APPENDIX 9 :

FLORA AND FAUNA SURVEY REPORT

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Prepared for:
THE NEWCASTLE WALLSEND COAL COMPANY PTY LIMITED

FLORA AND FAUNA SURVEY
FOR THE PROPOSED
ELLALONG COLLIERY EXTENSION
NEAR CESSNOCK,
NEW SOUTH WALES
JANUARY 1995

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1.0 BACKGROUND

The study area is situated over 10 km to the southwest of Cessnock in the Hunter Valley, New South Wales (refer **Figure 1**). The major feature of the area is the Broken Back Range which bisects the area as an east-west ridgeline.

The study area has, in the past, been surrounded by a number of underground coal mining operations: Pelton Colliery to the northwest and Ellalong Colliery to the south. The Cessnock No. 1 abandoned mine is also located near the centre of the study area.

Part of the study area was the subject of a flora and fauna investigation by Bartrim and Martin Biological Studies (1987) as part of the Bellbird South Coal Project EIS prepared by Epps and Associates (1988) (see **Attachments 1, 2** and **3**). The study area has been subject to logging, grazing and residential development over the last 100 years.

The entire portion of the study area previously covered by the Bellbird South EIS was devastated by bushfire in September 1994. The proposed reject emplacement areas delineated as 3 and 4 were also totally burned out.

2.0 METHODOLOGY

Flora and fauna investigations were carried out on 28, 29 and 30 December 1994, between the hours of 8.00 a.m. and 5.00 p.m. Spotlighting in unburnt areas was also undertaken on the night of 30 December 1994. Additional spotlighting and amphibian searches were conducted on the night of 5 January 1995 after rainfall.

Forest areas were surveyed at 500 m intervals along the length of the Broken Back Range within the study area. At these intervals 100 m transects were run either side of the access road with all species within 10 m of the line recorded.

Fauna species were surveyed using observation techniques, spotlighting, scat, track, and tree scratch identifications as well as call identification for avian species. No trapping for small mammals was conducted due to the complete lack of groundcover after the fires. Reptilian searches were conducted where fallen logs and other shelter was found.

3.0 RESULTS

3.1 FLORA

Vegetation associations which existed prior to the September bushfires and which should in time regenerate successfully have been extensively logged for mining supports over many years. Other areas have been cleared for pasture. Grazing has occurred in both forested and cleared areas. **Figure 2** shows the flora assemblages found in the study area. Results of data extractions from the New South Wales National Parks and Wildlife Geographical Information Systems Division database for rare or threatened plants showed only three species occurring in the Cessnock area. None of these plants were observed in the study area, however *Tetratheca juncea* may be found on the slopes of the Broken Back Range within the Aberdare State Forest, in areas not subject to grazing.

The area previously studied was found to contain: open dry sclerophyll forest dominated by *Eucalyptus maculata* (Spotted Gum), *E. crebra* (Ironbark) and *E. punctata* (Grey Gum). Understorey species in these forests consisted predominantly of *Themeda australis* (Kangaroo Grass), *Bursaria spinulosa* (Blackthorn) and *Allocasuarina torulosa* (Forest Oak).

Reject emplacement Area 1, located north of the existing Pelton Colliery supports a less disturbed open forest, comprising predominantly *E. crebra*, *E. maculata*, and *E. microcorys* (Tallowwood). Typical understorey species of open forest on East Coast ranges are to be found here, including *Dodonea triquetra* (Hop Bush), *Persoonia linearis* (Geebung) and *Breynia oblongifolia*. Herbaceous plants included *Hardenbergia violacea*, *T. australis* and *Macrozamia sp.*

Areas 3 and 4 are best described as woodland due to the extent of timber removal and disturbance by grazing. Tree species in these areas consist of *E. maculata, E. punctata, E. tereticornis* (Forest Red Gum), *E. fibrosa fibrosa*, *E. moluccana* (Grey Box) and *E. microcorys*, with *E. maculata* dominating in all areas. Understoreys are thick in places but of less diversity than those found around the Broken Back Range. Typically, understoreys are dominated by *Hakea gibbosa*, *Callistemon linearis* and *Casurina sp*. Many weeds have intruded, especially into the wetter areas; weed species include *Cynodon dactylon* (Couch), *Taraxacum officinale* (Dandelion) and *Sida rhombifolia* (Paddy's Lucerne).

The proposed Sandy Creek Road Fan Shaft site located to the south of the old Cessnock No. 1 mine workings contained a relatively unburnt but highly disturbed community of *E. maculata, E. moluccana* dominated woodland. Understorey species included *B. spinulosa, C. linearis* and juvenile *Casuarina sp*.

The area has been used as a quarry, rubbish dump, pasture and has also been subjected to logging. These land uses have reduced the community to an even aged stand of woodland with no distinct understorey and a very low herbaceous layer.

Riparian vegetation located in the south of Bellbird South Application Area and the sub lease area as shown on **Figure 2** is comprised mainly of *Casuarina glauca* with large specimens of *E. amplifolia, E. tereticornis* and *Angophora floribunda*. The understorey generally comprise of *Melaleuca linarifolia, Leptospermum attenuatum* and *M. nodosa*. Low shrubs are mostly comprised of *Bursaria spinulosa* with herbaceous layer dominated by *Lomandra sp*. Many weed species were present in the creek area due to drought conditions.

3.1.1 Rare or Threatened Plant Species

A fulllist of species observed can be found in **Table 1**.

3.1.2 Grevillia montana

This species has a risk code of 2KC - in Briggs and Leigh (1994) meaning that the species has the following attributes:

2	=	a geographic range of less than 100 km
K	=	is poorly known
C	=	the population is reserved
-	=	the adequacy of the reservation is unknown

A specimen of *G. montana* was observed on a steep northern slope of the Broken Back Range along the Pelton Forest Road. The observed location combined with other areas considered as a possible habitat are shown on **Figure 2**. These areas have been considered as free from grazing but may be subject to intermittent grazing in drought conditions.

Due to the steep sloping habitat preference of the species the effect of the proposal upon it are minimal. The only area of habitat located in the proposal area is found along the Broken Back Range. This area will be subject to subsidence but it is expected to be negligible see **Appendix 10**.

3.2 FAUNA

No rare or endangered fauna as listed in Schedule 12 of the National Parks and Wildlife Act, 1974, were found in the study area, during this survey. Results of a data extractions from the New South Wales NPWS GIS division database of fauna sightings showed no rare or endangered fauna sightings from the Cessnock area.

Avifauna was the most abundant and diverse vertebrate fauna observed on site with a total of 25 species being identified. The extent of burned forest areas reduced the numbers of birds recorded during the survey.

The presence of *A. torulosa* as an understorey in open forest communities along the Broken Back Range and its importance as a food resource for *Calyptarhynchus lathamii* (Glossy Black Cockatoo) require that it be preserved.

The proposed development's surface structures will have the biggest impacts on habitat. These structures are not located in *A. torulosa* communities, furthermore, these communities are found mainly within the Aberdare State Forest which will only be subjected to negligible subsidence due to underground mining activities associated with the proposed development.

Very low numbers of mammals were observed with only three species observed: *Macropus gigantus* (Grey Kangaroo) *Oryctolagus cuniculis* (Rabbit) and *Vulpes vulpes* (Fox). Several other species of Possum and Kangaroo would be expected to occur within these forest types. Previous surveys reported no small mammals. Trapping was not performed due to the lack of undergrowth and ground cover, which was destroyed in September 1994 by bushfires.

Herptofauna was abundant on the night of 5 January 1995 after two days of rain and with overcast, humid conditions persisting. The diversity of the Herptofauna was, however, low with only four species observed. Conditions in the swamp near the Old Cessnock No. 1 mine workings were improved by this rainfall with the area under water increasing by about 1 cm over the entire surface of the swamp.

One shell of a *Chelodina longicollis* (Long-necked Tortoise) was found at the swamp and this species would be expected to occur in the area under wetter conditions.

A full list of observed and expected species can be found in **Table 2**.

3.2.1 Koala Habitat Protection - SEPP 44

The proposed development is in the Cessnock local government area and is larger than one hectare in size. As such the development has been assessed in terms of SEPP 44.

Schedule 2 - Feed Tree Species of SEPP 44 show the Koala's preferred Eucalypt food species. The proposal contains areas of habitat with the following Schedule 2 feed tree species:

Eucalyptus tereticornis
Eucalyptus microcorys
Eucalyptus punctata.

Tree densities were lower than undisturbed open forest with no large mature specimens of any species being located in potential Koala habitat due to post logging operations and current grazing practices.

None of the areas contained Schedule 2 species as the dominant vegetation in either the upper of lower strata of forest.

No Schedule 2 species are considered to occur in the proposed development area in densities of 15 per cent or greater.

Adjacent areas in the Mount View area contain more extensive tracts of potential Koala habitat and due to the inaccessible nature of this area densities of Schedule 2 species may be greater than 15 per cent.

The proposed development will not remove existing linkages to the Mount View area, or further deplete any forest links to areas in the south and east.

3.2.2 Endangered Microchiropterans

Following studies undertaken in December 1994 and January 1995 on the mining lease area, the following endangered species were identified as ones which may utilise the habitat located to the north of the existing Pelton Colliery, identified in **Figure 2** as Remnant Open Forest. These fauna species were not present in NPWS GIS database extractions for the Cessnock area.

Yellow-bellied Sheathtail Bat (*Taphozous flaviventris*)

This species of sheathtail bat is an insectivorous canopy feeder which usually roosts in tree hollows in eastern New South Wales, Queensland, Northern Territory and northern Western Australia.

Little is known about the species but reports suggest that it migrates during winter from cooler to warmer areas to hibernate and take advantage of increased insect populations.

Eastern Little Mastiff Bat (*Mormopterus norfolkensis*)

This species of freetail Bat is also an insectivorous canopy feeder roosting in tree hollows and under loose bark in woodland and sclerophyll forest, from approximately Sydney in New South Wales along the coastal strip to Frazer Island in Queensland.

There is little known about the bat's preferred habitat with conclusions being drawn from sightings and the habits of similar species.

3.2.3 Effects of the Proposal

The proposed reject emplacement area, delineated as Area 1 located to the north of the existing Pelton Colliery has been subjected to logging for mine uses over many years. This has resulted in a very low number of large trees with suitable hollows for roosting. Competition for these roosts is high as other mammal, avian and reptilian species also utilise these hollows. The small size of these bats, when faced with competition from other fauna usually results in the eviction of the bats.

The area of forest described as remnant open forest occupies approximately 88 hectares of ground on the mining lease. The proposed emplacement Area 1 will occupy only 15 hectares of remnant open forest, with a further 17 hectares occupying already cleared or severely altered land.

Linkages to similar or superior forest occur to the west of the proposed emplacement Area 1 where a large expanse of forest occurs along a steep ridgeline. This forest is never likely to be subjected to development and was not logged extensively due to its steep slopes.

It is in these areas that any displaced fauna would find refuge and any colonies of these bat species which may occur in the area would be found.

3.3 FURTHER INVESTIGATIONS

Investigations of flora and faunal communities were conducted over a short summer period following severe bushfires and in drought conditions.

The timing of any studies should reflect optimum conditions for the recovery of small mammals, including bats and amphibians.

Surveys are not expected to locate any endangered species, however in the event of endangered fauna species being located on land affected by the proposal, ongoing surveys may be required to monitor the status of faunal communities in and around the proposed development.

4.0 ENDANGERED FAUNA (INTERIM PROTECTION) ACT, 1991

The effects of the proposal have been assessed in accordance with the Endangered Fauna (Interim Protection) Act, 1991, which lists factors A to G which must be taken into account. These criteria are discussed below.

A. " The extent of modification or removal of habitat, in relation to the same habitat type in the locality. "

The Broken Back Range, Aberdare State Forest area will be subjected to land subsidence of between 1 m and 1.5 m. New surface structures are proposed to be constructed at the abandoned Cessnock No. 1 Colliery site. Clearing of reject emplacement Area 1 is uncertain at present, but would affect less than 50 per cent of the habitat type. Extensive tracts of habitat comparable to the Broken Back Range exist to the west and south.

B. " The sensitivity of the species of fauna to removal or modification of its habitat. "

No endangered or rare fauna were recorded in the survey. The entire area has been severely burned and is currently regenerating.

Populations of *Xanthomyza phyrgia* (Regent Honeyeater) could utilise habitats on site.

Xanthomyza phyrgia, if present in the area, would utilise *Eucalypt* blossoms found along the Broken Back Range for feeding whilst migrating. No change is expected to occur in the flora assemblage along the range, as a result of the proposed development.

C. " The time required to regenerate critical habitat, namely, the whole or any part of the habitat which is essential for the survival of that species of fauna. "

No critical habitat is to be removed as new surface facilities are to be restricted to cleared or already developed areas. Subsidence over vegetated areas will not cause any damage to existing habitats.

D. " The effect on the ability of the fauna population to recover, including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities. "

Significant areas of forested land are linked to the Broken Back Range to the east and west of the proposed development. These areas provide similar habitat should the development impact upon fauna or flora within the lease boundaries.

No impacts are envisaged to populations beyond the area proposed for development.

E. " any proposal to ameliorate the impact "

All surface facilities will be constructed in cleared areas or areas already greatly disturbed. Tree screens and runoff controls such as contour banks and siltation filters will be installed where appropriate to blend the surface structures into the surrounding areas.

Prior to disturbance of reject disposal areas, site specific rehabilitation management plans will be developed. It is proposed to return all coarse reject emplacement areas to native bushland.

Details of proposed works can be found in **Section 9** of the EIS.

F. " being assessed for wilderness nomination "

The study area is not currently, and is never likely to be, considered by the NPWS-NSW for wilderness nomination.

G. " any adverse effect on the survival of that species of protected fauna or of populations of that fauna "

The development is unlikely to have an adverse impact on any Schedule 12 species which may occur on site, as the majority of works will be underground and the topographic relief of the Broken Back Range is able to absorb any subsidence effects without loss of habitat.

Should threatened *herptofauna* be found in the proposed development area, there is adequate habitat in the form of dams located throughout the study area. Ellalong Lagoon, a major wetland, is also located 2 km to the southwest and will provide adequate habitat for any displaced fauna.

5.0 CONCLUSIONS

No rare or endangered fauna were observed during the study. The proposed development should not cause adverse impacts upon fauna or flora populations with most surface structures being confined to cleared or highly disturbed areas, e.g. abandoned mines or quarries. Comparable habitat to that which may be disturbed is abundant in areas which adjoin the study area.

6.0 RECOMMENDATIONS

The major fire which totally burned the entire study area except for very small patches has made flora and fauna investigations difficult.

Areas where *G. montana* could be expected to occur as shown in **Figure 2**. These areas are outside of the surface structures which form the major impact upon flora and fauna in the area. The negligible subsidence levels predicted will not have significant impact on habitats of *G. Montana* in the proposed development area.

The flora aspects of the study area have been well covered in a previous study however, small mammals, bats, amphibians and reptiles were not and these populations need to be resampled at a later date when regrowth of understorey flora has begun and drought conditions lessened.

TABLE 1
OBSERVED FLORA LIST

Key: OF = Open Forest; WD = Woodland; I = Introduced; R = Remnant Open Forest; WT = Wetland; D = Disturbed Open Forest; C = Cleared

Name		*Botanic Name*	Where Found
Creeping Oxalis	I	*Oxalis corniculata*	WT, OF
		Hardenbergia violacea	D, R, OF
		Patersonia sp	OF
Running Postman		*Kennedia rubicunda*	OF
Blackthorn		*Bursaria spinulosa*	D, WD, R, OF
Sickle wattle		*Acacia falcata*	OF
Guinea flower		*Hibbertia scandens*	OF
		Pomax umbellata	OF
		Breynia oblongifolia	D, WD, R, OF
Hop bush		*Dodonea triquetra*	R, OF
Prickley Moses		*Acacia ulicifolia*	OF
		Dianella caerulea	OF
		Dianella sp	OF
Common Reed		*Phragmites australis*	OF
Wild Tobacco Tree	I	*Solanum mouritianum*	WT
Fireweed, Groundsel	I	*Senecio sp*	WT
South American Amaranth	I	*Amaranththus quitensis*	WT
Dandelion	I	*Taraxcum officinale*	WT,WD, D
Fleabane	I	*Conzya sp*	WT
Spear thistle	I	*Cirsium vulgare*	WT
Cudweed	I	*Gnaphalium pensylvanicom*	WT
Sheoak		*Casurarina glauca*	WT
Teatree		*Melaleuca sp*	WT, WD, D
		Melaleuca nodosa	WD, D
Native Cherry		*Exocarpus cupressiformis*	R, WD, D
Couch	I	*Cynodon dactyton*	WD, D
		Dichondra repens	WD, D
Paddy's Lucene		*Sida rhombifolia*	WD, D
Paspalum	I	*Paspalum dilatum*	WD, D
Water Couch	I	*P. distichum*	WT
Blady Grass	I	*Imperata cylindrica*	R, WD, D

TABLE 1
OBSERVED FLORA LIST

Key: OF = Open Forest; WD = Woodland; I = Introduced; R = Remnant Open Forest; WT = Wetland; D = Disturbed Open Forest; C = Cleared

Name	*Botanic Name*	Where Found
	Grevillia montana	OF
Silver Wattle	*Acacia dealbata*	OF
	Hibbertia riparia	OF
Grey Gum	*Eucalyptus punctata*	D, WD, OF
White Stringybark	*E. globoidea*	OF
Sydney Peppermint	*E. piperita*	OF
Brown Stringybark	*E. capitellata*	OF
	Hakea gibbosa	OF, D
Forest Oak	*Casuarina torulusa*	D, WD, OF
	Helichrysum leucopsideum	OF
Forest Red Gum	*E. tereticornis*	OF
	Dodenea viscosa	R
Pinkwood	*Beyeria viscosa*	R
Broad leaved white Mahogany	*E. umbra umbra*	R, D
Broad-leaved red Ironbark	*E. fibrosa fibrosa*	R, OF, WD, D
Tallowood	*E. microcorys*	R, WD, OF
Yellow Tea-tree	*L. flavescens*	WD, OF
Grey box	*E. moluccana*	WD
Spotted gum	*E. maculata*	OF, R, D, WD
Burrawang	*Macrozania sp*	R, OF
Glycine	*Glycine sp*	OF
Geebung	*Persoonia linearis*	OF, R
Kangaroo Grass	*Themeda australis*	OF, R, D
	Oxylobium sp	OF
Mountain Devil	*Lambertia formosa*	OF
	Callistemon linearis	OF, D
	Jacksonia scoparia	OF
	Wahlenbergia sp	OF
Turpentine	*Syncarpia glomulifera*	OF

TABLE 2
FAUNA SPECIES LIST

Key: OF = Open Forest; WD = Woodland; VR = Vulnerable & Rare; R = Remnant Open Forest; WT = Wetland; O = Observed; D = Disturbed Open Forest; C = Cleared; I = Introduced

Scientific Name		Common Name	Habitat
Mammals			
Tachyglossus acuteatus		Short-beaked Echidna	OF, R, D, WD
Phascogale tapoatafa	*VR*	Brush-tailed Phascogale	OF, R
Antechinus flavipes		Yellow-footed Antechinus	OF, R, D
A. stuartii		Brown Antechinus	OF, R, D, WT, WD
Sminthopsis murina		Common Dunnart	OF, R
Planigale maculata	*VR*	Common Planigale	OF, R
Isodon macrourus		Northern Brown Bandicoot	OF, R, D, WT, WD
Perameles nasuta		Long-nosed Bandicoot	OF, R, D, WT, WD
Vombatus ursinus		Common Wombat	OF, R, D, WT, WD
Pseudocheirus peregrinus		Common Pingtail Possum	OF, R, D, WT, WD
Petaurus breviceps		Sugar Glider	OF, R, D, WT, WD
Trichosurus vulpecula		Common Brushtail Possum	OF, R, D, WT, WD
Macropus rufogriseus		Red-necked Wallaby	R, D, WD
M. giganteus		Eastern Grey Kangaroo	R, WD, D, OF
M. robustus		Common Wallaroo	OF
Pteropus poliocephalus		Grey-headed Flying Fox	OF, R, D, WT, WD
P. scapulatus		Little Red Flying Fox	OF, R, D, WT, WD
Taphozous flaviventris	*VR*	Yellow-bellied Sheathtail - Bat	OF, R, D, WT, WD
Tadarinda australis		White-striped Mastiff - Bat	OF, R, D, WT, WD
Mormopterus luriae		Little Northern Mastiff - Bat	OF, R, D, WT, WD
M. norfolkensis	*VR*	Eastern Little Mastiff - Bat	OF, R, D, WT, WD
Nyctophilus gouldii		Gould's Long-eared Bat	OF, R, D, WT, WD
N. geoffroyi		Lesser Long-eared Bat	OF, R, D, WT, WD
Miniopterus schreibersii	*VR*	Common Bent-wing Bat	OF, R, D, WT, WD
M. australis		Little Bent-wing Bat	OF, R, D, WT, WD
Chalinolobus gouldii		Gould's Wattled Bat	OF, R, D, WT, WD
C. morio		Chocolate Wattled Bat	OF, R, D, WT, WD
Myotis adversus	*VR*	Large-footed Mouse-eared Bat	OF, R, D, WT, WD
Nycticeius rueppellii		Greater Broad-nosed Bat	OF, R, D, WT, WD
N. greyii		Little Broad-nosed Bat	OF, R, D, WT, WD
Eptesicus pumilus		Little Cave Eptesicus	OF, R, D, WT, WD
E. vulturnus		Little Forest Eptesicus	OF, R, D, WT, WD
Hydromys chrysogaster		Water Rat	WT
Rattus rattus	*I*	Black Rat	OF, R, D, WT, WD
Mus musculus	*I*	House Mouse	OF, R, D, WT, WD
Lepus capensis	*I*	Brown Hare	C, WD
Oryctolagus cuniculus	*I*	Rabbit	OF, WD, C
Canis familiaris dingo		Dingo	OF, WD, C
Vulpes vulpes	*I, O*	Fox	OF, R, D, WT, WD
Felis catus	*I*	Feral Cat	OF, R, D, WT, WD
Equus caballus	*I, O*	Horse	C, OF, D

TABLE 2
FAUNA SPECIES LIST

Key: OF = Open Forest; WD = Woodland; VR = Vulnerable & Rare; R = Remnant Open Forest; WT = Wetland; O = Observed; D = Disturbed Open Forest; C = Cleared; I = Introduced

Scientific Name		Common Name	Habitat
Amphibians & Reptiles			
Crinia signifera		Brown Froglet	WT, C, WD
Limnodynastes dumerilii	*O*	Banjo Frog	WT, C
L. ornatus		Ornate Burrowing Frog	WT, C
L. peronii	*O*	Striped Marsh Frog	WT, C
L. tasmaniensis		Spotted Marsh Frog	WT, C
Paracrinia haswelli	*O*	Haswell's Froglet	WT, C
Pseudophryne bibroni		Bibron's Toadlet	WT, C
Uperoleia laevigata		Smooth Toadlet	WT, C
Littoria aurea	*T*	Green & Golden Bell Frog	WT, C
L. caerulea		Green Tree Frog	WT, C, WD
L. dentata	*O*	Bleating Tree Frog	WT, C, WD
L. fallax		Dwarf Tree Frog	WT, C, WD
L. freycineti		Freycinet's Frog	WT, C, WD
L. jervisiensis		Jervis Bay Tree Frog	WT, C, WD
L. latopalmata		Broad-palmed Frog	WT, C, WD
L. nasuta		Rocket Frog	WT, C, WD
L. peronii		Peron's Tree Frog	WT, C. WD
L. tyleri		Tylers Tree Frog	WT, C, WD
L. verreauxii		Verreaux's Tree Frog	WT, C, WD
Gemmatophora muricata	*O*	Jacky Lizard	OF, D, R, WD
Physignathus lesueurii lesueurii		Eastern Water Dragon	WT, C
Pogona barbata		Eastern Bearded Dragon	OF, R, D, WT, WD
Tympanocryptis diemensis		Mountain Dragon	OF, R
Diplodactylus vittatus		Stone Gecko	OF, R, D, WT, WD
Gehyra variegata		Tree Dtella	OF, R, D, WT, WD
Oedura robusta		Robust Velvet Gecko	OF, R, D, WT, WD
Underwoodisaurus milli		Thick-tailed Gecko	OF, R, D, WT, WD
Delma plebeia			OF, R, D, WT, WD
Lialis burtonis		Burton's Snake Lizard	OF, R, D, WT, WD
Pygopus lepidopodus		Common Scaly-foot	OF, R, D, WT, WD
Anomalopus swansoni			OF, R, D, WT, WD
Carlia foliorum			OF, R, D, WT, WD
C. tetradactyla			OF, R, D, WT, WD
C. vivax			OF, R, D, WT, WD
Cryptoblepharus virgatus virgatus		Fence Lizard	OF, R, D, WT, WD
Ctenotus robustus			OF, R, D, WT, WD
C. taeniolatus		Copper-tailed Skink	OF, R, D, WT, WD
Cyclodomorphus casuarinae		She-oak Skink	OF, R, D, WT, WD
Lampropholis delicata			OF, R, D, WT, WD
L. guichenoti		Garden Skink	OF, R, D, WT, WD
L. mustelina		Weasel Skink	OF, R, D, WT, WD
Leiolopisma duperrayi			OF, R, D, WT, WD
L. platynotum		Red-throated Skink	OF, R, D, WT, WD
Sphenomorphus quoyii		Eastern Water Skink	OF, R, D, WT, WD
Tiliqua scincoides		Blue-tounged Lizard	OF, R, D, WT, WD
Varanus gouldii		Gould's Goanna	OF, R, D, WT, WD
V. varius	*O*	Lace Monitor	OF, R, D, WT, WD

