APPENDIX A: Regionally significant fauna found on Bimblebox Nature Refuge

Species		Conservation Status
Birds		
Wandering Whistling Duck	*Dendrocygna arcuata*	Marine
Straw-necked Ibis	*Threskiornis molucca*	Marine
Black-necked Stork	*Ephippiorhynchus asiaticus*	**Near Threatened (DERM)**; Conservation Significance for Desert Uplands
Australian Bustard	*Ardeotis australis*	Conservation Significance for Desert Uplands
Whistling Kite	*Haliastur sphenurus*	Marine
Black Falcon	*Falco subniger*	Conservation Significance for Desert Uplands
Bush Stone-Curlew	*Burhinus grallarius*	Conservation Significance for Desert Uplands
Squatter Pigeon	*Geophaps scripta scripta*	**Vulnerable (EPBC)**; Conservation Significance for Desert Uplands
Brown Treecreeper	*Climactereris picumnus*	Conservation Significance for Desert Uplands
Speckled Warbler	*Chthonicola sagittata*	Conservation Significance for Desert Uplands
White-eared Honeyeater	*Lichenostomus leucotis*	Conservation Significance for Desert Uplands
Black-chinned Honeyeater	*Melithreptus gularis*	**Near Threatened (DERM);** Conservation Significance for Desert Uplands
Hooded Robin	*Melanodryas cucullata*	Conservation Significance for Desert Uplands
Grey-crowned Babbler	*Pomatostomus temporalis*	Conservation Significance for Desert Uplands
Great Egret	*Ardea alba*	Marine; Migratory(CAMBA, JAMBA)
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Marine
White-bellied Cuckoo-shrike	*Coracina papuensis*	Marine
Horsfield's Bronze-cuckoo	*Chrysococcyx basalis*	Marine
Channel-billed Cuckoo	*Scythrops novaehollandiae*	Marine
Southern Boobook	*Ninox novaeseelandiae*	Marine
Sacred Kingfisher	*Todiramphus sanctus*	Marine
Rainbow Bee-eater	*Merops ornatus*	Marine; Migratory(JAMBA)
Spangled Drongo	*Dicrurus bracteatus*	Marine
Australian (Richard's) pipit	*Anthus novaeseelandiae*	Marine
Black-throated Finch (southern)	*Poephila cincta*	**Endangered (EPBC)**; Conservation Significance for Desert Uplands
Tree Martin	*Hirundo nigricans*	Marine
Rufous (Nankeen) Night Heron	*Nycticorax caledonicus*	Marine
Mammals		
Common Dunnart	*Sminthopsis murina*	Conservation Significance for Desert Uplands
Spectacled Hare Wallaby	*Lagorchestes conspicillatus*	Conservation Significance for Desert Uplands

Rufous Bettong	*Aepyprymnus rufescens*	Conservation Significance for Desert Uplands
Koala	*Phascolarctos cinereus*	Conservation Significance for Desert Uplands
Desert Mouse	*Pseudomys desertor*	Conservation Significance for Desert Uplands
Reptiles		
Mulga Snake (King Brown Snake)	*Pseudechis australis*	Conservation Significance for Desert Uplands
Butterflies		
Wanderer Butterfly	*Danaus plexippus*	Migratory (Bonn)
Plants		
Large-podded Tick-trefoil	*Desmodium macrocarpum*	**Near Threatened (DERM)**

APPENDIX B: Bird species found on Bimblebox Nature Refuge 2003-2011

1	Emu	*Dromaius novaehollandiae*
2	Brown Quail	*Coturnix ypsilophora*
3	Unidentified Button Quail	
4	Little Button-quail	*Turnix velox*
5	Red-chested Button-quail	*Turnix pyrrhothorax*
6	Australian Pelican	*Pelecanus conspicicilliatus*
7	Australasian Darter	*Anhinga melanogaster*
8	Pied Cormorant	*Phalacrocorax varius*
9	Little Pied Cormorant	*Microcarbo melanoleucos*
10	Little Black Cormorant	*Phalacrocorax sulcirostris*
11	Australasian Grebe	*Tachybaptus novaehallaniae*
12	Wandering Whistling Duck	*Dendrocygna arcuata*
13	Plumed Whistling Duck	*Dendrocygna eytoni*
14	Pacific Black Duck	*Anas superciliosa*
15	Grey Teal	*Anas gracilis*
16	Hardhead (White-eyed Duck)	*Aythya australis*
17	Australian Wood (Maned) Duck	*Chenonetta jubata*
18	White-necked (Pacific) Heron	*Ardea pacifica*
19	White-faced Heron	*Egretta (Ardea) novaehollandiae*
20	Great Egret	*Ardea alba*
21	Nankeen (Rufous) Night Heron	*Nycticorax caledonicus*
22	Strawneck Ibis	*Threskiornis spinicollis*
23	Yellow-billed Spoonbill	*Platalea flavipes*
24	Black-necked Stork	*Ephippiorhynchus asiaticus*
25	Brolga	*Grus rubicundus*
26	Australian Bustard	*Ardeotis australis*
27	Bush Stone-curlew	*Burhinus grallarius*
28	Masked Lapwing	*Vanellus miles*
29	Black-fronted Dotterel	*Elseyornis (Charadrius) melanops*
30	Black-shouldered Kite	*Elanus axillaris*
31	Letter-winged Kite	*Elanus scriptus*
32	Black Kite	*Milvus migrans*
33	Whistling Kite	*Haliastur (Milvus) sphenurus*
34	Wedge-tailed Eagle	*Aquila audax*
35	Little Eagle	*Hieraaetus morphnoides*
36	Brown Goshawk	*Accipiter fasciatus*
37	Collared Sparrowhawk	*Accipiter cirrhocephalus*
38	Black Falcon	*Falco subniger*
39	Brown Falcon	*Falco berigora*
40	Nankeen Kestrel	*Falco cenchroides*
41	Peaceful Dove	*Geophelia striata*
42	Diamond Dove	*Geophelia coneata*
43	Bar-shouldered Dove	*Geophelia humeralis*
44	Common Bronzewing	*Phaps chalcoptera*

