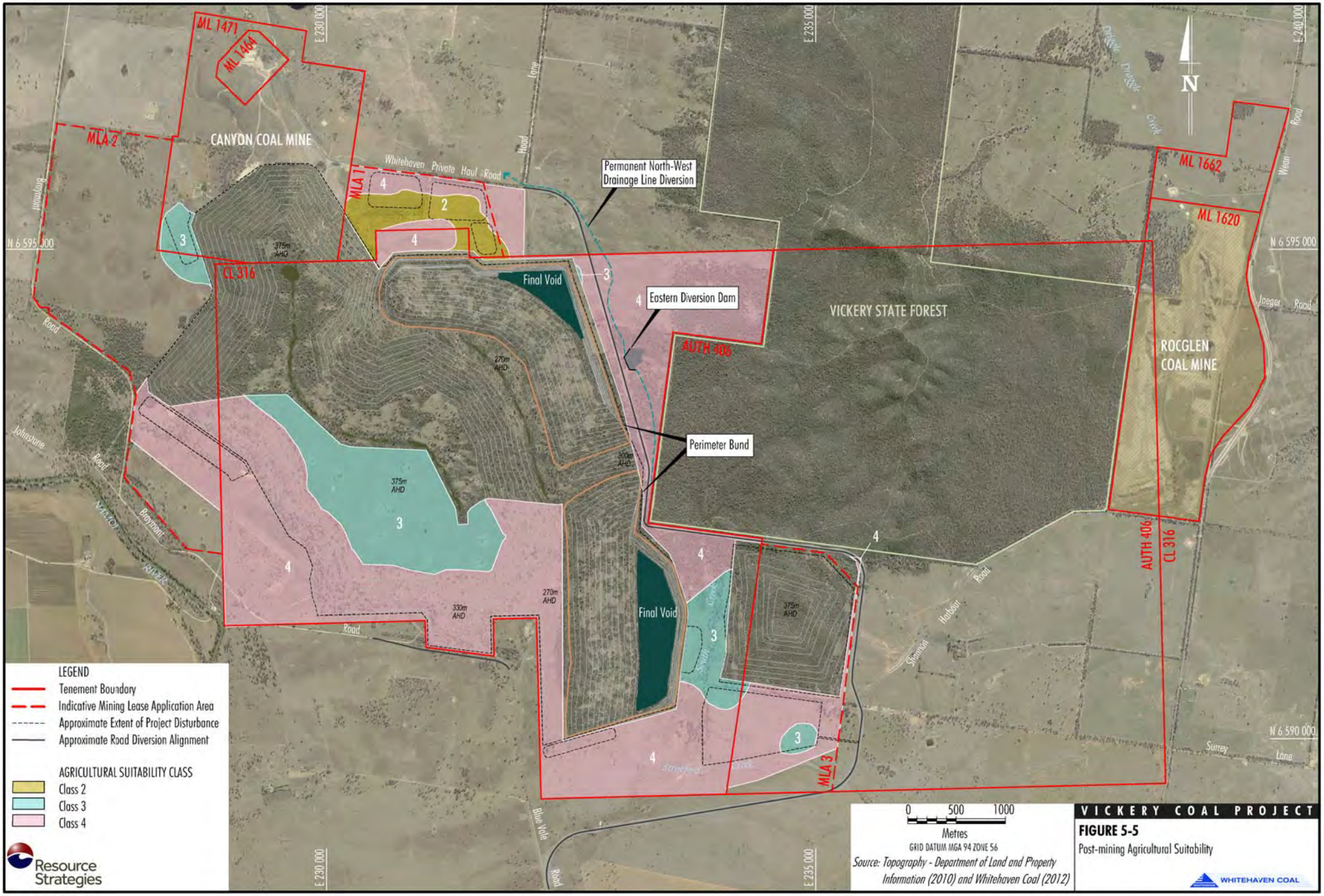

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Local landholders currently use the rehabilitated areas of the Vickery Coal Mine for cattle grazing, and these farmers have indicated that the grazing capability of the rehabilitated areas is equal to, or better than other areas in the Project area not previously disturbed by mining (Appendix G).