TABLE 2
FAUNA SPECIES LIST

Key: OF = Open Forest; WD = Woodland; VR = Vulnerable & Rare; R = Remnant Open Forest; WT = Wetland; O = Observed; D = Disturbed Open Forest; C = Cleared; I = Introduced

Scientific Name		Common Name	Habitat
Morelia spilota sp.		Diamond/Carpet Snake	WT, C, R
Boiga irregularis		Brown Tree Snake	OF, R, D, WT, WD
Dendrelaphis puctulata		Common Tree Snake	OF, R, D, WT, WD
Acanthophis antarcticus		Common Death Adder	OF, R, D, WT, WD
Cryptophis nigrescens		Eastern Small-eyed Snake	
Demansia psammophis psammophis		Yellow-faced Whip Snake	
Hemiaspis signata		Black-bellied Swamp Snake	WT, C, WD
Notechis scutatus		Eastern Tiger Snake	OF, R, D, WT, WD
Pseudechis porphyriacus		Red-bellied Black Snake	R, D, WT, WD
Pseudonaja textilis textilis		Eastern Brown Snake	OF, R, D, WT, WD
Rhinoplocephalus dwyeri		Dwyer's Snake	OF, R, D, WT, WD
Vermicella annulata annulata		Common Bandy Bandy	OF, R, D, WT, WD
Ramphotyphlops nigrescens		Blind Snake	OF, R, D, WT, WD
R. proximus		Blind Snake	OF, R, D, WT, WD
R. wiedii		Blind Snake	OF, R, D, WT, WD
Avifauna			
Poliocephalus poliocephalus		Hoary-headed Grebe	WT
Tachybaptus novaehollandiae		Australasian Grebe	WT
Podiceps cristatus		Great-Crested Grebe	WT
Phalacrocorax melanoleucos		Little-Pied Cormorant	WT
P. sulcirostris sulcirostris		Little Black Cormorant	WT
P.carbo		Australian Darter	WT
P. varius		Great Cormorant	WT
Anhinga melanogaster		Pied Cormorant	WT
Pelecanus conspicillatus		Australian Pelican	WT
Ardeola ibis		Cattle Egret	WT, WD, C
Egretta garzetta		Little Egret	WT
E. intermedia		Intermediate Egret	WT
E. alba		Great Egret	WT, WD, C
Ardea novaehollandiae	*O*	White-faced Heron	WT, WD, C
A. pacifica		Pacific Heron	WT, WD
Nycticorax calendonicus	*O*	Nankeen Night Heron	WT, WD
Platalea regia		Royal Spoonbill	WT,
P. flavipes		Yellow-billed Spoonbill	WT
Threskiornis spinicollis		Straw-necked Ibis	WT, C
T. aethiopica		Sacred Ibis	WT, C
Plegadis falanellus		Glossy Ibis	WT
Stictonetta naevosa	*VR*	Freckled Duck	WT
Chenonetta jubata	*O*	Wood Duck	WT
Aythya australis		Hardhead	WT

TABLE 2
FAUNA SPECIES LIST

Key: OF = Open Forest; WD = Woodland; VR = Vulnerable & Rare; R = Remnant Open Forest; WT = Wetland; O = Observed; D = Disturbed Open Forest; C = Cleared; I = Introduced

Scientific Name		Common Name	Habitat
Anas superciliosa	*O*	Pacific Black Duck	WT
A. gracilis	*O*	Australian Grey Teal	WT
A. castanea		Chestnut Teal	WT
Malacorhynchus membranaceus		Pink-eared Duck	WT
Biziura lobata		Musk Duck	WT
Accipiter cirrhocephalus		Collared Sparrowhawk	C, WT
A. fasciatus		Brown Goshawk	C, WT
A. novaehllandiae		Grey Goshawk	C, WT
Circus assimilis		Spotted Harrier	C, WT
Haliastur sphenurus		Whistling Kite	C, WT
Hieraaetus morphnoides		Little Eagle	C, WT
Aquila audax		Wedge-tailed Eagle	C. WT
Elanus notatus		Black-shouldered Kite	C, WT
Falco subniger		Black Falcon	C, WT
F. berigora		Brown Falcon	C, WT
F. cenchroides	*O*	Nankeen Kestrel	C, WT
F. longipennis		Australian Hobby	C, WT
F. peregrinus		Peregrine Falcon	C, WT
Turnix varia		Painted Button Quail	WT, C, WD
T. pyrrhothorax		Brown Quail	WT, C, WD
Coturnix australis		Stubble Quail	WT, C, WD
C. pectoralis		Red-chested Button-Quail	WT, C
Porzana pusilla		Baillon's Crake	WT, C
Rallus philippensis		Buff-banded Rail	WT, C
Fulcia atra		Eurasian Coot	WT, C
Gallinula tenebrosa		Dusky Moorhen	WT
Porphrio porphyrio	*O*	Purple Swamphen	WT
Vanellus tricolor		Banded Lapwing	WT, C, WD
Vanellus miles	*O*	Masked Lapwing	WT, C, WD
Erythrogony cinctus	*O*	Red-kneed Dotterel	WT
Charadrius melanops		Black-fronted Dotterel	WT
Calidris acuminata		Sharp-tailed Sandpiper	WT
Gallinago hardwickii	*O*	Japanese Snipe	WT
Himantopus himantopus		Black-winged Stilt	WT
Larus novaehollandiae		Silver Gull	WT, C
Ocyphaps lophotes		Crested Pigeon	OF, R, D, WT, WD
Phaps chalcoptera		Common Bronzewing	OF, R, D, WT, WD
Geopelia striata		Peaceful Dove	OF, R, D, WT, WD
Streptopelia chinensis		Spotted Turtle-Dove	OF, R, D, WD
Callocephalon fimbriatum		Gang-gang Cockatoo	OF, R, D, WD, C
Cacatua roseicapilla		Galah	OF, R, D, WD, C
C. galerita		Sulphur- crested Cockatoo	OF, R, D, WD, C
Calyptorhynchus funereus		Yellow-tailed Black-Cockatoo	OF, R, D WD
C. lathami	*VR*	Glossy-Black Cockatoo	OF, R, D, WD
Trichoglossus haematodus		Rainbow Lorikeet	OF, R, D, WD
T. chlorolepidotus		Scaly-breasted Lorikeet	OF, R, D, WD, C

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Scientific Name		Common Name	Habitat
Lathamus discolor	*VR*	Swift Parrot	OF, R, D, WD
Glossopsitta concinna		Musk Lorikeet	
G. pusilla		Little Lorikeet	
Alisterus scapularis		King Parrot	OF, R, D, WD
Platycercus eximius		Eastern Rosella	OF, R, D, C, WT, WD
Psephotus haematonotus	*O*	Red-rumped Parrot	WT, C, WD
Neophema pulchella	*VR*	Turquoise Parrot	WT, C, WD
Cuculus pyrrhophanus		Fan-tailed Cuckoo	OF, R, D, C, WT, WD
C. variolosus		Brush Cuckoo	OF, R, D, C, WT, WD
C. pallidus		Pallid Cuckoo	OF, R, D, C, WT, WD
Chrysococcyx lucidus		Shining Bronze-cuckoo	OF, R, D, C, WT, WD
C. osculans		Black-eared Cuckoo	OF, R, D, C, WT, WD
C. basalis		Horsefield's Bronze-Cuckoo	OF, R, D, C, WT, WD
Centropos phasianinus		Pheasant Coucal	WT, OF, R, D, WD
Scythrops novaehollandiae		Channel-billed Cuckoo	WT, OF, R, D, WD
Eudynamis scolopacea		Common Koel	WT, OF, R, D, WD
Dacelo novaeguineae	*O*	Laughing Kookaburra	OF, R, D, C, WT, WD
Halcyon sancta		Sacred Kingfisher	OF, R, D, C, WT, WD
H.pyrrhopygia		Red-backed Kingfisher	OF, R, D, C, WT, WD
Merops ornatus	*O*	Rainbow Bee-eater	WT, C
Eurystomus orientalis		Dollarbird	OF, R, D, C, WT, WD
Tyto alba		Barn owl	WT, WD, R
T novaehollandiae	*VR*	Masked Owl	WT, WD, R
Ninox novaeseelandiae		Southern Boobook	WT, WD, R
Eurostopodus mysticalis		White-throated Nightjar	WT, OF, D, R, WD
Aegotheles cristatus		Australian Owlet-nightjar	WT, OF, D, R, WD
Podargus strigoides		Tawny Frogmouth	OF, D, R, WD
Hirundapus caudacutus		White-throated Needletail	WT, C
Hirundo neoxena	*O*	Welcome Swallow	WT, C
Cecropis ariel		Fairy Martin	WT, C
C. nigricans		Tree Martin	WT, C
Cheramoeca leucosternum		White-backed Swallow	WT, C
Mirafra javanica		Singing Bushlark	WT, C
Anthus novaeseelandiae	*O*	Richard's Pipit	WT, C
Coracina novahollandiae		Black-faced Cuckoo-Shrike	OF, R, D, C, WT, WD
C. tenuirostris		Cicadabird	OF, R, D, C, WT, WD
Lalage sueurii		White-winged Triller	OF, R, D, C, WT, WD
Petoica phoenica		Flame Robin	OF, R, D, C, WT, WD

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Scientific Name		Common Name	Habitat
Petoica multicolor		Scarlet Robin	OF, R, D, C, WT, WD
Microeca leucophaea		Brown Flycatcher	OF, R, D, C, WT, WD
Falconculus frontatus		Crested Shrike-tit	R, OF, D, WD
Pachycephala pectoralis		Golden Whistler	OF, R, D, C, WT, WD
P. rufiventris		Rufous Whistler	OF, R, D, WD
Colluricincla harmonica		Grey Shrike Thrush	OF, R, D, WD
Myiagra inquieta		Restless Flycatcher	OF, R, D, C, WT, WD
M. rubecula		Leaden Flycatcher	OF, R, D, C, WT, WD
Rhipidura folignosa	*O*	Grey Fantail	OF, R, D, C, WT, WD
R. leucophrys		Willly Wagtail	OF, R, D, C, WT, WD
Psophodes olivaceus		Eastern Whipbird	OF, R, D, WD, WT
Pomatostomus temporalis		Grey-crowned Babbler	OF, R, D, WD
Acroceophalus australis		Australian Reed-warbler	WT
Cisticola exilis	*O*	Golden-headed Cisticola	WT
Malurus cyaneus	*O*	Superb Blue Wren	OF, R, D, C, WT, WD
M. melanocephalus		Red-backed Wren	WT, C
Chthonicola sagittata		Speckled Warbler	OF, R
Sericornis pyrrhopygius		Chestnut-rumped Heath-Wren	OF, R
Gerygone olivacea		White-throated Warbler	WT, C
Acanthica lineata		Striated Thornbill	OF, R, D, C, WT, WD
A. nana	*O*	Yellow Thornbill	OF, R, D, C, WT, WD
A.chrysoptera		Brown Thornbill	OF, R, D, C, WT, WD
A.pusilla		Weebill	OF, R, D, C, WT, WD
Smicornis brevirostris	O	Yellow-rumped Thornbill	OF, R, D, C, WT, WD
Daphoenositta chrysoptera		Varied Sittella	OF, R, D, C, WT, WD
Cormobates leucophaea		White-throated Treecreeper	OF, R, D, C, WT, WD
Climacteris picumnus		Brown Treecreeper	OF, R, D, WD
Anthochaera carunculata		Red Wattlebird	OF, R, D, WD
Philemon citreogularis		Little Friarbird	OF, R, D, WD
P. corniculatus		Noisy Friarbird	OF, R, D, WD
Entomyzon cyanotis		Blue-faced Honeyeater	WD
Manorina melanocephala		Noisy Miner	OF, R, D, C, WT, WD
Melithreptus lunatus		White-naped Honeyeater	OF, R, D, WD
M. brevirostris		Brown-headed Honeyeater	OF, R, D, WD
Meliphaga lewinii		Lewin's Honeyeater	OF, R, D, WD
Lichenostomus melanops		Yellow-tufted Honeyeater	OF, R, D, WD
L. chrysops		Yellow- faced Honeyeater	OF, R, D, WD
L. penicillatus		White-plumed Honeyeater	OF, R, D, WD
L. fuscus	O	Fuscous Honeyeater	OF, R, D, WD

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Scientific Name		Common Name	Habitat
Phlidonyris nigra		White-cheeked Honeyeater	OF, R, D, WD
Xanthomyza phrygia	*T*	Regent Honeyeater	R, OF
Myzomela sanguinolenta		Scarlet Honeyeater	R, OF, D, WD
Acanthorhynchus tenuirostris		Eastern Spinebill	OF, R, D, C, WT, WD
Lichmera indistincta		Brown Honeyeater	OF, R, D, C, WT, WD
Plectorhyncha lanceolata		Striped Honeyeater	R, OF, D, WD
Zosterops lateralis		Silvereye	OF, R, D, C, WT, WD
Dicaeum hirundinaceum		Mistletoe bird	OF, R, D, C, WT, WD
Paradalotus punctatus		Spotted Pardalote	OF, R, D, C, WT, WD
P. striatus striatus		Striated Pardalote	OF, R, D, C, WT, WD
Aegintha temporalis	*O*	Red-browed Firetail	OF, R, D, C, WT, WD
Poephila bichenovii		Double-barred Finch	WT, C
P. gutata		Zebra Finch	WT, C
Lonchura castaneothorax		Chestnut-breasted Mannikin	WT, C
Carduelis carduelis		European Goldfinch	WT, C
Passer domesticus		House Sparrow	WT, C
Oriolus sagittatus		Olive-backed oriole	OF, R, D, WD
Sturnus vulgaris		Common Starling	WT, C
Acridotheres tristis		Common Myna	WT, C, WD
Dicrurus megahynchus		Spangled Drongo	OF, R, D, WD, WT
Grallina cyanoleuca		Magpie-lark	OF, D, WD, WT
Corcorax melanorhamphos		White-winged Chough	OF, R, D, WD
Artamus cyanopterus	*O*	Dusky Woodswallow	WT, WD, C
A. leucorhynchus		White-breasted Woodswallow	WT, WD, C
Cracticus nigrogularis		Pied Butcherbird	OF, R, D, C, WT, WD
Strepera graculina		Pied Currawong	OF, R, D, C, WT, WD
Gymnorhina tibicen tibicen	*O*	Australian Magpie	OF, R, D, C, WT, WD
Corvus coronoides	*O*	Australian Raven	OF, R, D, C, WT, WD

ATTACHMENT 1

PLANT SPECIES RECORDED IN THE BELLBIRD SOUTH AREA, EPPS AND ASSOCIATES, 1988

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PLANT SPECIES RECORDED IN THE BELLBIRD SOUTH AREA, EPPS AND ASSOCIATES, 1988

Scientific Name	**Common Name**	**Status**
Adiantaceae Pteridophyta		
Adiantum aethiopicum L.	Common Maidenhair Fern	P
Cheilanthes sp.		
Azolla filiculoides	Azolla	
Dennstaedtaceae		
Pteridium esculentum (Forst. f) Cockayne	Bracken	
Salviniaceae		
** Salvinia molesta D.S. Mitchell*	Salvinia	
Alismataceae		
# Alisma plantago-aquatica L.	Water Plantation	
Cyperaceae		
? Baumea juncea (R.Br) Palla		
# Bolboschoenus fluviatilis Bsp	Marsh Clubrush	
# Cyperus exaltatus Retz	Lofty Sedge	
# C. odoratus L.	Scented Sedge	
C. sp		
Eleocharis sphacelata R.Br.		
?Schoenoplectus validus	River Clubrush	
Hydrocharitaceae		
Ottelia ovalifolia (R.Br.) Rich	Swamp Lily	

Scientific Name	Common Name	Status
Junceae		
# Juncus polyanthemus Buchen s. str	Many-flowered Rush	
J. usitatus L.A.S. Johnson	Common Rush	
Junacaginceae		
Triglochin procera R,Br.	Water Ribbons	
Liliaceae		
Tricoryne elatior R.Br.		
Najadaceae		
#Najas tenufolia r. Br.	Water Nymph	
Orchidaceae		
Caladenia alba R. Br.		P
Poaceae		
Cymbopogan refractus (R.Br.) A. Camus	Barbwire Grass	
Cyndon dactlylon (l.) Pers	Couch	
Echinopogan sp. Beauv.	Hedgehog Grass	
Entolasia sp. Stapf		
Eragrostis brownii Nees ex steud		
Imperata cylindrica Beauv. var. major (Nees) C.E. Hubbard	Blady Grass	
Phragmites australis (Cav.) Trin. ex steud	Common Reed	
Stipa L. sp.		
Themeda australis (R.Br)Stapf	Kangaroo Grass	
Potamogetonaceae		
# Potamogeten tricarinatus F. Muell & A. Benn ex A. Benn	Floating Pondweed	

Scientific Name	Common Name	Status
Typaceae		
# Typha orientalis C. Presl.	Broad-leaf Cumbungi	
Xanthorrhoeaceae		
Lomandra longifolia Labill		
Lomandra obliqua (Thinb.) Macbride		
Dicotyledonae		
Amaranthaceae		
Alternanthra denticulata R.Br.	Joyweed	
Apiaceae		
**Hydrocotyle bonariensis Lamk*		
Apocynaceae		
# Parsonsia straminea (R.Br) F.Muell	Common Silkpod	
Asteraceae		
Helichrysum apiculatum (Labill.) D. Don		
Helichrysum diosmifolium (Vent.) Sweet		
Olearia elliptica D.C.		
Senecio lautus Forst. f. ex Wild	Fireweed	
Celastraceae		
Maytenus silvestrus Lander & L.A.S. Johnson		
Campanulaceae		
Wahlenbergia Schrad. sp.		
Casuarinaceae		
Allocasuarina torulosa	Forest Oak	
Casuarina glauca Sieber ex Spreng	Swamp Oak	
Elatinaceae		
# Elatine gratioloides A. Cunn	Waterwort	
Epacridaceae		
Leucopogon r.Br. sp.		
Monotoca scoparia (Sm.) R. Br.		
Styphelia sp. Soland Sm ex		
Euphorbiaceae		
Phyllanthus thymoides Muell. Arg.		
Fabaceae		
Daviesia acicularis Sm		
Dulicifolia Andr.		
Desmodium sp. Desv.		
Dillwynia retorta (Wendl.) Druce	Eggs & Bacon	
Glycine clandestina Wendl.		
Hardenbergia violacea (Schneev.) Stearn		

Scientific Name	Common Name	Status
Indigofera australis Wild	Native Indigo	
Jacksonia scoparia R. Br.	Dogwood	
Oxylobium ilicifolium (Andr.) Domin		
Pultenaea cunninghamii (Benth.) Williamson		
Hypericaceae		
Hypericum gramineum Forst. f.		
Lentinbulariaceae		
# Utricularia exoleta R. Br.	Floating Bladderwort	
Lobeliaceae		
Pratia purpurascens (R. Br.) E. Wimmer		
Mimosaceae		
Acacia falcata Wild		
Acacia myrtifolia (Sm.) Wild		
Acacia parvipinnula Tindale		
Acacia terminalis (Salisb.) Macbride	Sunshine Wattle	
Acacia ulicifolia (Salisb.) Court	Prickly Moses	
Acacia sp. Wild.		
Myrtaceae		
Angophora floribunda (Sm.) Sweet	Rough-barked apple	
? Callistemon linearis DC		
?Eucalyptus amplifolia Noudin	Cabbage Gum	
?Eucalyptus capitellata Sm.	Brown Stringybark	
Eucalyptus crebra F. Muell.	Narrow-leaved Ironbark	
Eucalyptus eximia Schauer	Yellow Bloodwood	
Eucalyptus fibrosa F.Muell.	Broad-leaved Ironbark	
Eucalyptus maculata Hook	Spotted Gum	
Eucalyptus moluccana Roxb	Grey Box	
Eucalyptus punctata DC	Grey Gum	
Eucalyptus tereticornis Sm.	Forest Red Gum	
Leptospermum attentuatum Sm.		
Leptospermum flavescens Sm.s.lat.	Common Tea Tree	
Leptospermum juniperinum Sm.		
** Melaleuca decora (Salisb) Britten*		
Melaleuca linariifolia Sm.	Snow-in summer	
Melaleuca nodosa (Soland ex Gaertn.) Sm.	Ball Honey-myrtle	
Melaleuca thymifolia Sm.		
Melaleuca sp.		
Syncarpia glomulifera (Sm.) Nied	Turpentine	
Onograceae		
# Ludwigia peploides (Kunth) Raven	Water Primrose	
Pittosporaceae		
Billardiera scandens Sm	Dumplings	
Bursaria spinosa Cav.	Blackthorn	
# Polygonum decipiens R.Br.	Slender Knotweed	
# P. hydropiper l.	Water Pepper	
P. lapathifolium L.	Pale Knotweed	
# P. orientale L.	Prince's Feather	
# P.strigosum R.Br.	Spotted Knotweed	
Scientific Name	**Common Name**	**Status**

Proteaceae		
Banksia spinulosa Sm.	Hairpin Banksia	
Grevilla montana R.Br.		
Hakea sericea Schrad		
Isopogan anemonifolius (Salisb.) Knight	Drumsticks	
Persoonia linearis Andr.		
Ranunculaceae		
Clematis aristata R.Br ex DC		
Ranunculus inundatus R.Br. ex DC		
**R.scleratus L.*	Celery-leaf Buttercup	
Rosaceae		
* *Rubus L sp*	Blackberry	
Rubiaceae		
Pomax umbellata (Gaertn) Soland ex A. Rich		
Rutaceae		
Boronia polygalifolia Sm.		P
Santalaceae		
Exocarpus cupressiformis Labill.	Native Cherry	
Thymelaeaceae		
Pimelea linifolia Sm.	Rice Flower	
Verbenaceae		
* *Lantana camara L.*	Lantana	
Violaceae		
Viola hederacea Labill.	Ivy-leaved Violet	

ATTACHMENT 2

VEGETATION COMMUNITIES IN THE BELLBIRD SOUTH AREA, EPPS AND ASSOCIATES, 1988

ATTACHMENT 2

VEGETATION COMMUNITIES IN THE BELLBIRD SOUTH AREA, EPPS & ASSOCIATES, 1988

Community	Habitat Type	Trees Common Species	H (m)	C %	Tall Shrubs/ Small Trees Common Species	H (m)	C %	Low Shrubs Common Species	H (m)	C %	Herbs & Ground Cover Common Species	H (m)	C %	Comments
1.Spotted Gum/Ironbark Open forest	Dry Sclerophyll Forest	Eucalyptus maculata E. fibrosa, Variable occurrence of E. capitellata, E. crebra, E.punctata and Syncarpia glomulifera	13-20	50-80	Acacia falcata, A. parvipinnula, A. sp, Allocasuarina torulosa, Callistemon linearis, Helichrysum diosmifolium, Leptosperum attenuatum, Juvenile tree spp. Personia linearis In some gullies: Melaleuca nodosa, Melaleuca sieberi, A. parvipinnula	2-13 8 3-5	0-70 40 100	Acacia myrtifolia, A. ulicifolia, Daviesia ulicifolia, Grevilla montana, Hakea sericea, Persoonia linearis, Pimelea linifolia	1-2	10-80	Billardiera scandens, Cheilanthes sp., Clematis aristata, Entolasia sp.,Eragrostis brownii Glycine clandestina, Hardenbergia violacea, Hibbertia vestita, Hypericum gramineum, Imperata cylindrica, Lepidosperma sp., Pomax umbellata, Tricoryne elatior, Wahlenbergia gracillis	<0.5	20	Highly disturbed over all parts of study area investigated