45	Crested Pigeon	*Ocyphaps (Geophaps) lophotes*
46	Squatter Pigeon	*Geophaps scripta*
47	Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*
48	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*
49	Galah	*Eolophus (Cacatua) roseicapilla*
50	Sulphur-crested Cockatoo	*Cacatua galerita*
51	Rainbow Lorikeet	*Trichoglossus haematodus*
52	Red-winged Parrot	*Aprosmictus erythropterus*
53	Cockatiel	*Nymphicus hollandicus*
54	Budgerigar	*Melopsittacus undulatus*
55	Pale-headed Rosella	*Platycercus adscitus*
56	Pallid Cuckoo	*Cuculus pallidus*
57	Brush Cuckoo	*Cuculus variolosus*
58	Black-eared Cuckoo	*Chrysococcyx osculans*
59	Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*
60	Shining Bronze-Cuckoo	*Chrysococcyx lucidus*
61	Channel-billed Cuckoo	*Scythrops novaehollandiae*
62	Pheasant Coucal	*Centropus phasianinus*
63	Southern Boobook	*Ninox novaeseelandiae*
64	Barn Owl	*Tyto alba*
65	Tawny Frogmouth	*Podargus strigoides*
66	Australian Owlet-nightjar	*Aegotheles cristatus*
67	Laughing Kookaburra	*Dacelo novaeguinea*
68	Blue-winged Kookaburra	*Dacelo leachii*
69	Forest Kingfisher	*Todiramphus macleayii*
70	Red-backed Kingfisher	*Todiramphus pyrrhopygia*
71	Sacred Kingfisher	*Todiramphus sanctus*
72	Rainbow Bee-eater	*Merops ornatus*
73	Dollarbird	*Eurystomus orientalis*
74	Varied Sitella	*Daphoenositta chryspotera*
75	Brown Treecreeper	*Climacteris picumnus*
76	Variegated Fairy-wren	*Melarus lamberti*
77	Red-backed Fairy-wren	*Melarus melanocephalus*
78	Striated Pardalote	*Pardalotus striatus*
79	Speckled Warbler	*Chthonicola (Sericornis) sagittata*
80	Weebill	*Smicrornis brevirostris*
81	White-throated Gerygone	*Gerygone olivacea*
82	Western Gerygone	*Gerygone fusca*
83	Inland (Broad-tailed) Thornbill	*Acanthiza apicalis*
84	Chestnut-rumped Thornbill	*Acanthiza uropygialis*
85	Yellow (Little) Thornbill	*Acanthiza nana*
86	Buff-rumped Thornbill	*Acanthiza reguloides*
87	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
88	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*
89	Striped Honeyeater	*Plectorhyncha lanceolata*

90	Noisy Friarbird	*Philemon corniculatus*
91	Little Friarbird	*Philemon citreogularis*
92	Blue-faced Honeyeater	*Entomyzon cyanotis*
93	Noisy Miner	*Manorina melanocephala*
94	Yellow-throated Miner	*Manorina flavigula*
95	Singing Honeyeater	*Lichenostomus virescens*
96	White-eared Honeyeater	*Lichenostomus leucotis*
97	Fuscous Honeyeater	*Lichenostomus fuscus*
98	Grey-fronted Honeyeater	*Lichenostomus plumulus*
99	White-plumed Honeyeater	*Lichenostomus penicillatus*
100	Black-chinned Honeyeater	*Melithreptus gularis*
101	Brown Honeyeater	*Lichmera indistincta*
102	Grey-crowned Babbler	*Pomatostomus temporalis*
103	Red-capped Robin	*Petroica goodenovii*
104	Hooded robin	*Melanodryus cucullata*
105	Jacky winter	*Microeca fascinans (leucophaea)*
106	Crested Bellbird	*Oreoica gutturalis*
107	Grey Shrike-Thrush	*Colluricincla harmonica*
108	Golden Whistler	*Pachycephala pectoralis*
109	Rufous Whistler	*Pachycephala rufiventris*
110	Grey Fantail	*Rhipidura fuliginosa*
111	Willie Wagtail	*Rhipidura leucophrys*
112	Leaden Flycatcher	*Myiagra rubecula*
113	Restless Flycatcher	*Myiagra inquieta*
114	Magpie-Lark	*Grallina cyanoleuca*
115	Spangled Drongo	*Dicrurus bracteaus*
116	Olive-backed Oriole	*Oriolus sagittatus*
117	Figbird	*Specotheres viridis*
118	Spotted Bowerbird	*Chlamydera maculata*
119	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
120	White-bellied Cuckoo-shrike	*Coracina papuensis*
121	Ground Cuckoo-shrike	*Coracina maxima*
122	White-winged Triller	*Lalage sueurii*
123	Masked Woodswallow	*Artamus personatus*
124	White-browed Woodswallow	*Artamus superciliosus*
125	Black-faced Woodswallow	*Artamus cinereus*
126	Dusky Woodswallow	*Artamus cyanopterus*
127	Little Woodswallow	*Artamus minor*
128	Grey Butcherbird	*Cracticus torquatus*
129	Pied Butcherbird	*Cracticus nigrogularis*
130	Australian Magpie	*Gymnorhina tibicen*
131	Pied Currawong	*Stepera graculina*
132	Australian Raven	*Corvus coronoides*
133	Torresian Crow	*Corvus orru*
134	Apostlebird	*Struthidea cinerea*

135	Tree Martin	*Hirundo nigricans*
136	Fairy Martin	*Hirundo ariel*
137	Australian (Richard's) Pipit	*Anthus novaeseelandiae*
138	Horsfield's Bushlark	*Mirafra javanica*
139	Rufous Songlark	*Cincloramphus mathewsii*
140	Brown Songlark	*Cincloramphus cruralis*
141	Double-barred Finch	*Taeniopygia bichenovii*
142	Zebra Finch	*Taeniopygia guttata*
143	Black-throated Finch	*Poephila cincta cincta*
144	Plum-headed Finch	*Neochmia modesta*
145	Mistletoebird	*Dicaeum hirundinaceum*

APPENDIX C: Climate change impacts on flora and fauna[1]

