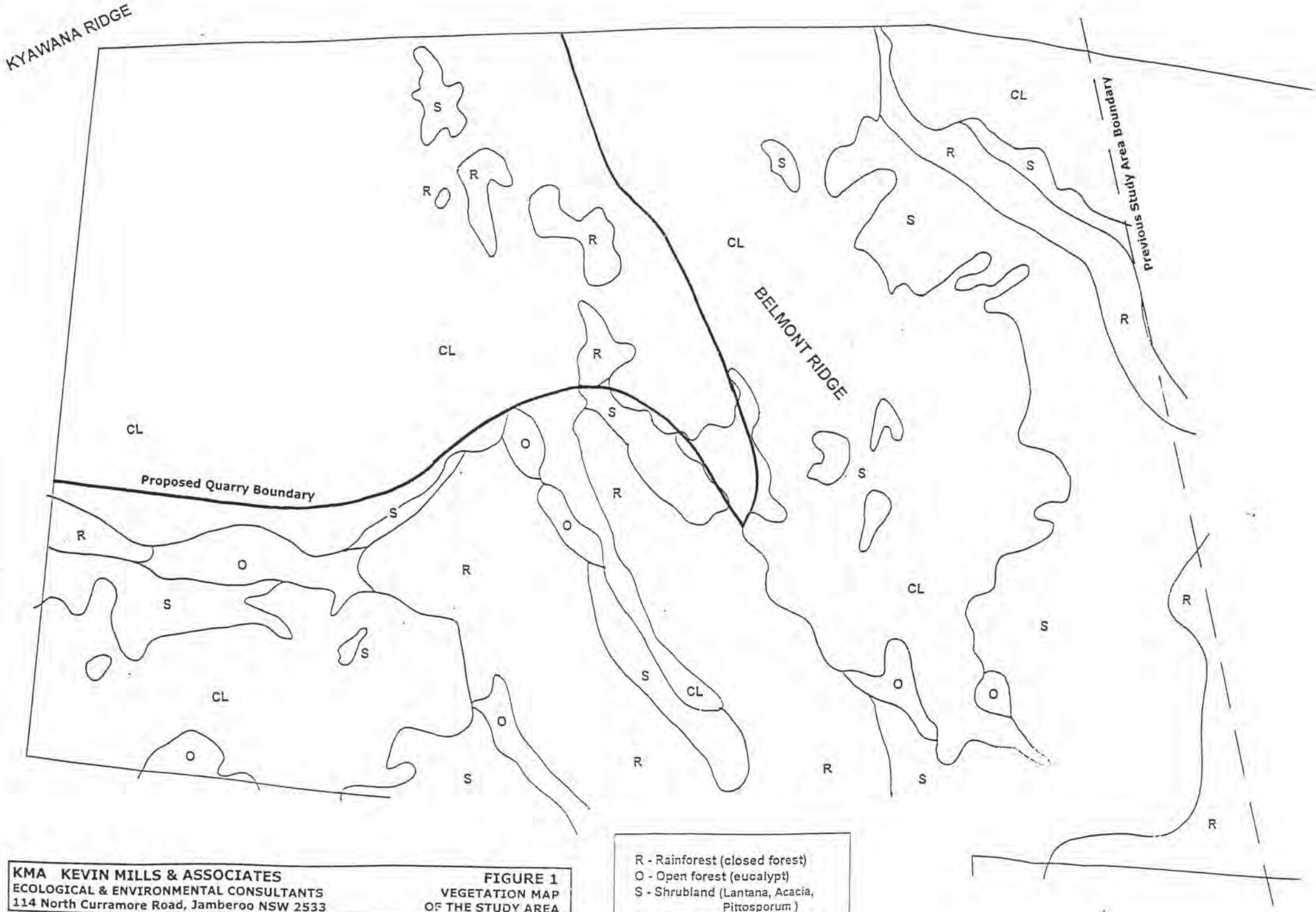

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FIGURE 1
VEGETATION MAP
OF THE STUDY AREA

R - Rainforest (closed forest)
O - Open forest (eucalypt)
S - Shrubland (Lantana, Acacia, Pittosporum)
CL - Cleared land

These communities are summarised in terms of their structure, classification in previous literature, occurrence and floristics.

Table 1
Vegetation Communities in the Study Area

1. Rainforest (Closed Forest)	Mainly within the valleys and gullies surrounding the study area; small regrowth stands occur on the eastern slopes of the quarry site.
2. Open Forest	Remnants of this forest occur at various places in and near the study area, but most of the eucalypt forest in the study area has been cleared; some sites now support dense stands of Black Wattle.
3. Lantana Shrubland	Shrubland , dominated by the introduced Lantana, occurs in various places, usually on the edges of forest.
4. Sedgeland/Rushland	Small patches of wetland plants occur on the dams on the quarry site.
5. Grassland	Most of the study area is grassland, dominated by introduced plants.

1. Subtropical Rainforest (Closed Forest)

Structure: The height of the trees and shrubs varies from 5 to 35 metres, depending on location. Stands of relatively undisturbed closed forest, with continuous closed canopy and mature trees occur along the main creekline and gully to the south of the study area. Stands on hill-slopes generally consist of a few over-mature individuals, surrounded by regrowth native tree species and, often, an outer band of Lantana. Ground cover is absent to sparse, usually consisting of ferns or small soft-wooded perennials. Lianas are plentiful, especially near edges.

Occurrence: Continuous stands occur along two sections of the main creekline, extending from the CSR Quarry, through a gully described by QEM (1994) as the Cody property. Small patches occur on the eastern slopes of quarry site.

Floristics: Mills and Jakeman (1995) describe Subtropical Rainforest Ficus - Planchonella - Baloghia - Streblus as occurring on "...the steep rocky slopes on the latite rock outcrops of the Gerringong Volcanics...". This vegetation type approximates Floyd's (1990) classification of Dry Rainforest Suballiance 23.

Common tree species include Black Plum *Diospyros australis*, Red-fruited Olive Plum *Cassine australis*, Sweet Pittosporum *Pittosporum undulatum*, Whalebone Tree *Streblus brunonianus*, Muttonwood *Rapanea variabilis* on hill slopes and Lilly Pilly *Acmena smithii*, Murrogun *Cryptocarya microneura*, Bolly Gum *Litsea reticulata* and Brush Cherry *Syzygium australe* in gullies. Common emergent trees are figs *Ficus* spp. in remnant stands and Red Ash *Alphitonia excelsa* in regrowth stands.

Common weed species along edges and along drainage lines include Lantana *Lantana camara*, Blackberry *Rubus fruticosus*, Mist Flower *Ageratina riparia*, Moth Vine *Araujia sericiflora* and Madeira Vine *Anredera cordifolia*. Common native species of the edges include Native Hibiscus *Hibiscus heterophyllus*, Whalebone

Tree *Streblus brunonianus*, Cockspur Thorn *Maclura cochinchinensis*, Tree Violet *Hymenanthera dentata* and Breynia *Breynia oblongifolia*.

Ferns occasionally occur in moist sites, including Climbing Fishbone Fern *Arthropteris tenella*, Giant Maidenhair *Adiantum formosum*, Necklace Fern *Asplenium flabellifolium*, Prickly Rasp Fern *Doodia aspera* and Rock Felt Fern *Pyrrosia rupestris*.

2. Open Forest

Structure: Eucalypts to 35 metres, either with a mesic understorey to three metres and a sparse groundcover of herbs and ferns or with a dense understorey of Lantana. The trees generally have tall straight trunks and broad, open canopies. Along some edges, the understorey consists of pasture grass.

Occurrence: The most extensive stands occur to the east of the quarry site, off the present study area. A small stand of eucalypt forest occurs on the southern edge of the study area; regrowth eucalypts and wattles, as well as some rainforest trees, occur along the creek tot he south.

Floristics: Common eucalypts in this plant community are Forest Red Gum *Eucalyptus tereticornis* and White-topped Box *Eucalyptus quadrangulata* with occasional occurrences of Coast Grey Box *Eucalyptus bosistoana*. Forest Red Gum is a common regenerating species in the shrubland on the north-east facing slopes of Belmont Ridge and Prickly-leafed Paperbark *Melaleuca styphelioides* occurs close to drainage lines. Dense thickets, either of Black Wattle *Acacia mearnsii* and Lantana Lantana *camara* often form a large portion of the understorey, although in more sheltered areas, native mesic species such as Hairy Clerodendrum *Clerodendrum tomentosum*, Red-fruited Olive-plum *Cassine australis*, Native Olive *Notelaea venosa*, White Euodia *Melicope micrococca* and Guioa *Guioa semiglauca* are regenerating.

3. Lantana Shrubland

Structure: Shrubs from two to four metres, often forming dense monotypic thickets. Several rocky sites occur in which only scattered shrubs occur with a sparse ground cover of herb, grass and hardy fern species.

Occurrence: Small stands occur around the edges of the forest remnants and regrowth trees. The largest stands occur outside the quarry site, to the south.

Floristics: The introduced shrub Lantana *Lantana camara* dominates the community. The most common canopy species in a large part of this plant community is *Acacia mearnsii*. Other native regrowth stands include Native Hibiscus *Hibiscus heterophyllus*, Forest Red Gum *Eucalyptus tereticornis*, Muttonwood *Rapanea variabilis* and Red-fruited Olive-plum *Cassine australis*.

Along some sections of the edge are dense stands of Illawarra Zieria *Zieria granulata*, a plant species of conservation significance. The remnant stands of vegetation, within this shrubland stand consist almost entirely of Bracelet Honey-Myrtle *Melaleuca armillaris*, a distinctive vegetation type which is discussed later.

4. Sedgeland/Rushland

Structure: The community consists of sedges, reeds and rushes growing to 1.2 metres, but usually lower.

Occurrence: The sedgeland/rushland occurs as narrow bands along drainage lines and around the edges of the farm dams.

Floristics: Various native and introduced wetland plant species occur on the moist sites around the study area. The common species include Water Primrose *Ludwigia peploides*, Slender Knotweed *Persicaria decipiens* and Common Rush *Juncus usitatus*, and one dam has a dense growth of Cumbungi *Typha orientalis*. Common introduced species include Umbrella Sedge *Cyperus eragrostis* and Club-rush *Isolepis prolifera*.

5. Grassland

Structure: Improved pasture, which mainly consists of introduced grasses but includes clumps of native grasses, grows as a continuous vegetative cover to about 0.4 metres in height, except in rocky areas, where native sedges and grasses are more common.

Occurrence: Grassland occurs on hilltops and slopes, within fenced areas. It covers most of the study area away from the steeper, rocky gullies, including the proposed access road route.

Floristics: The most extensive grass species is Kikuyu *Pennisetum clandestinum* although White Clover *Trifolium repens* and Paspalum *Paspalum dilatatum* also form continuous swards. The dense pasture swards are not heavily grazed and are especially lush where soil moisture levels are high. Other introduced grass species, which mainly occur near disturbed areas, include Whisky Grass *Andropogon virginicus* and Rhodes Grass *Chloris gayana*. Two native species which form clumps over extensive areas are Tall Sedge *Carex appressa* and Large Tussock Grass *Poa labillardieri*. Small native herbs which occur within the grass sward include Small St John's Wort *Hypericum gramineum*, Forest Starwort *Stellaria flaccida* and Kidney Weed *Dichondra repens*.

2.3 PLANT SPECIES

A plant species list for each vegetation community is presented in Appendix 1. In total, 221 native plant species were recorded in the wider study area; this includes the proposed quarry site as well as the two properties owned by Cleary Bros (Bombo) Pty Limited. Most of these native species are associated with the rainforest remnants and regrowth stands on the edges of the study area.

Nomenclature

The plant species names in this report are the current names published by the National Herbarium of New South Wales in the *Flora of New South Wales* (Harden 1990-1993) and in the supplement to Volume 1 (Harden & Murray 2000). Most of the common names are from the *Flora of New South Wales* (op. cit.) and *Australian Plant Genera* by Baines (1981).

2.4 VEGETATION OF CONSERVATION SIGNIFICANCE

Subtropical Rainforest (Closed Forest)

Illawarra Subtropical Rainforest has been listed as an endangered ecological community under the *Threatened Species Conservation Act 1995*; see Appendix 3. If the stands of rainforest are typical of the classifications described by Floyd (1990) and Mills and Jakeman (1995), their conservation status may also be discussed in the national and regional context: Dry Rainforest Suballiance 23 is considered to be inadequately conserved in the national context and is "...not reserved in the south" (Floyd 1990). Mills and Jakeman (1995) observed that 55% of the land on which rainforest occurs in the Illawarra is privately owned, and that in the case of subtropical rainforest only 9.4% of the total remaining area occurs in reserves, i.e. Killalea State Park. "The greatest threat to the district's rainforest is the gradual loss and degradation, through a myriad of unsympathetic land uses associated with the rural and semi-urban environment in which the rainforest occurs" (Mills & Jakeman 1995).

Paperbark Shrubland

The shrubland at the eastern end of the property but outside the area of the proposed quarry, may appear unattractive and apparently dominated by black wattle, but within the stands are remnant patches of *Melaleuca* shrubland, which is a characteristic vegetation type on lower exposed ridgetop sites where soils are thin and rock outcrops are common (Fuller & Mills 1985). This community is a significant visual feature of the Dunmore-Jamberoo area and provides habitat for several large populations of the nationally vulnerable plant species *Zieria granulata*.

Illawarra Lowlands Grassy Woodland

This community has been listed as an endangered ecological community under the *Threatened Species Conservation Act 1995*; see Appendix 2. The stand of eucalypts in the study area was surveyed to determine its structural and floristic characteristics and to determine if it met the criteria of the Illawarra Lowlands Grassy Woodland community, as documented in the Final Determination.

This stand of eucalypts is dominated by Forest Red Gum *Eucalyptus tereticornis* and Coast White Box *Eucalyptus quadrangulata*. The understorey is a mixture of rainforest species, typical native grassland species and weeds. This type of forest was termed Moist Red Gum Forest by Kevin Mills & Associates (1997), and is at the "moist end" of the complex of communities known as Illawarra Lowlands Grassy Woodland. The rainforest species present include Cockspur Thorn *Maclura cochinchinensis*, Native Olive *Notelaea longifolia*, Black Plum *Diospyros australis*, Whalebone Tree *Streblus brunonianus*, Guioa *Guioa semiglauca*, Native Quince and *Alectryon subcinereus*. The native grassland species present include Bergalia Tussock *Carex longebrachiata*, Kidney-weed *Dichondra repens*, Crane's-bill *Geranium* sp., Twining Glycine *Glycine clandestina,* Australian Basket-grass *Oplismenus aemulus* and Love-grass *Eragrostis* sp. The weed species include Kikuyu Grass *Pennisetum clandestinum*, Olive *Olea europaea*, Lantana *Lantana camara*, Spear Thistle *Cirsium vulgare*, Ribbed Plantain *Plantago lanceolata*, Fleabane *Conyza* sp. and Fireweed *Senecio madagascariensis*.

2.5 THREATENED FLORA

Several plant species of conservation importance were found in the study area and nearby during this and previous studies in the area. These species are listed in Table 2. The distribution of these species in and near the present study area is shown on Figure 2.

Table 2
List of Plant Species of Conservation Importance

Endangered or Vulnerable Plant Species		
Cynanchum elegans	White Cynanchum	Vine
Daphnandra sp. aff *micrantha* (*"johnsonii"*)	Illawarra Socketwood	Tree
Zieria granulata	Illawarra Zieria	Shrub
Regionally Significant Plant Species		
Actephila lindleyi	Actephila	Shrub/small tree
Alchornea ilicifolia	Native Holly	Shrub
Austromyrtus acmenoides	Scrub Ironwood	Small tree
Canthium coprosmoides	Coast Canthium	Small tree
Cinnamomum oliveri	Oliver's Sassafras	Tree
Deeringia amaranthoides	Deeringia	Shrub
Dodonaea viscosa subsp. *augustifolia*	Hopbush	Shrub
Geijera latifolia	Brush Wilga	Tree
Omalanthus stillingifolius	Small Bleeding Heart	Shrub

Endangered or Vulnerable Plant Species

Three plant species that occur in the study area are classified by the Briggs and Leigh (1996) as having national conservation significance; all three are threatened (endangered) species in New South Wales (*Threatened Species Conservation Act 1995*); these species are also listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. These species are: *Cynanchum elegans*, endangered, *Daphnandra* sp aff. *macrantha "johnsonii"*, vulnerable and *Zieria granulata*, vulnerable. The location of these species on and near the study area is shown on Figure 2.

Cynanchum elegans

Status: This species has a conservation rating of 3ECi (Briggs & Leigh 1996), which indicates that the species is endangered and therefore at risk of disappearing from the wild within the next two decades.

The species has a geographic range of less than 100 kilometres although occurring only in small populations which are mainly restricted to highly specific and localised habitats. Protected areas where this species occurs include Goulburn River National Park (Matthes & Nash 1993), Woko National Park and Camels Hump Nature Reserve (Briggs & Leigh 1996). Harden (1992) states that the species is rare, recorded from rainforest gullies, scrub and scree slopes from the Gloucester district to the Wollongong area and inland to Mt Dangar. Recent local recordings of this species include creeklines in Farmborough Heights and in the Keira Green Corridor. Individuals have also been recorded in small remnant stands at Cobbitty and Fairfield (NPWS 1997). In all cases only one individual or a very small population has been recorded (M. Matthes and A. Bofeldt pers. comm.). This species is listed as endangered in Part 1 Schedule 1 of the TSC Act 1995.

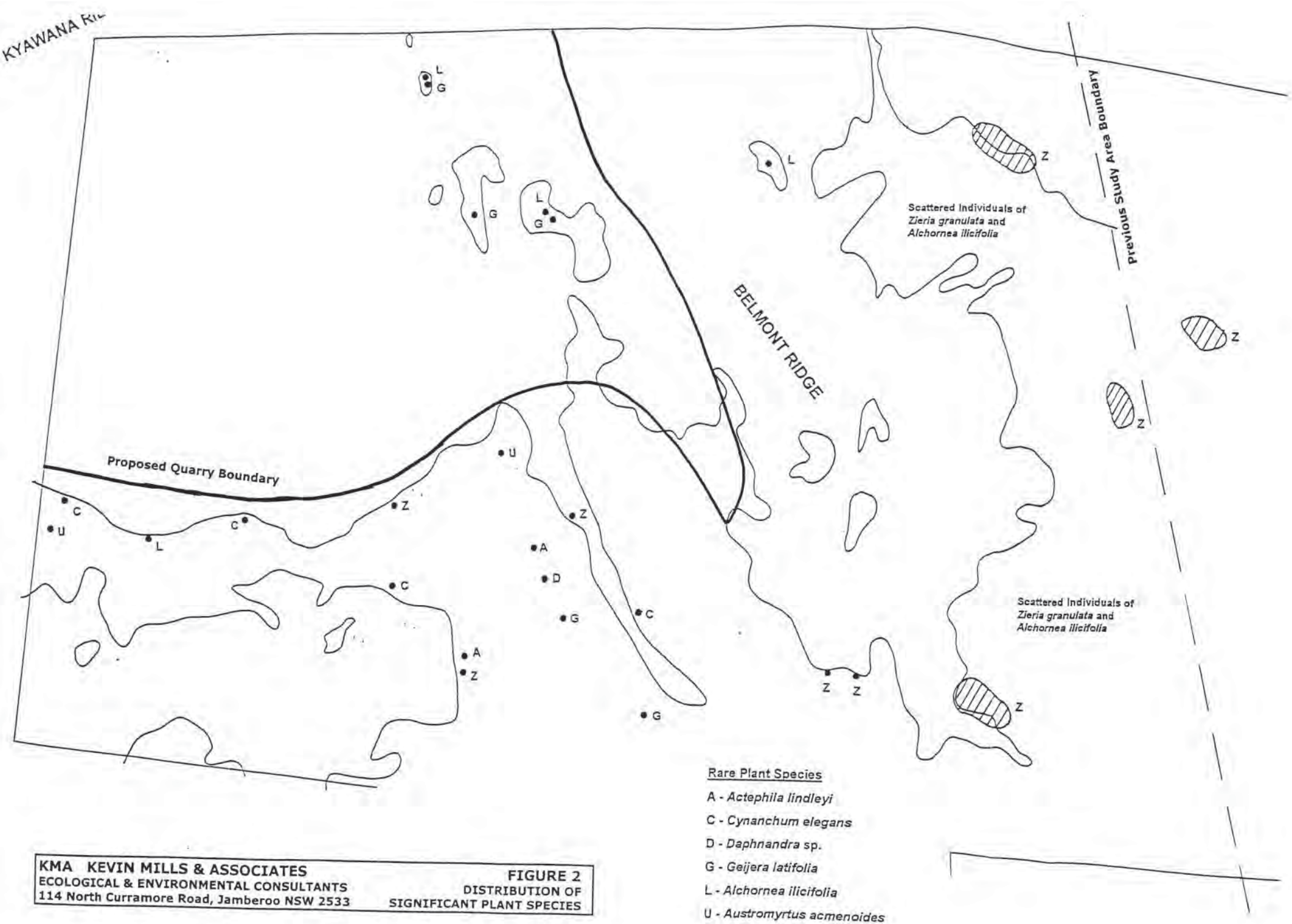

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FIGURE 2
DISTRIBUTION OF
SIGNIFICANT PLANT SPECIES

A recovery plan for this species includes the following observations (Matthes & Nash 1993):
"None of the populations recorded in the Illawarra are protected and all are under some degree of immediate threat. If these threats are successful then *C. elegans* may become extinct in the Illawarra within ten years. At this stage, until we understand more about the population dynamics of *C. elegans* every individual must be considered important for the long term survival of the species.