Original Paper 100% Recycled

Community	Habitat Type	Trees Common Species	H (m)	C %	Tall Shrubs/Small Trees Common Species	H (m)	C %	Low Shrubs Common Species	H (m)	C %	Herbs & Ground Cover Common Species	H (m)	C %	Comments
2. Yellow Bloodwood Open-forest	Dry Sclerophyll Open Forest	Eucalyptus eximia, Ironbark sp. E. punctata, Stringybark sp.	10-13	40	Acacia terminalis, Daviesia ulicifolia, Persoonia linearis, Juvenile tree spp.	≤3	20	Banksia spinulosa, Bossiaea, rhombifolia, Daviesia sp., Dillwynia acicularis, D. retorta, Grevillea montana, Hakea sericea, Isopogon anemonifolius, Monotoca scoparia, Oxylobium ilicifolium	0.5-1.5	10-60	Entolasia sp., Lomandra obliqua, Pomax umbellata, Xanthorrhoea sp.	<0.5	<10	On very rocky hillsides with skeletal soil

Original Paper 100% Recycled

Community	Habitat Type	Trees Common Species	H (m)	C %	Tall shrubs/Small Trees Common Species	H (m)	C %	Low shrubs Common Species	H (m)	C %	Herbs & Ground Cover Common Species	H (m)	C %	Comments
3. Cabbage Gum/Forest Red gum Woodland/ Open-forest	Shallow gully /Watercourse Vegetation	Eucalyptus amplifolia, (?) Angophora floribunda, Occasional Stringybark sp. E. punctata, Casuarina glauca In some sectors E. tereticornis appears to replace E. amplifolia.	<25	20-50	Casuarina glauca,Melaleuca linarifolia In some areas clumps of Acacia parvipinnula, Leptospermum attentuatum and Melaleuca nodosa occur with little tree stratum development Dense strands, of M. decora may be associated with the occurrence of E. tereticornis	10-15	20-60	Variable - may comprise: Melaleuca nodosa or Callistemon linearis, Jacksonia scoparia, Melaleuca thymifolia M.spp. or along Quorrobolong Creek: Acacia spp., Bursaria spinosa, Indigofera australis, Leptospermum flavescens, Rubus sp.	 1-2 1-1.5 1-4	 <5 <5 30-50	Boronia polygalifolia Cheilanthes sp., Desmodium sp., Entolasia sp., Helichrysum apiculatum, Pteridium esculentum, Stipa sp., Along Quorrobolong Creek: Adiantium aethiopicum, Lomandra longifolia and Viola hederacea are common. In sections of Quorrobolong Creek retaining water at the time of survey, species such as Potamageton tricarinatus, Ranunculus validus Triglochin procera were present.	<1	50-90	

Community	Habitat Type	Trees Common Species	H (m)	C %	Tall Shrubs/Small Trees Common Species	H (m)	C %	Low Shrubs Common Species	H (m)	C %	Herbs & Ground Cover Common Species	H (m)	C %	Comments
4. Grey Gum/Rough-barked Apple, Woodland/ Open-forest	Dry Sclerophyll Forest (Transitional)	Eucalyptus punctata, Angophora floribunda Variable occurrence of E. moluccana, E.amplifolia? Syncarpia glomulifera, and E. capitellata	17-25	20-70	Acacia parvipinnula, A.sp., Bursaria spinosa, Exocarpus cupressiformis, Leptospermum attentuatum, Melaleuca linariifolia, M. nodosa, Persoonia linearis	2-10	30-70	Acacia sp., A. ulicifolia, Banksia spinulosa, Bursaria spinosa, Grevillea montana, Hakea sericea, Leptospermum attenuatum, Melaleuca nodosa, Styphelia sp.	0.5-2	10-50 10	Billardiera scandens, Boronia polygalifolia, Caladenia alba, Cheilanthes sp. Desmodium sp., Helichrysum apiculatum, Pomax umbellata, Pratia purpurascens	<1	10-80	Great variation in under-storey speciation and cover indicative of transitional nature of community
5. Grey Box Open-forest		Eucalyptus moluccana, E.sp. Occasional E. punctuata	<25	50	Acacia falcata A sp., Bursaria spinosa Juvenile eucalypts occasional Melaleuca decora?	2-4 <10	10-50	Grevillea montana Helichrysum diosmifolium Leucopogon sp., Juvenile eucalypts	0.5-1.5		Cymbopogon refractus, Echinopogon sp., Eragrostis brownii Pomax umbellata, Pratia purpurascens, Stipa sp.	<0.5	40-50	Has been logged and grazed- little shrub understorey development

Original Paper 100% Recycled

Community	Habitat Type	Trees Common Species	H (m)	C %	Tall Shrubs/Small Trees Common Species	H (m)	C %	Low Shrubs Common Species	H (m)	C %	Herbs & Ground Cover Common Species	H (m)	C %	Comments
6. Swamp Oak Open/Closed-forest		Casuarina glauca, Melaleuca decora? Occasional Eucalyptus amplifolia?, E. tereticornis	10-18	30-80	Melaleuca nodosa (in clumps) Casuarina glauca Occasional Bursaria spinosa	2-7	30-80				Cynodon dactylon other grass spp, Casuarina cladodes	<1	80	Regrowth of juvenile Casuarinas evident around edges grazed. Forms fringe around Ellalong Lagoon predominantly on southern side

Original Paper 100% Recycled

Community	Habitat Type	Trees Common Species	H (m)	C %	Tall Shrubs/Small Trees Common Species	H (m)	C %	Low Shrubs Common Species	H (m)	C %	Herbs & Ground Cover Common Species	H (m)	C %	Comments
7. Semi-permanent Freshwater Swamp	Semi-permanent Freshwater Swamp/Open Water	1. Ellalong Swamp Lagoon						Large expanses of Eleocharis sphacelata with patches of Phragmites australis, Typha orientalis	1.5 -2	50-70	In very damp but drying sectors around lagoon edges, the following species were present: Salvinia molesta (wettest areas), Alisma plantago-aquatica? Ranunculus scleratus Triglochin procera. Extending outward from this, was bare mud (c.1-3cm wide), Juncus Swamp with J. usitatus and Polygonum lapathifolium and in some areas a final zone of pastureland/ fresh meadow with Polgonum lapathifolium, Alternanthera denticulata and other 'weed' species	<0.5	100	Large body of water in centre covered with Salvinia molesta at time of survey. To east, along entrance channel to lagoon, water free of weed and channel lined by reeds. Swamp very dry at time of survey and weeds starting to colonise drying mud. Dieback of Eleocharis reed beds evident along eastern channel.

Community	Habitat Type	Trees Common Species	H (m)	C %	Tall Shrubs/Small Trees Common Species	H (m)	C %	Low Shrubs Common Species	H (m)	C %	Herbs & Ground Cover Common Species	H (m)	C %	Comments
		2. Swamp SE of Kalingo Pit Top. Some clumps of Melaleuca sp. on north/north-eastern edge						Similar species as 1. but predominantly Eleocheris sphacelata	2	50	Similar to 1. but very narrow zone around edge			Waterweed present but not totally covering water. Edge patches of reeds heavily grazed by cattle.

ATTACHMENT 3

FAUNA SPECIES LISTS, BELLBIRD SOUTH AREA, EPPS AND ASSOCIATES, 1988

ATTACHMENT 3

AVIFAUNA SPECIES IN THE BELLBIRD SOUTH AREA, EPPS & ASSOCIATES, 1988

Common Name	Scientific Name	Habitat	Source of Record	Status In NSW
Australian Pelican	Pelecanus conspicillatus	ES	H	C-MC
Darter	Anhinga melanogaster	ES	*,P,	MC
Great Cormorant	Phalacrocorax carbo	ES	*,P,	C
Pied Cormorant	P.varius	ES	H	MC
Little Black Cormorant	P. sulcirostris	ES	H,P,	A
Little Pied Cormorant	P. melanoleucos	S,ES	H,*	A
Australian Little Grebe	Podiceps novaehollandiae	S,ES	*,P,	A
Pacific Heron	Ardea pacifica	ES	*,P,	C
White-faced Heron	Ardea novaehollandiae	ES	*,P	A
Cattle Egret	Ardeola ibis	ES	H,	MC
Great Egret	Egretta alba	ES	*,P	C
Little Egret	E. garzetta	ES	P,	MC
Intermediate Egret	E. intermedia	ES	H	MC
Little Bittern	Ixobrychus minutus	ES	P	U
Australasian Bittern	Botaurus poiciloptilus	ES	P	MC-U
Sacred Ibis	Threskiornis molucca	ES	H,*,P	A
Straw-necked Ibis	T. spinicollis	ES	H,*	A
Royal Spoonbill	Platelea regia	ES	P	MC
Yellow-billed Spoonbill	P. flavipes	ES	H	MC
Plumed Whistling Duck	Dendrocygna cytoni	ES	P	MC
Black Swan	Cygnus atratus	ES	*,P	C
Freckled Duck	Stictonetta naevosa	ES	H	C
Pacific Black Duck	Anas superciliosa	ES	P	A
Grey Teal	A. gibberifrons	ES	H,P	A

Common name	Scientific Name	Habitat	Source of Record	Status In NSW
Chestnut Teal	Anas castanea	ES	H,P	MC
Australian Shoveler	A. rhynochotis	ES	H,P	MC
Hardhead	Aythya australis		P	C
Maned Duck	Chenonetta jubata	ES	H,P	A
Musk Duck	Biziura lobata	ES	H	MC
Black-shouldered Kite	Elanus notatus	ES	P	C-MC
Whistling Kite	Haliastur sphenurus	ES	P	MC
Brown Goshawk	Accipiter fasciatus	ES	H,P	MC
Collared Sparrow Hawk	A. cirrhocephalus	ES	P	MC
Wedge-tailed Eagle	Aquila audax	C1	*R	MC
White-bellied Sea-eagle	Haliaetus leucogaster	ES	H,P	U(SC)
Marsh Harrier	Circus aeruginosus	ES	H,P	MC
Peregrine Falcon	Falco peregrinus	ES	P	U(V)
Australian Hobby	F. longpipennis	ES,F	*,P	MC
Australian Kestral	F. cenchroides	ES	H,*,P	C
Brown Falcon	Falco berigora	ES,F	H,*,P	MC
Quail sp.	Coturnix sp.	F	*	
Crake	Porzana pusilla	ES	Pa	C-MC
Spotted Crake	P. fluminea	ES	P,	MC
Dusky Moorhen	Gallinula tenebrosa	ES	H,*,P	A
Purple Swamphen	Porphyrio porphyrio	S,ES	H,*,P	A
Eurasian Coot	Fulica atra	ES	H,P	A
Masked Lapwing	Vannellus miles	S,ES	H,*,P	A
Red-kneed Plover	Erythrogonys cinctus	ES	H	MC
Grey Plover	Charadrius melanops	ES	H	C
Greenshank	Pluvialis squatarola	ES	H	R(SC)
Japanese Snipe	Tringa nebularia	ES	W	C
Sharp-tailed Sandpiper	Gallinago hardwickii	ES	P	MC
Black-winged Stilt	Calidris acuminata	ES	H,P	C(SC)

Common Name	Scientific Name	Habitat	Source of Record	Status in NSW
Spotted Turtledove	Streptopelia chinensis	ES	H	I
Peaceful Dove	Geopelia placida	ES,F	H,*	A
Common Bronzewing	Phaps chalcoptera	E,F	H,*	A
Brush Bronzewing	P.elgans	F	*	MC
Crested Pigeon	Ocyphaps lophotes	ES	H	A
Wonga Pigeon	Leucosarcia melanoleuca	ES	H	MC
Little Lorikeet	Glossopsitta pusilla	ES,F	*,P	C
Funereal Cockatoo	Calyptoryhnchus funereus	ES,C1/F	H,*(Heard)	MC
Glossy Black Cockatoo	C. lathami	C1/F	*,R,P	MC(SC)
Gang-gang Cockatoo	Callocephalon fimbriatum	F	*	MC(V)
Galah	Cacatua roseicapilla	ES	P	A
Australian King Parrot	Alisterus scapularis	E	H	C
Crimson Rosella	Platycercus elegans	F	P	A
Eastern Rosella	Platycercus eximius	ES,F,C1	H,*	A
Pallid Cuckoo	Cuculus pallidus	ES	H	C
Brush Cuckoo	C. variolosus	ES	H	MC
Fan-tailed Cuckoo	C. pyrrhophanus	ES,F	*,P	C
Shining Bronze Cuckoo	Chrosococcyx lucidus	E,S	H	S
Tawny Frogmouth	Podargus strigoides	F(Road kill)	*	A
Azure Kingfisher	Ceyx azureus	ES	H	MC
Laughing Kookaburra	Dacelo novaeguinea	ES,F	*,P	A
Sacred Kingfisher	Halycon sancta	ES	H,P	A
Rainbow Bee-eater	Merops ornatus	ES	H	A(SC)
Welcome Swallow	Hirundo neoxena	ES,F	H,*,P	A
Tree Martin	Cecropis nigricans	ES	H,P	A
Fairy Martin	C. ariel	ES	H,P	A
Australian Pipit	Anthus novaeseelandiae	ES	H,P	A
Black-faced Cuckoo-shrike	Coracina novaehollandiae	ES,F	H,*,P	A
Grey-crowned Babbler	Pomatostomus temporalis	C1(Road kill)	*,P	A(SC)

Common Name	Scientific Name	Habitat	Source of Record	Status in NSW
Golden-headed Cisticola	Cisticola exilis	ES	H,P	A
Little Grassbird	Megalurus gramineus	ES	H,P	A
Clamorous Reed-warbler	Acrocephalus stentoreus	ES	H,P	A
Superb Fairy-wren	Malurus cyaneus	ES,F,(Ck)	H,*,P	A
White-throated Warbler	Gerygone olivacea	ES	H	A
Weebill	Smicornis brevirostris	E	H	A
Striated Thornbill	Acanthiza lineata	ES	P	A
Yellow Thornbill	A.nana	ES	P	A
Brown Thornbill	A.pusilla	ES	P	A
Buff-rumped Thornbill	A.reguloides	E	H	A
Yellow-rumped Thornbill	A.chrysorrhoa	ES	H	A
White-browed Scrubwren	Sericornis frontalis	ES	P	A
Speckled Warbler	Chthonicola sagittata	E	H	C
Jacky Winter	Microeca leucophaea	ES	P	A
Scarlet Robin	Petrocia multicolor	ES	H	C
Rose Robin	P.rosea	ES	H	C
Eastern Yellow Robin	Eopsaltria australis	ES,F	*,P	A
Grey Fantail	Rhipidura fuliginosa	ES,F	H,*,P	A
Willie Wagtail	R.leucophrys	ES,C1	H,*,P	A
Leaden Flycatcher	Myiagra rubecula	ES	H	C
Restless Flycatcher	M.inquieta	ES	H	A
Golden Whistler	Pachycephala pectoralis	ES	H	A
Rufous Whistler	P.rufiventris	ES,F	*,P	A
Grey-shrike Thrush	Colluricincla harmonica	ES,F	H,*,P	A
Shrike-tit	Falcunculus frontatus	E	H	C(SC)
Eastern Whipbird	Psophodes olivaceus	ES,F	*	A
Sittella	Neositta chrysoptera	E	H	C
Brown Tree Creeper	Climacteris picumnus	ES	P	A
White-throated Tree Creeper	C. leucophaea	E	H	A
Mistletoe bird	Dicaeum hirundinaceum	ES	P	A
Spotted Pardalote	Pardalotus sp.	ES	P	A

Common Name	Scientific Name	Habitat	Source of Record	Status in NSW
Yellow-tipped Pardalote	P. striatus	ES	P	MC
Silvereye	Zosterops lateralis	ES	H,P	A
Lewin's Honeyeater	Meliphaga lewinii	E	H	A
White-naped Honeyeater	Lichenostomus fuscus	ES	P	A
Fuscous Honeyeater	L. chrysops	ES,F	P	A
Yellow-faced Honeyeater	L. penicillatus	ES	P	A
White-plumed Honeyeater	L. leucotis	ES	H	A
White-eared Honeyeater	L. melanops	ES,F	H,*	A
Yellow-tufted Honeyeater	M. lunatus	ES,E	H,P	A
Noisy Friarbird	Philemon corniculatus	ES,F	H,*	A
White-cheeked Honeyeater	Phylidonyris nigra	E	H	A
Striped Honeyeater	Plectorhyncha lanceolata	ES	H	A
Eastern Spinebill	Acanthorhynchus tenuirostris	E	H	A
Bell Miner	Manorina melanophrys	F(Ck)	*	C
Noisy Miner	M. melanocephala	ES,F	*	A
Red Wattlebird	Anthochaera carunculata	E	H	A
Red-browned Firetail	Emblema temporalis	ES	H	A
Double-barred Finch	Poephila bichenovii	ES	H	A
House Sparrow	Passer domesticus	ES	H	I
Common Starling	Sturnis vulgaris	ES	H	I
Brown-headed Honeyeater	Melithreptus brevirostris	ES	H	A
Olive-backed Oriole	Oriolus sagittatus	ES	H	C
Magpie-lark	Grallina cyanoleuca	ES,C1	H,*	A
White-winged Chough	Corcorax melanorhamphos	E,F	H,*	C
Dusky Woodswallow	Artamus cyanopterus	ES,F	H,*	A
Pied Currawong	Strepera graculina	ES,F,C1	H,*	A
Pied Butcherbird	Cracticus nigrogularis	ES,F	H,*	A
Grey Butcherbird	C. torquatus	ES,F,C1	H,*	A
Australian Magpie	Gymnorhina tibicen	ES,F,C1	H,*	A
Satin Bowerbird	Ptilonorhynchus violaceus	E	H	C
Australian Raven	Corvus coronoides	ES,F	H,*	A

Nomenclature according to Morris et al, (1981)

KEY

HABITAT

ES	-	Ellalong Lagoon
S	-	Small lagoon within study area
E	-	Ellalong Area
F	-	Forested Areas/Wooodland
C1	-	Cleared Areas/Grazing Land
Ck	-	Creek

SOURCE OF RECORD

H	-	Outings by Hunter Bird Observers Group or Newcastle Flora and Fauna Protection Society
*	-	Recorded during autumn, 1987 by Bartrim & Martin Biological Studies.
***R**	-	Observed by local resident.
P	-	Recorded by F.W.C. Van Gessel, 1975 in Pelton area.
WT	-	Listed in Waterhouse (1987).

STATUS IN NSW

R	-	Rare
U	-	Uncommon
C	-	Common
MC	-	Moderately Common
A	-	Abundant
(SC)	-	Of special concern
(V)	-	Rare/Vulnerable
		(National Parks & Wildlife (Amendment) Act, 1983.)
		(Morris et al, 1981)

MAMMAL SPECIES IN THE BELLBIRD SOUTH AREA

Common Name	Scientific Name	Source of Record
Short-beaked Echidna	Tachyglossus aculeatus	R
Common Wombat	Vombatus ursinus	R
Common Ringtail Possum	Pseudocheirus peregrinus	S
Common Brushtail Possum	Trichosurus vulpecula	R
Eastern Grey Kangaroo	Macropus giganteus	R
Wallaroo	M. robustus	E
Rabbit	Oryctolagus cuniculus	S
Horse	Equus caballus	O
Domestic Cow	Bos tarus	O

Nomenclature from Strahan (Ed) 1983

KEY

R - Reported by local resident
S - Signs of animal observed during surveys
O - Observed during surveys
E - Observed by company personnel

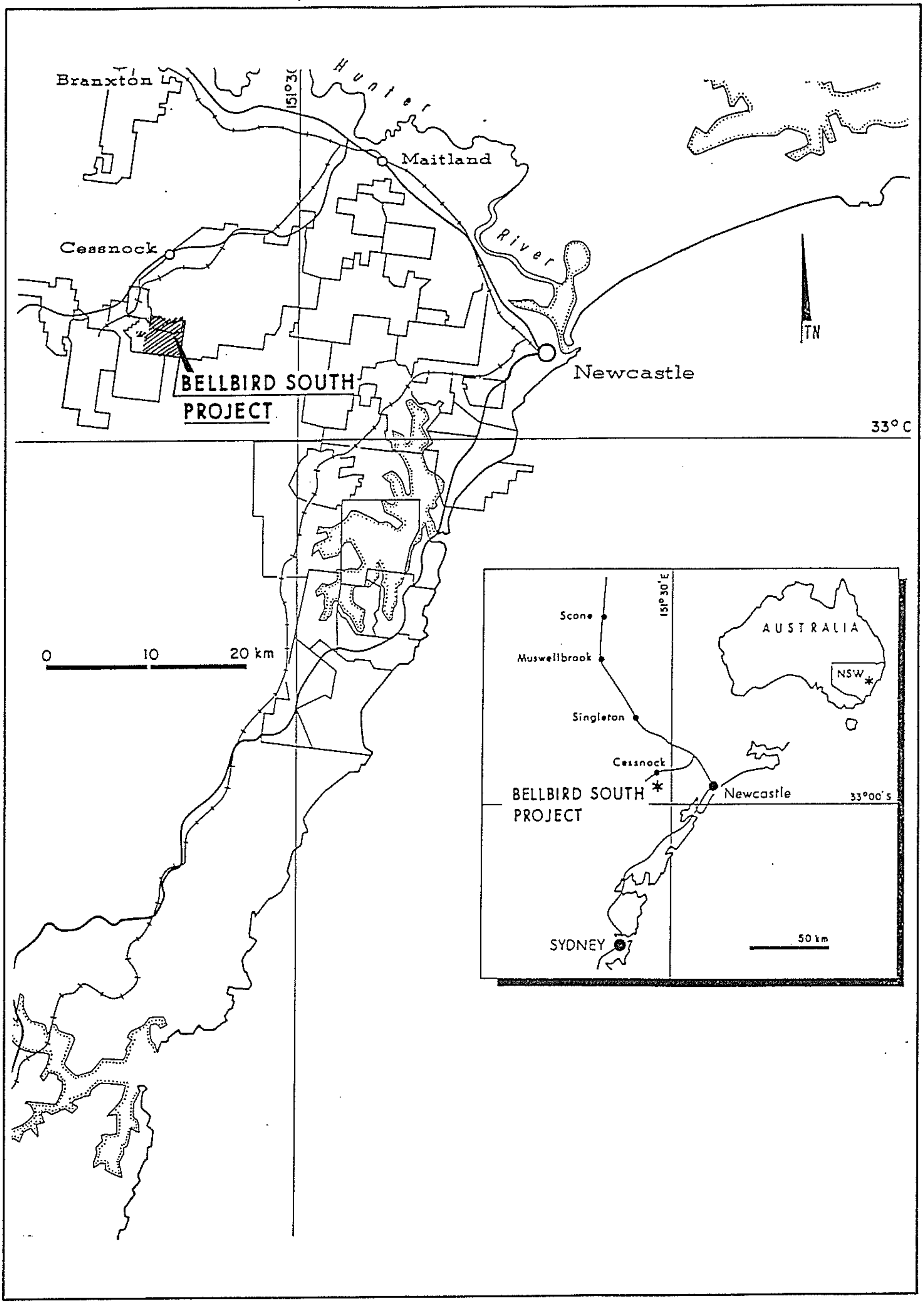
REPTILES IN THE BELLBIRD SOUTH AREA

Common Name	Scientific Name	Source of Record
Bearded Dragon	Amphibolurus barbatus	C
Lace Monitor	Varanus varius	R,E
Fence Skink	Cryptoblepharus sp.	O
Copper-tailed Skink	Ctenotus taeniolatus	O
Red-bellied Black Snake	Pseudechis porphyriacus	R

Nomenclature from Cogger, (1975)

KEY

C - Captured during field surveys
R - Reported by local residents
E - Observed by company personnel
O - Observed during surveys