Environmental change	Responses by individual organisms
Temperature	Metabolic and developmental rates in animals, and photosynthesis and respiration in plants, increase with increasing temperature until some upper limit. Increasing temperatures will interact with water stress for both plants and animals, and will affect the timing of important life cycle events such as reproduction and diapause (a quiescent period during a life cycle). Advances in spring events and delays in autumn events are probable for many species, and will result in a lengthening of the vegetative growing seasons in many regions. Animals also respond to temperature by altering their behaviour, for example, by seeking shade, altering the time of day they are most active or changing the position they occupy in the water column. In many reptiles, temperature during development affects sex ratios. Fundamental geographic ranges of many species are thought to be determined mainly by temperature extremes (e.g. hottest day in summer, coldest day or frost incidence in winter).
CO_2	Plants increase photosynthetic rate as the concentration of CO_2 increases in the atmosphere or in water (in the case of algae), until the CO_2 concentration or another factor (such as light, water or nutrients) becomes limiting – this process is known as the 'CO_2 fertilisation' effect (Box 5.1). Increasing CO_2 also reduces stomatal conductance, thereby increasing water use efficiency, particularly in C3 plants. CO_2-driven changes in productivity are usually accompanied by changes in plant chemical composition (such as increasing ratios of carbon to nitrogen, and altering the concentrations of secondary metabolites such as phenolics and tannins), as well as changes in plant structure and the allocation of biomass to various plant parts. Impacts of increasing CO_2 will vary considerably among different plant functional types and different vegetation types, and will depend on temperature and the availability of water and soil nutrients. As CO_2 is gradually absorbed by oceans and fresh water, the water
	becomes more acidic (lower pH), which increases the solubility of calcium carbonate, the principal component of the skeletal material in aquatic organisms.
Water	Water supply is critical for all organisms, and water – together with temperature – ultimately sets the fundamental distributional limit for all species. In plants, stomatal conductance declines as atmospheric CO_2 increases, resulting in lower transpiration rates. In regions where precipitation declines, increasing CO_2 may therefore mitigate water stress to some extent.
Extreme events	Extreme weather events such as floods, droughts, storms and fire can affect population dynamics, species boundaries, morphology, reproduction, behaviour, community structure and composition, and ecosystem processes. Changes in the frequency, intensity and seasonality of extreme events may have larger impacts on many species and communities than the directional shifts in temperature and changes in rainfall patterns.

[1] Biodiversity and Climate Change Expert Advisory Group (Steffen, W. et al), 2009, *Australia's Biodiversity and Climate Change: A strategic assessment of the vulnerability of Australia's biodiversity to climate change*, Commonwealth of Australia, pp.90-91. Available at http://www.climatechange.gov.au/publications/biodiversity/biodiversity-climatechange.aspx (accessed 30.11.11).

APPENDIX D: Summary of Research undertaken on Bimblebox Nature Refuge (Glen Innes)

Anderson, E.R. (Birds Australia).

Trends in avian diversity at 'Glen Innes' [Bimblebox Nature Refuge], Central Queensland

Fourteen long term bird monitoring sites have been established at 'Glen Innes' [Bimblebox Nature Refuge] in the intact eucalypt woodlands to monitor trends in avian diversity due to climate change and land use. The sites have been located to measure the effects of grazing pressure and fire on the property. The sites are also integrated with the other research activities being implemented by EPA and DPI & F. A significant outcome will be the assessment of the potential for birds as surrogates for monitoring biodiversity and ecological health on a landscape scale.

Fensham, R (Qld Herbarium)

Maintaining the open character of eucalypt woodlands with fire

'An experimental trial has been established at 'Glen Innes' [Bimblebox Nature Refuge], with co-funding from Land and Water Australia and the Queensland EPA. The project seeks to weigh the costs and benefits of using fire in conjunction with pastoralism. The project will look at the effects of fire on the structure of woodlands, their biodiversity, and pastoral production.'

McCosker, J (EPA)

Relationships between biodiversity and land condition PhD thesis

'My work involves the assessment of the biodiversity condition of silver-leaved ironbark across 25 properties in the Desert Uplands. The main focus is avian and plant diversity and how this is related to grazing land management on these various properties. My hope is that the work will yield; a simple biodiversity assessment tool, the biodiversity values, and awareness of positive grazing management strategies that are compatible with the maintenance of biodiversity'.

Queensland DPI & F

1. Developing Long-term Carrying Capacity models for the Desert Uplands

This project has customised the procedure for estimating LCC for the climate and soils of the land types in the Desert Uplands. The work involved fine tuning the procedure by working with 9 commercial properties. We have now moved on to the case study stage, working with graziers on-property to assess the usefulness of the procedure in strategic decision making. Glen Innes is one of these properties. Land types and land condition have been assessed. Discussions are on-going with the owners for the potential for a wet season spelling strategy through rotational grazing to assist in the improvement of land condition.

2. Understanding change in Queensland's grazed woodlands (TRAPS woodland monitoring).

The first project consists of five woodland monitoring sites on Glen Innes [Bimblebox Nature Refuge] designed to provide quantitative information on woody vegetation trends for silver-leaved ironbark and poplar box communities in this region. These five sites are part of a larger network of over 100 monitoring sites covering the grazed woodlands within Queensland. These sites provide information to generate a fundamental understanding of the impact of management (grazing, fire), climate and increasing carbon dioxide concentrations in the atmosphere on woodland vegetation. Long term

monitoring is necessary, as woody species can survive 80 years or more and the outcomes of management strategies are not apparent in the short term.

Outputs from the TRAPS monitoring network have been published in a number of collaborative projects through the CRC for Tropical savannas, CRC for Greenhouse Accounting and Meat and Livestock Australia funding. Recent publications include:

- Hoffmann, MB. (2006)Application of tree and stand allometrics to the determination of biomass and its flux in some north-east Australian woodlands. Masters thesis. University of Central Queensland.
- Burrows, WH, Henry, BK, Back, PV, Hoffmann, MB, Tait, LJ, Anderson, ER, Menke, N, Danaher, T, Carter, JO and McKeon, GM (2002)Growth and carbon stock change in eucalypt woodlands in northeast Australia: ecological and greenhouse sink implications. Global Change Biology. 8: 769-784.
- Bray SG, Liedloff A, Sim AK, Back PV, Cook G, Hoffmann M (2007)Comparison of woody vegetation change datasets from the grazed woodlands of central Queensland In 'Proceedings of the Northern Beef Research Update Conference'. Townsville.
- Fensham RJ, Bray SG, Fairfax RJ (2007)Evaluation of aerial photography for predicting trends in structural attributes of Australian woodland including comparison with ground-based monitoring data. Journal of Environmental Management 83, 392-401.