5.4.2 Eastern Emplacement

The Eastern Emplacement would also be constructed predominantly with batter slopes of 10^{o} or shallower.

All sides of the Eastern Emplacement would be designed to gradually slope up from the natural surface to the maximum elevation of 375 m AHD.

The top surface of the Eastern Emplacement would be flat and would have dimensions of approximately 300 m by 400 m. Rainfall runoff would drain from the Eastern Emplacement via reverse graded berms and armored drop structures on the batters.

The sediment dam constructed in the MIA that collects runoff from the Eastern Emplacement would be retained until the rehabilitated surface is stable and runoff water quality is similar to runoff from similar landforms outside the Project area (Section 5.4.4).

The Eastern Emplacement would be revegetated with native tree, shrub and grass species to create a native woodland/forest that would connect with the existing vegetation to the north in the Vickery State Forest (Figure 5-4).

5.4.3 Open Cut Final Voids

At the completion of mining, the final landform would include two final voids located to the east of the Western Emplacement (Figure 5-2). Towards the end of the mine life the voids would be separated by a 'saddle' of infill at approximately 240 m AHD (Figure 2-7). This 'saddle' would be built up further post-closure to a final height of approximately 300 m AHD so that it provides a permanent land bridge from the Vickery State Forest across the mine site to the Namoi River.

The voids would be maintained post-closure as it would be cost prohibitive to backfill them at the end of the mine life (Section 6.6.2). The retention of the voids would also prevent sterilisation of the coal resources to the north and east of the Project.

The northern final void would be bounded by highwalls on its northern and eastern sides, with shallower slopes (i.e. 10 to 15°) on the western and southern sides (Figure 5-2).

The southern final void would be bounded by highwalls on its eastern and southern sides, with shallower slopes (i.e. 10 to 15°) on the western and northern sides (Figure 5-2).

The highwalls for the final voids would be designed to be geotechnically stable in the long-term, and would be at a nominal angle of approximately 60°. If required, additional works (e.g. placement of additional waste rock at the base of the highwall) would be undertaken following the completion of mining to improve their long-term geotechnical stability.

The catchment area of the final voids would be confined by permanent perimeter bunds (Figure 5-2). The combined catchment area of the northern and southern final voids would be approximately 490 ha. The final void catchment areas (excluding the pit lakes and highwalls) would be revegetated with native tree, shrub and grass species.

The permanent north-west drainage diversion and eastern diversion dam (Figure 5-4) constructed for the Project would be maintained post-mining to direct clean up-catchment runoff flowing west from the Vickery State Forest away from the northern final void.

Inflows into the final voids would comprise incident rainfall, runoff and groundwater inflows (including waste rock emplacement infiltration). Once mining operations and backfilling activities in the open cut cease, inflows to the final voids would no longer be collected and pumped out, and as a result, the voids would gradually begin to fill with water (Section 4.4.2).

One of the rehabilitation and mine closure goals for the Project is to avoid potential impacts to groundwater systems and receiving surface waters surrounding the Project.

To meet this goal, the final voids would be designed to form localised groundwater sinks, preventing salts or poorer quality groundwater from migrating out from the Project area and adversely impacting the adjacent groundwater aquifers.

An assessment of potential impacts to surface water and groundwater associated with the final voids has been conducted as part of the Groundwater Assessment and Surface Water Assessment (Appendices A and B, respectively).

The results of final void recovery simulations indicated that the northern void would reach an average water level of 167 m AHD approximately 100 years after mining ceases and the level would oscillate between about 164 and 172 m AHD thereafter, and the southern final void would reach an average water level of 147 m AHD approximately 100 years after mining ceases and the level would oscillate between about 146 and 150 m AHD thereafter (Appendix B).

The equilibrium water levels in the pit lakes would be approximately 90 to 100 m lower than pre-mining watertable levels at the northern final void, and approximately 105 to 115 m lower at the southern void (Appendix B).