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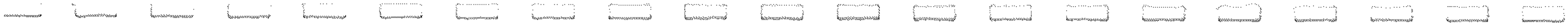
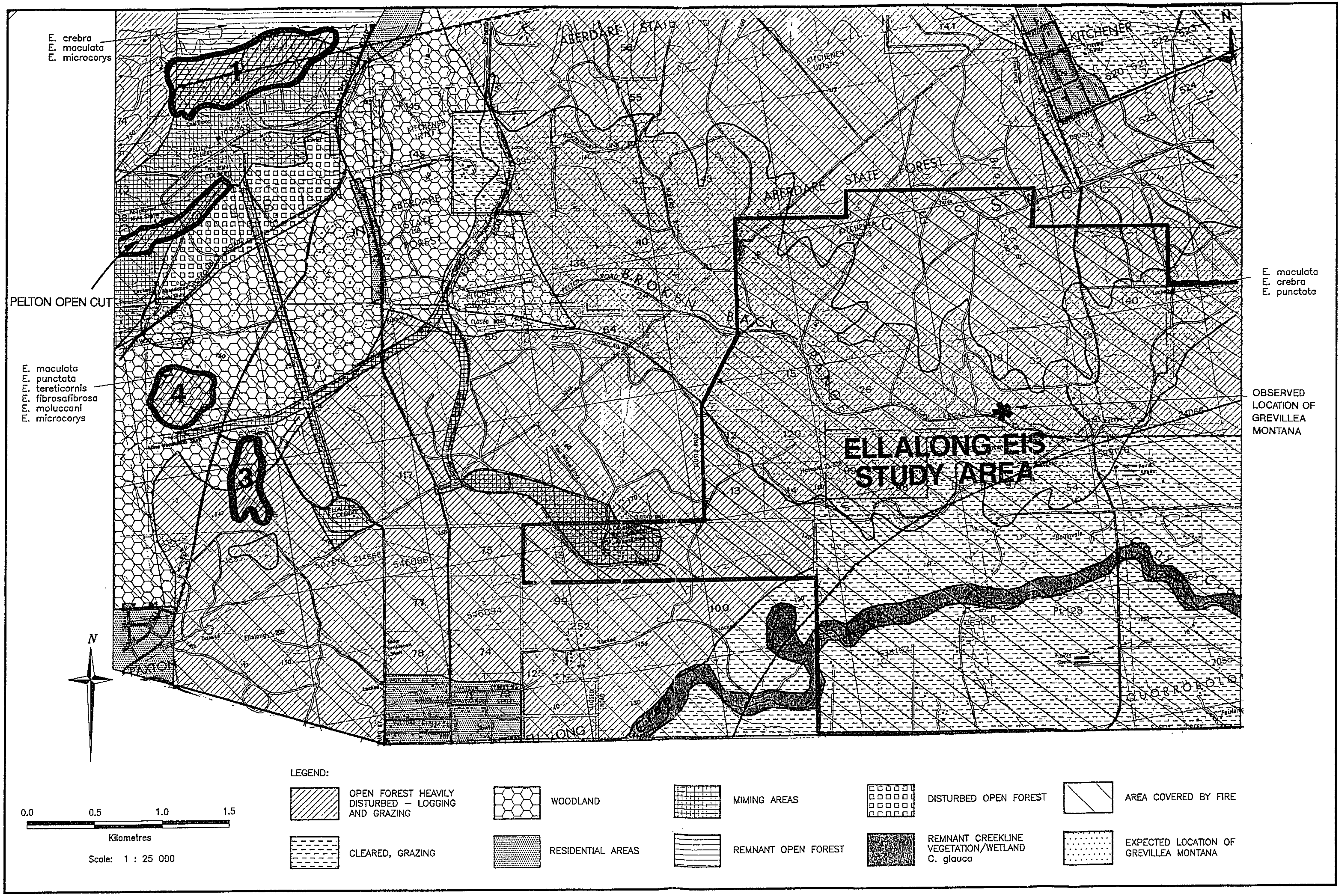
LOCATION PLAN

FIG. 1





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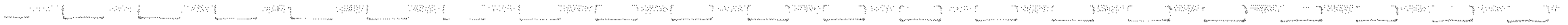
VEGETATION TYPES

FIG. 2

APPENDIX 10:

SUBSIDENCE AND VIBRATION

Reports and Policy



APPENDIX 10

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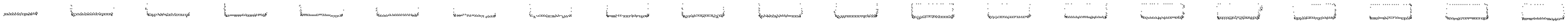
1.0 ASSESSMENT OF THE IMPACT OF SUBSIDENCE FROM PROPOSED LONGWALL OPERATIONS IN THE BELLBIRD SOUTH EXTENSION OF ELLALONG COLLIERY, G. E. HOLT & ASSOCIATES, MAY 1995



G E Holt & Associates Pty Ltd
Geotechnical Engineers

ASSESSMENT OF THE IMPACT OF SUBSIDENCE FROM PROPOSED LONGWALL OPERATIONS IN THE BELLBIRD SOUTH EXTENSION OF ELLALONG COLLIERY

May 1995

ACN 003551184

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ASSESSMENT OF THE IMPACT OF SUBSIDENCE FROM PROPOSED LONGWALL OPERATIONS IN THE BELLBIRD SOUTH EXTENSION OF ELLALONG COLLIERY

1.0 INTRODUCTION

This report has been prepared to determine likely subsidence levels and impacts arising from proposed mining of the Greta Seam by the longwall method of operation in the Bellbird South extension to Ellalong Colliery, N.S.W. It covers prediction of likely subsidence levels in the proposed mining area, assessment of the likely impacts of coal extraction, and suggests measures that might be employed to mitigate the effects of subsidence.

Particular issues of concern with regard to subsidence are the impact on houses, farm structures and improvements, public roads, water courses and vibration. Vibration is subject to separate reporting, and is not considered in this assessment report.

The report outlines the mine plan proposed by Ellalong Colliery, and before discussing detailed subsidence calculations for the mine layout, provides some background information on subsidence prediction for readers less familiar with subsidence prediction methods. An explanation of terminology is also given in Appendix I at the end of the report.

1.1 PROPOSED MINE PLAN

The location of the proposed longwall mining area is shown in Figure 1. The proposed mining area includes 14 longwall panels located to the north of the original 9 panels mined in Ellalong Colliery. The Greta Seam is at approximately 400 m depth near the old Bellbird South shafts, and dips south easterly to a depth of around 600 m at the end of the proposed 14 panels. This compares with mining depths between 300 m and 550 m in the current workings.

The mine will be developed from headings driven north east then east from the current longwalls. These headings are designed to be permanently stable by incorporation of solid pillars between the access headings, and large solid barriers between the roads and adjoining longwall panels. The first eight longwall panels, numbered 15 to 22, will be developed east from panels 13 and 14 for which approval has already been granted. The next 6 panels, numbered 23 to 28 will be located north of the first set. Future mining beyond these panels will be subject to a separate application some time in the future.

The longwall extraction panels will be formed by driving two roadways (gate roads) away from the main headings, forming pillars of coal (chain pillars) 100 m long and 38 m wide (rib-rib) between them on each side of the block to be mined. Panel lengths will vary according to location. At the end of a planned panel the two sets of double roadways will be connected (by a start road) to allow installation of the longwall equipment. The first eight panels will be 211.7 m wide, and the later 6 panels will probably be widened to 255 m.

The Greta Seam has variable thickness and will not be mined in its entirety due to mining and coal quality constraints. The height of workings will vary between 3.4 m and 4.5 m.

The pillars remaining between the access roadways for each panel will yield in time, but will not entirely crush out. The coal remaining in the yielded pillars will provide some support for overlying strata, and this will reduce the amount of settlement of the roof rocks above the workings compared settlement resulting from with total extraction of coal.

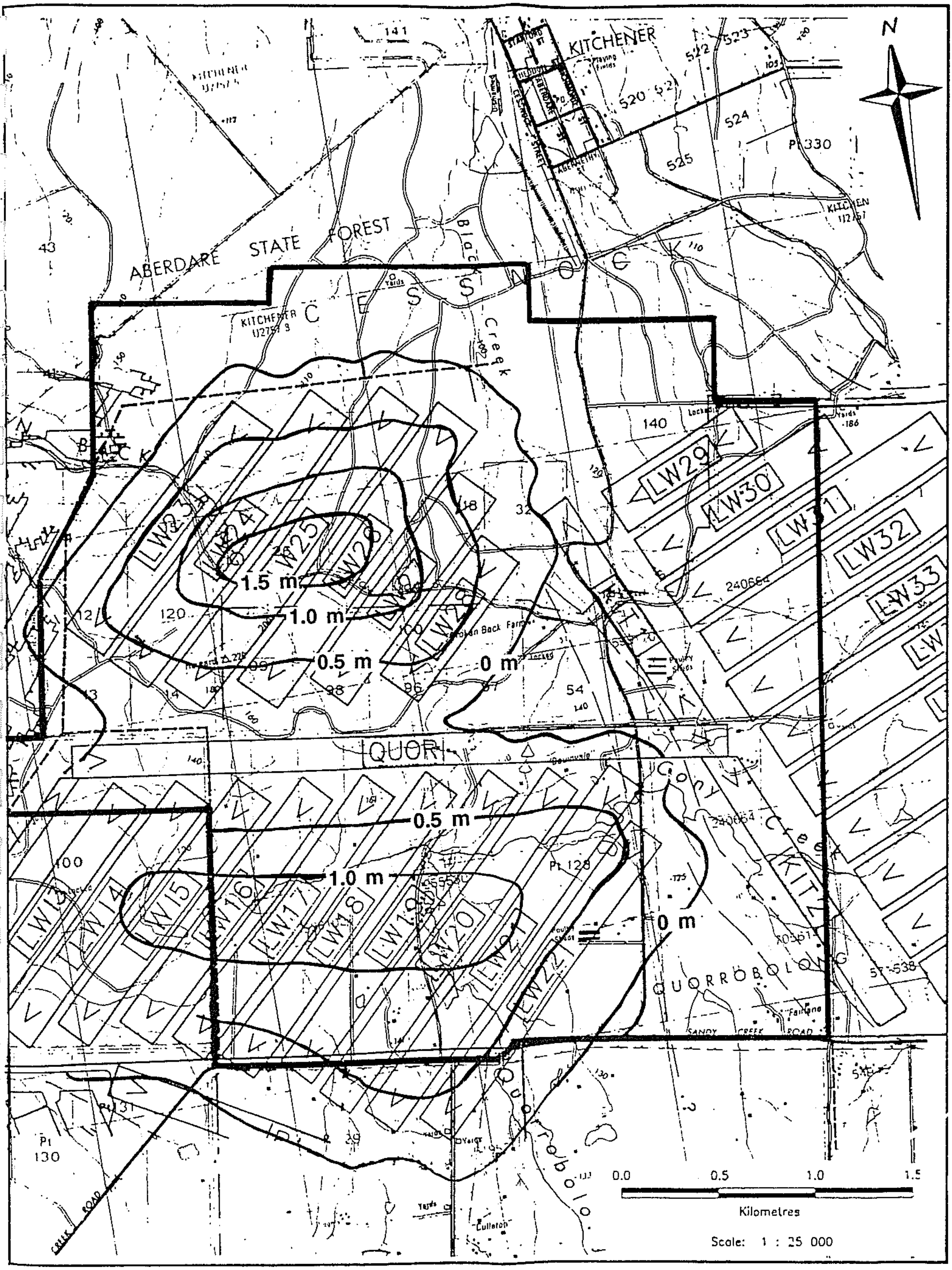


FIGURE 1: MINE LAYOUT & SUBSIDENCE CONTOURS FOR PROPOSED ELLALONG EXPANSION

2.0 SUBSIDENCE REGULATION AND PREDICTION METHODS

2.1 SUBSIDENCE TERMINOLOGY

A standard set of symbols, terms and definitions has developed for empirical subsidence prediction and are set out in Appendix I. A diagram showing the relationship of the terms is also provided in the Appendix.

In general the amount of ground strain and curvature arising from subsidence determines how much surface damage might occur, not the actual amount of vertical subsidence. However the best understood measure is the vertical ground movement, or vertical subsidence because all the other parameters; strain, tilt, position of maximum subsidence, position of inflection point etc, are calculated from this.

This is why commonly only the maximum subsidence is discussed in reports. The other values can be calculated empirically from the subsidence value if the vertical subsidence and depth of mining are known, and also in the case of Ellalong Colliery be extrapolated from measured data.

2.2 REGULATORY FRAMEWORK

To further assist landowners the Mine Subsidence Board was set up in 1929 to assist in managing problems before, during and after subsidence, and legislation in this field has been periodically updated since then. The Board concentrates on payment of compensation for damage to land and/or improvements caused by subsidence, and regulating surface development within proclaimed mine subsidence districts. The Ellalong area is not within a proclaimed Mine Subsidence District, but this does not affect payment of compensation for damage, or repair of damage as a result of subsidence.

The Board has pointed out that not all damage to structures in coal mining areas is due to subsidence. Soil movement is common, particularly with our climate of prolonged dry followed by short, intense, wet spells. These climatic conditions play havoc with soils subject to shrinkage and expansion, and these soils occur particularly in the Newcastle and Hunter Valley coalfields.

Consequential loss arising from subsidence events is not covered by the Mine Subsidence Compensation Act (1961), but by The Coal Mining Act (1973), since replaced by the Mining Act (1992), through the Mining Warden for an order of compensation against the mining company. There are available damage criteria tables based on strain, developed from British mining experience (Appendix II). While there are no local damage assessment tables, strain is the same the world over, and if 5 mm/m strain damages a masonry wall in Britain, 5 mm/m will damage a similar masonry wall in Australia. Consequently it is possible to make reasonable engineering judgements concerning likely subsidence damage by reference to British experience.

Provided a land owner and mining company can reach an agreement prior to mining current practice is for individual mining companies to come to agreement with land owners for repair of land, while monitoring operations to build a site specific data base of knowledge on subsidence. Otherwise claims for consequential loss must be made through the Mining Warden.

Subsidence guidelines are used to predict the maximum likely subsidence levels in order to design for worst case conditions. Predictions are based on conceptual mine plans which often change, as mining is a dynamic process. Often only average cover depths and seam thickness dimensions are available, and while there is variation about average values, the predictions are sufficiently accurate to determine the likely impacts.

Actual subsidence can vary significantly from predictions if unknown geological anomalies cause changes to expected ground movement. Cross cutting dykes of hard rock, such as occur in the worked out longwall area of Ellalong Colliery can cause marked change from expected subsidence. If the structures are identified in new mining areas, some allowance can be made. Much effort is expended searching for such structures because they can also have a severe impact on the mining of coal. This reduces the risk of mining, and the consequent risk of large variations in expected subsidence.

2.3 PREDICTION METHODS FOR ELLALONG EXPANSION PROPOSAL

2.3.1 Introduction

When coal is mined from a coal seam by underground methods, the support provided by the coal to overlying rocks is removed. Some rocks such as siltstone and shale can span over small distances, and not collapse into an opening below. Others such as sandstone and conglomerate can span 80 m or more before collapsing, or caving.

When the distance to span over mined out areas becomes too much for the particular strata (or layers), they break and fall in to the space underneath. If enough roof strata are affected by the collapse then effects can be carried through to the surface. The movement of the surface is known as subsidence. Movement continues until caving rock blocks up the available space.

Unlike a steel beam, which is made of the same material throughout, and whose strength and behaviour properties can be predicted accurately, strata are extremely variable in composition, strength and behaviour. There are no physical laws that can accurately describe the way in which rocks behave, and all assessments of the behaviour of rocks and rock strata must be through approximations based on experience (empirical methods) or computer based mathematical modelling.

2.3.2 Empirical Guidelines Method

In New South Wales the Department of Minerals and Energy has produced three booklets detailing empirical methods for predicting subsidence from single seam workings. These are for the Southern, Western and Newcastle Coalfields (Holla, 1985 & 1987). The method contained in each booklet is based on the results of a number of subsidence surveys carried out in each of the coalfields. The methods are completely empirical, based on real subsidence monitoring of single seam workings. The early workings at Ellalong Colliery were utilised in preparation of the Newcastle Coalfield Guideline.

Recent experience on prediction of subsidence for multiple longwall panels (Holla, 1988) has seen the development of curves which relate individual panel dimensions to pillar widths in order to determine likely maximum subsidence levels. This replaces the method of working with the effective mined height and percentage of coal extracted, to determine maximum subsidence. This yields more realistic estimates of maximum subsidence.

The curves were developed for the Southern Coalfield but are considered by Holla to be applicable to other areas, they have been used in recent Development

Guidelines are clearly an indicator of maximum values over a coalfield and it is accepted that predictions for a specific mine site can be improved if local knowledge is available. Ellalong Colliery has conducted subsidence surveys over its longwall panels for many years. The results of the surveys enables future subsidence prediction to be estimated more accurately than reliance on the Guideline and Multiple Panel Method, and summary relevant details are given in the next section.

Consequently the best practical means for prediction at Ellalong Colliery is to use the empirical methods from the Surface Subsidence Prediction Guidelines (Holla,1987), updated by recent experiences with multiple longwall panel subsidence (Holla, 1988), and employing local subsidence experience at Ellalong Colliery.

2.3.3 Subsidence Measurement at Ellalong Colliery

Several subsidence lines and grids have been monitored above the workings since 1983. Detailed surveys were conducted over a grid established in Ellalong village, and lines were established over the main group of panels covering longwall panels 5 to 9. A further line was set up over the more recent panels 10 to 12A. Locations of the subsidence lines are shown in Figure 2. The most useful surveys for future prediction of subsidence are those along Sandy Creek Road. This survey line detects the maximum subsidence and strains experienced at the surface and yields sufficient information to provide site specific modifications to the general guideline prediction method. A summary of the survey information is given in Figure 3.

Maximum subsidence recorded is 1.145 m over a supercritical area of extraction, Panels 5 to 9, with chain pillar width of 38 m. Cover depth varied between 350 m and 500 m, and mined thickness averaging 3.7 m.

PANEL NUMBER	RANGE OF WORKING DEPTH (m)	AVERAGE DEPTH H (m)	MINING HEIGHT T (m)	PANEL WIDTH W (m)	PILLAR WIDTH (m)	PILLAR WIDTH / H	W / H	Sm / T	MAXIMUM SUBSIDENCE Sm (m)	ANGLE OF DRAW (Degrees)	GOAF EDGE SUBSID. (m)	ZERO SUBSID. Distance From Panel	Tensile Strain (mm/m) 400Sm/H	Compress. Strain (mm/m) 600Sm/H	Tilt (mm/m) 1800Sm/H	Radius of Curvature (km)	Inflection Point Posn. - inside: D/H	D (m)	0.5Sm (m)
ELLALONG	aver. values	412.50	3.55	201.00	34.00	0.08	0.49	0.32	1.14	35.00									0.57
MEASURED	400.00		3.50	190.00	30.00	0.08	0.48	0.26	0.91	perp. to		300.00							0.46
# DATA	to		to							panel			1.00	0.60	3.00	not			
										22.00	0.20	to				available			
PANELS 5 TO 9	425.00		3.60	212.00	38.00	0.09	0.50	0.32	1.15	parallel to panel		230.00					-0.29	-123.00	0.58
ELLALONG	aver. values	412.50	3.55	201.00	34.00	0.08	0.49	0.38 *	1.35		0.86	206.25 **					-0.22	-90.75	0.67
PREDICTED	400.00		3.50	190.00	30.00	0.08	0.48	0.37	1.30	26.50	0.82	200.00					-0.24	-96.00	0.65
DATA	to		to										1.31	1.96	5.89	5.00			
												to							
PANELS 5 TO 9	425.00		3.60	212.00	38.00	0.09	0.50	0.39	1.40	26.50	0.91	212.50					-0.17	-72.25	0.70

TABLE 1: MEASURED AND PREDICTED MAXIMUM SUBSIDENCE DATA ATELLALONG COLLIERY

* Maximum subsidence based on multi-panel curves (Holla, 1988)

Mine measured data based on Longwall Panels 5 to 9

** Maximum strains, tilt etc based on Newcastle Guideline (Holla, 1987)

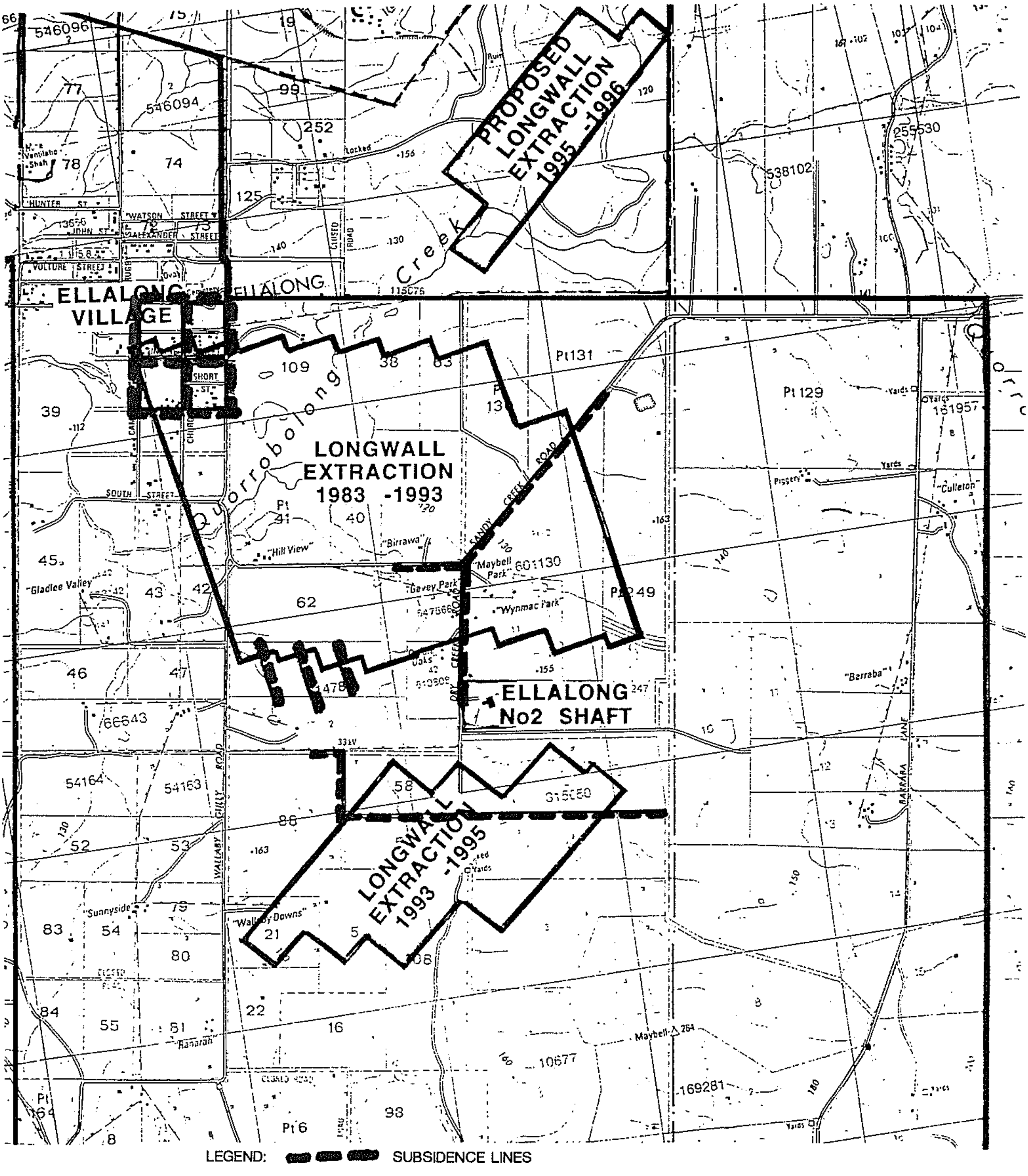
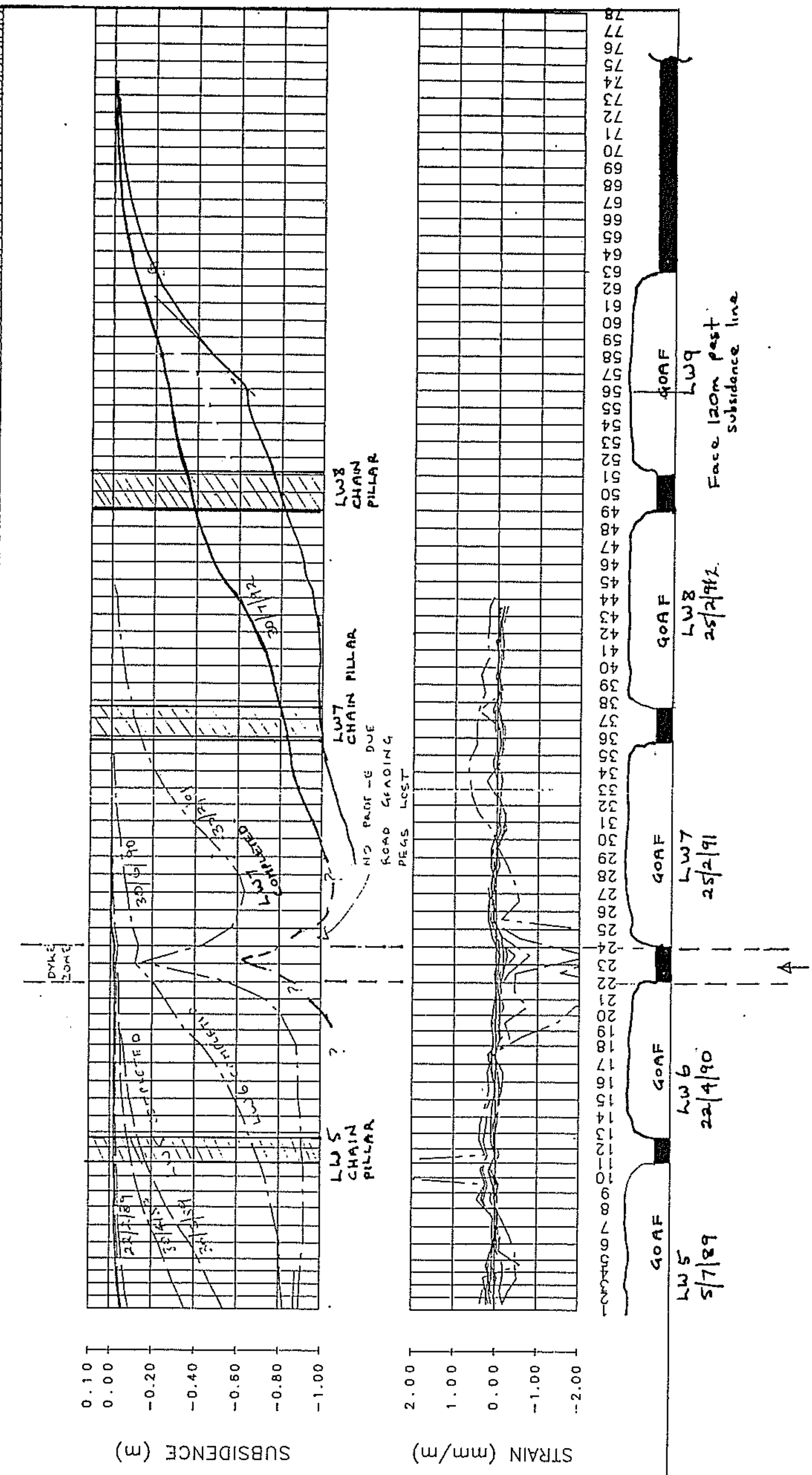