3. Assessment of vegetation change in the Burdekin Catchment of Queensland

The 2nd project was an analysis of woody vegetation change over centennial and decadal time-scales. Being able to assess vegetation change over longer time scales provides information on whether the currently observed tree thickening is above the long term average tree density at a particular location. The tree thickening may be linked to modern land management (e.g. grazing domestic livestock, fire suppression) and/or increased carbon dioxide concentrations in the atmosphere. The technique used analysed soil carbon isotopes which relates to a change in ratio of tree and grass carbon entering the soil carbon over time. Two sites were analysed at Glen Innes (the sites were also TRAPS sites) with another 46 sites assessed in the Burdekin catchment and a site assessed near Longreach. The results of the project are published in:

- Bray SG, Krull ES, Harms BP, Baxter N, Rutherford M, Yee M, Cogle L (2006)'Assessment of vegetation change in the Burdekin Catchment of Queensland – project report. QI06091.' Department of Primary Industries and Fisheries, Queensland, QI06091.
- Krull E, Bray S, Harms B, Baxter N, Bol R, Farquher G (2007)Development of a stable isotope index to assess decadal-scale vegetation change and aplication to woodlands of the Burdekin catchment, Australia. Global Change Biology 13.
- Dr Rudd, C. Ground-storey Vegetation Monitoring (Grass Check)A series of permanent "GRASS Check" (Grazier Rangeland Assessment for Self-Sustainability) and photo points have been established across the property. Monitoring, undertaken annually, is based on ground-cover and species composition. A broad assessment of land condition is made at each site using calculations of pasture yields, tree and shrub density and growth rates. Data is condensed, correlated and addressed so that the impacts of management practices, trials and climatic events can be independently evaluated. This project is designed to detect the less obvious but more important subtle changes and pasture and under-storey vegetation.

Vanderduys, E et al. (CSIRO)

Flora and fauna diversity in cleared and intact woodlands of the Desert Uplands

CSIRO Sustainable Ecosystems currently have a biodiversity monitoring programme in place on 'Glen Innes' [Bimblebox Nature Refuge] and two neighbouring stations. This programme is part of a much larger project assessing the relationship between the grazing practices and biodiversity. BioTools seeks to answer questions such as: How does grazing affect different species of animals and plants in Queensland's rangelands? How do activities associated with grazing, such as woodland clearing and thinning, burning and waterpoint management affect different species of animals in Queensland's rangelands?

From the information we gather in our surveys we hope to be able to provide a series or recommendations, or 'tools', for graziers who may wish to manage for biodiversity on some shape or form on their land. As part of our biodiversity monitoring programme we have established 10 permanent monitoring sites on 'Glen Innes' [Bimblebox Nature Refuge] in a number of different regional ecosystems. These monitoring sites are located in country with little grazing pressure and no tree clearing.

The important point is that they are located in close proximity to other monitoring sites we have established on neighbouring properties where broad-scale tree-clearing has occurred and/or grazing pressure is significantly higher. This provides a unique opportunity to compare the long-term effects of the management practices in place on these neighbouring properties with those in place on 'Glen Innes'.

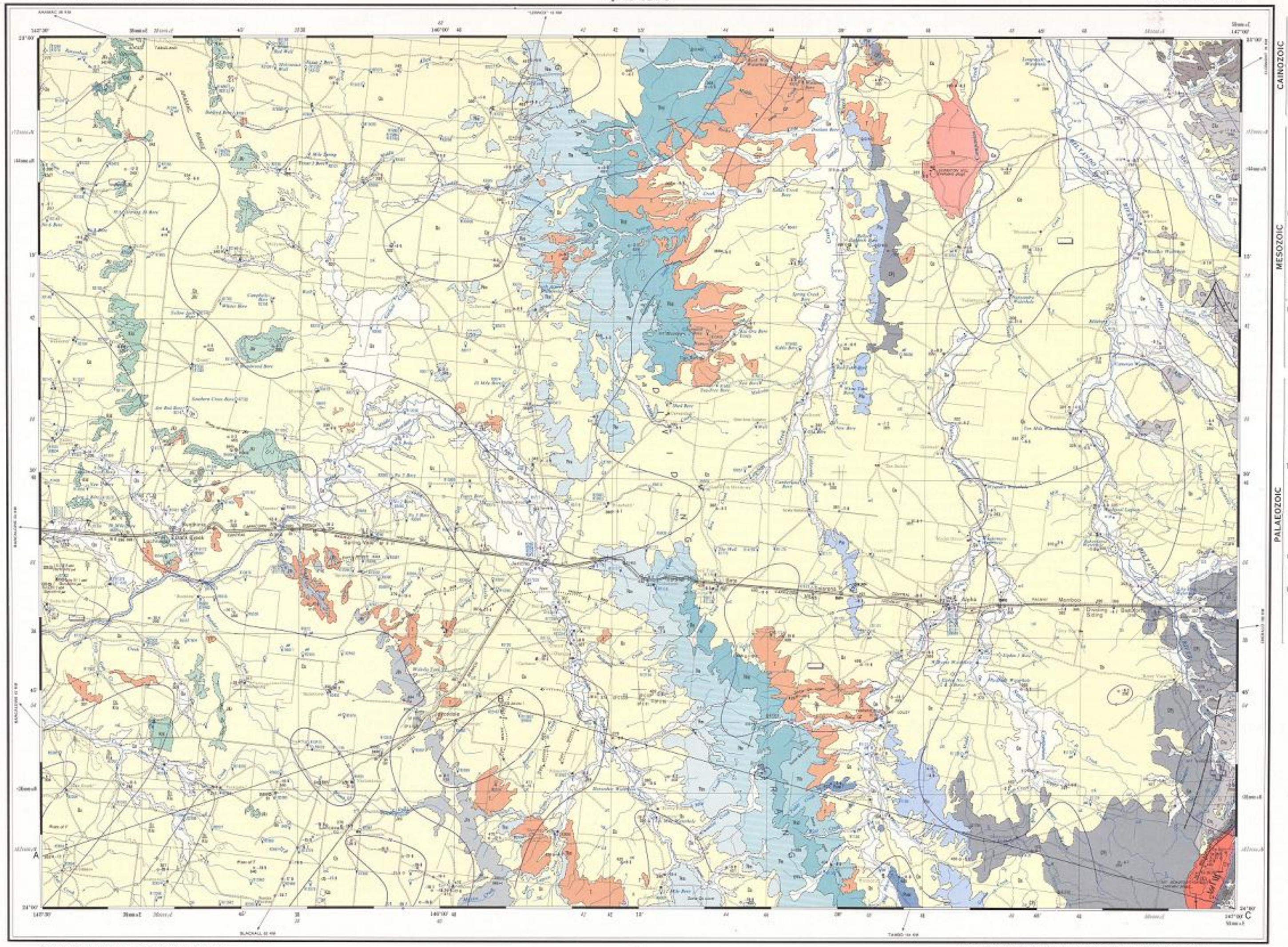
Coal exploration activities are likely to affect the results of our ongoing monitoring activities, by creating increased human presence in a relatively isolated area, increasing 'edge effects' on woodland fauna, and resulting in significant amounts of clearing.