Figure 5-4 is a simulation of the rehabilitated Project area showing the two pit lakes at their equilibrium levels. The cross-section shown on Figure 5-3 includes the northern final void and pit lake.

Both voids would act as permanent groundwater sinks, and the pit lakes are not predicted to spill under any of the simulated climatic sequences (Appendix B).

Final void salinity is predicted to increase slowly with time, reaching about 5,000 mg/L and 7,000 mg/L after 100 years in the northern and southern final voids, respectively (Appendix A). Over time, the salinity in the final voids would continue to increase through evaporative concentration.

As long as the voids remain as groundwater sinks, there would be no deleterious effect on the beneficial uses of any groundwater sources (Appendix A).

An adaptive management approach to final void design and mine closure planning would be adopted during the life of the Project. This would involve Whitehaven periodically reviewing and evaluating alternative methods for achieving the rehabilitation and mine closure goals for the Project (e.g. new technology and/or rehabilitation methods may become available that would achieve the goals more efficiently).

Final void design and mine planning would be undertaken by Whitehaven in consultation with relevant government agencies as a component of the Rehabilitation Management Plan and MOP (Section 5.6). This would include model verification and re-simulation of the behaviour of the final void pit lakes using the results of the groundwater and surface water monitoring programs.

Appropriate safety bunds and/or fencing and signage would be installed around the perimeter of the voids to restrict access.

5.4.4 Water Management Infrastructure

At the cessation of mining activities, and once they are no longer required, the mine water dams would be emptied by pumping to the final voids. Any dam liners would then be removed and appropriately disposed of, and any contaminated soils would be removed and/or treated. The dams would then be either retained for future use as water storages, or they would be filled and/or reprofiled and revegetated.

Sediment dams would be retained pending the achievement of long-term acceptable water quality in runoff from rehabilitated landforms, after which point they would be removed and the areas rehabilitated. Some sediment dams may be kept for livestock watering, if suitable.

5.4.5 Mine Infrastructure Area

The mine facilities and infrastructure that would be removed at the end of the Project life would include:

- coal and gravel crushing, screening and loadout infrastructure;
- administration and workshop buildings and stores;
- heavy vehicle servicing, parking and washdown facilities;
- sewage treatment facilities; and
- hydrocarbon and dangerous goods storage facilities.

During the decommissioning phase, the priority would be to dismantle fixed equipment and infrastructure for removal from site and re-use at another location, or for recycling.

Non-salvageable/non-recyclable infrastructure would be disposed of at suitable off-site disposal areas, or on-site, subject to demonstration that no land contamination risk would be posed and relevant approvals are obtained.

Land contamination assessments would be conducted and any contaminated soil would be remediated in accordance with the relevant guidelines (including guidelines under section 145C of the EP&A Act and the NSW *Contaminated Land Management Act, 1997*).

Some concrete hardstands, site access roads, sheds, buildings and sediment dams may be retained for alternate post-mining uses, if agreed with the relevant government agencies.

Once all the equipment and infrastructure components have been removed and any land contamination has been remediated, the MIA would be deep ripped, topsoiled and seeded with native grasses to return the area to land suitable for cattle grazing and cropping in rotation with sown pastures. (i.e. Class 3 and 4 Agricultural Suitability land).

5.4.6 Private Haul Road and Kamilaroi Highway Overpass

The private haul road and Kamilaroi Highway overpass would be decommissioned and the area rehabilitated to a condition of comparable Agricultural Suitability to the surrounding land (i.e. Class 2 and 3), unless otherwise agreed with the relevant government agencies.

5.5 GENERAL REHABILITATION PRACTICES AND MEASURES

The following sub-sections summarise the general rehabilitation practices and measures that would be implemented at the Project.

The success of progressive rehabilitation activities would be regularly evaluated throughout the Project life and the results would be used to inform future rehabilitation initiatives.

5.5.1 Vegetation Clearing Measures

Vegetation clearance for the Project would be undertaken progressively and the area cleared at any particular time would generally be no greater than that required to accommodate the mine's needs for the following 12 months (Section 4.9.3). Areas to be cleared would be delineated, restricting clearing to the minimum area necessary to undertake the approved activities.