Populations in the Study Area: Fourteen specimens of *Cynanchum elegans* were recorded by QEM (1994) on the CSR land in the area adjoining the present study area. Three of the specimens would be removed for quarrying operations by CSR, while the eleven other individuals occur in areas that would not be affected. Of these individuals recorded, two occur within the study area of this report. Three specimens were recorded on the "Cody gallery rainforest". No further disturbance has taken place in this area, so these plants are expected to still be present. Four specimens were recorded on the northern fringe of the stand downslope of the CSR Quarry. This section has since been subjected to some clearing and disturbance as part of quarrying operations.

An additional individual was recorded on the southern edge of the band of closed forest occurring on the southwest-facing slopes of Belmont Ridge.

Daphnandra sp. aff *micrantha* (*"johnsonii"*)
Illawarra Socketwood is the only tree species that is endemic to the Illawarra rainforests (Fuller & Mills 1985). This species is a small tree and is described by Harden (1990) as a very rare small tree, confined to the Illawarra area. Small populations or individuals have been recorded between Scarborough and Berry, generally in closed forest. Distribution appears to be restricted to sites below 200 metres above sea level. Most recorded populations of this species appear to be ramets (clones) from a single individual and in most cases sexual reproduction does not appear to be taking place.

Harden (1990) describes the globose shape of the fruiting receptacle as a distinguishing feature. It is possible that this globose fruiting body is a false fruit, as the globose fruiting bodies do not appear to contain seeds. Globose and narrow-cylindrical fruits were collected from the individual in the "Cody gallery rainforest" in 1993. The seeds collected from the narrow-cylindrical fruits were found to have a viability of 50% (A. Bofeldt pers. comm.).

Mills and Jakeman (1995) have proposed that this species have a conservation rating of 2VCi, and observe that the only known conservation area in which the species occurs is in Budderoo National Park, in the gorge at Minnamurra Falls. Although searches were carried out, no individuals of this species were recorded in the study area.

Zieria granulata
Status: This species has a conservation code of 2VCi (Briggs & Leigh 1996). The code indicates that the species has a geographic range of less than 100 kilometres, is not presently endangered but is at risk from disappearing from the wild over the next 20-50 years and is reserved, but not adequately, in Budderoo National Park and in Killalea State Recreation Area. This species is listed as vulnerable in a national context in Part 2 Schedule 1 of the TSC Act (1995). Mills and Jakeman

(1993) describe the distribution of *Zieria granulata* as extending from Broughton Village to Albion Park. The Dunmore area accounts for an estimated 80% of the total known population and the stands occurring in the study area occur near the northern limit of distribution for this species. A small stand occurring on fill material at Kanahooka is not considered to be naturally occurring (Mills & Jakeman 1993).

Populations in the Study Area: The largest populations of this species were recorded along the western and eastern edges of the shrubland on Belmont Ridge. Small populations or scattered individuals were also recorded within the shrubland, and along the closed forest edge to the south and downslope of the farm buildings on Belmont Ridge. Three large individuals were recorded on the northern edge of the "Cody gallery rainforest" (QEM 1994). Seedlings were recorded in the population occurring near a farm dam on the western edge of the shrubland stand. No seedlings were recorded within the shrubland stand, although it appears that this area is heavily grazed, so it is possible that emergent seedlings are regularly eaten. The larger populations contain from 30 to 200 individuals. The total number of individuals occurring in and along the edge of the shrubland would exceed 1000.

Regionally Significant Plant Species

Nine plant species listed as regionally rare by Mills (1988) and Mills and Jakeman (1995) were recorded in the study area during this and previous studies; see Table 2. The status and location of the species of regional conservation significance are discussed below. The distribution of the species is shown on Figure 2.

Three of these species have been classified "Category 1" by Mills (1988): *Actephila lindleyi*, *Austromyrtus acmenoides* and *Deeringia amaranthoides*. By the use of the term, "Category 1", Mills (1988) refers to species that are very rare in the Illawarra (<10 known occurrences) and in need of particular conservation and consideration in conservation planning and environmental impact assessment.

Actephila lindleyi is considered to be very rare in southern New South Wales, and usually occurs as a single specimen in subtropical rainforest (Mills 1988). This species was recorded by QEM (1994) in the "Cody gallery rainforest" as well as in another area which has since been partially cleared. It was not found in the area of the proposed quarry.

A small population of *Austromyrtus acmenoides* was recorded in the closed forest below the CSR Quarry, and an additional specimen was recorded near the northern extent of the "Cody gallery rainforest". This species occurs no further south than Jamberoo (Mills 1988, 1989) and is rare in the Illawarra (A. Bofeldt and M. Robinson pers. comm.). Harden (1991) describes the distribution of this species as ... common north of the Hunter Valley, and ... as far south as the Illawarra region". This species was not found in the area of the proposed quarry.

Deeringia amaranthoides occurs in subtropical rainforest and is listed as being conserved in Royal National Park, Morton National Park and Devils Glen Nature Reserve. Mills (1988) considers that this species is rare in the region "... and possibly also in the State". This species was recorded near the creekline in the closed forest following the major creekline below the CSR Quarry. This species was not found in the area of the proposed quarry.

Four species recorded during the survey have been classified as "Category 2" by Mills (1988). "Category 2" refers to species that are rare in the region but generally better conserved and/or abundant than Category 1 species.

Alchornea ilicifolia occurs on the margins of rainforest remnants, particularly on volcanic hills between Berkeley and Kiama. The only conservation area where this species is recorded is Killalea State Park (Mills 1988). Specimens of *Alchornea ilicifolia* occur along the edges of the shrubland on Belmont Ridge, as well as along the edges of sections of closed forest, including the vegetation immediately downslope of the CSR Quarry and remnant patches on Belmont Ridge and Kyawana Ridge. A few specimens of *Alchornea ilicifolia* were found in the proposed quarry area; see Figure 2.

Canthium coprosmoides occurs throughout the Illawarra in subtropical rainforest but "... is nowhere a common tree ..." (Fuller & Mills 1985). Individuals of this species were recorded in the closed forest in the main creekline and in the gully at the south-eastern end of the study area. This species was not found in the area of the proposed quarry.

Cinnamomum oliveri occurs at its southern limit in the Jamberoo area (Fuller & Mills 1985) and prefers high rainfall areas, particularly on the escarpment. This species was recorded at several sites in the closed forest along the main creekline, as well as in the closed forest band on Belmont Ridge. This species was not found in the area of the proposed quarry.

Geijera latifolia is an occasional occurrence in several small remnant rainforest patches, as well as along rainforest stands occurring on south-facing hill-slopes. This species is conserved in Macquarie Pass National Park and Mount Brown Reserve. Local occurrences are generally restricted to "... drier areas of rainforest, nearly always on volcanic soils" (Mills 1988). A few specimens of *Geijera latifolia* were found in the proposed quarry area; see Figure 2.

Dodonaea viscosa subsp. *augustifolia* is a shrub species found in dry ridgetop communities, usually with *Melaleuca armillaris*, in the Dunmore-Jamberoo area, but is otherwise not found in the region. This species occurs in the eastern part of the property, on dry ridges. This species was not found in the area of the proposed quarry.

Omalanthus stillingifolius is a shrub species recorded by QEM (1994) on the margins of the Eastern Ridge (CSR) Quarry. This species occurs on rocky sites mainly in coastal areas, but is uncommon in the Illawarra region. No individuals of this species were found during the current survey.

3 FAUNA

3.1 METHODOLOGY FOR THE FAUNA STUDY

While the vegetation survey was conducted across the entire study area, i.e. the two properties involved, the fauna study targeted only those areas within the proposed quarry area, the proposed access road and immediately adjacent to them. Cognisance was also taken of the valley below the proposed quarry site. The

habitats there are cleared land, small patches of regrowth vegetation, including rainforest and lantana, and small wetlands at the four farm dams. Large fig trees also add to the diversity of habitat components on this land.

The initial fauna survey was undertaken in February and March 1998, and subsequent surveys were undertaken in July 2001. The surveys concentrated on mammals, avifauna, reptiles and amphibians.

Species Detection
The aim of the survey was to detect as many as possible of the fauna species present. Birds were identified in the field by observation and/or call. Reptiles and amphibians were sought in suitable habitats; habitat niches were targeted, rocks and logs were removed and then carefully replaced. Mammals were mainly sought by the presence of scats and dung. Many of the methods usually used to detect mammals were inappropriate, because most of the study area for the fauna survey is cleared land.

Fauna Habitats
A description of the fauna habitats in the study area was prepared, because the types of habitats available in an area influence which fauna (including threatened species) occur there, as well as the diversity and abundance of fauna. The fauna habitat descriptions are provided in Section 3.2.

Threatened Species
Information on the distribution of threatened fauna is obtainable from various reports and publications, and from the Wildlife Atlas database of the National Parks and Wildlife Service. The consultant also maintains a regional database of records of threatened and uncommon fauna. Because of personal experience and the availability of such resources, the consultant is familiar with most threatened fauna occurring in the Albion Park area. Threatened fauna were searched for by the methods already described and an assessment of potential threatened fauna habitat was undertaken.

Nomenclature
The nomenclature in this report is based on the Australian Museum's *The Mammals of Australia* edited by Strahan (1995), the Royal Australasian Ornithologists Union's *The Taxonomy and Species of Birds of Australia and its Territories* by Christidis and Boles (1994) and *Reptiles and Amphibians of Australia* by Cogger (1992).

3.2 FAUNA HABITATS

There are four main habitat types in the study area; these are the dams, the large fig trees, remnant rainforest and the paddocks; these habitats are discussed below.

3.2.1 THE DAMS

There are four farm dams in the study area, all constructed for the purpose of providing water for grazing stock. They also provide habitat for some species of native fauna. The dams are relatively small, ranging in area from about $110m^2$ to $630m^2$. Table 3 summarises some of their physical characteristics and their relative

importance as habitat. Numbered 4, 5, 6 and 9 the location of the dams is shown on Figure 3.

Table 3
Size, Vegetation Cover and Habitat Importance of the Farm Dams

Dam No.	Approximate Area (m^2)	Order of Size smallest-largest	Vegetation Cover (%)	Relative Importance of Habitat (low/medium/high)
4	630	4	60	Medium
5	230	3	0	Low
6	230	2	0	Medium
9	110	1	50	Low

1. Dam numbering is consistent with Kevin Mills & Associates (1998).

The dams contain a mixture of native and introduced wetland plants. All of the dams were surrounded by Kikuyu Grass *Pennisetum clandestinum* and other pasture species, and the edges had been trampled and grazed by cattle.

Dam No. 4
Dam No. 4 is about $630m^2$ in area and is the largest dam in the study area. Although usually well covered with wetland plants, most of the vegetation was removed a few days before the fauna study commenced; the vegetation removed was deposited on the southwestern slope of the dam. Pacific Azolla *Azolla filiculoides* was the most common species. Other native plant species present include Tall Spike-rush *Eleocharis sphacelata*, Water Primrose *Ludwigia peploides*, Common Rush *Juncus usitatus* and Water Couch *Paspalum distichum*, as well as the introduced species Umbrella Sedge *Cyperus eragrostis* and Club-rush *Isolepis prolifera*.

The following native fauna species were recorded: Pacific Black Duck *Anas superciliosa*, Chestnut Teal *Anas castanea*, Australian Wood Duck *Chenonetta jubata*, Masked Lapwing *Vanellus miles* and White-faced Heron *Egretta novaehollandiae*.

Dam No. 5
Dam No. 5 is one of the smaller dams, about $230m^2$ in area. At the time of inspection it contained no aquatic vegetation and was nearly dry. Nor was there any vegetation on its steep earthen sides. The dam had been recently scoured.

Dam No. 6
Dam No. 6 is also one of the smaller dams in the study area. It is about $230m^2$ in area. In 1998 approximately 70% of its water surface was covered with aquatic vegetation. The most abundant plant was the introduced Club-rush *Isolepis prolifera*; other common plant species included Common Rush *Juncus usitatus*, Water Couch *Paspalum distichum* and Pacific Azolla *Azolla filiculoides*, which are all native species. Water Primrose *Ludwigia peploides* and Water Plantain *Alisma plantago-aquatica* were also present, but uncommon, as was the introduced Umbrella Sedge *Cyperus eragrostis*. In 2001, the dam was almost devoid of vegetation.

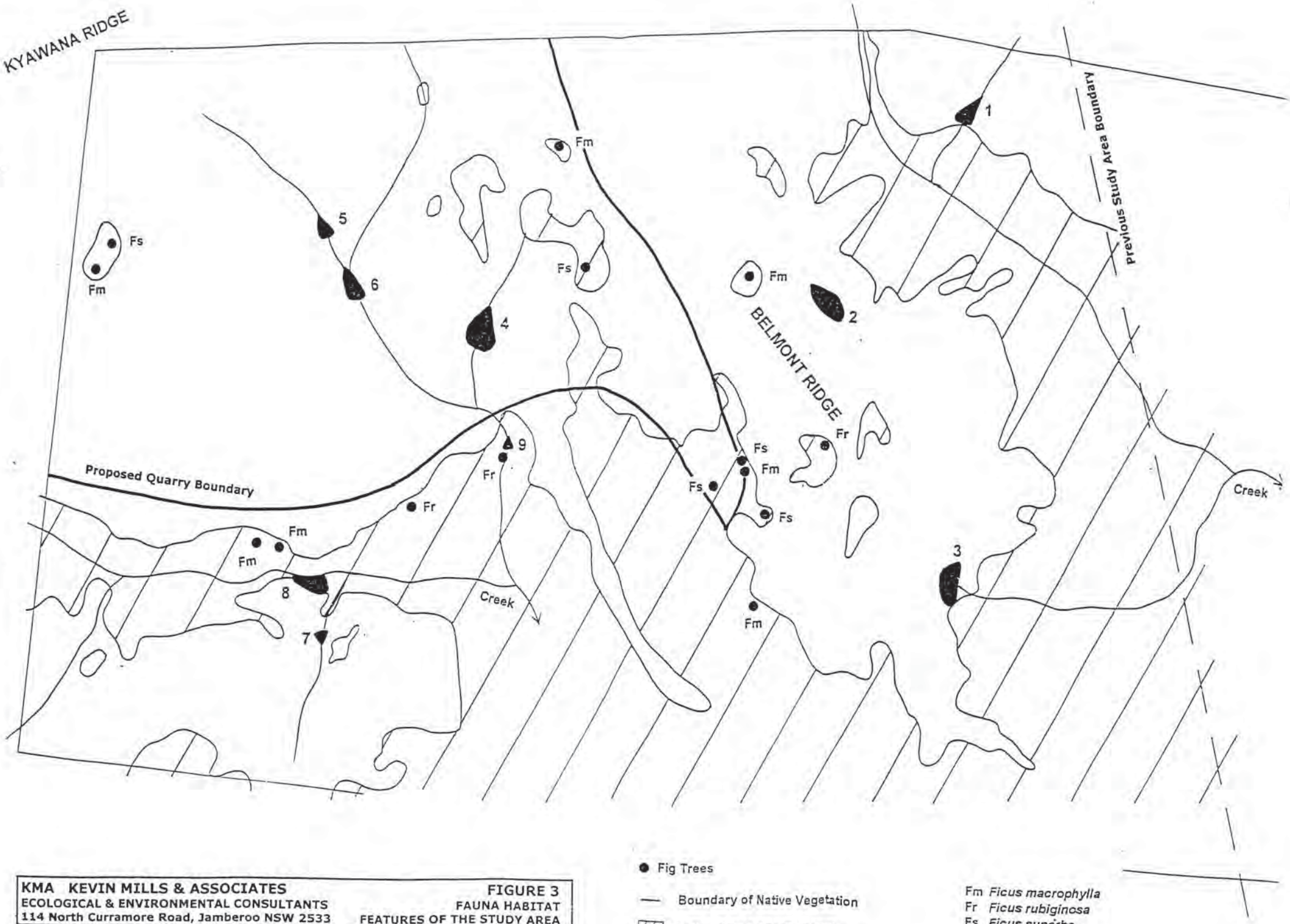

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FIGURE 3
FAUNA HABITAT
FEATURES OF THE STUDY AREA

● Fig Trees

— Boundary of Native Vegetation

Native Vegetation Remnants

Fm *Ficus macrophylla*
Fr *Ficus rubiginosa*
Fs *Ficus superba*

The following fauna species were recorded: Brown-striped Frog *Limnodynastes peronii* and Latham's Snipe *Gallinago hardwickii*.

Dam No. 9
Dam No. 9 is a small weir on the creek below Dam No. 4; it is about 110m^2 in area. About 50% of its area was covered in wetland plants. Water Couch *Paspalum distichum* was the most abundant species; the other wetland species present were Water Plantain *Alisma plantago-aquaticum*, Water Primrose *Lugwigia peploides*, Water Pepper *Persicaria hydropiper* and the introduced Umbrella Sedge *Cyperus eragrostis*.

The following fauna species was recorded: Common Eastern Froglet *Crinia signififera*.

3.2.2 THE LARGE FIG TREES

The large fig trees in and near the study area are shown on Figure 3. Four species are present: *Ficus superba*, *Ficus obliqua*, *Ficus macrophylla* and *Ficus rubiginosa*. These trees are important to the fauna that rely on them for food at certain times of year, when the figs are fruiting. Fauna species that utilise figs as a food source include the Topknot Pigeon *Lopholaimus antarcticus*, Green Catbird *Ailuroedus crassirostris*, Satin Bowerbird *Ptilonorhynchus violaceus*, White-headed Pigeon *Columba leucomela* and the Grey-headed Flying-Fox *Pteropus poliocephalus*. Each species has been recorded in the study area or is expected to occur there, largely because of the presence of the large fig trees. Although large fig trees occur throughout the whole district, their removal should be avoided wherever possible, for they are mostly very old trees, and not readily replaced in less than 50 to 100 years.

3.2.3 REMNANT RAINFOREST

As already explained, rainforest remnants occur in and near the study area. The rainforest vegetation in the gullies is expected to support a wide range of rainforest dependent fauna. The small regrowth patches in the paddocks (see Figure 3) are expected to support a few fauna species, but not rainforest-dependent species in particular. The most common species found there were birds; mammals are unlikely to be present given their small size and isolation. Important elements of the rainforest habitat include the diverse range of plant species bearing fleshy fruit, large emergent trees, rocky ground and permanent creeks. On regional, state and national levels, the rainforest habitat is of high conservation importance.

3.2.4 PADDOCKS

Most of the introduced fauna recorded in the study area occur in the grassland in the paddocks. The paddocks also support some native fauna species, mostly the hardier species such as the Australian Magpie, Australian Raven, Richard's Pipit, Welcome Swallow and Yellow-rumped Thornbill.

3.3 FAUNA SPECIES

Mammals

The mammals recorded in the study area are listed in Table 4 with notes on the method of detection. One native and three introduced mammal species were recorded. Several other native mammals would no doubt also occur in the study area, such as the Short-beaked Echidna *Tachyglossus aculeatus*, Common Brushtail Possum *Trichosurus vulpecula*, Grey-headed Flying Fox *Pteropus poliocephalus*, Bush Rat *Rattus fuscipes* and several species of microchiropteran bat.

Table 4
Mammal Species recorded in the Study Area

Species	Method of Detection: Day obs.	Night obs.	Trapping	Diggings/ burrows	Scats/ dung	Dreys (nests)	Calls
Swamp Wallaby *Wallabia bicolor*	Remains found						
Fox* *Vulpes vulpes*					X		
Rabbit* *Oryctolagus cuniculus*	X			X	X		
Domestic Cattle* *Bos taurus*	X						

*Introduced species

Avifauna

The bird species recorded during the survey are listed in Table 5. Forty-nine species were observed and/or heard in and near the study area, six of which were introduced.