APPENDIX E: 1:250 000 Geological Map of Jericho Queensland[2]

[2] Bureau of Mineral Resources, Geology and Geophysics 1972, 'Jericho Queensland, Sheet SF 55-14', Department of National Development. Available from http://www.geoscience.gov.au/bin/mapserv36?map=/public/http/www/geoportal/250/index.map&mode=browse&layer=map250&queryon=true

JERICHO

QUEENSLAND



Reference

Era	Period	Unit	Symbol	Description	
CAINOZOIC	QUATERNARY		Qa	Alluvium, some gravel	
			Qs	Sand, gravel, rubble	
				Chemically altered (kaolinized): in part silicified and ferruginized sediments	
	TERTIARY		T	Argillaceous sandstone, sandy mudstone, limestone; partly lateritized	
			Tb	Basalt	
MESOZOIC	LOWER CRETACEOUS	Rolling Downs Group: Allaru Mudstone	Kla	Mudstone, siltstone, minor labile sandstone	section only
		Toolebuc Limestone	Klo	Limestone, calcareous shale	section only
		Wallumbilla Formation	Klu	Mudstone, siltstone, limestone, calcareous shale	section only
		Doncaster Member	Kld	Mudstone, glauconitic mudstone and siltstone, limestone	
	JURASSIC TO LOWER CRETACEOUS	Ronlow Beds	JKr	Quartz and labile sandstone, mudstone, minor coal	
	MIDDLE TO UPPER JURASSIC	Injune Creek Group	Jmi	Labile sandstone, mudstone	
	LOWER JURASSIC	Hutton Sandstone	Jlh	Quartz sandstone	
	MIDDLE TO UPPER TRIASSIC	Moolayember Formation	Rm	Mudstone, sandstone, siltstone, shale	
	LOWER TO MIDDLE TRIASSIC ?	Clematis Sandstone	Rc	Quartz sandstone, minor siltstone and mudstone	
	LOWER TRIASSIC	Dunda Beds	Rld	Labile sandstone, siltstone, mudstone	
		Rewan Formation	Rlr	Mudstone, siltstone, labile sandstone	
PALAEOZOIC	UPPER PERMIAN	Blackwater Group	Puw	Labile siltstone, carbonaceous sandstone, minor limestone and coal	
		Peawaddy Formation	Puj	Carbonaceous labile sandstone, siltstone, shale. Section only	
	LOWER PERMIAN	Colinlea Sandstone	Plc	Labile and quartz sandstone, minor siltstone and coal	
	UPPER CARBONIFEROUS TO LOWER PERMIAN	Joe Joe Formation	CPj	Mudstone, labile sandstone, siltstone, shale	
	LOWER CARBONIFEROUS	Drummond Group: Ducabrook Formation	Clu	Interbedded feldspathic sandstone and green and brown mudstone; minor limestone and tuff	
		Star of Hope Formation	Cls	Quartz sandstone, minor pebbly sandstone, conglomerate, lithic sandstone, oolitic limestone	
		Raymond Formation	Clr	Quartz sandstone, minor siltstone	
		Telemon Formation	Clt	Tuff, agglomerate, basalt, conglomerate, algal limestone, feldspathic sandstone, mudstone	
	UPPER DEVONIAN TO LOWER CARBONIFEROUS	Silver Hills Volcanics	DCs	Flow-banded and spherulitic rhyolite	
	UPPER DEVONIAN	Bushaby Formation	DUb	Pink feldspathic sandstone, siltstone, mudstone, varicoloured in part; minor conglomerate	section only
	LOWER PALAEOZOIC		Pzl	Partially welded acid vitric crystal tuff	section only
		Anakie Metamorphics	Pza	Schist, slate, fine grained sandstone, shale	section only

Geological boundary

Anticline, showing plunge

Syncline, showing plunge

Fault

Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

Strike and dip of strata

Unmeasured strike and dip of strata

Horizontal strata

Dip < 15°

Trend line

Lineament

Joint pattern

air-photo interpretation

Plant fossil locality

Locality reference number

Spore

Locality reference number of bottom-hole samples of seismic shot-holes

Measured section

Section reference number

Quarry

Gravel

Building stone

Drill hole: (a) stratigraphic hole, (b) scout hole

Petroleum exploration well—dry, abandoned

Abandoned bore or well

Artesian bore ceased to flow

Sub-artesian bore or well

Reg. No. (Qld. Irrig. Water Supply Comm.)

Earth tank or dam

Dam on stream

Waterhole

Spring

Road

Vehicle track

Railway with station

Telephone line

Fence

Homestead

Building

Built-up area

Airfield

Landing ground

Astronomical station

Elevation in metres, approximate

Position doubtful

Abandoned

Gravity station

Bouguer anomaly (milligals)

Isogal

Gravity anomaly—relative high

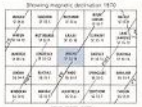
Gravity anomaly—relative low

Bouguer anomalies are based on the 1965 observed gravity values at isogal gravity base stations in and near the area. For the calculation of Bouguer anomalies 1·9 g/cm³ has been adopted as an average rock density

Published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, issued under the authority of the Hon. Sir Reginald Swartz, K.B.E., E.D., Minister for National Development.
Base map compiled by the Division of National Mapping from aerial photography at 1:48,000 and 1:85,000 scale.

INDEX TO ADJOINING SHEETS

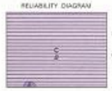
Showing magnetic declination 1970



Scale 1:250,000

Geology and Compilation 1964 by R. P. Vine, W. Jauncey, M. C. Galloway (B M R), D. J. Casey (G S Q)
1966 by F. Olgers, H. F. Doutch (B M R), J. Mollan ... Geological Survey of Qld
1971 by D. A. Exon (B M R)
Gravimetry 1960 by Geophysical Branch, B M R
1964 by American Overseas Petroleum Ltd
Cartography by Geological Branch, B M R
Drawn by Cartographic Drafting Services, Bendigo, Victoria
Printed by Leigh-Mardon Pty. Limited, Melbourne