Vegetation clearance protocols would be documented in the Biodiversity Management Plan for the Project and would be used to minimise impacts on flora and fauna. Key components of the vegetation clearance protocols would include aspects such as the delineation of areas to be cleared of native remnant vegetation, timing and methods to be used, pre-start clearing inspections by suitably qualified ecologist to confirm no impact on threatened species, and re-use of cleared vegetation debris in revegetation programs.

5.5.2 Soil Stripping Areas and Handling Measures

Soil Management Strategies

As described in Section 4.3.3, the following management measures would be implemented during the stripping of soils at the Project:

- Areas of disturbance would be stripped progressively, as required, to reduce potential erosion and sediment generation, and to minimise the extent of topsoil stockpiles and the period of soil storage.
- Areas of disturbance requiring soil stripping would be clearly defined following vegetation clearing.
- Topsoil and subsoil stripping during periods of high soil moisture content (i.e. following heavy rain) would be avoided to reduce the likelihood of damage to soil structure.

Any long-term soil stockpiles generated during the life of the Project would be managed to maintain long-term soil viability through the implementation of the following management practices:

- Topsoil and subsoil stockpiles would be limited to a maximum height of 3 m, with slopes no greater than 1:2 (V:H) and a slightly roughened surface to minimise erosion.
- Topsoil stockpiles would be constructed to minimise erosion, encourage drainage, and promote revegetation.
- Where additions such as lime, gypsum and fertiliser are needed to improve the condition of cut soil, they would be applied to the stockpiles in-between the application of separate layers from the scrapers.
- To avoid breakdown in soil structure, soil would not be trafficked, deep ripped or removed in wet conditions.

Ameliorants would be used where necessary to address potential soil constraints identified by McKenzie Soil Management (2012) during the Agricultural Resource Assessment (Appendix G).

Soil Reserves

A preliminary material balance calculation was conducted by McKenzie Soil Management (2012) to determine the quantity of soil available for rehabilitation (Appendix G).

The results of these calculations are summarised in Table 5-2. They indicate that there would be sufficient soil available to meet the rehabilitation concepts described in this EIS, based on a soil re-application depth of 0.3 m for areas rehabilitated to native woodland/forest, and 0.9 m for areas rehabilitated to land suitable for agricultural uses (Appendix G).

The volume of topsoil expected to be stripped, used in rehabilitation or stockpiled over the life of the Project is provided in Table 5-3.

Details of available soil resources, stripping and reapplication schedules, and stockpiling inventories would be included in the MOP, Biodiversity Management Plan and the Rehabilitation Management Plan.

A summary of soil management activities for each 12 month reporting period would be provided in the Annual Reviews for the Project

5.5.3 Stages of Rehabilitation

Once mining areas are no longer active, these areas would be rehabilitated to either native woodland/forest or land suitable for agricultural uses.

Stage 1 Rehabilitation involves the stabilisation of the area, the application of topsoil (at the depths described in Section 5.5.2) and the application of seed/cover crops.

A rehabilitation goal for the Project would be to apply seed/cover crops within approximately 1 year of a mining area becoming inactive.

Table 5-2
Preliminary Project Soil Balance

	Recommended Stripping Depth (cm)	Approximate Stripping Area (ha)	Approximate Volume (m^3)
Soil resource availability	No soil stripping	508	0
	< 15	408	611,480
	15 – 20	570	1,139,850
	20 – 30	321	961,790
	30 – 50	30	147,730
	50 – 60	195	1,171,490
	60 - 90	210	1,893,900
	Sub-total	*2,242*	*5,926,240*
Additional soil resource availability (following deeper excavation and gypsum treatment)	< 15	658	947,500
	15 – 30	652	1,956,890
	30 – 45	34	154,800
	Sub-total	*1,344*	*3,059,190*
Total soil resource availability			**8,985,430**

Source: After Appendix G.