FIGURE 2: SUBSIDENCE LINE LOCATION PLAN - ELLALONG COLLIERY



DATE FIRST MEASURED	PEG	DIST	R L	STRAIN
30-10-87	1	0.000	120.546	
30-10-87	2	14.831	120.749	0.20
30-10-87	3	14.915	120.987	0.20
30-10-87	4	15.050	120.956	0.13
30-10-87	5	14.308	121.330	0.21
30-10-87	6	18.518	121.772	0.11
30-10-87	7	20.270	122.361	0.00
30-10-87	8	21.763	123.215	0.00
30-10-87	9	18.424	123.978	0.00
30-10-87	10	18.007	124.684	0.06
30-10-87	11	17.224	125.294	0.17
30-10-87	12	16.871	125.770	0.00
30-10-87	13	18.152	126.037	0.11
30-10-87	14	19.580	126.126	0.10
30-10-87	15	20.441	125.020	0.10
30-10-87	16	20.529	125.758	0.00
30-10-87	17	21.148	125.472	0.09
30-10-87	18	21.212	125.151	0.09
30-10-87	19	17.470	124.789	0.06
30-10-87	20	18.588	124.430	0.11
30-10-87	21	18.744	124.127	0.05
30-10-87	22	20.320	123.980	0.00
30-10-87	23	21.903	124.032	0.05
30-10-87	24	20.913	124.321	-0.10
30-10-87	25	21.184	124.806	0.09
30-10-87	26	21.336	125.534	0.19
30-10-87	27	21.147	126.448	0.19
30-10-87	28	21.642	127.430	0.00
30-10-87	29	21.467	128.447	0.14
30-10-87	30	22.132	129.471	0.14
01-06-88	31	20.484	130.393	0.00
01-06-88	32	20.479	131.345	0.00
01-06-88	33	20.471	132.378	0.00
01-06-88	34	20.462	133.443	0.00
01-06-88	35	20.474	134.412	0.00
01-06-88	36	20.462	135.436	0.00
01-06-88	37	20.485	136.423	0.00
01-06-88	38	20.466	137.366	0.00
01-06-88	39	20.481	138.270	0.00
01-06-88	40	20.503	139.071	0.00
01-06-88	41	20.490	139.737	0.00
01-06-88	42	20.501	140.203	0.00
01-06-88	43	20.494	140.501	0.00
01-06-88	44	20.507	140.563	0.00
30-02-91	45	20.550	140.396	
30-02-91	46	20.446	140.035	
30-02-91	47	20.497	139.504	
30-02-91	48	20.468	138.856	
30-02-91	49	20.472	138.156	
30-02-91	50	20.498	137.379	
30-02-91	51	20.539	136.628	
30-02-91	52	20.456	135.788	
30-02-91	53	20.531	134.851	
30-02-91	54	20.531	133.923	
30-02-91	55	20.487	132.972	
30-02-91	56	20.559	132.126	
30-02-91	57	20.492	131.405	
30-02-91	58	20.534	130.969	
30-02-91	59	20.476	130.782	
30-02-91	60	20.501	130.841	
30-02-91	61	20.508	131.074	
30-02-91	62	20.546	131.422	
30-02-91	63	20.492	131.864	
30-02-91	64	20.505	132.467	
30-02-91	65	20.480	133.257	
30-02-91	66	20.481	134.128	
30-02-91	67	20.484	134.972	
30-02-91	68	20.494	135.893	
30-02-91	69	20.477	136.814	
30-02-91	70	20.483	137.728	
30-02-91	71	20.481	138.682	
30-02-91	72	20.482	139.620	
30-02-91	73	20.488	140.425	
30-02-91	74	20.484	141.239	
30-02-91	75	20.493	141.765	
30-02-91	76	20.490	142.128	
30-02-91	77	20.502	142.328	
30-02-91	78	20.505	142.287	

FIGURE 3: SUMMARY OF MAXIMUM MEASURED SUBSIDENCE AT ELLALONG COLLIERY

The maximum subsidence is around 31% of mined thickness. This range is low compared with predictions based on the multiple panel method of prediction for maximum subsidence, which would give a maximum subsidence value of 1.4 m. Comparison of the actual subsidence data and predicted information, based on the same mining dimensions is given in Table 1. The data suggest that the massive nature of the marine sandstone sequence above the Greta Seam is responsible for the reduction.

In addition the chain pillars will yield some amount with time but the coal still remains to reduce the amount by which all the roof strata can collapse. As a consequence the actual subsidence will be less than that indicated by the curves of Holla (1988). Strain and tilt values calculated by Ellalong Colliery from observed data are also lower than those calculated using the Newcastle Guideline method.

The maximum observed subsidence (32% of the mined height) is 1.145 m. It is likely that the actual maximum was missed because of the interference by a large dyke, and location of the surface subsidence grid as mentioned above, and that the maximum subsidence is closer to 1.2 m.

3.0 PREDICTION OF SUBSIDENCE LEVELS

3.1 MAXIMUM SUBSIDENCE PREDICTIONS

The proposed longwall workings will be single seam, extracting coal from part of the Greta Seam. The strata sequence above the Greta Seam consists of silty sandstone, sandstone and conglomerate of the marine Branxton Formation, with siltstone, sandstone and shales of the Paxton Formation forming the roof rocks to the Greta Seam. The Branxton Formation varies in thickness across the proposed longwall area, ranging between 350 m and 570 m thick, and it has massive bedding characteristics.

The maximum possible subsidence occurs in the Newcastle Coalfields when the width of the extracted area exceeds 1.6 x Depth of Cover(H). At Ellalong with chain pillars remaining between panels, extraction width never exceeds 1.6 x Cover Depth. It varies between 0.37 and 0.66 x Cover Depth.

PANEL NUMBER	RANGE OF WORKING DEPTH (m)	AVERAGE DEPTH H (m)	MINING HEIGHT T (m)	PANEL WIDTH W (m)	PILLAR WIDTH (m)	PILLAR WIDTH / H	W / H	Sm / T	MAXIMUM SUBSIDENCE Sm (m)	ANGLE OF DRAW (Degrees)	GOAF EDGE SUBSID. (m)	ZERO SUBSID. Distance From Panel	Tensile Strain (mm/m) 400Sm/H	Compress. Strain (mm/m) 600Sm/H	Tilt (mm/m) 1800Sm/H	Radius of Curvature (km)	Inflection Point Posn. - inside: D/H	D (m)	0.5Sm (m)
NEW MINE	aver. values	495.00	3.95	211.70	38.00	0.08	0.43	0.29	1.15	26.50	0.20	247.50	0.93	1.39	4.17		0.26	128.70	0.57
	400.00		3.40	211.70	38.00	0.10	0.53	0.32	1.09	26.50	0.20	200.00	1.09	1.63	4.90		0.33	132.00	0.54
PREDICTED	to		to													5.00			
PANELS												to							
15 TO 22	590.00		4.50	211.70	38.00	0.06	0.36	0.31	1.40	26.50	0.30	295.00	0.95	1.42	4.26		0.25	147.50	0.70
NEW MINE	aver. values	485.00	3.95	255.00	38.00	0.08	0.53	0.36	1.42	26.50	0.30	242.50	1.17	1.76	5.28		0.31	150.35	0.71
	420.00		3.40	255.00	38.00	0.09	0.61	0.37	1.26	26.50	0.30	210.00	1.20	1.80	5.39		0.36	151.20	0.63
PREDICTED	to		to													5.00			
PANELS												to							
23 TO 28	550.00		4.50	255.00	38.00	0.07	0.46	0.35	1.58	26.50	0.30	275.00	1.15	1.72	5.15		0.27	148.50	0.79
NEW MINE	aver. values	495.00	3.95	211.70	38.00	0.08	0.43	0.29	1.15	26.50	0.30	247.50	0.93	1.39	4.17		0.30	148.50	0.57
PREDICTED	400.00		4.50	211.70	38.00	0.10	0.53	0.32	1.44	26.50	0.30	200.00	1.44	2.16	6.48		0.38	152.00	0.72
MAX DIMEN	to		to													5.00			
LIMITS												to							
15 TO 28	590.00		3.40	211.70	38.00	0.06	0.36	0.31	1.05	26.50	0.20	295.00	0.71	1.07	3.22		0.22	129.80	0.53

TABLE 2: PREDICTED MAXIMUM SUBSIDENCE CALCULATIONS FOR ELLALONG COLLIERY EXTENSION

* Maximum subsidence modified by mine site survey

** Maximum strains, tilt etc based on Newcastle Guideline (Holla, 1987)

The chain pillars at Ellalong will have limited width (38 m) compared with the depth of mining, and will yield a little over time but will probably not fail. This phenomenon is observed in the records of subsidence over Longwall Panels 5 to 9 at Ellalong. Although the relatively smooth surface profiles could be attributed solely to the great thickness of cover strata, the coal remaining in pillars between each longwall panel also reduces the amount of subsidence, strain and tilt.

The mining height will influence subsidence levels. The mining height in the proposed longwall panels will vary between 3.4 m and 4.5 m depending on coal quality. This compares with 3.5 m to 3.6 m in the existing mine, and it complicates prediction because it is not known where the variation will be. Despite this the uncertainty can be quantified by considering the end points of subsidence based on maximum working height at shallowest depth of cover, and minimum working height at greatest depth, along with variation in longwall panel width.

The predicted maximum subsidence values are shown in Table 2 prefaced "NEW MINE PREDICTED PANELS 15 to 22, and 23 to 28". The values are reduced to take into account the particular local geology of the Ellalong area. Maximum subsidence is between 1.0 m and 1.6 m depending on cover depth and mined height. The maximum subsidence range for the first eight panels (15 to 22) will be between 1.1 and 1.4 m, while the range for the other 6 panels (23 to 28) is 1.3 m to 1.6 m. The maximum subsidence will occur with 4.5 m high workings at 550 m depth in the second group of eight widened panels.

The variation in maxima with other combinations of mining height, seam depth and panel width is also shown for all panels. It demonstrates that the extremes of subsidence influencing factors are catered for in the generalised calculations for each block of panels.

3.2 MAXIMUM STRAINS AND TILT

Surface strains have been calculated using the empirical formulae provided in the Newcastle Subsidence Guideline. The formulae in this guideline have been selected because the measured strains at Ellalong Colliery do approach the values predicted by the Newcastle Guideline, although actual ground strains are lower. The values given are consequently slightly higher than expected maxima.

Maximum compressive and tensile strain plus surface tilt predictions are given for in Table 2. Overall tensile strain values are in the range 1 mm/m to 1.7 mm/m while compressive strain values are in the range 1.0 mm/m to 2.2 mm/m. Tilt, which is the change in vertical movement over the measured interval, ranges between 3 mm/m and 7 mm/m. Maximum ground curvature is around 2 km, but commonly around 5 km.

Measured strains over Ellalong Panels 5 to 9 are the maximum recorded by the colliery, and peaked at 3.82 mm/m Tensile in the region of a cross cutting dyke. Otherwise surface strains remained close to zero. One compressive strain value of 5.5 mm/m is recorded but it is isolated, and the survey peg showed no previous history of movement, so is discounted.

Tilt measurements were not recorded, but a cross cutting dyke impacted on surface subsidence to the extent that Sandy Creek Road was disrupted, so localised tilts would have been very high at that time. The low strain records indicate that without discontinuities like the dyke tilt levels would be low.

3.3 SHAPE OF SUBSIDENCE PROFILES

A complete subsidence profile can be constructed with additional points, Goaf Edge Subsidence, Inflection Point, and the Zero Subsidence Limit. The zero limit is taken as 20 mm of ground movement to account for seasonal soil movements. Subsidence at the Inflection Point, which is the location of the change in surface stresses from tensile to compressive, is half the maximum measured, while the amount of goaf edge subsidence is the that measured over the outer most edge of the mined zone.

The guideline does predict high, and this is shown with determination of the Point of Inflection, and Goaf Edge Subsidence in Table 1, row 2.

Table 1 shows the real location of the Inflection Point over Panel 9, and the actual amount of subsidence, at the end of the first row. The predicted value is shown in the row beneath. The actual subsidence is 0.6 m at 123 m inside the goaf edge, whereas the guide would give its location 102 m inside, and with subsidence of 0.7 m. The differences are small, and thus give justification for using the guide for those determinations that cannot be made any other way. But it is clear that the maxima listed in Table 2 for the new mining area are indeed maxima.

The subsidence profiles developed at Ellalong are much flatter than the Guide would predict because of the massive nature of the cover rocks. While the profile is flatter, particularly in the tensile stress zone away from a mined panel, the actual limit of subsidence is similar for both measured and predicted distances. The zero limit ranges between 200 and 300 m from the edge of a mined area.

In summary the measurements at Ellalong Colliery to date indicate that less subsidence, strain and tilt occur over the surface than the best available guideline, the Newcastle Guideline, would predict. Actual subsidence is 300 mm to 400 mm less, strains are up to half predictions, and tilts also up to half predicted values. Goaf edge subsidence, and Inflection Point subsidence are substantially less, yet the limit for subsidence remains similar.

At the same time unusual surface events occurred in the vicinity of a large dyke, which extends from below seam to surface.

4.0 MINING SUBSIDENCE IMPACTS

4.1 SURFACE FEATURES

The land surface above the proposed workings comprises part of the valley of Ellalong Creek and the slopes of part of the Broken Back Range. Creek level drops from RL 130 on the eastern side to RL 120 on the western side of the longwall area. The creek RL remains at RL 120 west of the proposed longwall panels, and has undergone subsidence from previous colliery workings. The land on either side of the creek has been cleared and developed for farming.

The Broken Back Range is north of the creek and is covered by State Forest, Crown Land, and land owned by the colliery/partners. Maximum RL is 227 m at Howard Trig, while the spine of the range varies between 194 m and 170 m. Howard Trig is a prominent hill within the proposed mining area. The northern side of the range slopes down to approximately RL 110 m within the longwall area.

The ridge line of the Broken Back Range accounts for the large variation in depth of the Greta Seam over Longwall Panels 23 to 28.

The land around Ellalong Creek is subdivided, and 21 properties will be within the Zero Subsidence Line as outlined in Figure 1. The properties are numbered in accordance with the EIS document, and are listed in Table 3 for ready reference. The area is not in a declared Mine Subsidence District. However this makes no difference as recent changes to the Mine Subsidence Act means that property owners are protected as if the area was already declared.

Most houses and sheds, including poultry sheds are visible from public roads, and the visible buildings are listed in Table 3 below. However restrictions on entry to private land mean that the list is incomplete. In general houses are either older homes built on piers, or newer homes of brick veneer on slab construction. Some house have concrete water tanks nearby, and most have garages or sheds.

Property 15 has two long poultry sheds with feed silos in addition to farm sheds, and the Duff property has horse stables at the northern end.

All properties are fenced, and have power to dwellings from the main feeder lines along Sandy Creek and Quorrobolong Roads. The spans of the lines to dwellings is very large in a number of cases. Underground telephone lines are laid throughout the area. A number of properties have stockyards.

There is one licensed water bore within the longwall mining area (Property 12), and one licensed bore at the zero subsidence limit (Property 14). The aquifer in the Property 12 water bore is 10.7 metres deep, and is 0.6 m thick, while the borehole depth is nearly 40 m. Recorded yield is 1 L/sec, and water is "salty", but there is no record of its use on public file.

There are two timber bridges, and several concrete culverts that will be affected by subsidence. Three concrete culverts occur along Sandy Creek Road opposite the property 48, which also has some erosion control structures.
In the mining area a short section of Sandy Creek Road, and all of Quorrobolong Road are sealed.

In addition to improvements there are more than 30 dams situated on the alluvial plain or on the slopes adjacent to the plain, which will be undermined, or within the zone of subsidence.

4.2 IMPACT OF SUBSIDENCE ON IMPROVEMENTS

Subsidence will be confined to the area immediately above the planned longwall panels, and from approximately 200 m to 300 m beyond the longwall extraction area. Coal extraction will lower the land surface by up to 1.6 m as shown in Figure 1.

The amount of subsidence beyond the actual mining panels is low at 300 mm or less. This amount, along with the low strain values predicted will cause minimal to no disturbance to structures and improvements, where there are normal strata beneath.

Surface disturbance above the actual mining panels will generally be low because of the depth and dimensions of workings. The strain values measured over workings at Ellalong have been less than 1 mm/m tensile or compressive, except around a major dyke. These levels applied to house and farm sheds would result in negligible damage. Long poultry sheds would suffer some distortion because of their length. The prediction figures equate with low damage levels according to established criteria. There are however invariably occasional exceptions to the expected maximum because of unknown localised variability in rock strata, topography or geology.

Properties 9, 10, 11, 12, and 15 will experience maximum subsidence. Structures close to Sandy Creek Road on properties 10 and 11 will experience subsidence between 0.3 and 1.0 m. Strains and tilt levels should be considered as the maximum predicted. Cottages on properties 9, and 12 will experience maximum subsidence by virtue of locations towards the centre of the longwall area.
The chicken sheds on property 15 are positioned over the goaf edge of panel 22 and will be subsided around 0.5 m at the western end and 0.2 m at the eastern end. Strains and tilt will be near the maxima predicted. The cottage on property 15 will experience far less subsidence than 0.2 m because it is well beyond the longwall panels. This also applies to properties 13, 14, 20, 21, 30, and 52.

PROPERTY NUMBER	UNDERMINED BY LONGWALL Nos	VISIBLE IMPROVEMENTS
9	15 - 17	Nil visible
10	15 - 18	Metal clad workshop/shed plus 2 small metal clad sheds
11	16 - 19	Metal roof cottage, 1 small & 2 large sheds
12	17 - 22	Large metal roof cottage, 2 large metal sheds
13	18 - 19	Metal roof cottage & stable plus metal shed
14	19 - 22	W'board/metal roof cottage, 2 metal sheds, 1 Galv. shed
15	20 - 22	W'board/metal roof cottage, large metal shed, 1 C'bond shed, 2 Chicken Houses, food silos
16	15 - 16	Nil
17	22	Brick/tile cottage, 2 brick/metal garages
18	Edge of Zero Subsidence	Nil
20	22	3 Brick/tile cottages, 1 C'bond garage
21	Within subsidence	B/V house, other details not known
22	Within Subsidence	Nil
28	27 - 28	Nil visible
29	28	Nil visible
30	Edge of Zero Subsidence	House, concrete tanks, shed
32	27 - 28	Brick/Tile cottage, 3 Chicken sheds
42	Within Subsidence	Nil visible
48	Within Subsidence	Nil visible
51	22	Powerline
52	Within Subsidence	New W'board cottage, older cottage

TABLE 3: PRIVATE PROPERTIES AFFECTED BY SUBSIDENCE

* "Edge of Zero Subsidence", or "Within Subsidence" means that there is no longwall panel under the property but the property is within the Zero Subsidence Limit.

Other improvements within the mining area which include fences, power lines, concrete culverts, two timber bridges and buried telephone lines will be minimally affected. Location of water mains is unknown.

With regard to dams there has been no reported damage to any since commencement of longwall operations. With at least 30 dams in the area the experience to date is important. It follows that maintenance of water supplies and a mechanism for repairs assistance will be necessary should there nevertheless be any of water loss from a dam as a result of subsidence.

4.3 IMPACT ON LAND SURFACE

The land surface varies from the rolling flats adjacent to Ellalong Creek to the steep ridges of the Broken Back Range. The creek drops 10 m in elevation across the mining area, and the lowering of sections of the creek by up to 1.6 m will increase ponding along its course. The impact of previous subsidence of the creek has been minimal, and it is expected that lowering of the creek, and the surrounding land will have a similar minimum impact. The nature of strata, coupled with the low strains and tilt mean that there will be negligible impact on water bearing capability of unconsolidated soils. The one water bore in the area is shallow, and no impact is expected.

The impact of subsidence along the Broken Back Range will also be negligible. Although there are small extremes in topographic relief in the forest covering the range, it is unlikely that there will be any visible effects. On the steeper slopes some ground creep may occur down the slopes, particularly where panels retreat in the same direction as the slope. Surface cracking is unlikely due to the low strains expected at the surface.

Subsidence will be progressive as mining proceeds actual ground movement at any one time will be local in area, and will vary in effect. Measured strain and tilt levels are low, while predicted maxima, based on guidelines that are over predicting values, do approach levels where significant structural damage to buildings is likely on anything but a small scale.

Subsidence movements of any point at the surface are delayed until well after the passage of the longwall beneath. This delay is due to the massive nature of the Branxton Formation. Holla (1986) measured sub-surface movements over Longwall Panel 2 and found that surface movements were negligible when the face passed beneath. Mining face retreated 400 m before 90% of surface subsidence was recorded. There after movement will continue, as adjoining panels are mined. At some stage the massive strata fails because the amount of roof hanging up is too great. In the past such roof caving, or settlement appears to have produced pronounced vibration events that are subject to separate environmental assessment elsewhere within the Environmental Impact Statement.

4.4 IMPACT ON ARCHAEOLOGICAL SITES

Mining by underground methods at Ellalong will lower the surface by between 1.0m to 1.4 m. In the process the surface can move transversely by small amounts (ie, millimetres) as well as vertically downward. After mining the ground surface stabilises again.

Virtually all the ground surface remains intact. There are no cave structures known to contain archaeological remains that would be affected by mining, nor are there any cliff faces that might fall, nor soil faces that could subside and bury currently visible archaeological sites.

Concern has been previously expressed that erosion caused by subsidence, or loss of relics down cracks opened by subsidence will damage the archaeological record. The incidence of these two events will be so low that consideration of such an event should be discounted. The incidence would be infinitesimally small compared with the ongoing damage caused by farming and grazing. It ought to be remembered that the area has been subjected to intensive surface modification for the last 100 years.

Underground coal extraction, while lowering the surface, is still going to leave an essentially intact surface. The levels of subsidence are low, as are strain values, above the planned longwall panels which will undermine the sites. These factors will limit any movement of archaeological material from their present positions.

5.0 SURFACE MANAGEMENT

Management measures to mitigate the impact of subsidence caused by full seam extraction can be generally incorporated into normal land management programs for Company owned land. The principal management measures required will be any necessary to cover any ground cracking to avoid the chance of stock injury in the short term.

The most productive land is the alluvial land surrounding Ellalong Creek. The land is used primarily for grazing, and sometimes for cropping. Both land uses may require minor regrading of any ponded areas resulting from subsidence. Experience to date has not shown this to be necessary, but the issue is noted to ensure full awareness of the possible likelihood. The need for, and extent of regrading will depend on the land use.

Ellalong Colliery has in place a subsidence policy to assist private land owners where the provisions of the Mine Subsidence Compensation Act do not apply. With the mechanistic framework for covering the cost of any rehabilitation in place, land surface repair can be carried out by agreement with the land owner, and Ellalong Colliery. The policy also covers replacement of water supplies in the event of a loss. No such replacement has proved necessary to date.

The actual amount and timing of likely subsidence at any point on the surface can be determined accurately from the location of workings, and the delay before surface effects appear. Consequently any areas containing structures that might be adversely affected by subsidence can be visually monitored, and remedial action quickly undertaken if required. The emphasis is on possible impacts because the experience to date is one of little disturbance to surface improvements. However even the rare possibilities are required to be addressed by the impact assessment process, and are discussed below.

For dams this may mean partial reconstruction. In the unlikely event that any surface cracks appear they will be dozed over to prevent injury to stock, and restore the surface land. Fences can be inspected and repaired if posts are move out of alignment or wire broken. Pumps may need to be re-seated. Power lines, especially private ones, should be monitored as poles can tilt, causing power lines to break. Houses will need to be given the most attention, and slight damage is likely to occur at levels considered repairable.