Table 5
Bird Species recorded in the Study Area

Common Name	Taxonomic Name	Study Area	Nearby
Australian Magpie	*Gymnorhina tibicen*	X	
Australian Raven	*Corvus coronoides*	X	X
Australian Wood Duck	*Chenonetta jubata*	X	
Bar-shouldered Dove	*Geopelia humeralis*	X	
Black-shouldered Kite	*Elanus axillaris*	X	
Brown Gerygone	*Gerygone mouki*	X	
Brown Thornbill	*Acanthiza pusilla*	X	
Chestnut Teal	*Anas castanea*	X	
Clamorous Reed-Warbler	*Acrocephalus stentoreus*		X
Common Mynah*	*Acridotheres tristis*	X	X
Common Starling*	*Sturnus vulgaris*	X	
Crimson Rosella	*Platycercus elegans*	X	
Eastern Rosella	*Platycercus eximius*	X	
Eastern Spinebill	*Acanthorhynchus tenuirostris*	X	
Eastern Whipbird	*Psophodes olivaceus*	X	
European Goldfinch*	*Carduelis carduelis*		X
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	X	
Green Catbird	*Ailuroedus crassirostris*	X	
Grey Butcherbird	*Cracticus torquatus*	X	

.../contd

Table 5 (contd)
Bird Species recorded in the Study Area

Common Name	Taxonomic Name	Study Area	Nearby
Grey Fantail	*Rhipidura fuliginosa*	X	
Grey Shrike-thrush	*Collurincincla harmonica*		X
House Sparrow*	*Passer domesticus*	X	
Latham's Snipe	*Gallinago hardwickii*	X	
Laughing Kookaburra	*Dacelo novaeguineae*	X	X
Lewin's Honeyeater	*Meliphaga lewinii*	X	X
Little Eagle	*Hieraaetus morphnoides*	X	
Magpie-lark	*Grallina cyanoleuca*	X	X
Masked Lapwing	*Vanellus miles*	X	X
Mistletoebird	*Dicaeum hirundinaceum*		X
Nankeen Kestrel	*Falco cenchroides*	X	
Noisy Friarbird	*Philemon corniculatus*	X	
Pacific Black Duck	*Anas superciliosa*	X	
Pied Currawong	*Strepera graculina*	X	
Purple Swamphen	*Porphyrio porphyrio*		X
Red-browed Finch	*Neochmia temporalis*	X	
Red-whiskered Bulbul*	*Pycnonotus jocosus*	X	X
Richard's Pipit	*Anthus novaeseelandiae*	X	X
Satin Bowerbird	*Ptilonorhynchus violaceus*	X	X
Silvereye	*Zosterops lateralis*	X	
Spotted Turtle-Dove*	*Streptopelia chinensis*		X
Superb Fairy-wren	*Malurus cyaneus*	X	
Topknot Pigeon	*Lopholaimus antarcticus*	X	
Tree Martin	*Hirundo nigricans*	X	
Welcome Swallow	*Hirundo neoxena*	X	X
White-browed Scrubwren	*Sericornis frontalis*	X	
White-faced Heron	*Egretta novaehollandiae*	X	
Willie Wagtail	*Rhipidura leucophrys*	X	X
Yellow Thornbill	*Acanthiza nana*	X	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	X	

* Introduced species.

Bird counts were undertaken in the study area to gauge the abundance of birds on the site and the composition of the bird community in the area where quarrying is to be undertaken; the results are provided in Table 6. The results reflect the character of the landscape in the study area, which is mainly cleared land; the mix of hardy native species and introduced species is typical of the rural landscape.

Table 6
Results of Bird Counts in the Study Area

Common Name	Taxonomic Name	20.2.98 9.25-11.25	3.3.98 1.45-3.00	7.3.98 7.15-8.15
Australian Magpie	*Gymnorhina tibicen*	5	8	7
Australian Raven	*Corvus coronoides*	18	2	15
Australian Wood Duck	*Chenonetta jubata*	7		
Brown Gerygone	*Gerygone mouki*	1		
Brown Thornbill	*Acanthiza pusilla*		1	2
Chestnut Teal	*Anas castanea*	2		
Common Mynah*	*Acridotheres tristis*	3	1	
Common Starling*	*Sturnus vulgaris*	50	1	70
Crimson Rosella	*Platycercus elegans*		3	2
Eastern Rosella	*Platycercus eximius*			1
Eastern Spinebill	*Acanthorhynchus tenuirostris*	1		

.../contd.

Table 6 (contd)
Results of Bird Counts in the Study Area

Common Name	Taxonomic Name	20.2.98 9.25-11.25	3.3.98 1.45-3.00	7.3.98 7.15-8.15
Eastern Whipbird	*Psophodes olivaceus*	3	1	2
Green Catbird	*Ailuroedus crassirostris*			2
Grey Butcherbird	*Cracticus torquatus*	1	2	1
Grey Fantail	*Rhipidura fuliginosa*	2		
Latham's Snipe	*Gallinago hardwickii*	1		
Lewin's Honeyeater	*Meliphaga lewinii*	3	3	2
Little Eagle	*Hieraaetus morphnoides*	1		
Magpie-lark	*Grallina cyanoleuca*	2	2	2
Masked Lapwing	*Vanellus miles*	4		4
Nankeen Kestrel	*Falco cenchroides*		1	
Pacific Black Duck	*Anas superciliosa*	5	3	3
Pied Currawong	*Strepera graculina*			1
Red-browed Finch	*Neochmia temporalis*	1		4
Red-whiskered Bulbul*	*Pycnonotus jocosus*	5		2
Richard's Pipit	*Anthus novaeseelandiae*	5	1	
Satin Bowerbird	*Ptilonorhynchus violaceus*		1	6
Silvereye	*Zosterops lateralis*	10	6	3
Superb Fairy-wren	*Malurus cyaneus*			3
Topknot Pigeon	*Lopholaimus antarcticus*			42
Tree Martin	*Hirundo nigricans*	20		
Welcome Swallow	*Hirundo neoxena*	11	6	
White-browed Scrubwren	*Sericornis frontalis*	2	2	
White-faced Heron	*Egretta novaehollandiae*		1	
Willie Wagtail	*Rhipidura leucophrys*	3	1	1
Yellow Thornbill	*Acanthiza nana*	3		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	3	3	
No. of Individuals		172	49	175
No. of Species (total 37)		27	20	21

* Introduced species.

Reptiles and Amphibians

The species observed in the study area are listed in Table 7; three reptiles and two amphibian species were recorded. The low species diversity among the reptiles and amphibians is explained by the gross changes to the natural environment that have taken place, as well as the extreme drought conditions at the time of the survey. Additional species certainly occur in the area.

Table 7
Reptiles and Amphibians recorded in the Study Area

Species	Taxonomic Name	Method of Detection
Frogs		
Brown-striped Frog	*Limnodynastes peronii*	Calls
Common Eastern Froglet	*Crinia signifera*	Calls
Reptiles		
Grass Skink	*Lampropholis guichenoti*	Observed
Long-necked Tortoise	*Chelodina longicollis*	Observed
Red-bellied Black Snake	*Pseudechis porphyriacus*	Observed

3.4 THREATENED FAUNA

The *Threatened Species Conservation Act 1995* conserves threatened species, populations and ecological communities of animals and plants in New South Wales. Threatened fauna are listed on the schedules attached to the Act and are classified either as "endangered" (Schedule 1 species), "vulnerable" (Schedule 2 species) or "presumed extinct" (Schedule 1, Part 4).

No threatened fauna species were recorded in the study area but several are known to occur in the locality. Threatened fauna species recorded within a five-kilometre radius of the study area are listed in Table 8. The table and subsequent discussion do not include threatened fauna species for which there is no suitable habitat in or adjacent to the study area.

The study area is within the general distributional range of many species of threatened fauna. Not all were formally assessed, however; the reason(s) for their not being assessed include one or more of the following:

- the species has not been recorded in the study area or in the locality;
- it is so long since the species was last recorded that it is considered to have become locally extinct;
- the study area does not contain suitable habitat for the species;
- the habitat to be affected does not have the features required by these ecological specialists;
- the home range of the species is so large and the habitat to be affected in the study area is so small that the species would not be at risk;
- some species, for example migrating forest birds, are recorded so rarely in the locality that their occurrence is considered to be incidental.

Table 8
List of Threatened Fauna for the Dunmore - Albion Park District

Species		Status[1]
Endangered Species		
Litoria aurea	Green and Golden Bell Frog	TSC (E); EPBC (V)
Vulnerable Species		
Botaurus poiciloptilus	Australasian Bittern	TSC
Ninox strenua	Powerful Owl	TSC
Pteropus poliocephalus	Grey-headed Flying-fox	TSC (E); EPBC (V)
Ptilinopus regina	Rose-crowned Fruit-Dove	TSC
Dasyurus maculatus	Spotted-tailed Quoll	TSC

1. TSC: NSW *Threatened species Conservation Act 1995*; EPBC: Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. V – vulnerable; E – endangered.

Green and Golden Bell Frog

The closest known occurrence of the Green and Golden Bell Frog is Killalea Lagoon, about five kilometres to the east. The only wetlands in and near the study area are farm dams, and most of them do not contain habitat suitable for this frog. The only dam in the study area with suitable habitat is Dam No. 8, because of the presence of Cumbungi *Typha orientalis*; see Figure 3. All records of the Green and Golden Bell Frog in the Illawarra have been on the coastal lowlands, rather than hilly

country, so it is unlikely that the Green and Golden Bell Frog would occur in the study area.

Australasian Bittern
The Australasian Bittern has been recorded in the Minnamurra River system, at Dunmore and Jamberoo, at Killalea Lagoon and at Albion Park. There are large areas of suitable habitat at all of these locations, unlike the study area where there is only a small area of Cumbungi *Typha orientalis* on Dam No. 8. If the Australasian Bittern occurs in the study area, visits would be rare and fleeting because so little suitable habitat is present.

Powerful Owl
The Powerful Owl was regularly recorded in rainforest at Bass Point, eight kilometres east of the study area, between 1984 and 1991. The owl has also been recorded at various locations along the Illawarra escarpment. The Powerful Owl may roost in the rainforest in the study area and may forage there if arboreal mammals are present. It is unlikely that the owl would use the small patches of regrowth in the paddocks.

Rose-crowned Fruit-Dove
The Rose-crowned Fruit-Dove inhabits rainforest and was observed regularly at Bass Point between 1984 and 1989. Immature birds observed in 1985 and 1989 may indicate local breeding. The species was last seen in the district in 1995 at Mount Keira. The Rose-crowned Fruit-Dove may occur in the rainforests in the study area.

Spotted-tailed Quoll
There are many old records of the Spotted-tailed Quoll in the district (Robinson 1988), but few recent records from the Shellharbour area. Most recent records are from the forests along the escarpment south of Barren Grounds.

Grey-headed Flying-fox
The Grey-headed Flying-fox has recently been added to the list of threatened species in New South Wales. This species is relatively common in the Illawarra region during summer, when it makes nightly visits to gardens, orchards and isolated fruit trees to feed on fruiting trees. There is a known daytime roosting camp site at Flying Fox Gully, north of Jamberoo, about four kilometres to the south of the present study area. Flying-foxes no doubt visit the rainforest and fig trees on and near the quarry site.

Microchiropteran Bats
Several threatened bat species have been recorded in the district, including the Greater Broad-nosed Bat *Scoteanax rueppellii* (Tallawarra 1997), Large-footed Myotis *Myotis adversus* (Tallawarra 1997), Common Bentwing-Bat *Miniopterus schreibersii* (Kiama 1966) and Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*. Apparently no bat surveys have been undertaken in the vicinity of the study area. Bats would certainly occur in the general area, because of the presence of ample foraging habitat, large trees with hollows for roosting and other resources for bats; these are mainly in the valley to the south of the quarry site.

4 CONSERVATION ASSESSMENT

4.1 THREATENED SPECIES CONSERVATION ACT

The *Threatened Species Conservation Act 1995* conserves threatened species, endangered populations and endangered ecological communities in New South Wales. Threatened flora and fauna species are listed on the schedules attached to the Act and are classified either as "endangered" (Schedule 1 species), "vulnerable" (Schedule 2 species) or "presumed extinct" (Schedule 1, Part 4). Endangered populations and endangered ecological communities are listed on Schedule 1, in Parts 2 and 3, respectively.

The *Threatened Species Conservation Act 1995* amends the *Environmental Planning & Assessment Act 1979* (New South Wales 1979), requiring that the factors set out in Section 5A of the Act be considered in deciding whether there is likely to be a significant effect on threatened species, endangered populations or endangered ecological communities, or their habitats and, hence, whether a Species Impact Statement (SIS) is required. This process is commonly referred to as the "eight part test"; the test is applied below.

4.1.1 THREATENED FLORA

There are three threatened plant species adjacent to the area to be quarried; these are *Cynanchum elegans*, *Daphnandra* sp. aff. *micrantha* and *Zieria granulata*. The quarry has been designed to avoid all of the occurrences of these species. Recommendations are made in Section 5 to mitigate the potential impact of the quarry and its operation on these species.

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

All populations and occurrences of the three threatened plant species in the area are excluded from the proposed quarry site and access road. The approximate locations of these species in the area are shown on Figure 2. The closest plants to the quarry are on the edge of the regrowth vegetation along the creekline south of the quarry. These plants would be incorporated into the proposed buffer zone/revegetation area; this will be fenced prior to the commencement of quarry operations. It is recommended that the location of the fence be marked on the ground by an ecologist, then constructed as soon as possible. The proposed quarry will not disrupt the lifecycle of a local population of these species such that they are placed at risk of extinction.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

No endangered populations have been declared in the study area.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

As noted above, no known habitat for these species will be modified or removed by the proposed quarry. Measures are incorporated into the proposed development to protect and enhance the habitat of these plant species. These measures are primarily fencing the areas of occurrence and revegetating the enclosed areas with local native vegetation.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The quarry is located on grazing land and its configuration does not isolate known areas of habitat for the above plant species.

(e) whether critical habitat will be affected

No critical habitat has been declared in the study area.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region

None of the species under discussion are adequately represented in conservation reserves in the region.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

A "threatening process" is "a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities". "Key threatening processes" are listed under Schedule 3 of the Act.

To date, the NSW Scientific Committee has listed 16 key threatening processes under the Act; the relevance of these to the development of Stage 6 is discussed below.

Key Threatening Process	Relevance to Proposal
Alteration to the natural flow regimes of rivers, etc.	Not relevant.
Anthropogenic Climate Change	Not relevant.
Bushrock removal	Not relevant.
Clearing of native vegetation	Very minor clearing.
Competition and grazing by feral European Rabbit	Not relevant.
Competition from Feral Honey Bees	Not relevant.
High frequency fire resulting in the disruption of life cycle processes	Not relevant.
Importation of Red Imported Fire Ants	Not relevant.
Infection of native plants by *Phytophthora cinnamomi*	Not relevant
Invasion of native plant communities by *Chrysanthemoides monilifera*	Not relevant.
Infection by Psittacine Circoviral Disease in Parrots	Not relevant.
Loss and/or degradation of sites used for hill-topping by butterflies	Not relevant, not on hilltop.
Predation by *Gambusia holbrooki*	Not relevant.

Predation by the European Red Fox	Not relevant.
Predation by the Feral Cat	Not relevant.
Predation from the Ship Rat on Lord Howe Island	Not relevant.

The development of the hard rock quarry at Albion Park involves very minor clearing of native vegetation.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

Zieria granulata and *Daphnandra sp. nov.* are endemic to the Illawarra region and are therefore always close to the limits of their distribution. The southern limit of *Cynanchum elegans* is near Gerringong, well to the south of the study area.

"Eight Part Test" Conclusion - Threatened Flora Species
It is concluded that the proposed development of a quarry on the subject site is unlikely to have a significant effect on any threatened plant species, or their habitats, and that a Species Impact Statement is not required.

4.1.2 THREATENED FAUNA

No threatened fauna have been recorded in the study area, although several species were assessed in Section 3.4 and may occur in the area, particularly in the extensive stands of native forest to the south of the quarry site. The only species expected to occur on the quarry site itself is the Grey-headed Flying-fox, that visits the large fig trees of the district in summer to feed on their fruits.

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

The proposed quarry covers grazing land, with small patches of regrowth native vegetation and Lantana. These habitats are not expected to support any threatened fauna species. The one species that is expected to regularly visit the site in summer is the Grey-headed Flying-fox. This large bat feeds on the fruits of figs *Ficus* spp. and other rainforest trees. It is often seen feeding at night on the large old fig trees that dot the Illawarra landscape. Seven fig trees occur within the proposed quarry boundary; see Figure 3. Most occur on the eastern edge of the site and will not be removed for many years. The removal of this relatively small number of food trees, when there are many thousands in the region, is not likely to disrupt a local population of the species to such an extent that it is placed at risk of extinction. Fig trees will be planted in the revegetation areas, as shown on Figure 4.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

No endangered populations have been declared in the study area.

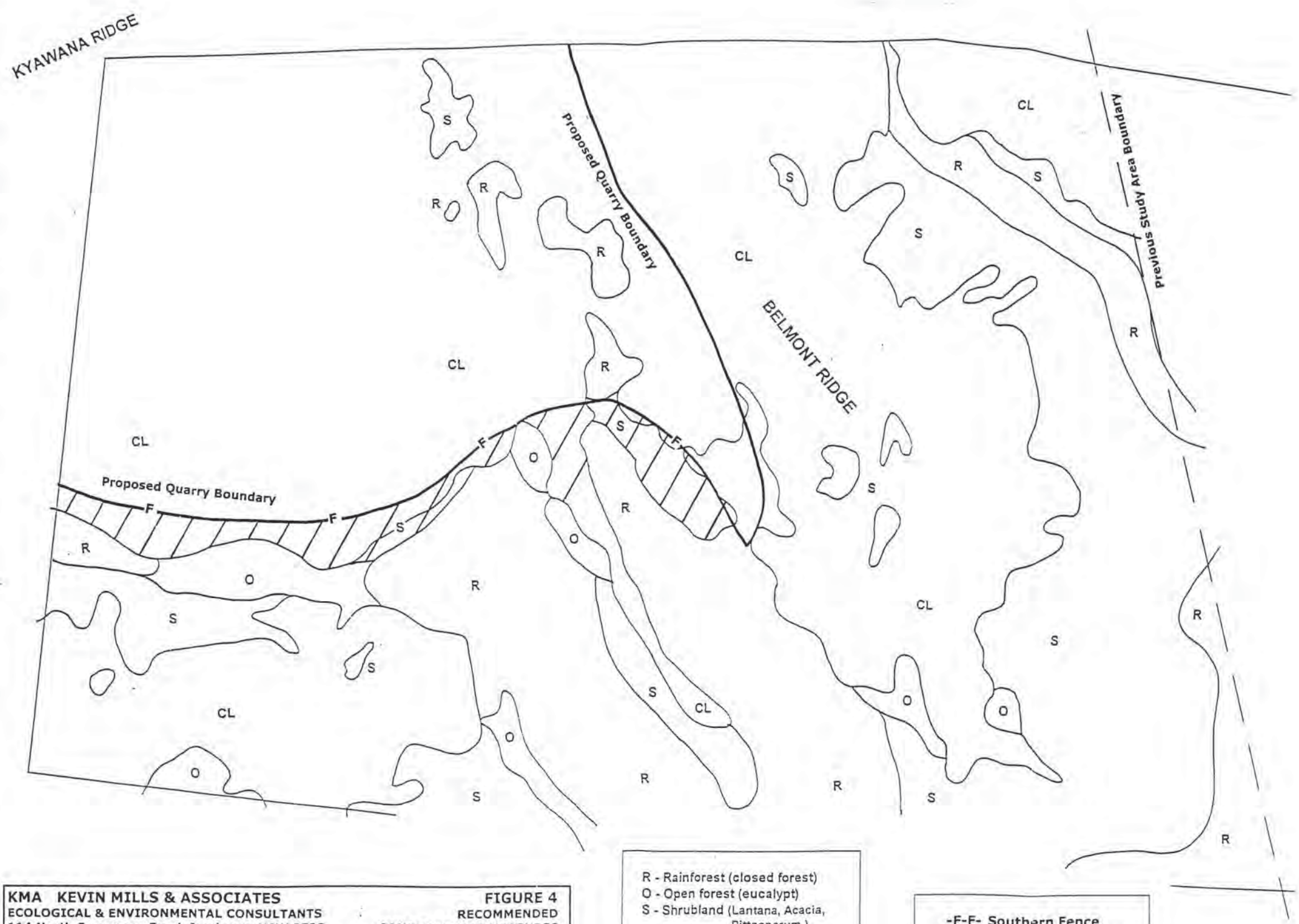

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FIGURE 4
RECOMMENDED
CONSERVATION MEASURES

R - Rainforest (closed forest)
O - Open forest (eucalypt)
S - Shrubland (Lantana, Acacia, Pittosporum)
CL - Cleared land

-F-F- Southern Fence
/ / / Revegetation Areas

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

The quarry will not modify or remove a significant area of known habitat for any of the threatened species listed in Section 3.4, including the Grey-headed Flying fox. The most important habitat for threatened species, should they occur in the area at all, is the large area of native rainforest and other vegetation in the gullies to the south of the quarry site. The proposed quarry will not affect this area.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

The quarry is located on farmland and will not result in any isolation or fragmentation of potential threatened fauna species habitat.

(e) whether critical habitat will be affected

No critical habitat has been declared in the study area.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region

None of the species discussed in Section 3.4 are likely to be adequately reserved in the region, although this has not been confirmed by research.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

A "threatening process" is "a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities". "Key threatening processes" are listed under Schedule 3 of the Act.

To date, the NSW Scientific Committee has listed 16 key threatening processes under the Act; the relevance of these to the development of Stage 6 is discussed below.