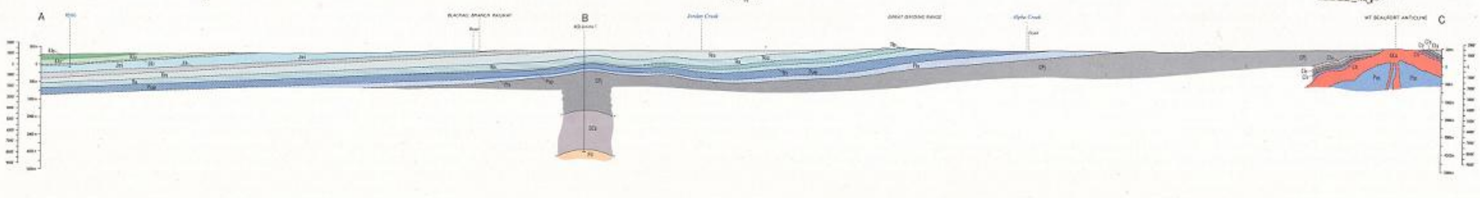
RELIABILITY DIAGRAM



Geology C General reconnaissance: many traverses and air-photo interpretation

Gravity A Detailed survey

B Reconnaissance

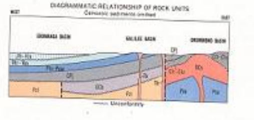


Section

Cainozoic sediments omitted

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS

Cainozoic sediments omitted



FIRST EDITION 1970

JERICHO

SHEET SF 55-14

Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., or the Geological Survey of Queensland, Brisbane

APPENDIX F: Review of Economic Impact Assessment (Economists at Large)

Review of Economic Impact Assessment for the China First Project EIS

Prepared by

Economists at Large Pty Ltd

December 2011

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Citation:

Campbell, R., 2011, *Review of Economic Impact Assessment for the China First Project EIS*, a report for the Bimblebox Nature Refuge Landholders, prepared by Economists at Large, Melbourne, Australia.

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Introduction

Background

The proposed China First Coal Project is for an open-cut and underground mine on pastoral land and remnant woodland in the Galilee Basin, Central Queensland. The proposal is for a 20-plus-year mine which will produce up to 40megatonnes of thermal coal per year. The proponent is currently seeking project approval and has prepared an environmental impact statement.

The China First Project is one of several mining proposals in this traditionally pastoral area. The Bimblebox Nature Refuge landholders are concerned that the proposed projects will substantially affect the Bimblebox Nature Refuge, as well as impact on water and the community in the local area. Many communities in Australia are facing similar issues and are concerned that the often-touted benefits of the mining boom may be overstated and/or not accruing to local people.

This submission

The Bimblebox Nature Refuge landholders are making a submission on the China First Coal Project Environmental Impact Statement. As part of their submission they have asked Economists at Large to review the Economic Impact Assessment. In this submission:

Part 1:
We have reviewed all the key findings of the Economic Impact Assessment and have found that there are few unambiguous benefits to this project. The impacts of the project, as identified in the assessment, relate to trade-offs between industries and regions, rather than clear benefits.

No part of the economic assessment supports a claim in the EIS executive summary that the project will lead to "an additional 70,000 indirect jobs". This claim seems to be based on a misunderstanding of a finding of the economic impact assessment and should be immediately corrected.

Part 2:
Part of the reason for this ambiguity about the overall costs and benefits of the project relates to the nature of the assessment – it is based on economic impact assessment, not cost-benefit analysis. The entire economics profession, and the Queensland Department of Infrastructure and Planning, is in agreement that cost-benefit analysis is the best tool for decision making and project assessment.

Another issue to bear in mind throughout our report, is that while this assessment reviews the impacts of the project in isolation, many other large coal projects are being proposed in the same region. This is likely to exacerbate negative impacts associated with skilled labour shortages, exchange rate rises and inequitable distribution of benefits.

These problems are symptomatic of a wider planning issue in Australia: the project assessment process has become the project approvals process. The implicit assumption of this difference is that projects are in the public interest or "good for the economy". As we see here, not only are the benefits of the project ambiguous, but the question of is it in the public interest is not addressed.

We believe this issue is at the core of the public perception that mining projects are lacking a "social licence to operate" in farming areas. Conflicts between farming communities and coal and coal seam gas developments are making headlines regularly, with farmers and the broader community

losing confidence that such developments are in the community's best interests. Robust and transparent assessment of this project could help to address this issue.

Review of Key findings of the Economic Impact Assessment

In the executive summary of the Economic Impact Assessment, we are told that "*the China First Project will generate significant positive economic, employment and income impacts at the regional and State levels.*" (p x) This is misleading. The project will have significant economic impacts, some positive and some negative. These positive and negative impacts will not be shared equally. The distributive effects and the net cost or benefit are difficult to gauge from the economic impact assessment. This can be seen in each of the key findings:

> ***Key finding 1.*** *An increase in export revenues of $4.6 billion per annum through the export of 40 Mtpa of high quality thermal coal, representing an increase in Australian thermal coal export revenues of approximately 25.7% and an increase in total Australian exports of 2.0% from 2008/09 levels. The increase in export revenues may provide support for the strength of the Australian dollar.*(px)

An increase in export revenues does not represent an increase in economic welfare. Export revenue is not "free money". When a buyer buys our coal it is not because there is no coal in their country, but because to produce it themselves would require greater inputs of resources to extract it. We too have to put in effort and resources to extract coal, which uses scarce resources that would have been used in other activities. To claim increase in export revenue as the main "positive" economic impact is misleading.

Revenues in excess of costs, profits, do contribute to economic welfare. However what is important is the extent to which these benefits are retained in an economy. This is of great importance to the assessment of a project, as made clear by Eggert (2001) who states that when considering the perspective of local communities "*an analyst must be careful to … eliminate any net benefits that accrue to nonresidents of the community*" (p28). Eggert makes clear that in the case of a national-level assessment: "*a national government would consider profits send abroad as a cost.*" (p27) The ANU's Professor Jeff Bennett agrees, in recent work commissioned by coal company, Aston Resources:

> *Where the shareholders are not citizens, their mine benefits are expatriated and should not be included in the BCA. Careful attention should therefore be given to the register of shareholders and adjustments made to the producer surplus benefit calculation.* (Bennett 2011) (p3)

As mentioned in this key finding, this proposed project, and the many others like it currently before state governments, will strengthen the Australian dollar. This has a deleterious effect on Queensland's other exporting industries, such as tourism, manufacturing and agriculture. Tourism in Queensland has been particularly hard hit by increasing exchange rates, as fewer tourists arrive from overseas and more Australians holiday abroad. Tourism in Australia has shrunk from 3.1% of GDP in 2003-04 to 2.6% in 2009-10 (Richardson & Denniss, 2011).

> ***Key finding 2.*** *An increase in industry output in Queensland of $231.9 million per annum on average during the three year construction period, including an increase in output of $614.5 million per annum on average in the Study Area reflecting a draw of resources from elsewhere in Queensland.*

Industry output is also not an indicator of economic welfare. As stated above, producing output requires inputs, the use of resources that would have been used elsewhere. This is particularly important in this case, as we see that while the study area's output is forecast to rise by $614.5 million, Queensland's output is forecast to increase by only $231.9 million. This expansion takes place at the expense of output elsewhere in Queensland of $382.6 million. A considerable portion of the remainder likely comes at the expense of output elsewhere in Australia. At a national level there may be very little increase in output.