The banks of the creeks will need to be monitored for signs of slippage and erosion. Any such damage should be speedily stabilised before installation of permanent bank stabilisation measures. This work would be under the control of the relevant authorities. Experience to date with settlement of creeks and swampy areas is that there has been no discernible change.

The forgoing indicates that there may be impacts on the surface, but those impacts will not stop present land uses. Damage that might occur, as listed in this report, is capable of speedy repair. Any temporary loss of land use is recoverable through the Mining Act provisions, or by legal agreement with Ellalong colliery. The National Coal Board (NCB) damage code suggests that damage will be slight. This assessment considers the damage levels will be little different that already experienced (leaving aside vibration events).

Houses for example, have on detailed investigation proven to be little affected by subsidence events such as settlement, tilt, and strain. The Mines Subsidence Board has paid claims for 4 house subject to subsidence damage in these categories, and purchased one property. This past experience provides a good indication of expected future structural damage to dwellings and other structures. The ability to protect and repair the houses will be improved by monitoring over panels preceding those underlying houses at risk. Once some monitoring data are available detailed impact studies on the houses will be possible.

The second phase of the application process required by Ellalong Colliery to undertake mining according to the requirements of the Department of Mineral Resources also affords protection to property owners. At this stage detailed predictions are carried out on all relevant structures and plans to avoid, minimise or repair are put in place in consultation with property owners.

6.0 CONCLUSIONS

Longwall extraction operations in the Greta Seam will cause surface subsidence estimated at between 1.0 m and 1.6 metres, depending on working thickness within the seam, and depth and width of workings. At the same time depth of cover increases to the southeast and under the Broken Back Range. This means that the amount of subsidence will vary slightly across the mine area.

In general the impact on the surface is expected to be low. While the damage code indicates slight damage, the location, age and construction of the houses might result in greater damage. Improved assessment of possible structural damage will become available with results of ongoing subsidence monitoring.

The Company's subsidence management policy will have provision for assistance where any damage is not covered by legislation.

Existing water courses will not be unduly affected, and are expected to re-establish.

There is a low probability that some dams might suffer minor damage, requiring replacement water supplies until repaired and refilled.

The impact on surface run off and ground water is predicted to be minimal.

There is expected to be minimal to no impact on archaeological sites within the mined area. The nature and concentration of sites coupled with the small amount of actual surface damage that might occur renders the chance of damage to a particular site extremely small, and this must be considered a tolerable risk level.

Overall the subsidence impacts from longwall operations in the Greta Seam will be small, and capable of mitigation and control. They will require ongoing subsidence monitoring, coupled with land management practices, and arrangements to protect, assist or compensate property owners. Experience in managing the surface, particularly the more productive cleared land will increase with time, and management plans should be capable of adjustment to use experience gained.

G E HOLT & ASSOCIATES PTY LTD

Graham Holt

Graham Holt MIEAust CPEng
Principal Geotechnical Engineer

REFERENCES

HOLLA, L (1988) Effects of Underground Mining on Domestic Structures - Prediction Versus Performance. 5th Aust.-New Zealand Conference on GEomechanics, Sydney, N.S.W. August.

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APPENDIX I

SUBSIDENCE TERMINOLOGY

SUBSIDENCE TERMINOLOGY

The following symbols, terms and definitions are taken from " Mining Subsidence in New South Wales 1. Surface Subsidence Prediction in the Southern Coalfield" by L. Holla, published by the Dept of Mineral Resources, December, 1985. Units of measurement are given in brackets.

H = cover depth (m)
L = panel length (m)
T = effective extracted seam thickness (m)
W = panel width (m)
e = distance between panel centre line and point of maximum subsidence

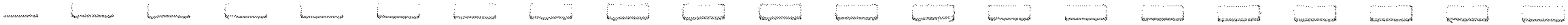
D = distance of inflection point from goaf edge (m)
S = subsidence at any point (m)
Sc = subsidence at panel centre line
S_{z} (or S_{max}) = maximum subsidence along a profile (m)
Gmax = maximum change in tilt along a subsidence profile (mm/m)
Rmin = minimum radius of curvature along a profile (km)
+Emax = maximum tensile strain along a profile (mm/m)
-Emax = maximum compressive strain along a profile (mm/m)
K1 = tensile strain factor (non-dimensional)
K2 = compressive strain factor (non-dimensional)
K3 = tilt factor (non-dimensional)

TERMS AND DEFINITIONS

Cover depth(H): The depth of a seam below the surface averaged over the extraction panel.

Critical area: The area of panel which causes the maximum possible subsidence of one point on the surface. The area which causes S_{max} to reach its maximum value.

Extracted seam thickness: The thickness of seam extracted, averaged over the panel.



Effective extracted seam thickness (T): The extracted seam thickness, modified if required, to account for unmined pillars (modification based on the percentage of extraction within the panel).

Goaf: Mined out area into which the immediate roof layers break off in large fragments.

Inflection Point: The point on the subsidence profile at which strain changes sign and subsidence is half S_{max}.

Panel: The plan area of coal extraction.

Panel length (L): The longitudinal distance along a panel measured in the direction of mining.

Panel width (W): The transverse distance across a panel, usually equal to the face length plus the widths of roadways on two sides.

Sub-critical area: An area of panel smaller than the critical area.

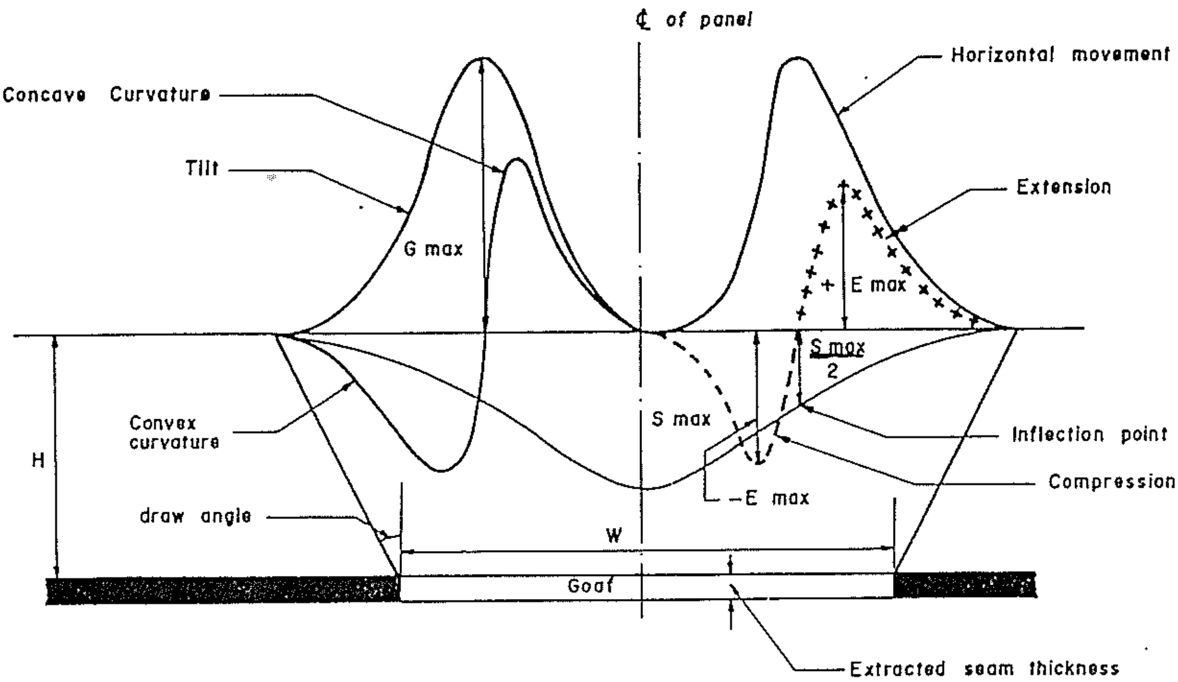
Super-critical area: An area of panel greater than the critical area.

CRITERIA FOR DETERMINATION OF MAXIMUM SUBSIDENCE

Maximum subsidence can be predicted using the empirical guidelines if the following criteria are met:

- Only one seam is extracted, or in the case of multi-seam extraction, the workings in the other seams are too far away to have any influence.
- The extraction panel is nearly rectangular. Otherwise average width used.
- The extracted seam thickness is adjusted, if required to account for unmined pillars or pillar remnants. The adjusted thickness is referred to as the effective extracted seam thickness (T).
- The residual subsidence has occurred.
- The roof contained within the extracted panel is caved.
- The overburden is free from dykes, faults or other geological discontinuities which can alter the normal subsidence behaviour.

For the Newcastle Coalfield, maximum subsidence S_{max} occurs when panel width is equal to or greater than 1.6 x cover depth (H). The probable value of the maximum possible subsidence for critical and super-critical extraction widths can be taken as 0.55T. For the Southern Coalfield, S_{max} is 0.65T when W > or = 1.4 x cover depth (H).

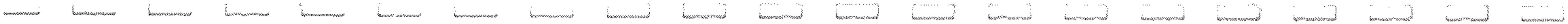


Characteristics of trough subsidence
Left half of profile: Vertical Components
Right half of profile: Horizontal Components

APPENDIX II

NATIONAL COAL BOARD (GREAT BRITAIN)

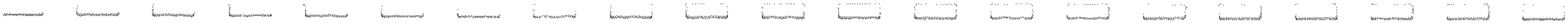
CLASSIFICATION OF SUBSIDENCE DAMAGE



As a result of experience gained over many years (in Great Britain)...... a damage scale classification has been devised which lists five accepted grades of subsidence damage. The classification is shown in the table below. The factors of strain and building length used in compiling the classification give only a general guide in the prediction of damage intensity. Accurate prediction also depends upon an expertise difficult to reduce in quantitative terms and which can only be acquired from a wide experience with buildings of various age and type of construction.

Change of Length of Structure	Class of Damage	Description of Typical Damage
Up to 0.03 m	1. Very slight or negligible	Hair cracks in plaster Perhaps isolated slight fracture in the building, not visible on outside.
0.03 m – 0.06 m	2. Slight	Several slight fractures showing inside the building. Doors and windows may stick slightly. Repairs to decoration probably necessary.
0.06 m – 0.12 m	3. Appreciable	Slight fracture showing on outside of building (or one main fracture). Doors and windows sticking; service pipes may fracture.
0.12 m – 0.18 m	4. Severe	Service pipes disrupted. Open fractures requiring rebonding and allowing weather into the structure. Window and door frames distorted; floors sloping noticeably; walls leaning or bulging noticeably. Some loss of bearing in beams. If compressive damage, overlapping of roof joints and lifting of brickwork with open horizontal fractures.
More than 0.18 m	5. Very severe	As above, but worse, and requiring partial or complete rebuilding. Roof and floor beams lose bearing and need shoring up. Windows broken with distortion. Severe slopes on floors. If compressive damage, severe buckling and bulging of the roof and walls.

National Coal Board Classification of Subsidence Damage (from Subsidence Engineers Handbook, Mining Department, NCB, 1975)



2.0 ELLALONG COLLIERY EXTENSION REPORT ON GROUND VIBRATION CAUSED BY MINING SUBSIDENCE, RENZO TONIN AND ASSOCIATES, 5 JANUARY 1995

TECHNICAL REPORT

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ELLALONG COLLIERY EXTENSION

REPORT ON GROUND VIBRATION CAUSED BY MINING SUBSIDENCE

Report No: T379F105

5 January, 1995

TABLE OF CONTENTS

1. INTRODUCTION

Underground mining in the current workings of the Greta Seam located approximately 350m beneath the Ellalong township began approximately in July 1983. The proposal considered in this report is an area located to the north of the current workings. The long wall panels which are the subject of this report are numbered LW16 to LW28.

It is now widely recognized that ground subsidence resulting from underground mining may also have associated with it ground vibration caused by the sudden failure of the rock strata above.

The aim of this report is to assess the likely impact of ground vibration caused by underground mining on houses in the immediate vicinity, in particular the likelihood of damage which may possibly occur.

As with the study of Earthquakes, it is not possible to predict the magnitude of ground vibration resulting from subsidence nor is it possible to predict the epicentre or the likely time of occurrence. Geologists point to the edge of the longwall as being the most likely place for shear fractures but lack of data prevents a more positive prediction.

The fact is, that interest in vibration has only occurred over the past few years in Sydney and therefore data relating to this subject is very scarce.

However, over the years, Ellalong Colliery and the Mines Subsidence Board have monitored a number of ground vibration excursions at various locations in Ellalong resulting from the current mining activity. The data was analysed by Renzo Tonin & Associates Pty Ltd in report reference T331FT05 dated 5th October 1994. An important conclusion of the report was that the vibration data was shown to scale in a manner consistent with ground vibrations associated with subsidence.

It is possible to derive from the data a set of scaling laws which are assumed to apply to this region generally. The scaling laws assist in predicting vibration levels at given distances provided that the magnitude of the events (equivalent to the Richter strength of an earthquake) and the epicentre of the vibrations are known.

The difficulty we face is that the magnitude and epicentre of ground tremors are not known with any certainty and cannot be determined *a priori*. Therefore, the approach taken in this report is to assume that the magnitudes previously measured are likely to occur again in the subject region of mining considered here.

The epicentre is assumed to be located anywhere in the subject region. For this site, however, the exact location of the epicentre is not a critical factor because there is no predominance of housing development in any one region on the site.

We point out that these are conservative assumptions given that the cantilever surcharging (cover depth) is 100m less for longwalls 13, 14,15 and 16 compared with the current workings at Ellalong and hence it is less likely that the same magnitude of events would be expected. However, for longwall 17 onwards, the same magnitude of events may occur.

Based on these assumptions, we are able to determine a possible range in vibration levels which can be expected **if a vibration history similar to that experienced in the current workings is repeated here.**

We stress that there is no mechanism by which we are able to predict that the vibration history will repeat itself. In fact it is quite possible that no vibration will occur at all.

2. DESCRIPTION OF HOUSES IN THE AREA AND SUSCEPTIBILITY TO DAMAGE

The location of the closest houses potentially affected by vibration from the mine are shown in Figure 1. Houses in the area were inspected from a vantage point on public roads nearby.

Houses in the region range from new residences to others which are possibly more than 50 years old. Construction materials included timber frame clad with weatherboard or compressed fibre cement sheeting. There were also a significant proportion which were brick veneer or possibly full brick construction. Practically all houses are single storey constructions. Some structures are chicken sheds.

Troublesome soft clays, or sands having a small clay content are not expected to be prevalent in this area. By comparison with other houses in the Ellalong area, foundations are expected to be strip or pad footings in buildings of more recent origin and brick or timber posts in some of the older houses. It is expected that the newer buildings are constructed on reinforced concrete raft slabs.

Visual inspections shows that some houses have corrugated iron or metal deck roofing and others are tiled.

Our experience with inspection of damage to houses in Ellalong from the current workings shows no consistent pattern which would categorise one particular form of construction as being more prone to reports of defects than another.

Neither does it appear on the evidence that a particular type of construction is more or less likely to suffer from a particular type of defect. For example no pattern emerges in the case of ceiling defects which would distinguish metal roof from tiled roof construction.

Vibration generally causes damage to structures by the action of differential movement in the structure. The upper part of a structure usually moves more than the foundation. If the upper part twists about the foundation, this racking motion produces characteristic shear stresses and failures particularly in cornices and ceilings.

When attempting to provide explanations for a defect present in a domestic residence it is important to be aware that there can be many underlying causes. In fact a combination of reasons frequently offers the most probable answer.

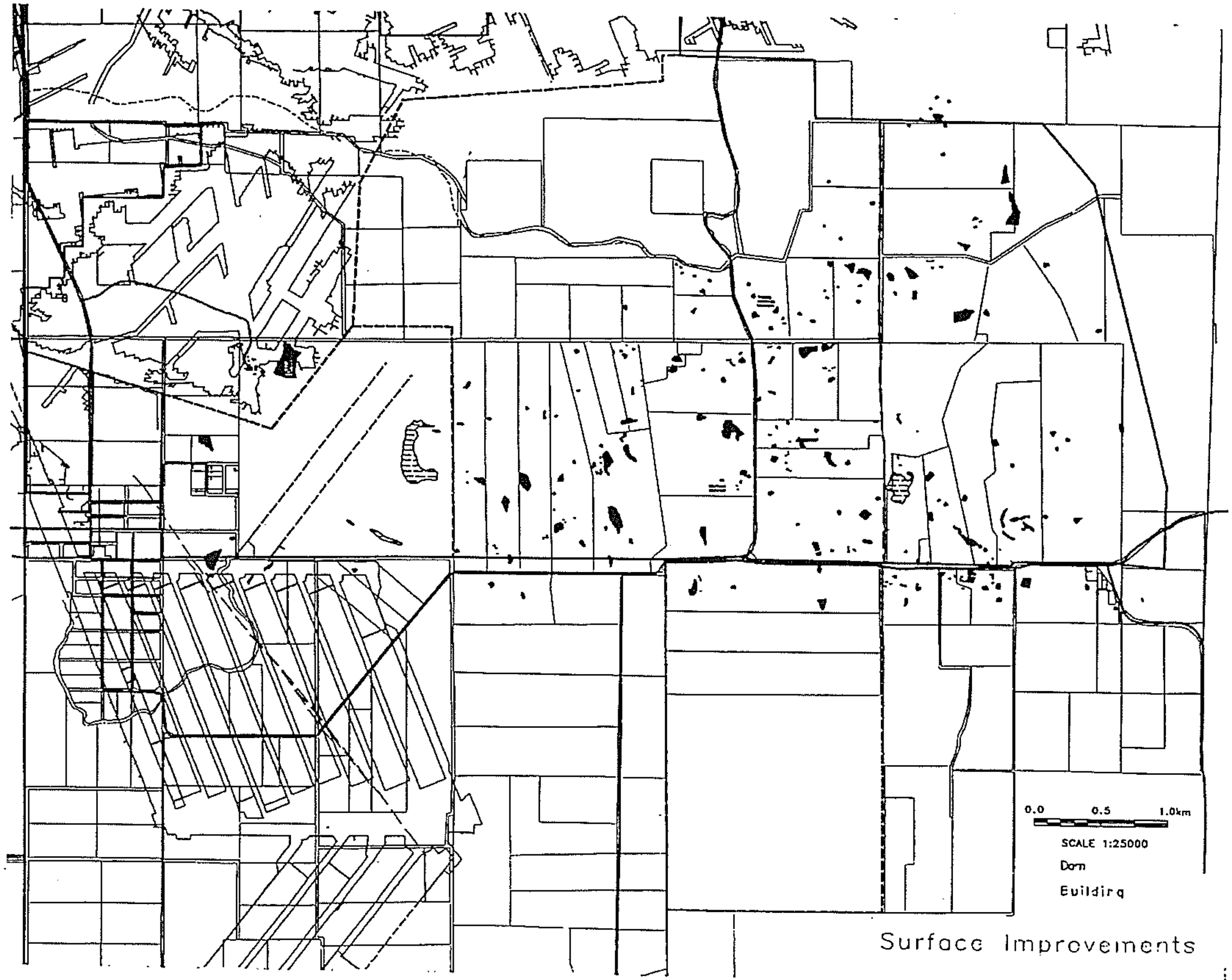


FIGURE 1: SITE PLAN SHOWING LOCATIONS OF HOUSES

In general terms these could include the following.

- There may be defects in the materials supplied for construction.
- Faulty construction techniques may have been used during installation.
- Most materials used in construction are likely to deteriorate with time. This process will be speeded up if circumstances are unfavourable or delayed by regular maintenance.
- A variety of external causes may responsible for the damage.

2.1 VIBRATION DAMAGE TO MASONRY AND CONCRETE

Cracks in the mortar between bricks are the first signs of damage in masonry. Crawford and Ward [1] recommend vibration levels up to 75mm/sec, measured perpendicular to the brick surface, can be tolerated before damage occurs.

Monolithic concrete, however, does not crack until particle velocities exceed 250mm/sec [1].

Reference [2] examines the effects of blasting on houses in Newcastle from channel deepening in the Hunter River. The response of a full brick house was investigated at Nobbys head which had been subjected to ground vibration levels as high as 22 mm/sec. Comparatively large amplitudes of vibration velocity were recorded on the exterior walls of this house. No significant exterior damage was evident in this case.

Brick veneer houses in the Stockton area were also examined in the study. One particular house constructed with lime mortar of poor quality was monitored. This house was one in a group subjected to peak particle velocities greater than 5 mm/sec for a significant number of blasts and all showed similar types of failure although the types of failure and the velocity levels are unreported.

2.2 VIBRATION DAMAGE TO PLASTER AND PLASTERBOARD

Siskind et al [3] in their study of ground vibration from mine blasting concluded that the following (low frequency) vibration levels were safe for residential type structures;

TABLE I - BLASTING VIBRATION LIMITS PROPOSED BY SISKIND et al

Type of Structure	Ground Vibration - Peak Particle Velocity mm/sec
Modern homes, drywall interiors	19
Older homes, plaster on wood lath construction for interior walls	12.5

3.0 THE NATURE AND CAUSE OF VIBRATION RESULTING FROM GROUND SUBSIDENCE

The long wall mining technique utilised to extract the coal resource permits a controlled collapse of the roof or goaf of the area from which coal has been extracted.

The earth subsides gradually over a period of time to fill the void. The pillars and abutments load up and ultimately this results in a tensile failure of the immediate roof cantilevers. Modelling work undertaken by the mine geologists and underground monitoring indicate that this occurs within 100m of the coal seam.

Two possible mechanisms for ground tremors include the following;

1. A sudden fracture of the rock lying above the mined out area due to the tensile and cantilever failure caused by the advancing mine face, and,

2. Slippage along a fault line or rock fracture zone.

This sudden release of energy results in ground vibration not dissimilar to a heavy weight falling on the ground. We refer to these vibration events as "ground tremors".

The ground tremors experienced at Ellalong have and are at present being monitored by a number of highly sensitive vibration instruments. These instruments record the vibration traces and the time of their occurrence.

The central issue of concern is the potential damage caused by the ground tremors to residences.

While very low amplitudes of vibration can be felt, this does not necessarily mean that such vibrations cause damage to buildings. Therefore, central to the discussion in the next section is a review of standards used by the international community to assess damage to structures caused by vibrations.

Ground vibration can be thought of as the rapid backwards and forwards motion of the ground. Most people may think that the best method of measuring the intensity of the vibration is to measure the maximum displacement amplitude of the motion backwards and forwards.

However, this is not the case because the displacement amplitude by itself is not a good indicator of damage potential, rather, one also needs to know how quickly the ground is moving backwards and forwards. For this reason, when assessing the likelihood of damage to structures from vibration, the amplitude or intensity of the vibration is most commonly measured in two ways;

- Acceleration amplitude, and,
- Velocity amplitude.

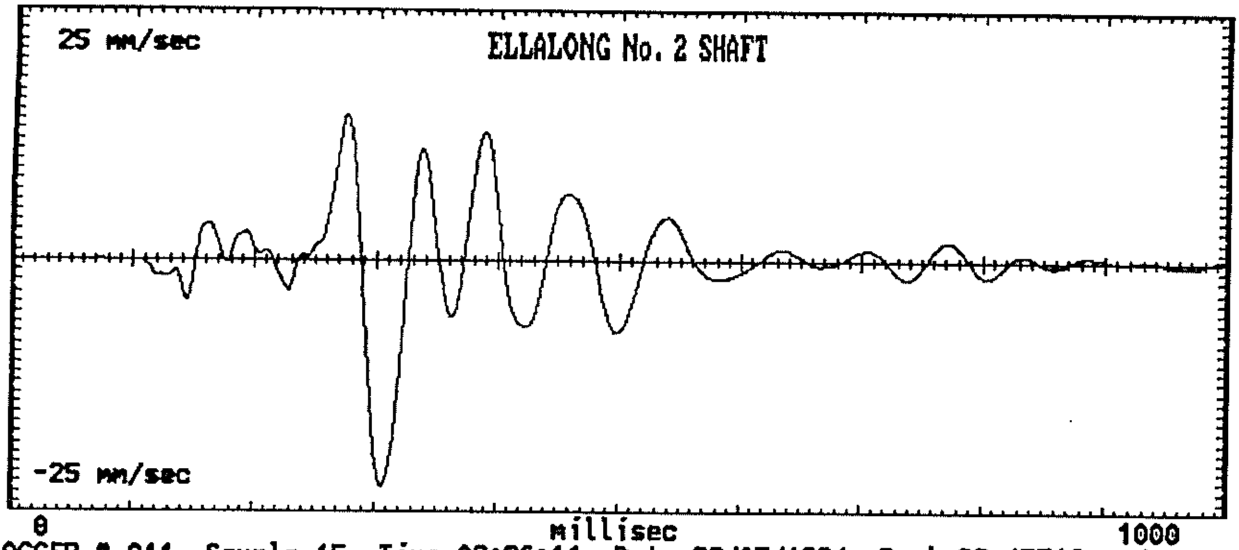
The choice of which of the two to use depends upon whether the ground vibration is of very low frequency (such as an earthquake) or moderately high frequency (such as a ground tremor caused by subsidence or blasting).