Key Threatening Process	Relevance to Proposal
Alteration to the natural flow regimes of rivers, etc.	Not relevant.
Anthropogenic Climate Change	Not relevant.
Bushrock removal	Not relevant.
Clearing of native vegetation	Very minor clearing.
Competition and grazing by feral European Rabbit	Not relevant.
Competition from Feral Honey Bees	Not relevant.
High frequency fire resulting in the disruption of life cycle processes	Not relevant.
Importation of Red Imported Fire Ants	Not relevant.
Infection of native plants by *Phytophthora cinnamomi*	Not relevant
Invasion of native plant communities by *Chrysanthemoides monilifera*	Not relevant.
Infection by Psittacine Circoviral Disease in Parrots	Not relevant.

Loss and/or degradation of sites used for hill-topping by butterflies	Not relevant, not on hilltop.
Predation by *Gambusia holbrooki*	Not relevant.
Predation by the European Red Fox	Not relevant.
Predation by the Feral Cat	Not relevant.
Predation from the Ship Rat on Lord Howe Island	Not relevant.

The development of the hard rock quarry at Albion Park involves very minor clearing of native vegetation.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

None of the fauna species discussed in this report is at or close to their known limit of distribution in Shellharbour.

"Eight Part Test" Conclusion - Threatened Fauna Species
It is concluded that the proposed development of a quarry on the subject site is unlikely to have a significant effect on any threatened fauna species, or their habitats, and that a Species Impact Statement is not required.

4.1.3 ENDANGERED POPULATIONS

Endangered populations are listed under Part 2 of Schedule 1 of the *Threatened Species Conservation Act 1995*. The study area does not contain any endangered populations

4.1.4 ENDANGERED ECOLOGICAL COMMUNITIES

Endangered ecological communities are listed under Part 3 of Schedule 1 of the *Threatened Species Conservation Act 1995*. Remnants of two such communities occur on and near the proposed quarry site. A small stand of Illawarra Lowlands Grassy Woodland occurs just outside the quarry area; see "open forest" on Figure 1. Within the proposed quarry area, there are small stands of remnant rainforest, part of the Illawarra Subtropical Rainforest community; see "rainforest" on Figure 1.

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

Not relevant to endangered ecological communities.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

Not relevant to endangered ecological communities.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

Illawarra Lowlands Grassy Woodland
There is one small area of eucalypts outside the southern boundary of the proposed quarry site, this is a remnant of Illawarra Lowlands Grassy Woodlands. The Final Determination for this community is provided at Appendix 2; see area marked "open forest" on Figure 1. The proposed quarry will not impact on this stand of trees. As noted elsewhere, it is proposed to fence this area and revegetate with local native species. This particular area will be revegetated with species that occur in Illawarra Lowlands Grassy Woodland, rather than rainforest species.

Illawarra Subtropical Rainforest
The study area contains stands of remnant subtropical rainforest; see "rainforest" on Figure 1. This vegetation is part of the rainforest complex known as Illawarra Subtropical Rainforest; the Final Determination to list this community as endangered is provided at Appendix 3.

The quarry site supports small regrowth stands of rainforest species. More importantly, large stands occur in the valley to the south, off the development site. The quarry avoids the most important, larger areas. The loss of even the smaller areas is of concern, because so little rainforest now remains in the district. For this reason, it is recommended that a major revegetation program be undertaken adjacent to the quarry site, to strengthen and expand the existing rainforest and other native vegetation existing there. If this is undertaken, then the loss of the small regrowth patches in the study area will not be significant in the long term. As noted elsewhere, the existing cleared area between the gully to the south of the quarry and the quarry itself is proposed to be revegetated with local native vegetation, principally rainforest; see Figure 4.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

Illawarra Lowlands Grassy Woodland
The quarry is on farmland and will not result in isolating any area of Illawarra Lowlands Grassy Woodland.

Illawarra Subtropical Rainforest
The quarry is on cleared farm land and has rainforest on one side; in this case the proposed quarry will not result in isolating the rainforest. The revegetation program will, in fact, strengthen links between existing rainforest areas.

(e) whether critical habitat will be affected

No critical habitat has been declared in the study area.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region

Illawarra Lowlands Grassy Woodland
Illawarra Lowlands Grassy Woodland is not adequately represented in conservation reserves in the region.

Illawarra Subtropical Rainforest
Illawarra Subtropical Rainforest is not adequately reserved in the region.

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

A "threatening process" is "a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities". "Key threatening processes" are listed under Schedule 3 of the Act.

To date, the NSW Scientific Committee has listed 16 key threatening processes under the Act; the relevance of these to the development of Stage 6 is discussed below.

Key Threatening Process	Relevance to Proposal
Alteration to the natural flow regimes of rivers, etc.	Not relevant.
Anthropogenic Climate Change	Not relevant.
Bushrock removal	Not relevant.
Clearing of native vegetation	Very minor clearing.
Competition and grazing by feral European Rabbit	Not relevant.
Competition from Feral Honey Bees	Not relevant.
High frequency fire resulting in the disruption of life cycle processes	Not relevant.
Importation of Red Imported Fire Ants	Not relevant.
Infection of native plants by *Phytophthora cinnamomi*	Not relevant
Invasion of native plant communities by *Chrysanthemoides monilifera*	Not relevant.
Infection by Psittacine Circoviral Disease in Parrots	Not relevant.
Loss and/or degradation of sites used for hill-topping by butterflies	Not relevant, not on hilltop.
Predation by *Gambusia holbrooki*	Not relevant.
Predation by the European Red Fox	Not relevant.
Predation by the Feral Cat	Not relevant.
Predation from the Ship Rat on Lord Howe Island	Not relevant.

The development of the hard rock quarry at Albion Park involves minor clearing of native vegetation, some of which is a part of the Illawarra Subtropical Rainforest community. No Illawarra Lowlands Grassy Woodland will be affected.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The site is not at the limit of distribution of Illawarra Lowlands Grassy Woodland or Illawarra Subtropical Rainforest, although as both communities are restricted to the Illawarra district they are always fairly close to their natural limit of distribution.

"Eight Part Test" Conclusion - Endangered Ecological Communities
It is concluded that the proposed development of a quarry on the subject site is unlikely to have a significant effect on any endangered ecological community, or their habitats, and that a Species Impact Statement is not required.

4.2 FAUNA HABITATS

The fauna habitats on the proposed quarry site include grassland, small patches of remnant rainforest and Lantana, small farm dams and occasional large fig trees. The farm dams and small patches of bushland do not provide significant habitat for native fauna. The large fig trees, however, are well used by fruit-eating fauna, particularly rainforest birds and the Grey-headed Flying-fox. The development includes a proposal to replace the rainforest and fig trees cleared for the quarry by revegetating a relatively large area of land adjacent to the quarry with local native plants, including fig trees. In the medium to long term there should be no significant impact on native fauna habitats.

4.3 SEPP NO. 44 - KOALA HABITAT PROTECTION

State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP 44) "aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline:
a. by requiring the preparation of plans of management before development consent can be granted in relation to areas of core Koala habitat;
b. by encouraging the identification of areas of core Koala habitat; and
c. by encouraging the inclusion of areas of core Koala habitat in environment protection zones" (New South Wales 1995).

SEPP 44 aims to identify "potential Koala habitat", which is defined as "areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component". If none of the tree species listed on Schedule 2 are present or if these species constitute less than 15% of the total number of trees present, then no further provisions of the Policy apply. If more than 15% of the trees on the area are of the species listed on Schedule 2, then an assessment by a qualified person must be undertaken to determine if the area contains "core Koala habitat"; this is defined as "an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population".

No Koala food trees occur in the quarry area; no further consideration of the Policy is required. The food tree Forest Red Gum *Eucalyptus tereticornis* occurs nearby, but not on the quarry site.

4.4 NATIVE VEGETATION CONSERVATION ACT

The *Native Vegetation Conservation Act 1997* came into operation on the 1 January 1998 (New South Wales 1997). The Act amended the *Soil Conservation Act 1938*

and various other Acts, and repealed *State Environmental Planning Policy No.46 - Protection and Management of Native Vegetation*.

Objectives of the Act
The objectives of the Act, as stated in Clause 3, are:
(a) to provide for the conservation and management of native vegetation on a regional basis,
(b) to encourage and promote native vegetation management in the social, economic and environmental interests of the State,
(c) to protect native vegetation of high conservation value,
(d) to improve the condition of existing native vegetation,
(e) to encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation,
(f) to prevent the inappropriate clearing of vegetation and
(g) to promote the significance of native vegetation,
in accordance with the principles of ecologically sustainable development.

Definition of Native Vegetation
"Native vegetation" is defined in Clause 6 of the Act as any of the following types of indigenous vegetation: trees, understorey plants, groundcover and plants occurring in a wetland. For the purpose of the definition, "groundcover" means any type of herbaceous vegetation, but it is only to be regarded as native vegetation if it occurs in an area where not less than 50% of the herbaceous vegetation covering the area comprises indigenous species.

Land excluded from the Act
Clause 9 identifies land excluded from the operation of the Act. As stated in Clause (a), the Act does not apply to land that is within a zone designated "residential" (but not "rural-residential"), "village", "township", "industrial" or "business" under an environmental planning instrument. Refer to Clause 9 for the full list of excluded land.

Under Clause 10, the Act also excludes certain other land. The Act "does not apply to any land within a local government area specified in Schedule 1", although it "does apply to land within any such local government area to the extent to which the land comprises State protected land". Schedule 1 currently lists Wollongong, Newcastle and local government areas in the Sydney region.

Regional Vegetation Management Plans (RVMPs)
One of the main initiatives of the Act is the development of Regional Vegetation Management Plans (RVMPs) by Regional Vegetation Committees, to provide a comprehensive strategy for managing native vegetation, based on regional needs. In areas with an approved RVMP, clearing that is consistent with the plan does not require development consent.

Clearing Native Vegetation in Areas without an RVMP
In areas without an approved RVMP, native vegetation can be cleared if the clearing is consistent with the exemptions in the Act and other clearing restrictions do not apply. Where exemptions do not apply, clearing can only be carried out after an application has been made to the Department of Land and Water Conservation and development consent has been granted. Where other clearing restrictions apply, such as tree preservation orders from local councils, approval from the appropriate authority is required.

Under Clause 21 of the Act, which relates to the clearing of native vegetation on land not subject to an RVMP, reference is made to "clauses 3 and 5 of Schedule 4 which provide that certain exemptions under SEPP 46 and the *Western Lands Act 1901* that existed before the commencement of this Act will be continued on a transitional basis". Clause 3(2) states that "subject to the regulations, the clearing of native vegetation for a purpose or extent described in Schedule 3 to SEPP 46 continues, after the repeal of SEPP 46 by this Act, to be clearing that is exempt from any requirement under Part 2 of this Act for development consent. Clause 3(3) states that "Subclause (2), and any regulation made for the purposes of that subclause, ceases to have effect in relation to the clearing of land to which a regional vegetation management plan applies".

SEPP 46 does not require development consent for the clearing of native vegetation described in Schedule 3, which provides a list of 12 exemptions. Among these exclusions are: (a) Minimal clearing, up to 2 hectares per annum; (b) Minimum clearing for the construction, operation and maintenance of farm; and (c) The removal of native vegetation, whether seedlings or regrowth, of less than 10 years of age. See Schedule 3 for a full list of exemptions. Development that is designated development is also exempt form the act.

The Clearing of Native Vegetation in the Study Area

An RVMP has not been prepared for the Shellharbour area. However, the proposed development is designated development, so that the provisions of the *Native Vegetation Conservation Act 1997* do not apply in this case.

4.5 POTENTIAL TO IMPACT ON DOWNSTREAM ENVIRONMENTS

The proposed quarry will change the amount and timing of the runoff entering the watercourse to the south of the quarry site. This watercourse traverses a rainforest valley to the east. The impact of the quarry and of changes to runoff to this watercourse on the rainforest is difficult to determine. A few observations can be made:

(i) The stream currently experiences a wide range of flow rates, from flooding to dry for long periods. This is a natural phenomenon.

(ii) The rainforest vegetation is probably not as dependent on stream flow as groundwater for its survival.

(iii) Changes in vegetation brought about by modified stream flows may take a long time to manifest themselves.

(iv) The most likely changes to the vegetation along the stream would be to the immediate vicinity of the channel. This may well manifest itself in the increase or decrease in plants such as ferns and weeds.

To minimise the potential impact of the quarry on stream flow, releases of water to the creek should:

- mirror local rainfall events as closely as possible;
- not be a continuous release of water;
- be discharged to the creek in such a way that erosion does not occur;
- be as low in nutrients as possible at the time of discharge.

The potential ramifications of changes to groundwater are far more speculative. Inputs to the creek from groundwater are completely unknown and difficult to determine. It seems unlikely to be a significant issue, given the proportion of the potential underground catchment affected. It is recommended that monitoring of groundwater levels below the quarry site, and of stream flows and/or releases of water from the quarry dam, be instigated.

4.6 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT

The Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) specifies that approval is required from the Commonwealth Minister for the Environment for actions that have, will have or are likely to have a significant impact on a matter of "national environmental significance".

The Act identifies six matters of national environmental significance; these are:

i. declared World Heritage Areas,
ii. declared RAMSAR wetlands,
iii. listed threatened species and ecological communities,
iv. listed migratory species,
v. nuclear actions, and
vi. the environment of Commonwealth marine areas.

Actions on or outside Commonwealth land that have, will have or are likely to have a significant impact on the environment on or outside Commonwealth land must also be referred to the Commonwealth Minister for assessment and approval, as well as the actions of Commonwealth agencies inside or outside the Australian jurisdiction that have, will have or are likely to have a significant impact on the environment inside or outside the Australian jurisdiction.

Environment Australia has published *Administrative Guidelines for Determining whether an Action has, will have, or is likely to have a Significant Impact on a Matter of National Environmental Significance under the Environmental Protection and Biodiversity Conservation Act 1999* (Environment Australia 2000), to assist proponents to decide whether a proposed action should be referred to the Minister for assessment and approval.

Some of the criteria in the guidelines refer to the concept of "habitat critical to the survival of a species or ecological community". The guidelines state, "habitat critical to the survival of a species or ecological community . . . includes the critical habitat for any species or community identified in recovery plans for those species/communities and the critical habitat on the Register maintained by the Minister for the Environment under the Act. However, there may not be recovery plans in place for all listed species and communities, as plans take some time to prepare. Similarly, the Register may not be comprehensive. The absence of a recovery plan or the fact that an area may not be listed on the Register of Critical Habitat does not mean that there is no habitat critical to the survival of the species or community."

"Habitat critical to the survival of a species or ecological community may include areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal,

- for succession,
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species/community."

"Habitat critical to the survival of a species or ecological community will depend largely on the particular requirements of the species/community in question. For example, areas only incidentally used by a vulnerable species, and which the species is unlikely to be dependent upon for its survival or recovery, are not areas of habitat critical to the survival of a species or ecological community."

"Some of the criteria below refer to actions likely to lead to a "long-term decrease" in the size of a population or a "long-term adverse effect" on a community. Depending on the level of endangerment and the nature of the action, not all actions which create an immediate decrease in the population of a naturally listed threatened species or impact on a community will have long-term consequences. For example, an act which causes injury or death to only one or a very small number of a species will not, except in the case of the most endangered of species, generally lead to a long-term or irreversible decrease in the population that normal processes, rates of mortality and recruitment could not buffer."

One nationally threatened species, the Grey-headed Flying-fox, is expected to occur on the quarry site. However, several internationally protected migratory bird species were recorded during this study, and others would also occur there. The potential for the proposed quarry to have a significant impact on listed threatened species and migratory species has been assessed below, by applying the criteria in the Commonwealth Minister's *Administrative Guidelines*. No Commonwealth listed ecological communities occur on the site. Three endangered plant species occur near the quarry site; see Section 4.1.

i. Criteria for Critically Endangered and Endangered Species

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- lead to a long-term decrease in the size of a population, or
- reduce the area of occupancy of the species, or
- fragment an existing population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of a population, or
- modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or
- interferes with the recovery of the species.

The following three endangered plant species occur near the quarry site, but not within the proposed quarry area: *Cynanchum elegans*, *Daphnandra* sp. 'C' (Illawarra) and *Zieria granulata*.

The species do not occur on the quarry site and the development of the quarry is not likely to result in any of the above impacts on these species.

ii. Criteria for Vulnerable Species

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- lead to a long-term decrease in the size of an *important population* of a species, or
- reduce the area of occupancy of an *important population*, or
- fragment an existing *important population* into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of an *important population*, or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or
- interferes substantially with the recovery of the species.

(*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.)

An *important population* is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

The Grey-headed Flying-fox is the only vulnerable species likely to occur on the quarry site. As noted elsewhere, this species is expected to visit the large fig trees on the site in summer. The eventual removal of the fig trees on the quarry site is not likely to have any of the above significant impacts on important populations of the Grey-headed Flying-fox. Part of an important population that camps nearby in Jamberoo Valley no doubt visit these fig trees to feed. However, this small number of trees is not likely to be habitat critical to the survival of this population. As noted elsewhere, it is proposed to replant a large area of rainforest and this will include fig trees.

iv. Criteria for Listed Migratory Species

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of *important habitat* of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established* in an area of *important habitat* of the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an *ecologically significant proportion* of the population of the species.

(*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.)

An area of *important habitat* is:

a) habitat utilised by a migratory species occasionally or periodically within a region that supports an *ecologically significant proportion* of the population of the species, or
b) habitat utilised by a migratory species which is at the limit of the species range, or

c) habitat within an area where the species is declining.

Various listed migratory species occur on the quarry site and nearby. Common Australian birds are listed under the Act and few locations would not have any of these. For example all ducks and all diurnal birds of prey are listed species.

The quarry site is very unlikely to:
- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of *important habitat* of a migratory species. The quarry site, which is almost all farmland, is very unlikely to be "important habitat", as defined above, for a listed migratory species.

- result in invasive species that is harmful to the migratory species becoming established in an area of *important habitat* of the migratory species. The area is not likely to be important habitat, and the quarry development will, as part of its management plan, incorporate weed and pest animal control programs.

- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an *ecologically significant proportion* of the population of the species. The few migratory species that would occasionally visit the quarry site would not be an *ecologically significant proportion* of the population of any listed migratory species.

5 CONCLUSION

Previous Recommendations
The previous study by Kevin Mills & Associates (1998) identified several significant ecological constraints to the expansion of quarrying on the two properties. The design of the proposed quarry is cognisant of these features, particularly the protection of threatened species and of rainforest vegetation. Several recommendations are provided in the previous report to mitigate the potential impact of a quarry in the area; these are reproduced below, with comment provided on each.

"(i) The quarry should not exceed the area shown on Figure 4.1, to avoid most of the significant ecological features in the area. This is only a nominal boundary. The exact boundary should be established during the EIS process to more accurately define the limits of the quarry and the required buffer areas along creeks and around areas of forest."

The land use zoning and the proposed quarry take into account this recommendation, such that all of the threatened species and the contiguous stands of native vegetation are excluded from the proposed quarry site. Further recommendations on this matter are provided below.

"(ii) An Environmental Impact Statement should be prepared for the quarry if the rezoning application is approved; the EIS should address, among other things, the following matters:
- rehabilitation of the edges of the quarry;
- the potential for indirect impacts on the threatened flora species;
- the potential for the threatened fauna listed in this report to occur in the area;

- the potential for downstream impacts on the rainforest environment due to stream capture and changes in water quality."

This report forms part of the EIS, and together address these matters.

"(iii) The proposal should include a major program of revegetation, to strengthen the rainforest vegetation in the area and to compensate for the rainforest removed to develop the quarry. The Company has indicated that if Council adopts the rezoning proposal they are willing, in conjunction with Council and a recognised consultant, to prepare a rehabilitation/revegetation plan immediately so that the plan is well advanced by the time extraction begins."

The EIS proposes such a revegetation program. A separate revegetation/native vegetation management plan should be prepared and its measures started before the quarry is begun.

"(iv) Because of the importance of fig trees to fauna, and the fact that some would be removed to develop the quarry, figs *Ficus* sp. should be a significant part of the revegetation program."

The inclusion of local native fig trees is proposed in the species to be planted in the revegetation areas.

Recommendations for Quarry Development

Now that the extent of the quarry has been finalised, further recommendations are appropriate; these are provided below.

(a) The buffer zone along the southern edge of the quarry should be pegged on site by an ecologist prior to fencing this boundary. The area inside this fence to the creek is the proposed revegetation area, referred to elsewhere.

(b) The above fence should be installed prior to the commencement of any excavation or other quarry work.

(c) Tree planting in the revegetation areas should start as soon as the above fence is in place.

(d) Stock should be removed as soon as possible from the regeneration areas.

(e) Trees and other species used for the revegetation program should be selected from the list of local native plants provided in this report.

(f) Trees and other plants for the revegetation program should be sourced from local plants, this will maintain the genetic integrity of the local species.

(g) Prior to clearing the patches of native plants on the quarry site, seeds, cuttings and other propagation material should be gathered for use in the revegetation program.

(h) Weed control in the revegetation areas will be required to ensure the success of plantings.

(i) Inspection of the revegetation areas by a qualified person should be undertaken annually and a report prepared and submitted to Council. This report should also make comment on any other relevant environmental matters, such as inspections of the creek below the water release point.

(j) The release of the water from the quarry site should be variable, rather than a continuous flow; this should mirror the local rainfall as far as possible.