Table 5-3
Approximate Topsoil Inventory

	Approximate Topsoil Volume Stripped (m^3)	Approximate Volume used in Rehabilitation (m^3)	Approximate Volume in Stockpiles (m^3)	Approximate Stockpile Area (ha)
Years 1 to 2	3,015,230	653,560	2,361,120	79
Years 2 to 7	2,152,040	983,420	3,529,190	118
Years 7 to 17	1,697,500	1,654,610	3,571,530	119
Years 17 to 26	1,763,390	1,178,020	4,156,360	139
Year 26 to mine closure	357,270	4,515,820	0	0
Total	**8,985,430**	**8,985,430**	N/A	

Source: After Appendix G.

Following the application of seed/cover crops, the rehabilitated areas would generally require approximately two years to establish self-sustaining vegetation, however, this may be influenced by the climatic conditions at the time.

This timing is based on rehabilitation experience at other Whitehaven operations (i.e. the Canyon and Tarrawonga Coal Mines [Sections 5.1 and 5.2]).

Stage 2 Rehabilitation represents areas with established vegetation, which would only require minor maintenance (e.g. weed control). The landforms would be safe and stable, with adequate, geomorphically stable drainage features.

The progressive areas of Stage 1 and 2 Rehabilitation for Project Years 2, 7, 17 and 26 are shown on Figures 2-4 to 2-7. Table 5-4 shows the approximate areas of disturbance and progressive rehabilitation for the Project.

Detailed descriptions of the stages of rehabilitation, and the associated areas and timing, would be described in the Annual Reviews for the Project.

5.5.4 Selection of Native Plant Species for Revegetation

Areas to be revegetated with native vegetation would initially be stabilised with a non-persistent cover crop.

Native tube stock and/or seeds would then be planted/seeded into the rehabilitation areas.

Native species would be selected on a site-by-site basis depending on nearby remnant vegetation associations, soil types, aspect and site conditions. Drought tolerance would also be a consideration in native species selection.

Revegetation of native woodland/forest areas would include the planting of endemic native species characteristic of the local woodland/forest communities. This may include species characteristic of the Box-Gum Woodland EEC (e.g. White Box overstorey as well as appropriate understorey) in areas with suitable soil, slope and aspect.

Areas to be revegetated with native woodland/forest would have topsoil applied to a depth of approximately 0.3 m (Appendix G).

Revegetation of areas to land suitable for agricultural uses would involve seeding of native grass species. These areas would have topsoil applied to a depth of approximately 0.9 m (Appendix G).

The list of suitable native plant species to be used in the revegetation of mine landforms and other Project disturbance areas would be determined in consultation with the relevant government agencies and would be documented in the Rehabilitation Management Plan, MOP and Annual Reviews for the Project.

Potential fauna habitat (e.g. logs/hollows) salvaged during pre-clearance surveys would be relocated to the woodland/forest rehabilitation areas.

Table 5-4
Approximate Areas of Disturbance and Progressive Rehabilitation for the Project

Project Years	Disturbed Area (ha)	Rehabilitated Area (Stages 1 and 2) (ha)		
		Land Suitable for Grazing	Native Forest/Woodland	Total
Years 1 to 2	648	74	0	74
Years 2 to 7	549	83	80	163
Years 7 to 17	531	99	275	374
Years 17 to 26	415	72	215	287
Year 26 to mine closure	99	452	790	1,242
Total	*2,242*	*780*	*1,360*	*2,140**

* The remainder of the Project area would consist of the road realignments (approximately 27 ha) and the two pit lakes (approximately 75 ha).

5.5.5 Establishment of Agricultural Land

The assessment of the physical and chemical properties of the soils within the Project area (Appendix G) has established that the soils generally within the western part of the Project area would be a suitable rehabilitation medium for agricultural uses post-mining. These soils are considered to be suitable for this purpose by McKenzie Soil Management (2012) as they have:

- favourable pH values;
- are non-saline;
- their exchangeable sodium percentage values are low enough to be treated easily with coarse-grade gypsum;
- their cation exchange capacity allows for natural decompaction through shrink-swell processes; and
- the favourable properties of these soils would not be modified greatly during stripping, stockpiling and re-spreading.