Acceleration amplitudes are typically used by seismologists to quantify damage potential from earthquakes. The low frequencies associated with earthquakes have the potential to produce large particle velocities and enormous displacements.

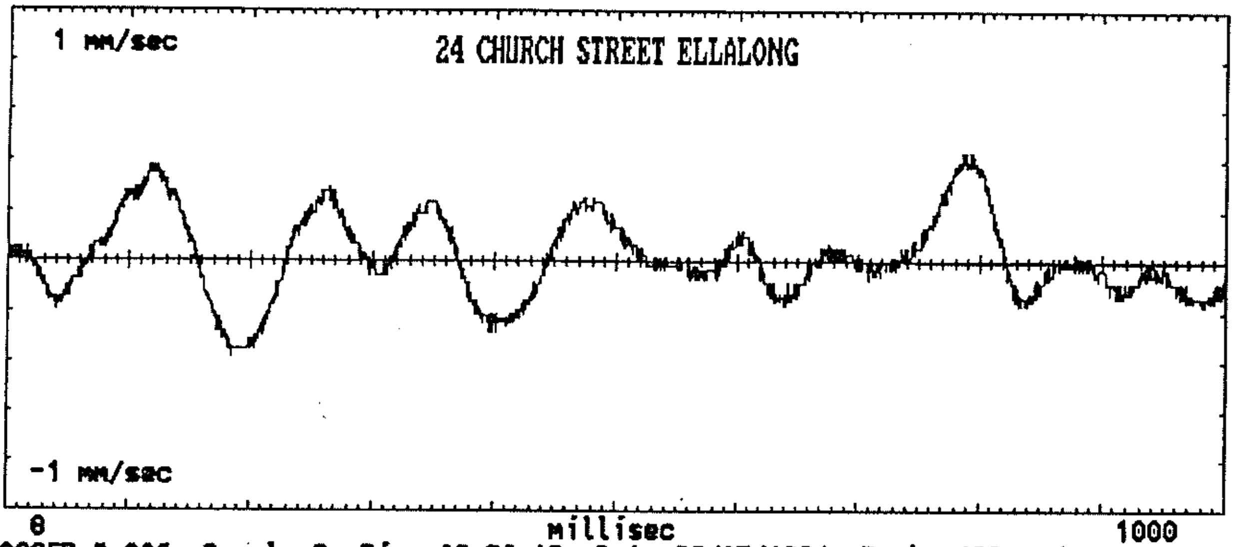
Earthquakes produce long-duration and very low frequency events. The vibration frequency and consequently the displacement and acceleration amplitudes depend strongly on the local geology. Thick solid overburden create long duration, low frequency wave trains.

Richter [4] observes that the damage potential of a given vibration is dependent on its duration - for example an earthquake lasting only for a few seconds may be insignificant but the same strength earthquake lasting for 25-30 seconds could produce very serious damage.

Ground tremors are short vibration events, usually not lasting more than a second. Figure 2 shows a typical ground tremor produced by subsidence.



LOGGER # 011 Sample 15 Time 09:26:11 Date 29/03/1994 Peak 22.47516 mm/sec



LOGGER # 006 Sample 2 Time 09:26:12 Date 29/03/1994 Peak .429 mm/sec

FIGURE 2:TYPICAL GROUND TREMOR CAUSED BY SUBSIDENCE

TOP TRACE- RECORDED AT No. 2 SHAFT

BOTTOM TRACE- RECORDED AT 24 CHURCH St.

4.0 VIBRATION DAMAGE CRITERIA

There are no standards anywhere in the world as far as we are aware that relate specifically to ground vibration caused by tensile failures. However, the nature of the vibration trace shown in Figure 2 is similar to that produced by blasting in open-cut mines. For this reason, and in the absence of any other directly applicable standards, we rely on those standards which specifically relate to damage produced in structures by ground vibration caused by blasting.

Without exception, these standards measure vibration amplitude by reference to the vibration velocity (i.e. the speed of backwards and forwards ground motion) and the units of measurement are millimetres per second, denoted mm/sec.

AS2187

The only standard in Australia which specifically relates to vibration damage resulting from ground vibration is Australian Standard AS2187 - 1993 "Explosives - Storage, transport and use".

This standard specifically relates to vibration effects produced by blasting but is relevant to ground tremors because the vibration resulting from both events is similar in nature.

The proposed limits take into account both human discomfort and structural integrity and would therefore be considered conservative. The standard recommends the following peak particle velocity limits;

TABLE II - VIBRATION LIMITS PROPOSED IN AUSTRALIAN STANDARD AS2187

Type of building or structure	Peak Particle Velocity mm/sec
Houses and low-rise residential buildings; commercial buildings not included below	10
Commercial and industrial buildings or structures of reinforced concrete or steel construction	25

The likelihood of damage in residential areas starts to increase at ground vibration levels above 10mm/sec.

DIN4150

The German standard DIN4150 "Structural Vibration in Buildings" 1986 has guideline values of vibration which may result in damage or a reduction in the utility value of the building. By a reduction in the "utility value" is meant;

1. an impairment of the stability of a structure or a building component,

2. a reduction in the load bearing capacity of floors,

3. the enlargement of cracks already present, or,

4. the separation of partitions or intermediate walls from load bearing walls.

The following table is recommended by the standard for evaluating the effects of short-term vibration in the frequency range of interest here, namely 10 to 50 Hz.

TABLE III - VIBRATION LIMITS PROPOSED BY DIN 4150

Type of structure	Foundation Vibration Velocity Limit mm/sec
Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20 to 40
Residential dwellings and buildings of similar design and/or use.	5 to 15
Structures that, because of their particular sensitivity to vibration, do not correspond to those listed above and are of great intrinsic value (e.g. buildings that are under a preservation order).	3 to 8

Provided the values given in Table III are observed, damage due to vibration, in terms of a reduction in the utility value, is unlikely to occur. If the above velocity values are exceeded, however, it does not follow that damage is inevitable, rather the circumstances of the particular case should be taken into account.

ISO 4866

International Standard ISO 4866 "Mechanical vibration and shock - Vibration of buildings - Guidelines for the measurement of vibrations and evaluation of their effects on buildings" (1990) categorises buildings according to their vibration susceptibility.

For a reason that is not clear, this standard no longer incorporates damage acceptability criteria even though the original draft standard DP 4866 (1975) promulgated the following recommendations;

TABLE IV - VIBRATION LIMITS PROPOSED BY DP 4866

Category of Damage	Velocity Range mm/sec
Threshold damage consisting of visible cracks in non-structural members such as plaster walls, etc	3 to 5
Minor damage consisting of visible cracks in structural members such as masonry walls, beams, columns, slabs, etc	5 to 30
Major damage consisting of large permanent cracks in non-structural members, settlement and displacement	no greater than 100

Based on this information it is our opinion that a level of 5mm/sec peak vibration is a conservatively low level below which damage due to vibration is unlikely to occur. This threshold level is taken to be the criterion for this report.

5.0 MEASURED VIBRATION LEVELS AT ELLALONG

Vibration levels caused by the existing mining activity are continuously measured at Ellalong at No2 Shaft. The Mines Subsidence Board also commenced vibration monitoring at two locations in the community, namely Church St and Wallaby Gully Road in 1993.

Typical vibration traces of a tensile failure on the 29th of March 1994 measured simultaneously at two locations are shown in Figure 2. Reference to the figure shows the typical characteristics of the ground tremor, notably a short vibration signature with maximum energy in the frequency range 10-13Hz.

The duration time of the ground tremors is of importance because in the case of vibrations of short duration the potential for damage is significantly less compared with long duration events.

If only for this reason, one should not apply the same magnitude descriptors to tensile failures as we do to earthquakes. In particular, the Richter scale measurement applied to short duration ground tremors can be entirely misleading as a measure of potential damage to structures.

The results of all the significant vibration events are shown in Figure 3. The squares in this figure depict the vibration measured at No 2 shaft while the diamonds depict the levels measured in Church St and Wallaby Gully Road.

Also shown on this figure is a line representing a vibration level of 5mm/sec below which it is considered, from a review of the standards quoted above, that damage is unlikely to occur.

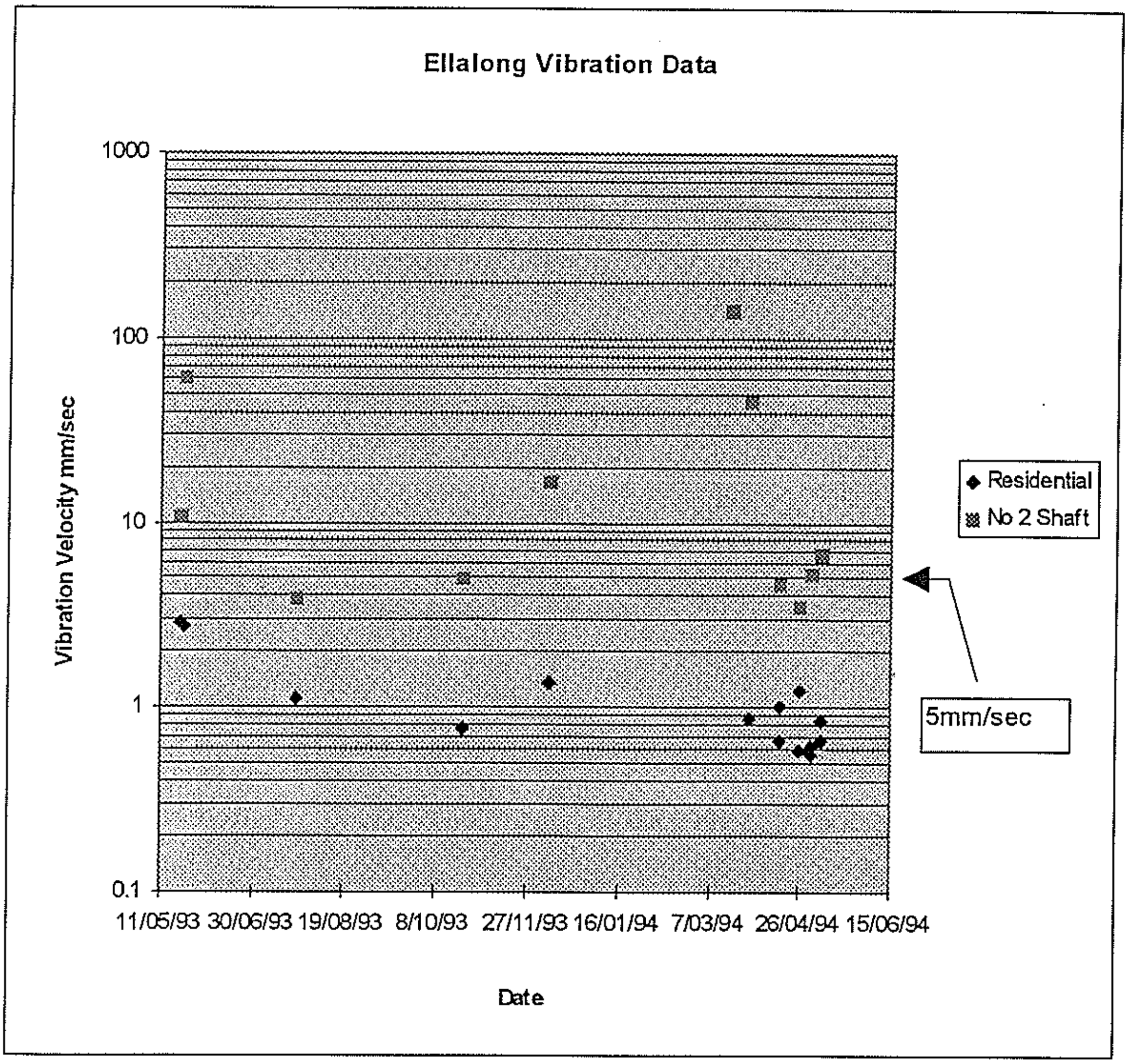


Figure 3 - Measured Vibration Levels at Ellalong from Current Workings

The determination of the epicentre of vibration events normally requires a considerable body of data collected simultaneously at many locations. At Ellalong, most vibration events were recorded simultaneously at only two locations and some at three.

The measured vibration data scales reasonably well with known theory as shown in Figure 4. This implies that the data is consistent with vibration events relating to tensile failures.

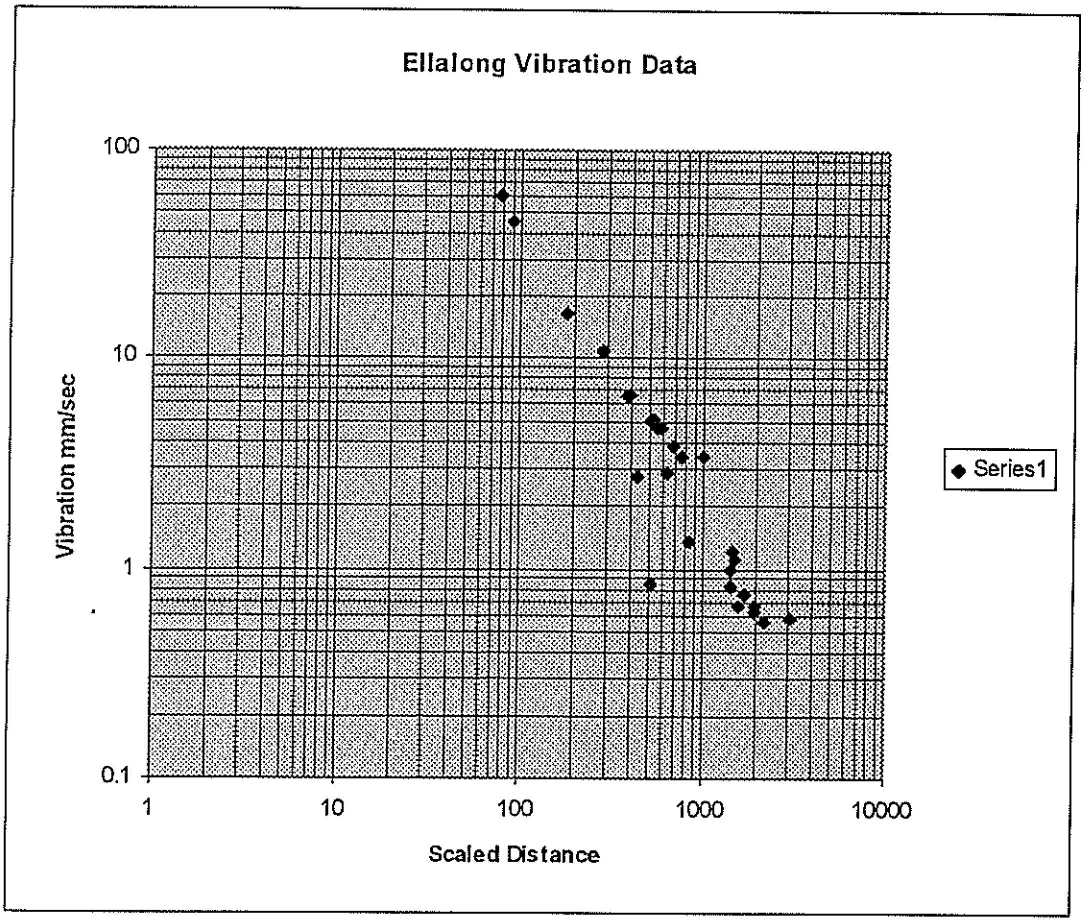


Figure 4 - Measured Vibration levels Scaled for Distance Measured from Epicentre

6.0 PREDICTED VIBRATION LEVELS FROM CURRENT PROPOSAL

We make the conservative assumption that magnitudes previously measured in Ellalong from the current workings are probable in the subject region of mining considered here. However, as previously stated, the cover depth is 100m less for longwalls 13, 14,15 and 16 compared with the current workings at Ellalong and hence it is less likely that the same magnitude of events would be expected. However, for longwall 17 onwards, the same magnitude of events may occur.

The epicentre is assumed to be located anywhere in the subject region although it is more likely that it is located close to the advancing longwall face. The exact location of the epicentre, however, is not critical to this study because there is no predominance of housing development in any one region on the site.

Based on these assumptions, we are able to determine a possible range in vibration levels which can be expected **if a vibration history similar to that experienced in the current workings is repeated here.**

The magnitude of ground tremors is measured by a non-dimensional number which can be likened to the Richter scale for earthquakes. The maximum vibration magnitude recorded at Ellalong is 3.05. The typical highest levels are in the range 1.0 to 2.0. Must vibrations measured have a magnitude less than 0.5

The following table shows, for magnitudes in the range considered, the horizontal distance beyond which the vibration level will be less than 5mm/sec peak.

TABLE V - SUMMARY OF THE EXTENT OF VIBRATION IMPACT ON HOUSES

Vibration Magnitude	Probable Relative Occurrence	Distance at Which Vibration Level Will be < 5mm/sec pk	Number of Houses Potentially Affected
3.0	0.7%	5,200m	50
2.0	1.4%	2,700m	9-18
1.0	1.4%	1,000m	6-12
0.5	7.5%	660m	3-4
<0.5	89%	Always	Nil

The column "Probable Relative Occurrence" means the likelihood, if a vibration were to occur, that its magnitude would be of the order indicated. A magnitude of order 3.0 may occur once in 1 or 2 years. This data is based on the Ellalong vibrations monitored by the mine and the MSB.

The approximate number of houses potentially affected by vibration of given magnitude are also shown. These numbers were determined by counting the houses within a given radius assuming the vibration epicentre is located anywhere on site.

If vibration occurs and the level of damage is similar to that experienced at Ellalong at present, then the type of damage one can expect will generally be cracks in cornices and wall junctions and the like which are more cosmetic than structural problems. The probability of vibration causing structural damage is extremely remote and even if it were to occur, would at most only amount to superficial damage consisting of visible cracks in structural members such as masonry walls, beams, columns, slabs, etc. In such a case, this would effect at most 2 or 3 houses.

We note that the Mines Subsidence Board has mechanisms for compensating damage caused by ground tremors resulting from tensile failures.

7.0 CONCLUSION

We conclude that a level of 5mm/sec peak vibration is a conservatively low level below which damage due to vibration is unlikely to occur.

If we assume that, for the new workings, the vibration history will be similar to that currently experienced then the potential damage to homes is likely to amount to cracks in cornices and wall junctions and the like which are more cosmetic than structural problems.

We stress that there is no mechanism by which we are able to predict that the vibration history will repeat itself. If ground tremors do occur, it is likely that the magnitude of vibration, for long walls 13-16, will be less than previously experienced. However, it is quite possible that no vibration will occur at all.

At worst, the probability of vibration causing structural damage is extremely remote and even if it were to occur, would at most only amount to superficial damage consisting of visible cracks in structural members such as masonry walls, beams, columns, slabs, etc. This would effect at most a small number of houses.

We conclude that the proposed extensions to the underground working may produce vibration which causes damage to houses but that such damage is likely to be of a minor nature.

REFERENCES

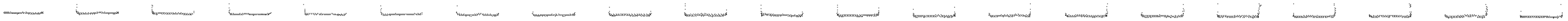
[1] Crawford, R and H.S. Ward. Dynamic Strains in Concrete and Masonry Walls. Dir. Bldg. Res. National Res. Council, Ottawa, Canada, Bldg. Res. Note 54, December 1965, 13pp.

[2] Goldberg, Meldrum and Drew. The Response of High-Rise and Domestic Buildings to Ground Vibration from Blasting, and its Relevance to the SAA Explosives Code AS2187. Trans I.E.Aust (Civil Transactions) CE27 No 3 August 1985.

[3] Siskind D. E. et al. Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting. Report RI 8507. US Department of Interior (1980).

[4] Richter, C.F. Elementary Seismology. W. H. Freeman and Co. San Francisco, 1958.

3.0 SUBSIDENCE MANAGEMENT POLICY FOR PRIVATE LANDS, ELLALONG / PELTON COLLIERY



THE NEWCASTLE WALLSEND COAL COMPANY PTY LIMITED

Subsidence Management Policy for Private Lands
ELLALONG/PELTON COLLIERY

THE NEWCASTLE WALLSEND COAL COMPANY PTY LIMITED (NWCC) WILL MAKE A COPY OF THIS POLICY AVAILABLE TO ALL OWNERS OF PRIVATE LAND WHOSE LAND WILL BE UNDERMINED.

Mine subsidence is the lowering of the surface due to the removal of the underlying coal seams.

In some instances, mine subsidence may cause damage to "improvements" and water resources.

"Improvements" are defined in the Mine Subsidence Compensation Act (1962) and include:

- any building or work erected or constructed on land
- any formed road, street, path, walk or driveway
- any pipeline, water, sewer, telephone, gas or other service main, whether above or below the surface of the land

This document addresses actions NWCC intends to take to minimise the impact of subsidence on landowners that may be affected by mining at Ellalong.

1. Landowners have the right to know when portions of their properties may be affected.

2. Schedules of extraction will be prepared showing the expected subsidence areas at quarterly intervals, two years ahead of mining. These schedules will be block outlines superimposed on aerial photos and copies will be supplied to affected landowners.

3. Immediately prior to mining, a structural report, including a comprehensive set of photos will be prepared in conjunction with Mine Subsidence Board (MSB) officials. Particular attention will be paid to plaster work in homes, door frames, window frames, operation of doors and windows, and the condition of fences and dams.

   The report, including a fully documented set of photos will be supplied to the potentially affected landowner, and the MSB.

4. Whilst the MSB is ultimately responsible for the cost of repairs to improvements damaged by subsidence, NWCC will assist the landowners if requested in making application to the MSB and to assist in arranging for any such repair work to be carried out at a time convenient to the landowner.

5. Repair work for surface damage caused by subsidence which is not covered by the Mine Subsidence Act, including ripping, ploughing or grading to repair surface damage or restore drainage patterns will be undertaken by NWCC to the reasonable satisfaction of the landowner.

5.1 The landowner is to detail this work in writing, and where appropriate by the use of plans and submit a request to NWCC that this work be undertaken.

5.2 NWCC shall within three months of the date of receiving this request carry out this work if it is satisfied on reasonable grounds that the damage has been caused by subsidence.

5.3 In the event that NWCC does not agree within the time limit to carry out the work, then the matter shall be referred to the MSB who shall appoint an independent agricultural expert to carry out an assessment of the work required on the land.

5.4 Upon receipt of the report by the independent agricultural expert, NWCC will carry out all of the work identified in that report.

5.5 NWCC shall bear the cost of reference to the independent agricultural expert.

Note that the MSB does cover earthwork repairs where these are required to eliminate Public or Private Danger.

6. **NWCC undertakes to:**

6.1 Deliver in the event of an interruption to water supplies caused by subsidence, (either through a change in quality or surface quantity) an equivalent amount of water of at least equivalent quality to a location convenient to the private landowner. If required NWCC is to provide at its cost a storage receptacle appropriate for the volume of water to be delivered.

6.2 Take such steps as are necessary to overcome the sterilisation of lands through ponding.

7. Surveys will be undertaken as a means of measuring subsidence for the purpose of improving prediction methods and to establish changes in drainage patterns caused by subsidence.