We see on page xiii that this expansion comes at the cost of long-term declines in agriculture and manufacturing industries. The effects of these declines may be greater costs for Queensland communities than are gained by expanding mining output, particularly as mining projects such as China First tend to be serviced by a fly-in-fly-out workforce (see page xviii).

> ***Key finding 3.*** *A $5.2 billion per annum on average boost to industry output in the Queensland economy during the first five years of operation, increasing to an average of $5.7 billion per annum on average thereafter to 2036/37. The majority of this increase in output will be captured by the mine catchment.*

As mentioned above, industry output is not a measure of economic welfare. It is misleading to suggest that any "boost" will be "captured" by the mine catchment. While the output of area may increase, to what extent any benefits accrue to the area is unclear. Benefits will accrue largely to shareholders and mine workers, only some of whom will work in the mine catchment and fewer still will live there. As is made clear in other sections of the assessment, declines in agriculture and small business will occur, making the impact on the economic welfare of the mine catchment difficult to gauge.

> ***Key finding 4.*** *Support and development for local business and industry, through securing local contracts for the supply of goods and services for the project where possible and through other flow-on activities and increased household consumption. Key industries supported by the China First Project include mining, transport and storage, construction and property and business services. A large proportion of goods and services are also anticipated to be sourced from elsewhere in the State, in particular from southeast Queensland.*

Despite being one of the key findings, there is little detail given on how the project will support and develop local business and industry. It is disappointing there is no quantitative assessment of this impact. Later in the report (page 29), only two potential beneficial impacts on local business could be identified, and neither seems convincing:

- *Generating demand for local goods and services.* This seems unlikely given the fly-in-fly-out nature of the workforce. A large proportion of the direct and indirect economic impacts of mining and employment bypass local economies and focus on the larger regional centres.

Such workforces generally get supplies and services from larger metropolitan centres (McHugh, 2009).

- *New rail infrastructure has the potential to assist in easing bottlenecks in the existing rail network....recognised as a common issue by coal companies* [which has a negative] *impact on Queensland's coal export capacity.* While there may be a need for infrastructure improvement in the region is uncertain how this development will assist any industry other than the coal industry. What benefits this development would provide to agriculture or tourism remains unclear, while enhancing export capacity of coal has negative implications to these industries through exchange rate movements and resource crowding out.

Key finding 5.*Increased competition for inputs such as land, labour and capital will result in resources moving to regions and industries that generate the greatest returns. As a result, output from the manufacturing and agricultural industries is estimated to decrease, largely due to increased competition for skilled labour.*

Some of these impacts are quantified in the assessment (page xiii).

Industry	Forecast decline in annual output to 2012-13	Forecast decline in annual output to 2018	Forecast decline in annual output to 2037
Agriculture ($M)	-42.0	-38.0	-15.2
Manufacturing ($M)	-209.3	-1,249.4	-1,050.8

Local residents already understand what this feels like in real terms, as a recent email shows:

Was talking to a local grazier a couple of days ago (15mins out of Springsure) who hasn't been able to get an electrician in to fix his pump from the floods at the beginning of the year. He is now organising to fly in an electrician from Brisbane! Similarly Ergon Energy are losing electricians to the mines at an alarming rate and there is talk that they will have to offer much better conditions and pay in order to retain them. The outcome being higher costs to Ergon and hence to us. (personal communication)

Key finding 6. *An increase in employment in Queensland of 2,975 full time equivalent (FTE) employees per annum on average during the three years construction period, including a draw of labour to the Study Area from elsewhere in Queensland and Australia. During the first five years of operation the China First Project is estimated to support an additional 4,464 FTE employment positions per annum on average in Queensland, and approximately 3,954 FTE employment positions per annum on average thereafter.*

Key finding 8.*A decrease in unemployment and the unemployment rate as a result of jobs created by the China First Project, in particular in the project's Study Area.*

As with the earlier discussion of output, Key Finding 6, finding a net increase in employment, disguises the considerable inter-industry trade offs, with job losses in some sectors – again mainly manufacturing and agriculture – and increases in mining-related sectors. Gains in later years seem dependent on increased employment in the public service as a result of increased royalty revenue. The relationship between royalty revenue and public service employment seems unclear and further examination should be made of this assumption than is provided on page 33. Also note that many of these jobs will be provided at the expense of jobs elsewhere in Australia.

Key Finding 8 does not necessarily follow from Key Finding 6. Job increases in the mining sector are likely to be for skilled positions in an already tight end of the labour market. The assumption on page 42 that 50% of jobs will go to people currently unemployed seems arbitrary, with no justification or source in economic literature. It is misleading to suggest that this project will materially affect Queensland's unemployment rate given the lack of substitutability of labour resources.

Note that Key Finding 6 seems to have been misinterpreted in the EIS executive summary, where it is claimed that:

> *A flow through benefit of an additional 70,000 indirect jobs is anticipated, with the majority of these expected to occur in Queensland.* (EIS Executive Summary p17 and repeated verbatim on p72)

The Economic Impact Assessment by AEC Group provides no backing to this claim. It does not mention "indirect jobs" at all. This claim may have been derived from a misinterpretation of table ES.7, where the project is estimated to increase overall employment by 3,954 relative to a no-project scenario for the years 2018/19 to 2036/37. If taken to mean that the mine increases employment cumulatively by 3,954 jobs every year for 18 years, this comes to 71,172 jobs. This is wrong. Table ES.7 is clearly labelled as "Deviation from the Baseline" not "number of unique jobs created per year". The author of the EIS executive summary has misunderstood the economic impact assessment. This error should be corrected immediately as it grossly overstates the employment impacts of the proposal.

> ***Key Finding 7.****Capacity building and skills development in the local labour force through apprenticeships, traineeships and skills training, as well as ongoing skills transfer between imported and local labour and the permanent migration of some skilled labour.*

These benefits could occur if sufficient coercion is applied by governments to the project proponents and other participants in the industry. However there is nothing in the modelling here to suggest that this will be the case, given the acknowledgement that most workers will be fly-in-fly-out. Expanding training and apprenticeships may also place strain on training and education systems that may not exist currently. While this point should be made in the "mitigation/enhancement strategies" urged, it is misleading to place it in the key findings. No quantification of these benefits exists and they will be contingent on good management of the project and wider industry.