As described in Section 5.4, the southern part of the Project area (i.e. the southern part of the Western Emplacement and the MIA) would be rehabilitated to land suitable for agricultural uses (i.e. Class 3 or 4 Agricultural Suitability).

McKenzie Soil Management (2012) determined that the topsoil in the volcanic zones in the western part of the Project area would be a highly suitable medium for rehabilitation. These soils would be selectively handled and used on the top surface and/or southern half of the Western Emplacement.

The areas to be rehabilitated to agricultural land uses would be prepared with a total soil profile depth of approximately 0.9 m overlaid on mine waste rock (Appendix G). The underlying mine waste rock is expected to have high porosity/permeability and is therefore expected to allow for beneficial deep drainage and deep root growth beyond the topsoil (Appendix G). This soil profile would provide root zone chemical and physical conditions that are at least as favourable for grazing as the existing agricultural land in the Project area (i.e. Class 3 or 4 Agricultural Suitability) (Appendix G).

Based on the available soil quantities and the soil profile described above, approximately 780 ha of land suitable for agricultural purposes would be re-established in the southern part of the Project area (Appendix G).

5.5.6 Erosion and Sediment Control Works

As described in Section 4.5.3, the site sediment and erosion control system would be managed through the Water Management Plan, which would be progressively developed and approved over the life of the Project. The sediment and erosion control system would be updated periodically to address changes over the Project life. The effectiveness of the system would be assessed through regular monitoring.

The operational sediment and erosion control works would be retained and maintained during the revegetation establishment phase. As described in Section 5.4.4, following the establishment of self-sustaining, stable final landforms, key elements of the operational sediment control structures would either be left as passive water control storages or would be removed.

5.6 REHABILITATION AND REVEGETATION MONITORING

The rehabilitation monitoring program for the Project would be designed to track the progress of revegetation and to determine the requirement for intervention measures such as thinning to reduce the density of revegetated areas, or additional plantings in areas where vegetation establishment has been sub-optimal.

The Project rehabilitation monitoring program would be documented in the Rehabilitation Management Plan and would describe the methods that would be used to:

- evaluate the coverage and application of topsoil prior to seeding;
- monitor drains and assess water quality to determine whether substantial silting of inverts and/or any localised failure of drain embankments has occurred;
- evaluate recently topsoiled areas after rain events (particularly on sloping ground) to assess whether significant rilling or loss of topsoil has occurred;
- evaluate the behaviour of placed topsoil over time (i.e. erosion or dispersion, compaction, salting or hard setting);
- assess the initial germination success in revegetation areas (including recording of diversity and abundance);
- monitor revegetation success over time (e.g. survival rate, plant growth, species diversity, weed content, fauna usage);

- evaluate potential threats to rehabilitated areas (e.g. weed invasion, pest species, dispersive soils or potentially acid forming-low capacity materials, erosion); and
- record key rehabilitation information (e.g. photographic records, surveys, file notation).

Annual revegetation surveys would be undertaken by an appropriately qualified and experienced person to identify the success of rehabilitation and identify any additional measures required to achieve ongoing rehabilitation success. A detailed monitoring report would be prepared annually that includes a summary of previous monitoring reports, results of the current year's monitoring and planned remedial works, if required.

The annual monitoring program would include the use of satellite imagery obtained on a regular basis over the life of the Project to document trends in rehabilitation over time. This process would compliment on-ground survey work. The monitoring results would be summarised in the Annual Reviews for the Project.

Key rehabilitation completion criteria for the Project are proposed in Table 5-5. These criteria have been developed with regard to *Development of Rehabilitation Completion Criteria for Native Ecosystem Establishment on the Coal Mines in the Hunter Valley,* Australian Coal Association Research Program Project C13048 (Australian Centre for Minerals Extension and Research, 2005).