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APPENDIX 1
LIST OF PLANT SPECIES FOR THE STUDY AREA

Key to Plant List

1. Recorded by QEM (1994)
2. closed forest
3. open forest
4. grassland
5. shrubland/regrowth
6. sedgeland/rushland (dams)

c - common
o - occasional
u - uncommon
plant species of conservation significance

FAMILY	GENUS SPECIES	*	1	2	3	4	5	6
FILICOPSIDA								
Adiantaceae	*Adiantum aethiopicum*		x	u				
	Adiantum formosum		x	u				
	Adiantum hispidulum		x	u	u			
	Cheilanthes distans		x					
	Cheilanthes sieberi		x		u	u	u	
Aspidiaceae	*Asplenium australasicum*		x	u				
	Asplenium flabellifolium		x	o	u			
	Lastreopsis acuminata		x	u				
	Lastreopsis microsora		x	u				
Azollaceae	*Azolla filiculoides*						o	
Blechnaceae	*Blechnum cartilagineum*		x	u				
	Doodia aspera		x		u		u	
Davalliaceae	*Arthropteris tenella*		x	o				
Dennstaedtiaceae	*Histiopteris incisa*			o				
	Hypolepis muelleri			u				
	Hypolepis glandulifera			u				
	Pteridium esculentum			o				
Dicksoniaceae	*Calochlaena dubia*		x			u		
Polypodiaceae	*Microsorium scandens*		x		u			
	Platycerium bifurcatum subsp. *bifurcatum*		x	u	u			
	Pyrrosia rupestris		x	o	u			
Sinopteridaceae	*Pellaea falcata* var. *falcata*		x	o	u		u	
CONIFEROPSIDA								
Podocarpaceae	*Podocarpus elatus*		x	u				
MAGNOLIOPSIDA - DICOTYLEDONS								
Acanthaceae	*Brunoniella australis*				o		u	
	Pseuderanthemum variabile		x	u	u			
Amaranthaceae	*Alternanthera denticulata*		x		u			u
	Amaranthus retroflexus	*	x			u		
	Deeringia amaranthoides	#	x	u				
	Nyssanthes erecta		x			u		
Amygdalaceae	*Prunus persica*	*					u	
Anacardiaceae	*Euroschinus falcata*		x	u				
Apiaceae	*Centella asiatica*				o		o	
	Hydrocotyle peduncularis		x					

	Hydrocotyle tripartita				u			
	Platysace ericoides		x					
Apocynaceae	*Parsonsia straminea*		x	c	o			
Araliaceae	*Polyscias elegans*		x	o				
Asclepiadaceae	*Araujia sericiflora*	*		o	o		o	
	Cynanchum elegans	#	x	u			u	
	Gomphocarpus fruticosus	*	x			u		
	Marsdenia flavescens		x	c				
	Marsdenia rostrata		x	o				
	Melodinus australis		x	u				
	Tylophora barbata		x		o		u	
Asteraceae	*Ageratina adenophora*	*	x	o				o
	Ageratina riparia	*	x	o	o			
	Bidens pilosa	*	x			o		
	Brachycome angustifolia var angustifolia		x					
	Cassinia trinervia		x		u		u	
	Cirsium vulgare	*	x			o		
	Conyza albida	*	x		o	o	o	
	Conyza bonariensis	*	x				o	
	Delairea odorata	*	x	u			u	
	Euchiton sphaericum					u		
	Hypochaeris radicata	*	x			o		
	Ozothamnus diosmifolius		x		o		o	
	Senecio linearifolius			u	u			
	Senecio madagascariensis	*	x			c	o	
	Sonchus oleraceus	*	x			o		
	Tagetes minuta	*	x					o
	Xanthium occidentale	*	x			u		
Basellaceae	*Anredera cordifolia*	*	x	u			u	
Bignoniaceae	*Pandorea pandorana*		x	c	o		u	
	Tecomaria capensis	*						
Brassicaceae	*Rorippa nasturtium-aqauticum*	*	x					u
Cactaceae	*Opuntia stricta*	*	x			o		
Campanulaceae	*Wahlenbergia gracilis*		x		o	o	u	
Caprifoliaceae	*Lonicera japonica*	*					u	
	Sambucus australasius		x	u			u	
Caryophyllaceae	*Stellaria flaccida*		x	o	u			
Celastraceae	*Cassine australis*		x	c			u	
	Celastrus australis		x	u				
Chenopodiaceae	*Einadia hastata*		x			u		
	Einadia nutans		x			u		
Clusiaceae	*Hypericum gramineum*					o		
Convolvulaceae	*Convolvulus erubescens*		x		u			
	Dichondra repens		x		u	o	u	
	Ipomoea indica	*					u	
Crassulaceae	*Bryophyllum delagoense*	*	x			o	o	
	Cotyledon orbiculata	*	x				u	
	Crassula sieberiana		x		o	u	o	

Cucurbitaceae	*Sicyos australis*		x	u				
Cunoniaceae	*Aphanopetalum resinosum*		x	u				
Dilleniaceae	*Hibbertia dentata*				u			
	Hibbertia scandens		x		u			
Ebenaceae	*Diospyros australis*		x	u				
	Diospyros pentamera		x	o				
Ehretiaceae	*Ehretia acuminata*		x	o			u	
Elaeocarpaceae	*Elaeocarpus kirtonii*		x	u				
	Sloanea australis		x	u				
Epacridaceae	*Leucopogon juniperinus*		x		u			
	Lissanthe strigosa						o	
Euphorbiaceae	*Actephila lindleyi*	#	x	u				
	Alchornea ilicifolia	#	x	o			o	
	Baloghia inophylla		x	o				
	Breynia oblongifolia		x	u	o		o	
	Claoxylon australe		x	u				
	Croton verreauxii		x	o			u	
	Glochidion ferdinandi var. *ferdinandi*		x	o				
	Omalanthus nutans		x	c	o		u	
	Omalanthus stillingifolius	#	x					
	Phyllanthus gasstroemii		x		u			
	Ricinus communis	*	x			u		
Eupomatiaceae	*Eupomatia laurina*		x	u				
Fabaceae: Faboideae	*Desmodium varians*					u		
	Erythrina x sykesii	*				u		
	Glycine clandestina		x		o	o		
	Glycine tabacina					u		
	Hardenbergia violacea					u		
	Indigofera australis		x		u		u	
	Kennedia rubicunda		x			u	u	
	Trifolium repens	*				c		
	Trifolium subterraneum	*	x			c		
Fabaceae: Mimosoideae	*Acacia binervata*				o		o	
	Acacia implexa		x		o		u	
	Acacia maidenii		x		u			
	Acacia mearnsii		x		o		c	
	Acacia melanoxylon				u			
	Pararchidendron pruinosum		x	u				
Flacourtiaceae	*Scolopia braunii*		x	u				
Gentianaceae	*Centaurium erythraea*	*	x			o		
Geraniaceae	*Geranium homeanum*		x					
	Geranium solanderi var. *solanderi*				u			
Goodeniaceae	*Scaevola albida*		x					
Icacinaceae	*Citronella moorei*		x	u				
	Pennantia cunninghamii		x	u				
Lamiaceae	*Ajuga australis*			u				

	Plectranthus graveolens(?)		x					
	Plectranthus parviflorus		x	o	o		o	
	Prostanthera linearis		x				u	
Lauraceae	*Cinnamomum oliveri*	#	x	u				
	Cryptocarya glaucescens		x	u				
	Cryptocarya microneura		x	c			o	
	Litsea reticulata		x	o				
Lobeliaceae	*Pratia purpurascens*				o			
Loranthaceae	*Amyema congener*		x	u			u	
Malaceae	*Pyracantha fortuneana*	*					u	
Malvaceae	*Abutilon oxycarpum*				u			
	Hibiscus heterophyllus		x	c	u		o	
	Modiola caroliniana	*	x			o		
	Sida rhombifolia	*	x			o		
Meliaceae	*Melia azedarach*		x	o			u	
	Synoum glandulosum		x	u				
	Toona ciliata		x	u			u	
Menispermaceae	*Legnephora moorei*		x	u			u	
	Sarcopetalum harveyanum		x	o			u	
	Stephania japonica var. *discolor*		x	u			u	
Monimiaceae	*Daphnandra* sp. aff. *micrantha*	#	x	u				
	Doryphora sassafras		x	u				
	Wilkiea huegeliana		x	u				
Moraceae	*Ficus coronata*		x	o			u	
	Ficus macrophylla		x	o		o		
	Ficus obliqua		x	u				
	Ficus rubignosa		x	u				
	Ficus superba var. *henneana*		x	u		o		
	Maclura cochinchinensis		x	c			o	
	Malaisia scandens		x	o			u	
	Strebulus brunonianus		x	c	o		o	
Myrsinaceae	*Rapanea howittiana*		x	u				
	Rapanea variabilis		x	u				
Myrtaceae	*Acmena smithii*		x	c			u	
	Angophora floribunda		x		u			
	Austromyrtus acmenoides	#	x	u				
	Eucalyptus amplifolia		x					
	Eucalyptus bosistoana		x		o			
	Eucalyptus quadrangulata		x		o			
	Eucalyptus tereticornis		x		c			
	Melaleuca armillaris		x		u		c	
	Melaleuca styphelioides		x		u			
	Syzygium australe		x	o				
Oleaceae	*Ligustrum lucidum*	*					u	
	Ligustrum sinense	*	x			u	u	

	Notolaea longifolia		x		u			
	Notolaea venosa		x	o			u	
	Olea europaea subsp. *africana*	*	x			u	u	
Onagraceae	*Ludwigia peploides* subsp. *montevidensis*		x					u
Passifloraceae	*Passiflora herbertiana*		x	u	u		u	
Phytolaccaceae	*Phytolacca octandra*	*	x			u		
Piperaceae	*Piper novae-hollandiae*		x	u				
Pittosporaceae	*Billardiera scandens*				u			
	Bursaria spinosa var *spinosa*		x				o	
	Citriobatus pauciflorus		x	c			o	
	Pittosporum revolutum		x	o			u	
	Pittosporum undulatum		x	o	o		o	
Plantaginaceae	*Plantago lanceolata*	*	x			o		
	Plantago major	*	x					o
Polygonaceae	*Acetosella vulgaris*	*	x				u	
	Muehlenbergia gracillima		x	u				
	Persicaria decipens		x					u
	Persicaria hydropiper		x					u
	Rumex crispus	*	x					u
Portulacaceae	*Portulaca octandra*	*				o		
Proteaceae	*Stenocarpus salignus*		x	u	u			
Ranunculaceae	*Clematis aristata*				u			
	Clematis glycinoides		x	u			u	
Rhamnaceae	*Alphitonia excelsa*		x	c	o		o	
	Emmenosperma alphitonoides		x	u				
	Pomaderris aspera		x				u	
Rosaceae	*Rubus fruticosus* sp. aggregate	*	x			o	u	
	Rubus hillii		x		u			
	Rubus parviflorus		x		o			
	Rubus rosifolius			u				
Rubiaceae	*Canthium coprosmoides*		x	u				
	Coprosma quadrifida (?)		x					
	Morinda jasminoides		x	u				
	Psychotria loniceroides		x	u				
Rutaceae	*Acronychia oblongifolia*		x	f				
	Citrus limonia	*	x			u		
	Geijera latifolia		x	o			u	
	Melicope micrococca		x	o			u	
	Sarcomelicope simplicifolia subsp. *simplicifolia*		x	u				
	Zieria granulata	#	x				o	
Santalaceae	*Exocarpos cupressiformis*		x		u		u	
Sapindaceae	*Alectryon subcinerus*		x	o			u	
	Cardiospermum grandiflorum	*	x	o	o		o	

	Diplogottis australis		x	o				
	Dodonaea viscosa subsp. *angustifolia*	#	x				o	
	Guioa semiglauca		x	o			u	
Sapotaceae	*Planchonella australis*		x	o			u	
Scrophulariaceae	*Verbascum thapsus*	*	x			o		
	Veronica plebeia				u			
Solanaceae	*Duboisia myoporoides*			u				
	Lycium ferocissimum	*					o	
	Solanum aviculare				u			
	Solanum brownii(?)		x					
	Solanum mauritianum	*	x		u		u	
	Solanum nigrum	*	x			u		
	Solanum pseudocapsicum	*	x			u		
	Solanum stelligerum		x			u		
Sterculiaceae	*Brachychiton acerifolius*		x		u		u	
	Commersonia fraseri		x	o			o	
Ulmaceae	*Trema aspera*		x	o			o	
Urticaceae	*Dendrocnide excelsa*		x	o				
	Urtica incisa		x	u			u	
Verbenaceae	*Clerodendrum tomentosum*		x	o	u		u	
	Lantana camara	*	x	c	c		c	
	Verbena bonariensis	*	x			o		
VIOLACEAE	*Hymenanthera dentata*		x	o			u	
	Viola hederacea		x		u		u	
Vitaceae	*Cayratia clematidea*		x	u				
	Cissus antarctica		x	u				
	Cissus hypoglauca		x	o			u	
MAGNOLIOPSIDA – MONOCOTYLEDONS								
Alismataceae	*Alizma plantago-aquatica*							u
Araceae	*Gymnostachys anceps*		x	u				
Arecaceae	*Livistonia australis*		x	o				
Commelinaceae	*Aneilema acuminatum*		x	o				
	Commelina cyanea		x	o				
	Pollia crispata		x	u				
Cyperaceae	*Bolboschoenus caldwelli*		x					u
	Carex appressa		x			u		
	Carex longebrachiata		x		u	u	u	
	Cyperus eragrostis	*						u
	Cyperus imbecillis				u			
	Cyperus polystachyos		x					u
	Eleocharis sphacelata		x					u
	Isolepis prolifera	*					c	
Iridaceae	*Romulea longifolia*	*	x			o		
Juncaceae	*Juncus usitatus*		x					o
Lemnaceae	*Spirodela oligorrhiza*		x					o
Philesiaceae	*Eustrephus latifolius*		x	o	o			
	Geitonoplesium cymosum		x	o	o			

Poaceae	*Andropogon virginicus*	*	x			o		
	Aristida ramosa		x		o	o		
	Aristida vagans				o			
	Axonopus affinis	*	x			o		
	Bothriochloa macra		x		u			
	Chloris gayana	*	x			o		
	Chloris truncata		x		u			
	Cynodon dactylon		x		o	u	u	
	Danthonia tenuior				o			
	Echinopogon caespitosus var. *caespitosus*		x		o	o		
	Microlaena stipoides var. *stipoides*		x		u			
	Oplismenus aemulus			c	c			
	Oplismenus imbecillis		x	c	c		u	
	Paspalum dilatatum	*	x			c	u	
	Paspalum distichum		x					u
	Pennisetum clandestinum	*	x		o	c		o
	Poa labillardieri		x		o	o		
	Sporobolus indicus var. *capensis*	*	x			u		
	Stenotraphum secundatum	*	x			u		
	Stipa ramosissima		x		o		u	
	Themeda australis		x		o		o	
Orchidaceae	*Dendrobium speciosum*		x					
	Pterostylis hildae(?)		x					
Potamogetonaceae	*Potamogeton crispus*		x					u
Smilacaceae	*Smilax australis*		x	c			u	
Typhaceae	*Typha domingensis*		x					
	Typha orientalis		x					u

APPENDIX 2
FINAL DETERMINATION FOR ILLAWARRA LOWLANDS GRASSY WOODLAND

Threatened Species Conservation Act 1995
NSW Scientific Committee
Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule I of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. The Illawarra Lowlands Grassy Woodland is the name given to the plant community from the local government areas of Wollongong City, Shellharbour City, and Kiama Municipality (within the Sydney Basin Bioregion) that is characterised by the following assemblage of species:

Acacia falcata
Acacia implexa
Acacia maidenii
Acacia mearnsii
Acacia stricta
Allocasuarina littoralis
Angophora floribunda
Aristida ramosa
Aristida vagans
Athropodium milleflorum
Boronia polygalifolia
Bothriochloa macra
Brachychiton populneus
Brunoniella pumilio
Bursaria spinosa
Callistemon salignus
Carex longebrachiata
Cheilanthes sieberi
Citriobatus pauciflorus
Commelina cyanea
Cymbopogon refractus
Daviesia genistifolia
Daviesia ulicifolia
Desmodium rhytidophyllum
Desmodium varians
Dianella revoluta
Dichondra repens
Dodonaea viscosa var angustifolia
Echinopogon caespitosus
Echinopogon ovatus
Entolasia stricta
Eragrostis sp.
Eucalyptus amplifolia
Eucalyptus bosistoana
Eucalyptus botryoides
Eucalyptus botryoides/saligna
Eucalyptus eugenioides
Eucalyptus longifolia
Eucalyptus pilularis
Eucalyptus tereticornis
Gahnia radula
Geitonoplesium cymosum
Geranium solanderi
Glycine sp.
Goodenia hederacea subsp *hederacea*
Hardenbergia violacea
Hibbertia aspera
Hypericum gramineum
Hypoxis hygrometrica
Jacksonia scoparia
Kennedia rubicunda
Lepidosperma laterale
Leucopogon juniperinum
Lomandra filiformis
Lomandra multiflora
Melaleuca decora
Melaleuca styphelioides
Microlaena stipoides
Oplismenus aemulus
Oplismenus imbecillis
Panicum sp.
Parsonsia straminea
Plectranthus parviflorus
Poa labillardieri
Pratia purpurascens
Pultenaea retusa
Pultenaea villosa
Rubus parvifolius
Stellaria flaccida
Themeda australis
Tricoryne elatior
Veronica calycina
Wahlenbergia sp.

2. The total species list of the community is considerably larger than that given in 1 (above), with many species present in only one or two sites or in very small quantity. In any particular site not all of the assemblage listed in 1 may be present. At any one time, seeds of some species may only be present in the soil

seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site and by its recent disturbance history. The number of species and the above-ground composition of species will change with time since fire, and may also change in response to changes in fire frequency.

3. Illawarra Lowlands Grassy Woodland has been recorded from the local government areas of Wollongong City, Shellharbour City and Kiama Municipality (within the Sydney Basin Bioregion).

4. Illawarra Lowlands Grassy Woodland includes the Yallah Woodland and Mills' (1997) communities of the Floodplains, communities of the Ridges and Slopes (Dry communities) and communities of the lower escarpment (Moist communities), but does not include Floodplain Communities dominated by *Casuarina* species or rainforest on latite soils.

5. Characteristic tree species in the Illawarra Lowlands Grassy Woodland are *Eucalyptus tereticornis, Eucalyptus eugenioides, Eucalyptus longifolia, Eucalyptus bosistoana and Melaleuca decora.*

6. Illawarra Lowlands Grassy Woodland occurs on relatively gently sloping to undulating lands less than about 200m elevation on Berry Siltstone, Budgong Sandstone and Quaternary alluvium.

7. Illawarra Lowlands Grassy Woodland provides habitat for the endangered orchid *Pterostylis gibbosa.*

8. No areas of Illawarra Lowlands Grassy Woodland are presently included in formal conservation reserves though some occur in small council reserves including Blackbutt Reserve and Croome Road Reserve in Shellharbour.

9. Large areas of Illawarra Lowlands Grassy Woodland have been cleared. Most remnants are small and fragmented and their long term viability is threatened. Some remnants consist of regrowht after clearing or other disturbances. Identified threats include further clearing, grazing, weed invasion, selective logging, rubbish dumping, housing and hobby farm developments and physical damage from recreational activities.

10. In view of the small size of existing remnants, the threat of further clearing and other threatening processes, the Scientific Committee is of the opinion that Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion is likely to become extinct in nature unless factors threatening its survival or evolutionary development cease to operate and that listing as an endangered ecological community is warranted.

Dr Chris Dickman
Chairperson
Gazetted: 24/12/99
Scientific Committee Exhibition period: 24/12/99 – 4/2/00

Reference: Kevin Mills & Associates (1997) *Ecological Study Figtree Estate and Forest Red Gum Communities of the Illawarra Coastal Plain.* (prepared for Stockland Trust Group Ltd Sydney).

Threatened Species Conservation Act 1995
NSW Scientific Committee
Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Illawarra Subtropical Rainforest in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. The listing of endangered ecological communities is provided for by Part 2 of the Act.
The Scientific Committee has found that:

1. Illawarra Subtropical Rainforest is the name given to the ecological community on high nutrient soils in the Illawarra area within the Sydney Basin Bioregion and is characterised by the following assemblage of species.

Adiantum formosum	*Alectryon subcinereus*
Alphitonia excelsa	*Baloghia inophylla*
Brachychiton acerifolius	*Cassine australis*
Cayratia clematidea	*Celastrus australis*
Cissus antarctica	*Citriobatus pauciflorus*
Dendrocnide excelsa	*Diospyros pentamera*
Diploglottis australis	*Doodia aspera*
Ehretia acuminata	*Ficus* spp.
Guioa semiglauca	*Hibiscus heterophyllus*
Legnephora moorei	*Maclura cochinchinensis*
Malaisia scandens	*Pennantia cunninghamii*
Piper novaehollandiae	*Planchonella australis*
Podocarpus elatus	*Scolopia braunii*
Streblus brunonianus	*Toona ciliata*
Wilkiea huegliana	

2. The total species list of the community is considerably larger than that given above, with many species present in only one or two sites or in very small quantity. The species composition of a site will be influenced by the size of the site, recent rainfall or drought condition and by its disturbance (including fire) history. The number of species, and the above ground relative abundance of species will change with time since fire, and may also change in response to changes in fire regime (including changes in fire frequency). At

any one time, above ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Illawarra Subtropical Rainforest has been recorded from the local government areas of Wollongong City, Shellharbour City, Shoalhaven City and Kiama Municipality (within the Sydney Basin Bioregion) and may occur elsewhere in the Bioregion.