> ***Key finding 9.****An increase in household incomes.*

Key finding 10.*Upward pressure on labour prices due to the increase in demand for skilled labour, particularly in industries experiencing skills shortages, further increasing household incomes. This increase is expected to be over and above any increases in the costs of living, representing an increase in real wages.*

Increases in household incomes will also not be distributed equally. This increase will be primarily felt by mine employees and those in related industries, while people in other industries may experience a decline. The assessment acknowledges that the mining boom has led to a "wealth divide between mining families and other residents (page xxii)" and provide no suggestion that this project will change this.

There is little examination of costs of living in the assessment, other than declining housing affordability. There is no discussion of food, fuel, clothing or other consumer prices in comparison to wage rates and this finding seems to be based on assumption rather than analysis.

Key finding 11.*An increase in*

- *Queensland Government revenues of approximately $364.9 million, primarily in the form of approximately $343 million per annum in royalty payments; and*
- *Australian Government revenues of approximately $709.8 million, primarily through avenues such as company tax (approximately $302.9 million), personal income tax (approximately $237.8 million) and goods and services tax (approximately $158.3 million).*

As with discussion of other revenues and outputs earlier, revenues to governments here are not a measure of benefit. This finding overlooks the fact that substantial subsidies are paid by governments to mining companies. While it is beyond the scope of this review to identify these in the case of the China First Project, common subsidies and tax breaks include:

- Direct subsidies
- tax holidays or concessional treatment with respect to payroll tax, rates and other taxes and levies
- in-kind assistance through the provision of cheap or free water and power
- Tax deductibility of research and exploration expenses
- Fuel rebates

(see (Richardson & Denniss, 2011)

Key finding 12.*Development of rail and port infrastructure, as well as local road infrastructure, an airstrip and utilities infrastructure to support the project. This will provide benefits to the entire study area by providing a link between the abundant resources in the*

Galilee Basin and export infrastructure, assisting in commercialising these resources. This infrastructure will also improve regional business capacity and competitiveness, and will provide positive legacy benefits for the region.

This finding raises three points already mentioned:

- It is difficult to identify how this infrastructure will be of benefit to the community and other industries. Developing infrastructure primarily for use by the coal industry may not provide infrastructure options with the widest economic benefit. This and other mining projects place major strain on existing road and rail infrastructure to the detriment of other users.
- Much of this infrastructure development may be subsidised by tax and ratepayers. The lack of quantification here suggests these benefits are again assumed rather than stemming from deeper analysis.
- As mentioned several times, maximising exports is not the same as maximising economic welfare. Decision makers should not be mislead by this confusion of "benefits" and "exports".

Lack of Cost-Benefit Analysis

The economic assessment of the China First project is based on computable general equilibrium analysis, with no cost-benefit analysis. To assess if the project is in the interests of the state and local communities, the assessment must be revised to include cost benefit analysis. While cost-benefit analysis is not explicitly required of the assessment, section 5.2 of the Terms of Reference for the project require the environmental impact statement (EIS) to:

> *provide a comparative analysis of how the project conforms to the objectives for 'sustainable development'–see the National Strategy for Ecologically Sustainable Development (1992)…This analysis should consider the cumulative impacts (both beneficial and adverse) of the project from a life-of-project perspective, taking into consideration the scale, intensity, duration and frequency of the impacts to demonstrate a balance between environmental integrity, social development and economic development.*

In other words the EIS should assess all the positives and negatives of the whole project in a way that shows whether the project will provide a net benefit to the state.

However, the Economic Assessment provides no analysis that can assist with this decision as it is based on impact assessment not cost-benefit analysis. This is clearly against the recommendations of the Department of Infrastructure and Planning's Project Assurance Framework, which states:

> *The primary method of economic evaluation of public sector policies and projects is cost- benefit analysis.* (Qld DIP 2011,p18)

The evaluation of mining projects with private sector involvement is no different, as is made clear by Eggert (2001):

> *Summing up, a benefit-cost framework for assessing the effects of a mining project is useful, even essential, for evaluating the impact of a mining project on the economic development of a local community or region. Such a framework focuses our attention on a number of critical issues: What is the overall effect of a project? What are the costs, and are the parties bearing the costs being compensated? What are the net benefits and how are they distributed?*

Virtually the entire economics profession agrees that cost-benefit analysis is essential for project assessment, see for example (Abelson, 2011; Dobes & Bennett, 2009; Ergas, 2009) and many others. In other states, cost-benefit analysis would be required for such a project; the NSW Department of Planning's Environmental Assessment Requirements require:

> *A detailed assessment of the costs and benefits of the Project as a whole, and whether it would result in a net benefit for the NSW community*(DoP NSW, quoted in the economic assessment of the Maules Creek Coal Project, (Gillespie Economics 2011, p4).

It is important to understand the difference between cost benefit and economic impact analysis. As the Queensland Department of Infrastructure and Planning explains:

> [Cost-benefit analysis should] *comprehensively identify and estimate as many costs and benefits of a project as can reasonably be measured, including those which can be thought of as social and environmental,* [in order]*to rank project options according to their net economic benefit.*(p18)

Whereas economic impact assessment:

> *typically measures the impact of a project on the volume of economic activity in a region (e.g. on gross domestic product or employment),*(Qld DIP 2011*,* p23)

The NSW Treasury confirms these interpretations:

> *Model based economic impact assessment is not a substitute for a thorough economic analysis of a policy. The appropriate method for analysing policy alternatives is benefit cost analysis (BCA).* (NSW Treasury 2009, p4)

To understand if the China First project is in the interests of the Queensland and local communities it is essential that economic analysis be based on thorough cost-benefit analysis, including consideration of social and environmental, in accordance with the Department of Infrastructure and Planning guidelines before further consideration is given to this project.

Conclusion

The China First Coal project will have impacts on the local and Queensland economies. Some of these impacts will be beneficial, while others will reduce the economic welfare of stakeholders. As the Economic Impact Assessment is focused on measures of impact, such as industry output, export revenues, labour demand, it does not provide an understanding of if the project's benefits outweigh its costs, nor of how any costs and benefits are distributed. What is certain is that participants in the mining industry – investors, employees – will benefit, while non-mining stakeholders, including the agricultural and manufacturing industries will face higher costs and difficulties related to a strong exchange rate. These factors will be exacerbated if similar large projects proposed for the region are approved.

What is needed is cost-benefit analysis, which would allow for a decision to be made in the Queensland public interest. This is the approach preferred by economists and the Queensland Department of Infrastructure and Planning.

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