The specific rehabilitation parameters and completion criteria would be determined in consultation with relevant government agencies and would be documented in the MOP and Rehabilitation Management Plan.

5.7 INTEGRATION WITH OTHER OFFSET MANAGEMENT STRATEGIES

5.7.1 Canyon Coal Mine

As described in Section 5.1, rehabilitation at the Canyon Coal Mine (i.e. within ML 1471) has been successfully completed.

The Project would involve the development of the northern extent of the Western Emplacement within a part of ML 1471.

Rehabilitation of the northern extent of the Western Emplacement for the Project would be conducted to integrate with and complement the existing rehabilitation at the Canyon Coal Mine (i.e. in terms of landforms and vegetation types).

5.7.2 Rocglen Coal Mine

The Rocglen Coal Mine is located to the east of the Vickery State Forest (Figure 5-4).

The rehabilitation strategy for the Rocglen Coal Mine includes the establishment of native vegetation on the western side of the site to connect with the vegetation in the Vickery State Forest (GSS Environmental, 2011).

The rehabilitation at the Rocglen Coal Mine would extend the vegetation corridor between the Namoi River and the Vickery State Forest which would be created by the rehabilitation (i.e. establishment of native forest/woodland) proposed for the Project (Section 5.4.1).

Table 5-5
Proposed Key Rehabilitation Completion Criteria

Project Component	Key Completion Criteria
Final Landforms	• Safe, stable, adequately drained post-mining landforms consistent with the surrounding landscape as evidenced by comparative photography, water quality monitoring and geotechnical surveys. • Geomorphic stability of drainage features comparable to existing natural drainage features as evidenced by cross-section and long-section surveys and monitoring of erosion.
Rehabilitation and Revegetation Areas	• Native woodland/forest and revegetation areas on a trajectory of forming a self-sustaining ecosystem and/or ecosystem function equivalent to reference sites (e.g. vegetation cover, landform stability, species diversity). • Native grassland/pasture areas demonstrated to be capable of successful agricultural uses.
Final Voids	• Surface water inflows to the final voids minimised through appropriate landform design as evidenced by revision of the water balance based on final as-built mine landforms. • Final voids profiled for long-term stability as evidenced by geotechnical surveys of high walls/end walls. • Perimeter bunding formed.

5.8 REHABILITATION MANAGEMENT PLAN

A Rehabilitation Management Plan would be developed and implemented for the Project, in consultation with the relevant government agencies in accordance with any requirements specified in the Development Consent for the Project.

It is expected that the Rehabilitation Management Plan would include the following:

- a description of the nature and timing of the progressive rehabilitation works (i.e. new areas) and rehabilitation management activities (i.e. maintenance of existing areas) that would be undertaken within the Project area;
- a description of how the planned rehabilitation works have been developed in consideration of the rehabilitation and mine closure goals for the Project (Tables 5-1 and 5-5);
- rehabilitation performance objectives, parameters and completion criteria;
- the rehabilitation monitoring program to be used to evaluate the performance of rehabilitation against the completion criteria;
- the mechanisms to be used to regularly report on the status of the rehabilitation works and the rehabilitation monitoring results; and
- a description of how the Rehabilitation Management Plan integrates with the other management plans required for the Project (i.e. Biodiversity Management Plan and MOP).

The Rehabilitation Management Plan would be prepared in consultation with the relevant government agencies, and in accordance with the relevant DRE rehabilitation and mine closure guidelines (e.g. consideration of the mine closure and rehabilitation principles contained in the Australian Mining Industry Council's *Mine Rehabilitation Handbook*).

5.9 CLOSURE STRATEGY

Whitehaven would develop a Final Void and Mine Closure Plan for the Project which would include details of the mine closure strategy.

The mine closure strategy would be developed with regard to the principles detailed in the *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council of Australia and Minerals Council of Australia, 2000) and in consultation with the Narrabri and Gunnedah Shire Councils, the DP&I and the local community.

The Final Void and Mine Closure Plan would be developed giving due consideration to relevant strategic land use policies, and would include details of the funding and maintenance requirements for the site and give consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.