4. Illawarra Subtropical Rainforest includes Subtropical Rainforest (Type 1), Moist Subtropical Rainforest (Type 2) and Dry Subtropical Rainforest (Type 3) of Mills, K & Jakeman, J. (1995 *Rainforests of the Illawarra District* (Coachwood Publishing, Jamberoo). (The classification of Mills & Jakeman was developed specifically for the Illawarra - in a broader context much of the community recognised here would fall within dry forest (suballiance 23) in Floyd, A. G. (1990). *Australian rainforests in New South Wales* (Vols 1 and 2, Surrey Beatty and Sons, Chipping Norton). Although rainforest canopies are generally closed, in highly disturbed stands the canopy may be irregular and open. Canopy height varies considerably, and structurally some stands are scrub.

5. Characteristic tree species in the Illawarra Subtropical Rainforest are *Baloghia inophylla, Brachychiton acerifolius, Dendrocnide excelsa, Diploglottis australis, Ficus* spp., *Pennantia cunninghamii* and *Toona ciliata.* Stands may have species of *Eucalyptus, Syncarpia* and *Acacia* as emergents or incorporated into the dense canopy.

6. Illawarra Subtropical Rainforest occurred mainly on the coastal Permian volcanics, but can occur on a range of geological substrates, mainly between Albion Park and Gerringong (termed the Illawarra Brush by Mills and Jakeman 1995) and north of Lake Illawarra on the Berkeley Hills (termed the Berkeley Brush by Mills & Jakeman 1995). The Illawarra Brush and Berkeley Brush originally covered about 13 600 ha and made up about 60% of the rainforest of the Illawarra area. Outlying occurrences of Illawarra Subtropical Rainforest also occur south to the Shoalhaven River and westwards into Kangaroo Valley, where areas of Permian volcanic soils occur. The community generally occurs on the coastal plain and escarpment foothills, rarely extending onto the upper escarpment slopes.

7. Illawarra Subtropical Rainforest provides habitat for the tree *Daphnandra* sp. C Illawarra, and in some drier stands the endangered vine *e.* The shrub *Zieria granulata* may grow near stands of Illawarra Subtropical Rainforest and in regrowth stands (K. Mills pers. comm.).

8. Small areas of Illawarra Subtropical Rainforest occur in Budderoo National Park, Macquarie Pass National Park, Morton National Park, Cambewarra Range Nature Reserve, Devils Glen Nature Reserve and Rodway Nature Reserve.

9. Large areas of Illawarra Subtropical Rainforest have been cleared for agriculture. Only about 3400 ha remains with about 13% of this (440 ha) in reserved areas (Mills & Jakeman 1995, L. Mitchell pers. comm). Illawarra Subtropical Rainforest occurs mainly on private land and is inadequately protected. Compared with warm temperate rainforest it is under-represented in conservation reserves.

10. Remnants are small and fragmented and their long term viability is threatened. Weed invasion is a major threat and invasive exotic species include *Lantana camara, Araujia sericiflera, Ageratina riparia, Ageratina adenophora, Delairea odorata, Senna pendula* var *glabra, Senna septemtrionalis, Tradescantia fluminensis, Cinnamomum camphora, Olea europea* subsp. *africana, Hedychium gardnerianum, Ligustrum lucidum, Ligustrum sinense, Passiflora subpeltata* and *Solanum mauritianum*. Other threats include further clearing, quarrying, grazing, inappropriate fire regimes, rubbish dumping and hobby farm developments.

11. In view of the above the Scientific Committee is of the opinion that Illawarra Subtropical Rainforest in the Sydney Basin Bioregion is likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Proposed Gazettal date: 01/11/02
Exhibition period: 01/11/02 - 05/12/02

Appendix P

ABORIGINAL ARCHAEOLOGICAL ASSESSMENT

AN ARCHAEOLOGICAL INVESTIGATION OF A PROPOSED HARD ROCK QUARRY EXTENTION NEAR ALBION PARK, NEW SOUTH WALES

A Report
to
Davron Engineering Pty Ltd

by

Robert Paton

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May 1998

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1. INTRODUCTION

Cleary Bros (Bombo) Pty Ltd proposes to expand the Company's hard rock quarry near Albion Park (Figure 1). The proposal incorporates about 1 square kilometre and will involve a continuation of the current quarrying located immediately adjacent to the study area. The exact sequencing of future quarrying activities has not yet been determined. Figure 2 illustrates the proposed and potential areas of quarrying which were surveyed in detail for the present study.

As part of the planning for the continued operation of the quarry, a number of environmental factors are being reviewed. One of these relates to the impact of the proposal on Aboriginal heritage/conservation values. To address this issue the consultant Robert Paton was commissioned by Davron Engineering Pty Ltd on behalf of Cleary Bros (Bombo) Pty Ltd to undertake a study of Aboriginal archaeological sites. This study forms part of the Company's rezoning application which, if successful, will allow an application to be prepared for continuation of the quarrying operation.

1.1. Aims of the study

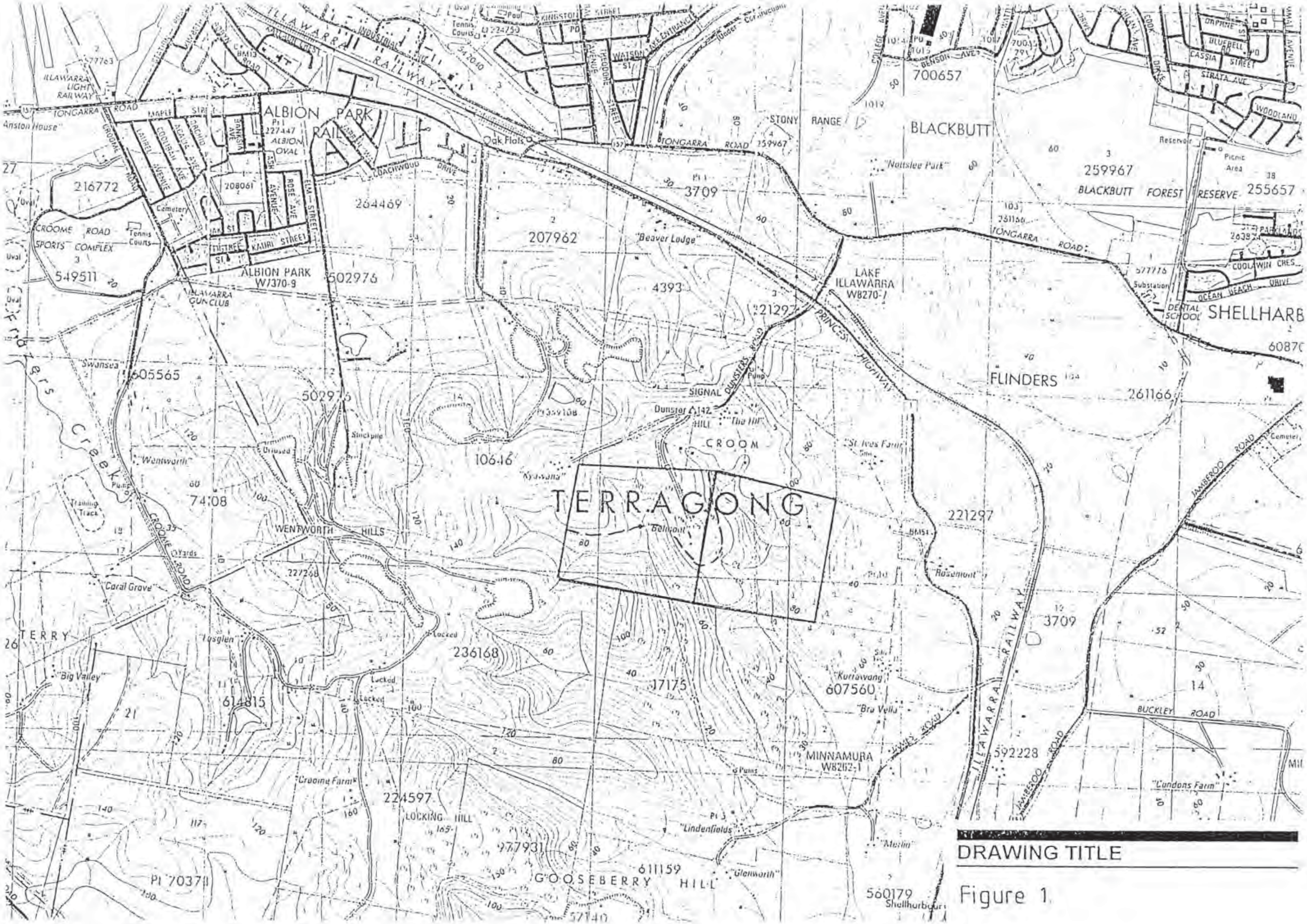
The investigation has three main aims:

1. To locate and record any Aboriginal sites in the proposed development area.

2. To consult with the local Aboriginal community regarding the development.

3. To identify any constraints that may be placed on the development by heritage issues.

The field survey was conducted in November 1997 by the archaeologists Robert Paton and Wilfred Shawcross. Mr Jimmy Davis, a consultant from the



DRAWING TITLE

Figure 1.

Illawarra Local Aboriginal Land Council, participated in the field investigation and was involved in discussions about the nature and scope of the proposed development. Information held in the New South Wales National Parks and Wildlife Service Head Office site register was examined to assist in understanding the known archaeological resources of the region. In addition previous reports and other relevant literature for the area was consulted to provide background context to the investigation.

2. ENVIRONMENTAL SETTING

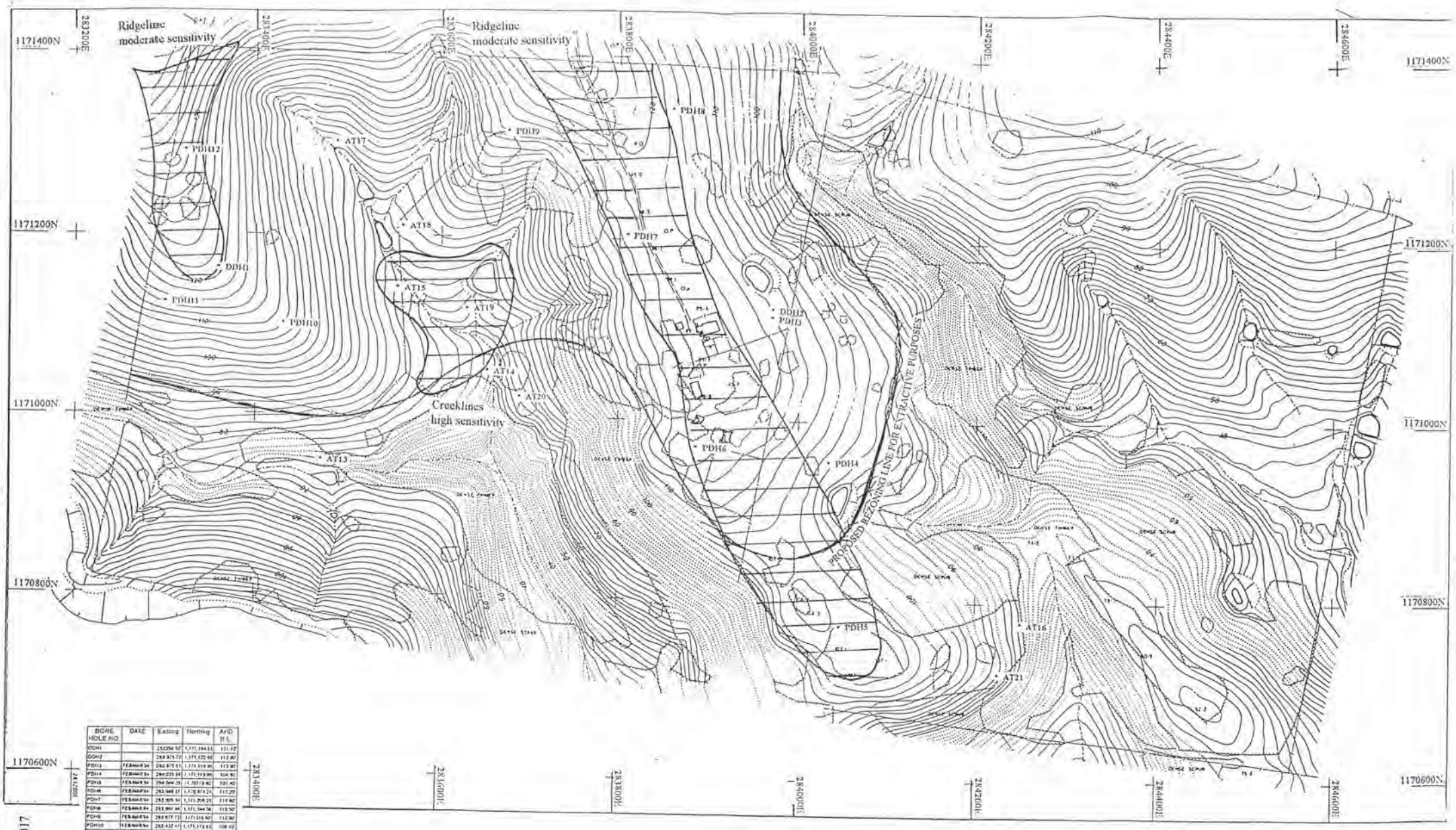
The study area is located in a rugged area in the immediate coastal hinterland. It lies at the easterly end of a moderately steep escarpment at a elevation of approximately 130 metres above sea level.

The topography of the study area is for the most part very steep. However there are several relatively flat ridgelines and a small flat area of low elevation where several minor streams meet (see Figure 2).

The geology of the area is based on volcanic and sedimentary rocks. Occasional rocks outcrop in the area but none of these were pronounced enough to be useful as shelters. Similarly, no rocks suitable for grinding stone implements were noted.

Several minor streams start on the plateau leading to short steep valleys cutting back into the plateau margins. These appear to contain water only after rain. Several seepage areas were also noted.

The original vegetative cover of eucalypt forest has been mostly cleared. Areas of moderately thick regrowth cover part of the study area. This regrowth consists of varying densities of eucalypt and acacia, in association with assorted shrubs and grasses.



BORE HOLE NO	DATE	Easting	Northing	AHD R.L.
DDH1		283256.50	1171164.61	121.19
DDH2		283375.72	1171122.68	117.80
PDH3	FEB/MAR'94	283 875.13	1171 019.95	113.90
PDH4	FEB/MAR'94	284 035.89	1170 918.86	104.50
PDH5	FEB/MAR'94	284 244.79	1170 728.80	101.40
PDH6	FEB/MAR'94	283 948.37	1170 874.23	117.27
PDH7	FEB/MAR'94	283 809.34	1171 208.25	114.60
PDH8	FEB/MAR'94	283 991.94	1171 344.36	119.50
PDH9	FEB/MAR'94	283 877.72	1171 518.50	113.90
PDH10	FEB/MAR'94	283 432.41	1171 513.63	108.10
PDH11	FEB/MAR'94	284 290.81	1171 321.63	114.50
PDH12	FEB/MAR'94	283 818.29	1171 295.80	110.50
AT13	APR/94	283 968.08	1170 993.42	79.10
AT14	APR/94	283 881.27	1171 054.00	99.20
AT15	APR/94	283 531.33	1171 144.72	80.00
AT16	APR/94	284 247.30	1170 779.73	75.90
AT17	APR/94	283 484.25	1171 304.99	92.20
AT18	APR/94	283 534.44	1171 212.28	85.00
AT19	APR/94	283 636.72	1171 333.90	75.70
AT20	APR/94	283 869.44	1171 525.25	72.00
AT21	APR/94	284 272.45	1170 721.42	84.30

Figure 2

Showing areas of varying degrees of archaeological sensitivity as indicated. All unmarked areas within the development site are deemed to be of low archaeological sensitivity.

CLEARY BROS(BOMBO) PTY LTD
ALBION PARK QUARRY OPERATIONS
CODY' S & LINDSAY LANES PROPERTIES
REZONING APPLICATION

September, 1998

BASE MAP: BHPE Drg No F045-01-017

Davron Engineering Pty Ltd
Project Ref: 9704-82

3. ARCHAEOLOGICAL BACKGROUND

3.1. Local studies

No systematic archaeological survey work has been undertaken in the immediate region. Most investigations have taken place in the lower country immediately abutting the coastline. Here most sites consist of shell middens and/or surface scatters of stone artefacts associated with the exploitation of the coastal fringe.

The most relevant archaeological survey was undertaken at the nearby Boral Croome Farm quarry at Dunmore (Navin and Officer 1996). This survey located one artefact scatter and a scarred tree in an environment similar to the present study area.

3.2. Regional context

Previous studies along the south coast of New South Wales have demonstrated Aboriginal occupation of the region dating back to the height of the last glacial period some 20,000 years ago (Lampert, 1971; Bowdler, 1976). During this period sea level was much lower than it is today and consequently the shoreline was up to 16km to the east of the present coast. Present sea levels stabilised some 6-7,000 years ago and most coastal sites date from this period. Coastal sites older than 7,000 years would have been submerged by rising sea levels associated with the melting of the glaciers and ice-caps.

The most commonly encountered archaeological sites in the region are shell middens and open campsites represented by scatters of stone artefacts. Rockshelter sites are also a feature of the regional archaeological record. Lampert (1971) divided these occupation sites into three basic groups:

1. Specialised foreshore sites focussing on the exploitation of coastal resources such as fish, shellfish and marine birds (e.g. Durras North, Wollumboola and

Wattamolla) where specialised fishing equipment was used (e.g. spears tipped with bone points and shell fish hooks).

2. Specialised estuarine sites focussing on the exploitation of inland resources.

3. Sites besides creeks or estuaries near the seashore where a range of inland and coastal resources were used (e.g. Burril Lake, Currarong and Curracurrang).

The archaeology of the forested hinterland is known mainly from studies undertaken by Poiner (1976) and Byrne (1983), Boot (1993) and Knight (1996).

Poiner (1976) argued that Aboriginal occupation of the south coast usually focused upon the resource rich and dependable coastline with occasional hunting and gathering forays into the forested hinterland when the coastal resources were in short supply.

Byrne (1983) completed a systematic study of some of the southern NSW forests and discovered that the most frequently occurring sites in the hinterland are small, surface scatters of stone artefacts. Byrne (1993) found that these sites are most likely to be found on flat ground along ridgelines or on gentle slopes overlooking creeklines. Byrne (1983) interpreted the abundance of small open campsites along ridgelines in the hinterland as reflecting patterns of movement through the generally rugged terrain rather than the result of long-term settlement.

Byrne's (1983) report is important not only because he describes the suite of small campsites he found, but also because it emphasises the problems of discovering sites in this difficult terrain. He decisively points to the need for the development of new methods of survey to find sites and to understand their character. His recognition of this need gave a fillip to research directed towards developing new approaches.

At about the same time the Department of Prehistory and Anthropology at the Australian National University was continuing its study of sites along the

NSW South Coast near Kiola, under the Directorship of Mr Ian Farrington, Lecturer in Prehistory. Until this point the work, involving Honours students, had primarily focussed on the coastal strip. However, interest began to shift inland as it became apparent that many sites were visible along public roads and forest tracks. Several years later, students have recorded several hundred sites in the hinterland between Ulladulla and Moruya. These sites provide a significant resource for understanding the nature of hinterland occupation.

Recently, the archaeological data gathered by the students over the years has been compiled and analysed by Knight (1996). Knight (1996) acknowledges that the analysis of the collated data was carried out at a basic level. However, several important trends in site type distribution were identified. These are as follows.

1) Sites were found to occur in varying degrees throughout all of the environmental zones present in the region.

2) The vast majority of hinterland sites are small surface scatters of stone artefacts numbering less than ten artefacts. Most artefacts at these sites are amorphous flakes and flaked pieces made from quartz, which occurs naturally throughout the region.

3) Site complexity (in terms of frequency occurrence of formal tools at sites) appears to be higher for artefact scatters of the hinterland zone compared to along the coast. In the hinterland zone, formal tool occurrence is apparent for sites of all sizes on all land form features.

4) Large open artefact scatters in the hinterland zone tend to be located at high point linear feature junctions. These locations also tend to be indirectly associated with nearby river or stream valleys.

5) Hinterland valley locations exhibit a lower frequency of larger sites. However, the largest artefact scatters recorded in the study are located on or near stream bank features. The highest frequency of sites containing formal tools also occur at valley locations. It would therefore appear that site size and

site complexity is influenced by close proximity to permanent water, mainly large creeks and rivers.

6) Rock shelter sites and grinding groove sites are essentially influenced by geomorphological factors. However, there also appears to be some degree of Aboriginal site selection in operation with regard to the location of grinding grooves.