8. A copy of this policy will be provided to both landowners and the Mine Subsidence Board.

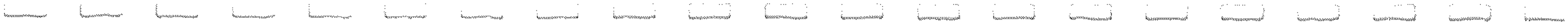
APPENDIX 11:

PROPERTY OWNERSHIP

PROPERTY NO.	OWNERSHIP AS AT NOVEMBER 1994	ADDRESS
6	Mr J.W. & Mrs J.D. Rayner	Joejie Quorrobolong Road, Quorrobolong, 2325
7	Mrs B.J. Kauter	4 Noster Place, Newcastle, 2300
8	Est Late F.W. Frost	15 Munro Street, Abernathy, 2325
9	Mrs R. Croan	11 Lynn Place, Speers Point, 2284
10	Mr R.H. Gardiner	7 Cheapside Street, Rathmines, 2283
11	Mr T.A. Duckworth	"Oakleigh" Sandy Creek Road, Quorrobolong, 2325
12	Bukanmain Pty Ltd	C/- Mr JB Reid GPO Box 3935, Sydney, 2001
13	S.J. & Mrs C.L. Duff	Lot 104 Quorrobolong Road, Quorrobolong, 2325
14	Barquin Pty Ltd	RMB 8640 Coachwood Road, Matcham, 2250
15	Mr F.J. & Mrs N. Muxlow	Quorrobolong Road, Quorrobolong, 2325
16	Mrs L.A. Guthrie	Sandy Creek Road, Quorrobolong, 2325
17	Mr A.E. & Mrs D.M. Blinkco	Lot 6 Quorrobolong Road, Quorrobolong, 2325
18	Mr G.M. & Mrs S.K. Thane	Lot 7 Quorrobolong Road, Quorrobolong, 2325
19	Mr A.J. & Mrs J.M. Conijn	RMB 7055, Taylor Road, Lisarow, 2251
20	Mr J.E. & Mrs O.J. Brown	Lot 9 Quorrobolong Road, Quorrobolong, 2325
21	Mr R.C. & Mrs C.M. Crampton	Lot 10 Quorrobolong Road, Quorrobolong, 2325
22	Mr DC & Mrs J Liddle	Lot 11 Sandy Creek Road, Quorrobolong, 2325
23	Mr L. O'Hearn	57 Dent Street, North Lambton, 2299

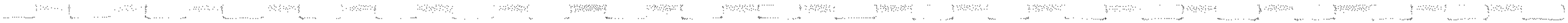
PROPERTY NO.	OWNERSHIP AS AT NOVEMBER 1994	ADDRESS
24	Mr R.L. O'Hearn	26 Farm Street, Speers Point, 2284
25	Mr J.D. Jordan & Ms T.L. McFarlane	2 Southampton Avenue, Buttaba, 2283
26	Mr P.F. Morton	C/- Lot 4 Sandy Creek Road, Quorrobolong, 2325
27	K.C. Borda	Greengate Road, Killara, 2071
28	Mr G.T. & Mrs L. Nicholls	89 Stockton Street, Nelson Bay, 2315
29	Mr G.T. & Mrs L. Nicholls	89 Stockton Street, Nelson Bay, 2315
30	Mr W.A. Fletcher & Ms J.A. Weismantel	Lot 51 Quorrobolong Road, Quorrobolong, 2325
31	Mrs B.J. Kauter	4 Noster Place, Newcastle, 2300
32	Mr P.C. Kauter	"El Cortija" Quorrobolong Road, Qurrobolong, 2325
33	Mr B.E. & Mrs K.A. Starkey	Lot 4 Off Quorrobolong Road, Quorrobolong, 2325
34	Mr B.A. & Mrs L.A. Watts	PO Box 143, Cessnock, 2325
35	L. M. P. & L. Campbell & D.L. Outteridge	87 Brighton Avenue, Toronto, 2283
36	Mr P.C. Kauter & BPK Hold. Super Fund	"El Cortija" Lot 51 Quorrobolong Road, Quorrobolong, 2325
37	The Boolaroo Land Co Pty Ltd	C/- 71 Main Road, Boolaroo, 2284
38	Mr P.F. Morton	C/- Lot 4 Sandy Creek Road, Quorrobolong, 2325
39	Mr L.D. McDonald	142A Dobell Drive, Wangi Wangi, 2267
40	J Outteridge P.D., L.J. & M.A. Campbell	C/- 87 Brighton Avenue, Toronto, 2283

PROPERTY NO.	OWNERSHIP AS AT NOVEMBER 1994	ADDRESS
43	Frost Holdings Pty Ltd	PO Box 493, Gosford, 2250
45	Abmay Pty Ltd	Athcourt, Cnr Watt & King Streets, Newcastle
46	Mr S.O. Smith	Barraba Lane, Quorrobolong, 2325
47	Abmay Pty Ltd	Athcourt, Cnr Watt & Kings Streets, Newcastle
48	Mr B.W. & Mrs. J.K. Fuller	Lot 11, Wynmac Park, Ellalong, 2325
49	Mr I.A.R. Jones and Miss A. Hancock	Lot 5 Sandy Creek Road, Ellalong, 2325
50	Mr K.N. and Mrs N. Kable	12 Delprat Avenue, Beresfield, 2322
53	Mr. I.J. & Mrs. P.E. Sowter	Gavey Park, Ellalong, 2325
54	Mrs M.J. McDonald	3 Atkinson Street, Bellbird, 2325
56	Southland Coal/NWCC	
57	Mrs M.J. McDonald	3 Atkinson Street, Bellbird, 2325



APPENDIX 12 :

PELTON/ELLALONG EPA LICENCE



ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

ORIGINAL

LICENCE

Licence Number: 000416
File Number: 900041/B01
In Force From: 1 October, 1994
In Force Until: 1 October, 1995

Name and Address of Licensee:
THE NEWCASTLE WALLSEND COAL CO PTY LTD
P.O. BOX 156
CESSNOCK NSW 2325

Name and Address of Premises, the subject of this Licence:
NEWCASTLE WALLSEND COAL COMPANY PTY LTD
WOLLOMBI ROAD
PELTON NSW 2325

This licence under the Pollution Control Act 1970 ("the Act") is granted to: THE NEWCASTLE WALLSEND COAL CO PTY LTD ("the licensee") in respect of premises situated at: WOLLOMBI ROAD, PELTON ("the premises") subject to the conditions specified below:

Other than in accordance with section 17B of the Act this licence is not transferable.

The conditions of this licence may be varied or revoked, or new co itions attached, at any time by notice in writing given to the licensee.

DEFINITIONS
In this licence except in so far as the context or subject matter otherwise indicates or requires -

"EPA" means the Environment Protection Authority.

"Certificate" means the form entitled Certificate of Compliance with Licence Conditions (copies of which are available from the EPA).

"head office", for the purpose of correspondence means
The Director-General,
Environment Protection Authority
PO BOX 1135 CHATSWOOD NSW 2057

"regional office" means
Environment Protection Authority
HUNTER Regional Office
NSW GOVERNMENT OFFICES, 117 BULL STREET
NEWCASTLE WEST NSW 2302
Phone (049)269971 Fax (049)296712

Postal Address
P O BOX 488G
NEWCASTLE NSW 2300

"after hours pollution line" means the phone answering service on (049)693488

d. weather conditions" means less than ten millimetres of rain falling within a 24 hour period.

ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

ORIGINAL

LICENCE

Licence Number: 000416
File Number: 900041/B01
In Force From: 1 October, 1994
In Force Until: 1 October, 1995

Name and Address of Premises:
NEWCASTLE WALLSEND COAL COMPANY PTY LTD
WOLLOMBI ROAD
PELTON NSW 2325

CONDITIONS

For the purpose of preventing, controlling or mitigating the pollution of the environment, this licence is granted subject to the following conditions:

LIMIT_CONDITIONS

L1. Except as may be provided by any other condition of this licence, the licensee must comply with section 16(1), (2), (3) and (4) of the Clean Waters Act, 1970.

L2. The licensee must not discharge substances which may pollute waters, at a point not authorised by this licence.

L3. This licence must be made available at the premises for reference by any person concerned in the activities to which it relates and be produced on demand to a member or officer of the EPA.

MONITORING_CONDITIONS

L4. The tests for any monitoring required by a condition of this licence must be carried out in accordance with the methods prescribed in the Clean Air Regulations 1964, Noise Control Regulations 1975 and with Regulation 3 of the Clean Waters Regulations 1972 or as otherwise specified or approved by the EPA in writing.

Meteorological_Data

L5. Wind velocity and direction, air temperature and rainfall shall be measured by an automatic on-site weather station.

Incident_Monitoring

L6. The licensee must maintain and operate, a 24 hour telephone service that provides for members of the public to directly contact a company officer to report incidents of pollution. The

ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

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WOLLOMBI ROAD
PELTON NSW 2325

licensee must make a company officer available during normal working hours to provide members of the public with information by telephone regarding environmental aspects of the company's operations.

7. The licensee must maintain a system which must be used to record details of all complaints received from members of the public and actions taken by the company to respond to such complaints.

8 The licensee must review and record at intervals of not longer than three months the effectiveness of the service and the degree of public satisfaction with the service.

OPERATIONAL_CONDITIONS

9. Pollution control equipment, fuel burning equipment or industrial plant installed in or on the premises must be maintained in an efficient condition and operated in a proper and efficient manner.

L10. Except as may be provided by any other condition of this licence, any activity conducted in or on the premises which has potential to adversely affect the environment must be conducted in a competent manner which does not adversely affect the environment.

11. Matter and substances on the premises must be processed, handled, moved and stored in a proper and efficient manner.

12. No alteration or modification to the place or method of disposal of wastes or pollutants, or to the method of operation of plant, works, fuel burning equipment or pollution control equipment, which is likely to cause or increase air or water pollution or noise being emmitted from the premises shall be made without approval in writing from the EPA.

13. The company must nominate at least two Company positions and means of contact, available to the EPA on a 24 hour basis with the authority to take immediate action to shut down any activity

LICENCE

on the instructions of the EPA.

REPORTING_CONDITIONS

L14. Any record required to be kept by a condition of this licence must be kept in a legible form at the premises and retained for a period of not less than two years following measurement or recording and produced on demand to a member or officer of the EPA.

L15. Where wastes are discharged to waters in accordance with the conditions of this licence, a record must be kept of the volume of wastes discharged which may be either ascertained daily or determined by measurement, certified plant production or authorised discharges to a sewerage system.

L16. The occurrence of any event which causes or is likely to cause substantial pollution of the environment must be notified to the EPA's regional office, head office or after hours Pollution Line as soon as practicable after it becomes known to the licensee or by one of its agents or servants.

L17. Where required by the EPA, a written report must be supplied to the EPA within 21 days of any event described in the preceding condition. Such a report must include full details known to the licensee (or those details that may be discovered after reasonable enquiry undertaken by the licensee) of the cause, time and duration of the event, the type, the volume and concentration of any pollutants, any remedial action taken and any measures taken or to be undertaken by or on behalf of the licensee to prevent or mitigate against a recurrence of such an event.

CERTIFICATE_OF_COMPLIANCE

L1" The licensee must forward the completed Compliance Certificate in respect of the previous licence period within 30 days of the granting of this licence. The licensee must state in the Certificate -

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NEW SOUTH WALES

Pollution Control Act, 1970.

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ORIGINAL

Licence Number: 000416
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In Force Until: 1 October, 1995

Name and Address of Premises:
NEWCASTLE WALLSEND COAL COMPANY PTY LTD
WOLLOMBI ROAD
PELTON NSW 2325

(i) the extent to which conditions of the preceding licence have been complied with; and
(ii) for the period covered by the Certificate identify any conditions not complied with; and the reasons for any non-compliance.

The period to which the Certificate relates must be from the granted on date of the preceding licence to the date on which that licence expired.

The Certificate for this licence must be supplied to the EPA within 30 days of the date at which this licence expires or is terminated or revoked.

OPEN_CUT_MINING_OPERATIONS

L19. Blasting operations must be carried out only between 9.00 a.m. and 3.00 p.m. Mondays to Fridays inclusive and at no time on Saturdays, Sundays or Public Holidays.

L20. Plant and equipment may be operated for mining purposes only between 0700 hours and 2030 hours Mondays to Fridays inclusive and at no time on Saturdays, Sundays and Public Holidays.

Plant and equipment may be operated Saturdays between 0700 hours and 1600 hours for maintenance purposes but at no time on Sundays or Public Holidays.

L21. Prior verbal approval from an EPA officer must be obtained for any blasting required for safety reasons outside the hours specified in condition L19. All residents within 1000 metres of the blast site must be notified at least 30 minutes before any safety blasts are detonated.

L22. All blasts must be monitored for vibration and overpressure at the Pyne residence (N6) or at other locations at the direction of the EPA.

L23. Ground vibration from blasting must not exceed 2 mm/second peak particle velocity when measured at any point within one metre of the Hunter water Corporations's Bellbird reservoir.

Ground vibration from blasting must not exceed 5 mm/second peak particle velocity for more than 5% of blasts over a period of 12 months and must not exceed 10 mm/second at any time when measured at any point within one metre of any residence in the vicinity of the works which is not owned by the licensee.

L24. The following noise monitoring must be carried out as set out on Figure 4 of the Pelton Land Use and Monitoring Plan and as specified below:-

L24.1. Quarterly monitoring of noise levels (LA10,T) must be undertaken at the following locations:

L24.1.1. Pelton Village (N1)

L24.1.2. The Pyne residence (N6)

L24.1.3. The O'Hearn residence (N9)

L25. Noise emanating from blasting operations must not exceed an over-pressure level of 115dB (linear peak) for more than 5% of the total number of blasts when measured at any noise sensitive locations (such as residential premises, schools or hospitals).

L26. Noise emanating from blasting operations must not exceed an over-pressure level 120dB (linear peak) at any time when measured at any noise sensitve location

LICENCE

Licence Number: 000416
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In Force From: 1 October, 1994
In Force Until: 1 October, 1995

Name and Address of Premises:
NEWCASTLE WALLSEND COAL COMPANY PTY LTD
WOLLOMBI ROAD
PELTON NSW 2325

127. The level of noise emanating from operation of the plant, including loading and unloading of material in or on the above premises, must not exceed an (LA MAX) sound pressure level of 53 dB(A) (daytime) or 47 dB(A) (night-time) when measured or computed at any point within one metre of any residence in the vicinity of the premises, using the "FAST" response on the sound level meter.

ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

ORIGINAL

LICENCE

Further conditions with respect to the Clean Air Act 1961

Licence Number: 000416
File Number: 900041/B01
In Force From: 1 October, 1994
In Force Until: 1 October, 1995

Name and Address of Premises:
NEWCASTLE WALLSEND COAL COMPANY PTY LTD
WOLLOMBI ROAD
PELTON NSW 2325

Prescribed Use Classification: COAL INDUSTRY WORKS, CLASS II

Operational Scale: more than 500 kilotonnes but not more than 2 megatonnes per annum

CONDITIONS

OPERATIONAL CONDITIONS

A1. Automatic water sprays provided at the point of discharge from dry materials holding hoppers to conveyor belts must be initiated on start-up of the conveyor when the material being discharged is not sufficiently wet to prevent dust generation.

A2. Fixed and mobile water sprays provided to control dust emissions from stockpiles must be operated at sufficient frequency to keep the entire surface of the stockpiles damp at all times to prevent entrainment of dry material particles into the atmosphere.

A3. At weekends, holidays or at other times when the stockpiles are totally unmanned, the operation of the fixed sprinkler system, referred to in condition A3, must be automatically controlled from a suitable anemometer positioned in clear wind, at a height of 10 metres above ground level. At these times, the sprinkler system must operate when winds in excess of 10 metres per second occur.

A4. Material removed during belt cleaning operations must be contained for dust free disposal or re-use. It shall not be discharged to the ground.

A5. Dry materials must not be allowed to bank-up against the windshields.

A6. Freeboard of at least 150 mm must be maintained between the gunnel of the tray on all trucks and the material being transported, in order to prevent spillage from haulers, trucks

ENVIRONMENT PROTECTION AUTHORITY
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Pollution Control Act, 1970.

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Further conditions with respect to the Clean Air Act 1961

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Name and Address of Premises:
NEWCASTLE WALLSEND COAL COMPANY PTY LTD
JOLLOMBI ROAD
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and trailers.

A7. Any spillages of materials onto haul roads, access roads, truck and conveyor loading areas, hardstand and maintenance areas, and from conveyors must be removed by sweeping, washing or grading at the end of each days operation.

A8. The undisturbed surface layer of a stockpile must be thoroughly wet before road truck loading operations from the stockpile are commenced.

A9. Sufficient mobile plant must be available in operating condition, to enable watering of all haulage roads and manoeuvring areas. This equipment must be used to suppress dust from all loading and unloading operations and from roadways.

A10. The air flow from radiator fans and exhaust gases from the motors of earth-moving equipment and trucks must be so directed that they do not impinge on the ground from a height of less than two metres.

11. Temporary roads and areas must be kept in a condition sufficiently damp to prevent traffic-generated and wind-blown dust.

12. Guide posts or other suitable barriers must be maintained along the edges of internal roads to prevent traffic movement onto unsealed areas of the works.

OPEN_CUT_MINING_OPERATIONS.

13. Clearing and stripping of top soil must be restricted to the minimum practicable distance, except as otherwise required by the EPA. The area stripped for this purpose must not exceed 4 hectares.

ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

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Further conditions with respect to the Clean Air Act 1961

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NEWCASTLE WALLSEND COAL COMPANY PTY LTD
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PELTON NSW 2325

Dust Control.

A14. Where practicable top soil must be stripped while moist. During dry conditions the area to be stripped shall be deemed moist if it has been watered at least hourly at a rate of one and a half litres per square metre.

A15. When the wind exceeds 10 metres per second averaged over a 5 minute period, overburden must not be discharged to an exposed area.

A16. Rehabilitation must be carried out as quickly as practicable, in such a manner as to minimise dust generation, and to the satisfaction of the EPA.

A17. Access to areas awaiting rehabilitation must be restricted by suitable markers.

A18. Fines collected from overburden drilling pollution control equipment must not be used for stemming unless moist.

A19. Detonating cordlines must not be covered with drilling materials unless the material is wetted.

MONITORING CONDITIONS

AIR.

A20. The following air quality monitoring must be carried out as set out on Figure 4 of the Pelton Land Use and Monitoring Plan and as described below:-

A20.1. A26.1 Dust deposition gauges must be installed and operated at the following locations:

A26.1.1 Pelton Village (P1)
A26.1.2 The Pyne Residence (P2)

A26.1.3 The O'Hearn Residence (P23)

A26.2 A Total Suspended Particulate monitor must be operated at:

A26.2.1 The Pyne Residence (P2)

A21. On Line Performance
A monthly summary of instrument non-availability for all instruments and the reason for non-availability must be prepared for instruments which fall below 80 % availability and submitted to the EPA in the Annual Environmental Report.

A22. Reporting Schedule
All operational, monitoring and meteorological data and reports required by this licence must reach the EPA no later than two months after the quarterly period being reported unless otherwise approved in the licence.

The data at this time must be supplied in hard copy. Later, the data including the raw data may need to be supplied in a computer compatible format to be approved by the EPA.

A23. Validation
Each report forwarded to the EPA must be accompanied by a statement which signifies that the requirements of the EPA have been satisfied as to the collection, analysis, and reporting of these data and signed by the General Manager or, in his absence, the Mine Manager.

A24. Publication Of Data
The data supplied under this licence may be used as to part of a regular, quarterly report published by the Authority for distribution to the public.

A25. Reporting Conditions
Any data compiled, collected or recorded in compliance with conditions of this licence, during the currency of this licence,

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must be supplied to the EPA in the manner specified in Data Reporting Form Number 1 stating - name and address of the licensee, name of the testing laboratory, parameters monitored, dates of sampling and results of analysis.

The data must be supplied to the EPA within 30 days of the expiry of this licence. Where the licensee does not apply for renewal of this licence, this licence is revoked by the EPA, or terminated by the licensee, any data remaining outstanding must be supplied to the EPA within 30 days of the expiry, revocation or termination of this licence.

A26. A summary of the mining operation and its progress during the period together with a summary and interpretation of monitoring results, meteorology data and rehabilitation must be submitted to the EPA in the form of an Annual Environmental Report.

ANNUAL ENVIRONMENTAL REPORT

An Annual Environmental Report must be prepared by the licensee and submitted to the EPA not later than 30th March of the following year.

The report must be in a format agreed to with the EPA and contain:

(a) details and plan of the mining operation during the period,

(b) summaries of monitoring data and meteorological information for the period,

(c) an interpretation of the monitoring data and assessments of its relationship to mining activity and meteorological information,

(d) details of rehabilitation carried out during the period.

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A total of 1 point(s) of discharge, the locations of which are specified individually hereafter, are authorised by this licence. The licensee may discharge in accordance with the conditions of this licence the volume, concentration or type of pollutants described below.

Location of authorised discharge point:
THE AUTHORISED POINT OF DISCHARGE IS THE POINT AT WHICH WASTES FROM TH
E PROCESS WATER DAM DISCHARGE TO BELLBIRD CREEK

Code number of authorised discharge point: 001

Discharge Classification: DRAIN, WITH DISCHARGE OF MORE THAN 500 BUT NOT MORE THAN 2,000 KILOLITRES/DAY

CONDITIONS

W1. For the purpose of this licence the monitoring point shall be immediately downstream of the gauging station.

W2. For the purpose of this licence "representative sample" shall mean a single sample taken from the discharge stream.

LIMIT CONDITIONS

Discharge from the Process Water Dam:

W3. The volume of wastes discharged must not exceed 2000 kilolitres on any day.

W4. The wastes that may be discharged must not:-

W4.1. contain more than 50 milligrams per litre of non-filtrable residue.

W4.2. be of a pH value of less than 6.5 or greater than 8.5.

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Discharge_from_the_monitoring_point:

W5. The wastes that may be discharged must not:-

W5.1. contain more than 6000 milligrams per litre of Total Dissolved Solids (TDS)

W5.2. be of a pH value of less than 6.5 or greater than 8.5.

W5.3. contain more than 1.0 milligrams per litre of iron (filtrable)

MONITORING_CONDITIONS

When_Discharges_Occur_From_the_Process_Water_Dam:

W6. The total volume of wastes discharged daily must be recorded in kilolitres.

W7. The following monitoring and recording of the wastes discharged must be carried out:-

W7.1. Daily on the basis of a representative sample, collected at a minimum of twelve hourly intervals and the sample analysed for:-

W7.1.1. pH

W7.1.2. conductivity (microSiemens per centimetre)

W7.1.3. non-filtrable residue (milligrams per litre)

When_Discharge_Occurs_From_the_Monitoring_Point:

W8 The total volume of wastes discharged daily must be recorded in kilolitres.

W9. The following monitoring and recording of the wastes discharged

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must be carried out:-

W9.1. Daily on the basis of a representative sample, collected at a minimum of twelve hourly intervals and the sample analysed for:-

W9.1.1. conductivity (microSiemens per centimetre)

W9.2. Monthly on the basis of a representative sample collected at a minimum of four week intervals and the sample analysed for:-

W9.2.1. Total Dissolved Solids (TDS) (milligrams per litre)

W9.2.2. iron (filtrable) (milligrams per litre)

W9.2.3. pH

W9.2.4. non-filtrable residue (milligrams per litre)

ENVIRONMENTAL MONITORING

W10. The following environmental monitoring of Bellbird/Black Creek must be carried out:

(a) once per week at a minimum of seven day intervals when there is no discharge from the Monitoring Point; and
(b) three times per week at a minimum of 48 hour intervals commencing as soon as practicable after discharge has commenced

at the following locations-

W10.0.1. Conductivity - at existing monitoring points W9, W21, W23, and W24; and

W10.0.2. Conductivity - at the point where Black Creek

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intersects Lomas Lane

W10.1. The following environmental monitoring of waters around the premises must be carried out monthly at a minimum of four week intervals at the following locations -

W10.1.1. non-filtrable residue (milligrams per litre)

W10.1.2. iron (filtrable) (milligrams per litre)

W10.1.3. conductivity (microSiemens per centimetre)

W10.1.4. pH

W10.1.5. Bellbird Creek at the Wollombi Road Boundary of the Pelton Mine landholding (Inflow to site)

W10.1.6. Bellbird Creek downstream of the Pelton Emergency Pollution Control Dam (Dam security check)

W10.1.7. Bellbird Creek at the Northern Boundary of the Pelton Mine landholding (Outflow from site)

W10.1.8. The unnamed creek at the Western Boundary of the Pelton Mine landholding (Inflow to site)

W10.1.9. The unnamed creek 10 metres upstream of the confluence with Bellbird Creek (Overflow from western area of site)

W10.1.10.Pelton Main Dam

W10.1.11.Process Water Dam

W10.1.12.Ellalong Dam

W10.1.13. "No flow" shall be reported on the result sheet, where no flow is occurring at the time of sampling.

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OPERATIONAL_CONDITIONS

W11. Each licence quarter the predictions of the likely salinity (TDS) of any waters discharged through the monitoring point must be reviewed and revised in accordance with the salinity of the water in Pelton Main Dam.

The results must be forwarded to the EPA within two weeks of the end of the quarter.

The allowable limit on salinity of water discharged at the monitoring point will be adjusted downwards in accordance with the predictions.

W12. The licensee must maintain a system acceptable to water users on Black Creek for advising those water users registered with the company of the discharge of waters through the monitoring point.

Where possible water users will be advised within the 24 hour period immediately prior to the commencement of any discharge. Where prior advice is not possible, advice will be given as soon as practicable after discharge commences.

The licensee will advise water users of the conductivity of water being discharged. The conductivity of the waters of Black Creek at the monitoring point located at the insection of Black Creek with Lomas Lane will be advised to water users on request.

W13. All drums and other containers holding any pollutant matter shall be stored in such a manner that any leakage or spillage shall be collected and retained for subsequent disposal by means which do not pollute waters. Effective measures shall be taken to exclude rain and surface stormwater runoff from container storage areas.

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W14. All erosion control and pollution control works must be inspected following every rainfall event. In addition, regular inspections must be undertaken during dry weather periods. All such inspections must be recorded in a log book. The log book must be made available to any authorised officer of the EPA on request.