As part of his PhD Thesis, Boot (1993) carried out extensive research in the hinterland region west of Nowra. In the course of the field surveying, Boot (1996) recorded a total of 410 open artefact scatters, 294 isolated finds and one midden site. Based on the analysis of the data, Boot (1993) made the following observations for site distribution in his study area.

1) The greatest density of sites tend to occur along major river valleys and broad well watered ridgelines.

2) Major river valleys show a much higher overall artefact density compared to other environmental zones.

3) The largest sites (in terms of artefact numbers) occurred within the major river valleys. The smallest sites occur at high altitudes, showing that the exploitation of these high altitude areas was not intensive.

Boot (1993) states that the data indicates that Aboriginal people accessed all areas of the south coast hinterland, but that major river valleys appeared to have been favoured over other environments. Some major ridgelines also appear to be a focus of activity, particularly those that were heavily forested (Boot 1993). These areas of high resource availability were probably repeatedly visited and occupied for long periods. Most of the open sites recorded in the hinterland are small, and are likely to be representative of short term campsites (Boot 1993).

In addition to the field survey, Boot (1993) excavated a total of 10 sites. Seven of these sites were rock shelters, with the remaining three sites being open

artefact scatters. Boot (1993) has obtained radiocarbon dates for each of these sites. For the rock shelters, the dates range between 250+ 80 BP and 12040 + 630 BP (years Before Present). For the open sites, the dates ranged between 850 + 160 BP and 4050 + 210 BP.

These dates show conclusively that the coastal ranges were occupied during the late Pleistocene. Prior to Boot's investigation, the oldest dates for Aboriginal occupation of the coastal ranges was 3770 + 150 BP, which was obtained by Flood (1980) from the Sassafras 1 site (Boot 1993).

Based on these findings, Boot (1993) is now of the opinion that Aboriginal occupation of the south coast hinterland during the Pleistocene was probably widespread but sparse. Boot (1993) further postulates that occupation of the hinterland became widespread and very dense in the last 4000 years, particularly since around 3000BP.

3.3. A predictive statement

Based on the above archaeological studies and on the local environment of the study area it is predicted that: sites will generally tend to occur on ridgelines, flatter areas and adjacent to stream banks, with the larger and more complex sites being in relatively close proximity to permanent fresh water. As such, it is suggested that sites (most likely artefact scatters) will be located on ridgelines and at lower elevations near the creek confluences (see Figure 2). Sites are very unlikely to occur on the steeply sloping valley sides.

Given that most of the major creeklines are within flora and fauna buffer zones, these sensitive areas are effectively protected. However, there are still a number of smaller, disturbed creeklines and ridges which are deemed to be of moderate or high archaeological sensitivity based on the known archaeological record. These areas are illustrated on Figure 2. It should be noted that even though these areas have been previously disturbed by rural activities, this does not diminish their sensitivity status nor the standing of any archaeological materials under the NPWS Act.

4. FIELD METHODOLOGY

4.1 Survey Strategy

The field investigation for the present study was carried out in November 1997. The survey team systematically walked all tracks, and areas where visibility allowed the ground surface to be viewed. In addition areas of ground with lesser visibility were traversed and inspected in detail.

4.2 Conditions of Visibility

Clearly conditions of ground surface visibility will affect how many sites are found. Visibility may also skew the results of a survey. If, for example, conditions of ground surface visibility vary dramatically between environmental zones, then this in turn will be reflected in the numbers of sites reported for each zone. Zones with the best visibility may be reported as having the most sites (because they are visible on the ground), while another zone with less visibility, but perhaps more sites, will be reported as having very little occupation. It is important therefore to consider the nature of ground surface visibility as part of any archaeological investigation.

For this study the conditions of ground surface visibility were very poor, being in the range of 1-5 percent. This poor range of visibility is due to the fact that the area contained few tracks and was heavily grassed, even in previously disturbed areas, at the time of the survey.

5. RESULTS OF THE SURVEY

No Aboriginal archaeological sites were located within the study area.

The results of this investigation were largely determined by the very poor ground surface visibility at the time of the fieldwork, even within previously disturbed farmlands. As described previously it was considered, based on studies from elsewhere, likely that Aboriginal people would have used the study area, albeit to a lesser extent than the coastal fringe. Based on this assessment it is likely that Aboriginal relics will be present that could not be detected during the present study.

6. ABORIGINAL CONSULTATION

Prior to commencement of the study, contact was made with Mr Jim Davis from the Illawarra Local Aboriginal Land Council. Mr Davis was informed about the nature and scope of the development as well as the character of the proposed archaeological investigation. Mr Davis accompanied the field team during the site inspection and his conclusions concurred with those of the archaeologist. Mr Davis stated that he was satisfied for his views to be summarised as such in this report.

7. SUMMARY AND RECOMMENDATIONS

No Aboriginal archaeological sites were located in the study area. Given the poor ground surface visibility in the study area and the moderate to high potential for locating archaeological sites it is recommended:

1. That prior to the quarry extension being allowed to proceed further archaeological work should be undertaken. This work should, in the first instance, involve: test pitting of the 3 areas of archaeological sensitivity depicted on Figure 2. An appropriate strategy for this test pitting should be formulated as part of an Application to the NSW NPWS. This may also involve some limited test pitting of areas outside these sensitive zones to test the model of site patterning.

2. It should be noted that all Aboriginal relics in NSW are protected under the NPWS Act. A copy of this report should be forwarded to the NSW NPWS for endorsement.

3. A copy of this report should be sent to the Illawarra Local Aboriginal Land Council for their endorsement. It should be noted that agreement will have to be reached with the Land Council as part of any application to undertake test pitting at the study area.

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Appendix Q

NON-INDIGENOUS HERITAGE ASSESSMENT

Non-Indigenous Heritage Assessment of the impact of the proposed quarry (Lot 1 DP 858245) near Signal Hill, Croom

Prepared for

Cleary Brothers (Bombo)
P.O. Box 210
Port Kembla

HLA-Envirosciences Project No W-1336

by

Dr Iain Stuart BA(Hons) MEnvSc
Principal Archaeology and Heritage Management

April 2003

This document was prepared for the sole use of Cleary Brothers (Bombo) and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of HLA-Envirosciences Pty Limited and Cleary Brothers (Bombo).

CONTENTS

FIGURES

PLATES

1.0 INTRODUCTION

Cleary Brothers (Bombo) has been extracting and processing basalt (actually Bumbo Latite) at its properties at Albion Park for some 40 years. The current proposal is to continue quarrying at a nearby site Lot 1, DP 858245. An Environmental Impact Statement (EIS) is being prepared to accompany the Development Application (DA) for the project. Independently Shellharbour Council is preparing a Local Environment Study (LES) to consider a rezoning application, which would allow the DA to be considered.

As part of the LES a draft report on European Heritage was prepared by Connell Wagner (2001). This incorporated earlier work on dry stone walls by Duggan (1997). The draft Connell Wagner report was made available for review as background for the present study.

In January 2003, HLA-Envirosciences Pty Ltd (HLA) was commissioned by Perram Partners to prepare a heritage assessment for the EIS. This is a separate study to the LES (which is still being finalised).

1.1 Study Area

The proposed quarry is located on Lot 1, DP 858245, Parish of Terragong, County of Camden, with a road traversing Lot 2 DP 858245 (this is shown in **Figure 1**). However the potential impact of the quarry on heritage items and on the cultural landscapes of dairying requires a larger area to be considered. Accordingly it was decided that the broad area of the Wentworth Hills be considered to establish cultural landscape patterning, this is shown in **Figure 2**.

1.2 Authorship

This report was prepared by Dr Iain Stuart, Principal Archaeology and Heritage Management with HLA. Dr Stuart was assisted by Miss Kylie McFadyen, Heritage Specialist with HLA. Dr Stuart's doctoral thesis was on the assessment of cultural landscapes in South Eastern Australia.

1.3 Report Constraints and Limitations

The contents of this report need to be considered against the constraints and limitations specified below.

Historical research has been undertaken in various archives and libraries, however it is physically impossible to check all possible sources of information and it may be that some unexpected documents or historical sources come to light that could result in the revision of the study area's history. Similarly archaeological evidence is subject to the vagaries of visibility and obtrusiveness and if these changes an archaeological site may suddenly be located.

Significance assessment represents a mixture of facts and interpretations and it is possible that another professional may interpret the historical facts and physical evidence in a different way.

In Section 7 a summary of the statutory requirements regarding heritage is provided. This is made on the basis of experience with the heritage system in NSW and does not purport to be legal advice. It should be noted that legislation, regulations and guidelines change over time and users of the report should satisfy themselves that the statutory requirements have not changed since the report was written.

2.0 ENVIRONMENTAL BACKGROUND

An understanding of the regional and local environment is critical in firstly understanding the natural landscape and how it was created. Secondly understanding the environment is critical in considering the responses to the environment over time.

The Illawarra landscape is notable for its steep escarpment and the long line of beaches along the coast. The distance between the two is of critical importance in understanding the environment. At the northern end of Illawarra the escarpment runs to the sea but to the south, where the study area is located the escarpment is 10 or more kilometres away. The furthest distance from the sea that the escarpment reaches is in the Albion Park area (immediately to the north of the study area) where the Macquarie Rivulet has cut a spectacular valley. This has exposed underlying deposits of basalt running on an east-west axis from Bass Point, through the Wentworth Hills and Mt Green.

A rough sketch section showing the topography and geology is reproduced from Derbyshire and Allen (1984:11) as **Figure 3**. The section shows the underlying rocks as being Gerringong Lattite, a form of basalt, which is a volcanic material dating to the Permian. Overlying this are sandstone formations, coal measures and the Narrabeen group of sandstone capped by Hawkesbury sandstone (Derbyshire and Allen 1984:10-11, Young 1983:8-9). Young argues that the principal force behind the erosion of the escarpment is not the inherent weakness of the escarpment itself but the erosive force of the streams in the south, principally the Macquarie rivulet and the Minnamurra River, which lie to the north and south of the study area (Young 1983).

In the general physiographic divisions of the Illawarra, the study area is defined as being in the coastal plain unit. In landscape terms the study area is located on the Wentworth Hills which is a ridge running roughly between Mount Stockland on the escarpment north-east towards the coast at Barrack Heights. Much of this ridge is gently undulating along its crest until Signal Hill is reached. To the north east of Signal Hill the ridge drops steeply by about 40m and then gently falls to the sea. The Wentworth Hills form the divide between the Lake Illawarra Catchment, a series of small streams running to the coast and the catchment of Rocklow creek, which joins the Minnamurra River at Minnamurra.

The study area has been mapped as part of the Kiama 1:100,000 soil landscape series as being in the Bombo soil landscape. This is an erosional landscape overlying Bumbo Lattite (which is or rather was exposed on the surface in some areas). The land surface is characterised by rolling low hills with slope gradients of 15to 20%. The crests are long and gently inclined on the north-east axis and on the upper slopes of ridges but are narrow on their shortest axis. The slopes generally are moderately inclined but tend to be steep in gullies (Hazelton 1992).

The original vegetation of the study area was closed forest and tall open forest (Hazelton 1992:43-44). A more sophisticated reconstruction of the vegetation pattern by Mills confirms this impression (Mills 1988). Little evidence of the original vegetation remains. There are some Moreton Bay figs (*Ficus macrophylla*) in the boarder study area but whether these are relic rainforest species or not is unclear. The study area has been cleared and there is a considerable amount of regrowth occurring on the mid slopes and mid-gullies.

The area specifically impacted on by the proposed quarry is best described as being located on the gently curving crest of the main ridge of the Wentworth Hills in a landscape that has been cleared.

3.0 HISTORICAL RESEARCH

Although the Illawarra was known to European settlers from Cook's mapping in 1770 and subsequent sea based exploration, the Illawarra region was only occupied after 1812 when various "gentlemen grazed stock in the hinterland (Perry 1963). This squatting settlement was followed by Governor Macquarie granting land to "respectable gentlemen" in late 1817. Among these were grants to D'Arcy Wentworth and his son, the redoubtable William Charles Wentworth. The instructions to the Surveyor General John Oxley and his assistant James Meehan were that each grantee was to have an equal proportion of good and bad lands, that the length of the grant be 3 times the width, and that the length not extend along waterfrontages although the width could (Jervis 1942:79).

The land granted in the study area was:

Portion 3	John Horsley	1200acres	9th January 1821
Portion 2	James Miteman	700acres	9th January 1821
Portion 4	D'Arcy Wentworth	1500 acres	9th September 1821

Both portions 2 & 3 have frontages to Lake Illawarra, while Wentworth's land abuts his grant of Portion 19, (Bass Point) which has ocean frontage. While Horsley's and Miteman's grants took in land that seems to have had a diverse range of vegetation types on it, and thus had areas relatively easy to bring into cultivation or to be used for grazing, Portion 4 includes the main line of the Wentworth Hills and the divide between Lake Illawarra and Kiama.

According to Mill's careful reconstruction of the vegetation patterns this area would have been mostly rainforest (Mills 1988). Rainforest would have required a considerable amount of effort to clear and it seems likely that the Wentworth family would not have undertaken much rainforest clearing but would have focused on bringing other more easily cleared lands into cultivation or grazing. The Wentworth family were absentee landlords living in Sydney. Wentworth's land was consolidated into a large estate owned by D'Arcy Wentworth known as the Peterborough Estate. The formation of this estate and its subdivision after Wentworth's death in 1827 underlies much of the settlement pattern in the region and study area. Wentworth, who didn't really marry, had a somewhat convoluted will leading to a complex inheritance as detailed below.

Partner	**Child**	
Catherine Cowley	William Charles	
	D'Arcy (II)	To Tasmania
	John	Drowned at sea
	Martha	Married John Reddall, died 1847, son Thomas A Reddall
Anne Lawes	Robert	
	Sophia	Married Robert Towns in 1833 died October 1878
	Mary Anne	Married Stephen Addison in 1840 and after his death married Charles Hollings
	Catherine	Married Benjamin Darley in February 1847 and after his death married William Thomas Bassett

Wentworth's will decreed that the Illawarra land be initially held by Robert, Mary-Anne, Sophia and Catherine as tenants in common with inheritance occurring strictly along the male line. If the line failed inheritance ran back to the previous male heir and his descendants. This seemed to produce nothing more than a muddle, which required a court case in the Supreme Court in Equity to unscramble and produced a 33 page Old System title written in longhand, which formed a deed of partition in September 1851 (Fol 25 Book 38 see Blayney 1959:25).

The result was that Catherine Darley obtained title to the Wentworth Hills (marked "D" on the title) and the study area however the boundary with the land held by Robert Wentworth (marked "A" on the title) is on the northern end of the main ridge. By this time portion 6 was also granted to Miss Isabella Reddall the daughter of Rev Thomas Reddall and grand daughter of Wentworth. She married a Mr Croker and the grant of 1280 acres was made on 29th March 1839. The property was named Croom. Ebenezer Russell later bought Croker's grant and began to clear it to grow wheat and potatoes. He built up the estate by acquiring Portions 7, 22 & 29 in 1856 and later his son John Russell became a prominent dairy farmer (Jervis 1942:194).

These properties were worked as a series of small farms leased to tenants and the land remained largely in the original grants. As these farms were leased it is difficult to trace the history of individual farms as leases were not necessarily lodged in the Titles Office.

Background on Dairying

The dairy industry in Australia largely developed in the Illawarra where the combination of a suitable environment and a speedy packet service to Sydney allowed the swift transport of butter and cheeses to Sydney (Ashton 1949:4). Some attempts to sell into the British market were made with varying success. In all cases the farmer was at the mercy of weather and the difficulties of sea transport in non-specialised ships not to mention unscrupulous agents.

A typical dairy farm of this time was a small family affair. Cousins quotes the *Illawarra Mercury* of 21 March 1871 as commenting, "Dairy farms vary in size from 50 to 400 acres and are mostly let to tenants according to the quality of the land and the state of the pastures. Many of these farmers milk from 60 to 100 cows and send two to five kegs a week to Sydney. .... The tenant is expected to erect all buildings, and fences and otherwise improve the land for the landlords benefit" (Cousins 1994:121). The dairy buildings would have consisted of a brick dairy, in which milk was left to stand and later where skimming and churning occurred, and a milking shed which was often a crude structure with a roughly paved floor. Most farms also had an associated piggery where pigs were raised on skim milk from the dairy.

The big change in the industry occurred in the 1880's and 1890's with introduction of the centrifugal cream separator and the development of refrigeration. This led to the opening of a large export market for butter and cheeses (Ashton 1949:4-9).

In the region around the study area Dairy farmers co-operatives were formed in the late 1860's with the Shellharbour Butter Export Company being formed in 1869 and another unnamed company being formed in October 1870. This company included a Mr Dunster (Bayley 1959:90). The aims of the co-operative companies were to assist in common marketing of products mainly to overseas markets. Later with the introduction of the cream separator from 1883 the co-operatives turned to producing butter and cheese. The co-operatives could raise capital to purchase equipment like separators and later refrigeration in a way that small farmers could not. The development of the factories resulted in a restructuring of the industry with milk being processed at the factory not at the farm.

Cousins also notes that the development of the supply of fresh milk (as opposed to milk products) to the Sydney market began in the late 1880s. The ability to supply fresh milk was enhanced with the completion of the railway to Sydney in 1888. The railway not only decreased travelling times, but could also run trains of refrigerated or cooled vans at appropriate times to reach the market. This caused a decided swing in the industry towards supplying fresh milk (Cousins 1994:134-135).

At the same time improvements were made to the cows themselves. Herd testing where the production of cream was measured was introduced on a limited scale in 1879 (Cousins 1994:146). This formed the basis for improving the breed as it developed criteria for measuring the success of any breeding program. In the Illawarra this led to the development of the Illawarra Shorthorn breed. Among the farmers listed as having an interest in cattle breeding were the Dunster family (see Cousins 1994:142-160).

From the 1890s onwards the dairy industry in the Illawarra was able to exploit two huge markets that had opened up to them. Firstly the Sydney market for fresh milk and the export market for dairy products such as cheeses and butter. The Co-Operatives were successful in improving the quality of the products, marketing and sales and distribution. This turned around the economics of dairying allowing greater investment in capital equipment on the farm and on farm improvements.

The Commonwealth produced manuals on the *Dairy Farming in Australia* in 1949 & 1950. These comprised some common overview chapters and specific state sections which included some common material, Victoria's manual was produced in 1949 while NSW's was produced in 1950 (Ashton 1949. Ashton and Laffan, 1950). Taken as a whole, the information in these texts allows an understanding of what an "ideal dairy farm" may have been like. This contributes to a comparison and understanding of the history and physical evidence in the study area. The discussion below is largely distilled from Ashton (1949) and Ashton and Laffan (1950).

The critical factor is the size of the herd as this is the source of the milk. The size of the herd is determined by both the acreage and quality of the land. The herd has to have a core of milking cows and replacements equivalent to about 2/3 of the herd. The carrying capacity of the farm must therefore be for a herd larger than those being milked and estimated at the least productive time of the year. The carrying capacity of the land can be developed by the improvement of pastures by introducing new species and fertilising. There is also a need for cows to obtain suitable drinking water (some 20 gallons per cow in summer it was suggested) as well as having water for cleaning of milking equipment. Water is stored in dams, tanks and troughs. The planting of shelterbelts of trees was encouraged to protect stock from the extremes of summer and winter weather.

There was no specific advice on the size of paddocks although subdivision was advised to allow production of crops and hay. Rectangular paddocks were recommended with gates to be located with a view to minimising the distance to the dairy. Fences were a standard five wire of which either one or two would be barbed.

The buildings were comprised of a milking shed which was to be constructed on a concrete base and divided into the bails where the cows were milked (by hand although at this time machines were being introduced), separator room and sterilizing room. There was also an engine room to power the plant. Care was to be used to design the buildings for easy washing and then for good drainage allowing the whole plant to be clean and dry.

Associated buildings included various storage sheds, piggeries, hay sheds and possibly a silage or a grain silo. Silage silos were made from reinforced concrete while grain silos could be in concrete or galvanised iron. Silage was quite important as a way of conserving fodder on farms particularly where high humidity made hay production difficult (Ashton and Laffan 1950:277).

Finally a good quality house was required as "A comfortable home makes for contentment and happiness" (Ashton and Laffan 1950:413).

Spatially the farm was organised with the buildings grouped as a central core to which the cows walked to and from twice a day. Dams and tanks would have been sited according to the terrain and paddock layout and shelter belts according to the terrain and wind directions. There was also a need for a good all-weather transport link to take the milk to market.

Background on Quarrying

With so much focus on the dairy industry it is easy to overlook the development of extractive industries such as coal and quarrying. The underlying lattite was exposed in places and used for road metal and building stone walls. In the 1870's substantial quarries were developed near Kiama and around Bombo (opened 1883) and Dunmore (opened 1923) (Cousins 1994:183-187).

History of the Dunster Family

The Dunster family are believed to have arrived in Australia in 1838. Joseph Dunster worked as an agent for the Illawarra Mercury and was elected to Shellharbour Council in 1859 (Bayley 1959:163). It is not clear when the Dunster family established themselves at "the Hill". The draft Heritage Assessment for the LES states that Joseph Dunster purchased 90 hectares of the Darley Estate at this time (2001:2.3) However, as the land was in the estate's hands until 1900 it is more likely that the Dunster's were long term tenants on the estate and this may explain the family comment that the house was built prior to their purchase of the land. Given the evidence quoted above it seems likely that as tenants the Dunster family had to construct the improvements themselves.

There is no doubt that the family and in particular William Charles Dunster were prominent in the development of the dairy industry and in the Municipality of Shellharbour.

The land ownership of the Dunster farm is of interest. Catherine Darley had a son, Benjamin Wentworth Darley who was baptised on the 14th June 1854. He inherited the land although Catherine Darley, later Catherine Bassett retained tenancy for life. Benjamin Wentworth Darley died on the 2nd June 1892 intestate. Emily Sophia Savage, who lived in London (presumably Darley's daughter) was appointed administratrix of Darley's estate in 1899. She and her Sydney solicitor George Edward Browne applied to bring the land under the provisions of the Real Property Act by way of Primary Application No 11372 of January 1900.

Accompanying this plan was a plan of subdivision DP 3709 surveyed in 1900. This subdivision probably represents the existing pattern of tenancies as the title shows the land had been leased in 1896 in exactly the same form. The subdivision pattern is shown in **Figure 4**. William Charles Dunster purchased lots 4 & 5, some 220 acres, from Emily Sophia Savage in February 1901 (Book 1339 Fol 88). Walter Dunster purchased Lot 6, some 112 acres, (on which Belmont stands) in November 1901 (Book 1339 Fol 88). Walter Dunster was listed as living at Newybar, Richmond River.

The plan of subdivision shows a road reserve across Dunster's land running through lots 4 & 5 to the western boundary of the land. The Dunster family retains ownership of lots 4 & 5 to the present day. Lot 6 however was sold to a Samuel Hercules McDonald of Albion Park in December 1912. McDonald retained ownership of the land leasing it to his sons from 1930 to 1937 who inherited it in December1948 (Book 1402 Fol 195). A formal road reserve leading off Dunsters Lane to Belmont farm was surveyed and resumed in May 1956. This would presumably have formalised unofficial access to the property.

It seems from this that Belmont farm may not have been established until McDonald took over the property and the Dunster family most likely would have included Walter Dunster's land in their farm. Thus tentatively Belmont house and farm would date from c1912 although this would have to be confirmed by further research. A building is shown at Belmont on the Kiama 1:63360 map which dates from 1932 so it seems likely that the farm was established by this date.

Background on Kyawana

Kyawana is located on the western side of Portion 5 but in the break up of the Wentworth Estate, this land was given to Robert Wentworth. Wentworth later sold the land and it ended up being owned by George Lawrence Fuller (the PA application is quite confusing at this point) in 1879. Fuller had extensive land holdings to the south at Dunmore and around Bass Point. Cousins notes that Fuller had 9000acres most leased out to tenant farmers (1994:43). Fuller was also involved in quarrying from 1880 initially he allowed quarrying on this land for a royalty but later opened up his own quarry at Dunmore (Cousins 1994:187).

In 1921 Fuller registered a subdivision plan DP10646 that was surveyed in December 1920 and registered on 29th March 1921.Unusually for subdivision plans this plan shows fences buildings and dams which acts as a record of the land subdivision at the time. The plan has 38 separate lots. The bulk of the lots are small 20acre lots west of the railway at Albion Park Rail. The rest of the land seems to have been farms, three lots of between 200 and 265 acres between the railway line and Lake Illawarra.

To the south there were lots 1 to 7 with an additional lot, 1A but missing Lot 4. The size of the lots is listed below:

Lot No	Acreage
1	139ac
1A	50ac
2	217ac
3	110ac
5	184ac
6	189ac
7	255ac

Lot 1A seems to have been destined to be a quarry as it takes in the exposed cliffs and the slopes facing north. A road and a rail easement were proposed to be created which strongly indicate that a quarry was planed for this area. Ironically however when quarries were established in this area they were located in the gullies on either side of this portion.

Kyawana farm is not depicted on the plan of subdivision. It is located on Lot 1 with an acreage of 139 acres located on the main ridge line of the Wentworth Hills, which curves through the land. Thus the lot

has a large area of gently sloping land. The absence of buildings suggests that Kyawana farm was erected after the sale of this land. However a building is depicted on the 1932 Kiama 1:63360 map, which suggests that the farm was established by then.

3.1 Historic Themes

A historic theme is a way of describing a major historical event or process, which has contributed to the history of New South Wales. Historic themes provide the background context within which the history, physical expression and significance of an item can be understood. Themes have been developed at National and State levels but Regional and Local themes can also be developed depending on the history of the area and item. The State and National themes are outlined in *New South Wales Historical Themes* issued by the NSW Heritage Office (2001). The most relevant theme that expresses the history of the site is that of Agriculture. This is expressed in the *New South Wales Historical Themes document* as follows.

Australian Theme	NSW Theme	Notes	Examples
3 Developing Regional and local economies	Agriculture	Activities relating to the cultivation and rearing of plant and animal species, usually for commercial purposes, can include aquaculture.	Hay barn, wheat harvester, silo, dairy, rural landscape, plantation, vineyard, farmstead, shelterbelt, silage pit, fencing, plough markings, shed, fish farm, orchard, market garden, piggery, common, irrigation ditch, Aboriginal seasonal picking camp.

The history of the study area clearly fits very well into this theme. The history of the study area reflects that of the dairy industry in the Illawarra but it is representative of the broader region rather than unique. The Dunster family played an important part in that history but their influence was limited to the Shellharbour area. They were obviously an important family to the local area but they did not play a lead role in the events in the history of the region. Possibly however the Dunster family is unique in the long period of occupation of their land and the long period of continuous dairy farming on the land.

4.0 FIELD INSPECTION

The site of the proposed quarry was initially inspected on the 23rd January 2002 and then a more extensive inspection was undertaken on the 21st March 2002. The inspection did not extend to "the Hill", as permission had not been obtained although it was possible to stand on public road easements and view the landscape. It has been also possible to map features from aerial photography and to use the report by Duggan (1997).

4.1 Physical evidence in the area of immediate impact

4.2 Stone Walls

The main evidence within the footprint of the quarry takes the form of fences and dams. Most the Fences are standard wire fences although Duggan has recorded three dry stone walls. Duggan describes these as follows

A) Small length (25m) over a rock outcrop with wire fence incorporated.
B) A 109m section on a steep hillslope
C) A long section of 136m built along a ridge line with shallow soil

It should be noted that wall C runs along the lot boundary on the eastern side of the study area and will not be impacted on by the proposed quarry. Wall A has been incorrectly plotted by Duggan and lies further to the south.

Duggan's interpretation is that the dry stone fences were erected when there were rock outcrops either exposed or just under the ground surface and it was physically impossible to put fence posts in. Certainly they do not enclose anything themselves and only make sense as part of an associated post and wire fence.

Plates 1 & 2 show Wall A. Plate 1 shows the wall in the landscape as part of a fence line. Plate 2 shows detail of the Wall with Wall B in the background. Plate 3 shows a detail of Wall B.

The author has had considerable experience in with dry stone walls from Western Victoria, and it appears that both these walls are considerably degraded with outward collapse of the walls creating more of a linear pile of rocks rather than a wall. Wall B seems to be in worse condition. In comparison with the walls in Western Victoria it seems that they are not as extensive and they have not been maintained as walls. Rather they have been used as bases into which fence posts could be put in to. Thus their original function as a wall has been superseded by the construction of wire fences on them.

All the stone walls are located on Lot 6 suggesting that they may have been only erected when this was under separate management possibly after 1912.

4.3 Belmont Farm

Belmont Farm consists of the house and gardens and remanent out buildings. The property is currently occupied although no one was at home when the inspection was undertaken.

The main house is of weatherboard construction with corrugated iron roof. It is roughly rectangular in plan with projecting bays facing the main entrance and to the east. The verandas on each side of the main

entrance have been filled in (using modern materials) but the veranda facing east is open giving extensive views to the east. At the rear of the buildings several skillion-roofed extensions are used to house service areas including a garage and a roofed open area at the back door. An extensive fenced garden area is to the south, this seems to have fruit trees and vegetables in it. The front entrance is marked by a white picket fence and oleander trees effectively screening the house to the north-west.

Plate 4 shows the front of the house. **Figure 5** is a sketch plan of the house. The outbuildings consist of various sheds. Plates 5 & 6 show outbuildings at Belmont. Plate 7 shows the entrance track looking back to Signal Hill. This shows Wall A and the row of trees lining the track near the northern property boundary.

In the fields where the actual quarrying activity is to occur, apart from Wall B there are a series of farm dams running up the creek lines. There are also some relic wire fences.

4.4 Kyawana farm

The inspection of Kyawana Farm was hampered by the fact that the site is overgrown by Lantana (*Lantana camara*), Cape Honeysuckle (*Tecomaria capensis*). The Pyrostegia is a garden escape, which and Orange has effectively surrounded the main house and many of the outbuildings. To access the main house you have to climb through the vines. Plate 8 shows Kyawana and a truly spectacular display of Pyrostegia.

Kyawana is basically square in shape with a large rear section containing bathrooms and laundry. The building is basically timber with weatherboard cladding but the sleep outs are in cement sheeting. The roof is corrugated galvanised iron. The building is derelict and in fair condition **(Figure 6).**

The surrounding outbuildings have been largely demolished except for the dairy, which has its structure largely intact but lacks machinery (Plate 9). There is a chimney at the rear, which seems to be odd, possibly a relic of an earlier layout. There is also an interesting display of graffiti on the walls.

Kyawana is located on land owned by CSR. It is no longer used as a home or dairy and the building is slowly deteriorating. There is no likelihood of it ever being used again in conjunction with dairying on the Wentworth Hills.

4.5 Archaeological Potential

Archaeological Potential is defined "as the degree of physical evidence present on an archaeological site" (Archaeological Assessment Guidelines 1996:34). From the historical evidence and from the field inspection there is no evidence of archaeological remains other than fences and dams in the area of immediate impact from the proposed quarry.

The fences have some archaeological potential as indicators of enclosing the landscape to make paddocks and it might be possible to see whether there is evidence of changing use of paddocks over time. Although physical evidence of fences in the form of posts and wires may be absent it is nearly impossible to remove all archaeological evidence of fences as a fence line will show up on aerial photographs and in subtle changes in the ground surface.

Dams are of some importance as sources of fresh water for dairy cattle and their location relative to fences helps understand how the landscape was used for dairying.

The outbuildings and remnant dairies around Belmont and Kyawana have archaeological potential as industrial archaeological sites. As dairying methods changed the dairies and associated buildings would have changed and these sites may contain information about the changing nature of the dairy industry preserved in their fabric. The quarry proposal is likely to impact only on the outbuildings of Kyawana.

5.0 CULTURAL LANDSCAPE ANALYSIS

5.1 What are cultural landscapes?

The definition of what a cultural landscape is varies between researchers and there has been a considerable debate about the concept (see Stuart 2000). For the purposes of this study the following definition of a cultural landscape has been adopted:

> "a geographic area (including both cultural and natural resources and the wildlife or domestic animals therein), associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values" (National Park Service. 1996).

This definition is the one used by the United States National Parks Services and is preferred to the somewhat limited one on the Australian Heritage Commission web site on practical grounds. It also relates more to the concept of a landscape as a spatial area greater than just a site or place rather than the concept of the landscape as a perception in the mind of the researcher, which is the view, adopted on the Australian Heritage Commission web site.

It should be noted as a way of clarification that there is a spatial hierarchy that is adopted in archaeology and geography that has landscapes as being a larger spatial entity than other terms such as "site" or "place". This is shown below:

Table 1 Spatial Hierarchy of Terms

Landscape	These occur within regions
Building, site, place, structure, landscape element, garden	These occur within Landscapes
Feature, structural element,	These occur within Buildings, sites, places, structures, landscape elements, gardens

The approach taken to cultural landscapes in this report has been to adopt the methodology of Keller and Keller (1987), Melnick (1984) and McClelland et al (1990) to the demands of this project. Their approach although orientated towards the requirements of the U.S. National Parks Service, is a useful methodology for gathering and organising information about a landscape. This approach is a morphological one where landscape characteristics are identified and recorded as a static record of the cultural landscape The characteristics are divided into "processes" which are characteristic human behaviours that have been instrumental in shaping the landscape and into "components" which are physical remains on the current landscape (McCelland et al 1990:4).

A detailed discussion of the landscape characteristics is presented in Appendix One. The characteristics to be "read" are.

Processes

1) Land Uses and Activities

2) Patterns of Spatial Organisation

3) Responses to the Natural Environment

4) Landscape practice

Components

5) Circulation Networks

6) Boundary Demarcations

7) Vegetation Related to Land use

8) Buildings Structures and Objects (including Portable relics)

9) Clusters and other patterning

10) Gardens

As can be seen there is a considerable overlap in the "process" characteristics. However they form an essential basis for placing the landscape within its historical and cultural context. These characteristics are a way of understanding the underlying historical processes that have resulted in the creation of cultural landscapes.

The Component characteristics are the physical expression of the historical processes that form cultural landscapes. This can result in a one off unique cultural landscape such as a large estate or a series of similar patterns of components within a large cultural landscape.

5.2 Processes

5.2.1 Land Uses and Activities

The principal land use in the area, since the 1840s has been dairy farming. This has been undertaken by tenant farmers on land leased from large landholders and later, when the large estates were gradually sold by small farmers on their own farms.

5.2.2 Patterns of Spatial Organisation

The land has been farmed in portions of between 120acres and 260acres located to include areas of flat or gently sloping land. The farms seem to be located on the main ridge of the Wentworth Hills (eg the Hill, Belmont, Kyawana, Croome Farms, Glenbrook) containing some land running down the slopes. Alternatively farms are located along the lower slopes of the hills containing some land running up the slopes (eg St Ives, Rosemont, Kurrawong and what appear to be farms on Lot 2 and Lot 7 of DP 10646). Thus each farm had a mixture of steep and relatively flat land.

The farms seem to have been divided into paddocks with the dairy and dwelling located close to each other. Each farm was linked to the main highway by roads to enable the milk to be taken market or from the 1880's, to a centralised location for processing and sale.

5.2.3 Responses to the Natural Environment

The first response to the natural environment was to clear the rainforest and to bring the land into production. This seems to have occurred in the period from 1820 to 1840. The development of farming was fully in line with the Victorian value of "improvement" where the natural environment is seen as "waste land" and it was seen as an owner's duty to improve such land by bringing it into production.

It seems from the pattern of sub-division that the mid slopes were the least favoured locations for dairy cows to graze (especially as some were cliffs) and so these areas were located at the margins of the farm. Generally however property boundaries seem to ignore the natural lie of the land although the boundary of Kyawana is an exception running along the top of cliffs. Roads and tracks follow the natural contours of the land.

5.2.4 Landscape Practice

The landscape practice relates purely to the methods of dairy farming, the fencing of land into paddocks, pasture improvement, provision of water and so on.

5.3 Components

5.3.1 Circulation Networks

Circulation networks would have been developed at several scales.

On the farm the cattle would have come in to the dairy for milking and then returned to the fields, twice a day.

The milk then would have been transported, probably once a day to regional dairy factories or larger bulk milk dairies. The distances travelled would have varied as the smaller factories consolidated into larger factories in regional centres such as Albion Park. However as the speed of transport improved it seems likely that the time taken remained the same.

The three farms on the main ridge would have used Dunsters Lane to travel to the factories or bulk dairies.

The 1932 Kiama 1:63360 map shows a track running along the main ridge line to Croom and Lockin Hill with connections to Croom Road which would have provided an alternative route to Albion Park. The track continued to join with the farms on the ridge crest around the southern side of Mt Terry and the head of Rocklow Creek.

5.3.2 Boundary Demarcations

The boundary demarcations were simple post and wire fences. Where the underlying basalt was close to the surface and impervious to posts a dry stone wall was erected.

There are no grand avenues or formal gates marking boundaries.

5.3.3 Vegetation Related to Land use

The principal vegetation relating to dairying is improved pasture there is only one area of planted shelter belts.

5.3.4 Buildings, Structures and Objects (including Portable relics)

The main buildings are the dwellings followed by dairies and other farm buildings such a piggeries, silos etc. These form a cluster of buildings and structures.

The paddocks are formed by post and wire fences, with the occasional stone wall. There are dams and farm tracks.

5.3.5 Clusters and other Patterning

The main pattern takes the form of the buildings and structures clustered in a flat or gently sloping area within the farm and the paddocks set out from the cluster organised according to terrain and property boundaries.

5.3.6 Gardens

There seems little evidence of formal gardens in this area although no doubt each farm would have had its own vegetable garden and orchard to provide fruit and vegetables for the families occupying the farm.

5.4 Conclusions

The area around the Wentworth Hills can be defined as being a cultural landscape consisting of a number of dairy farms that were originally formed as tenanted farms on large land holdings and later in the 20th century small family operated farms. The farms range in size from about 110 acres to about 260acres and consist of central core of a dwelling; dairy, associated farm buildings and fenced paddocks. The farms are located around the lower levels of the Wentworth Hills and along the main ridge of the Wentworth Hills. Each farm includes a mixture of flat or gently sloping land. The farms have been substantially cleared and grassed with improved pastures and some dams.

This landscape developed from the 1840s and despite considerable change in dairy technology at a general level the pattern probably dates from then. However both the dwellings and more particularly the dairies would have changed as a result of technological change in the industry and greater farm incomes.

In broad terms this cultural landscape has been slowly changed largely by increased urbanism in the areas of Albion Park Rail, Oak Flats and Shellharbour. In addition the quarries around Dunmore and south of Albion Park Rail are slowly expanding, although many of the quarries are in the marginal dairying land of the mid-slopes and their visual impact is well screened.

The proposed quarry in the study area is an example of this trend and will impact on the dairying cultural landscape on the main ridge of the Wentworth Hills.

Within Wentworth hills, cultural landscape is three farms, which are within the study area. These are "the Hill" (c1860's), "Belmont" and "Kyawana".

During the fieldwork in March 2002 the area around the headwaters of Rocklow Creek was examined. A similar pattern of dairy farms on the broad crest of the ridge was observed and it seems likely that there is a continuation of this cultural landscape along the ridge till the steep rise of the escarpment west of Jamberoo Road is reached.

6.0 SIGNIFICANCE ASSESSMENT

An assessment of significance is undertaken to explain why a particular site is important and to enable the appropriate site management to be determined. Cultural significance is defined in the *Australian ICOMOS Charter for the conservation of places of Cultural Significance* (the *Burra Charter*) as meaning "aesthetic, historic, scientific or social value for past, present or future generations" (Article 1.1). Cultural significance may be derived from the fabric of a place, association with a place, or the research potential of a place. The significance of a place is not fixed for all time, and what is of significance to us now may change as similar items are located, more historical research is undertaken and community tastes change.

The process of linking this assessment with a site's historical context has been developed through the Department of Urban Affairs and Planning (now Planning NSW) and the Heritage Council of NSW State Heritage Inventory Program (SHIP) and is outlined in the *Heritage Assessment Guidelines, NSW Heritage Manual.* The *Heritage Assessment Guidelines,* established six evaluation criteria (which reflect four categories of significance and whether a place is rare or representative) under which a place can be evaluated in the context of State, Regional or Local historical themes. These Guidelines have recently (mid August 2001) been updated by the guideline *Assessing Heritage Significance,* which reflects recent legislative, changes to the Heritage Act. It is understood that the guidelines in the Heritage Manual will be successively upgraded to reflect the new assessment criteria.

The Heritage significance criteria are:

Criterion (a) – an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (b) – an item has strong or special association with the life or to works of a or person, or group of persons, of importance in NSW's cultural or natural history (or its the cultural or natural history of the local to area);

Criterion (c) – an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area);

Criterion (d) – an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons;

Criterion (e) – an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (f) – an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area);

Criterion (g) – an item is important in demonstrating the principal characteristics of a class of NSW's:

cultural or natural places; or
cultural or natural environments.

(or a class of the local area's:

cultural or natural places; or
cultural or natural environments.)

An item is not to be excluded from the Register on the ground that items with similar characteristics have already been listed on the Register.

6.1 Significance Grading

Different components of a place may make a different relative contribution to its heritage value. Loss of integrity condition may diminish significance. In some cases it may be useful to specify the relative contribution of an item or components. While it is useful to refer to **Table 1** when assessing this aspect of significance it may need to be modified to suit its application to each specific item:

Table 2: Significance Grading Levels

GRADING	JUSTIFICATION	STATUS
Exceptional	Rare or outstanding item of local or State significance. High degree of intactness. Item can be interpreted relatively easily.	Fulfils criteria for local or State listing
High	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.	Fulfils criteria for local or State listing.
Moderate	Altered or modified elements. Elements with little heritage value but which contribute to the overall significance of the item.	Fulfils criteria for local or State listing.
Little	Alterations detract from significance. Difficult to interpret.	Does not fulfil criteria for local or State listing.
Intrusive	Damaging to the item's heritage significance,	Does not fulfil criteria for. local or State listing

Following Kerr (2000) the cultural significance of a precinct or element within a precinct can be expressed in three broad ways (these encompass the significance criterion above) through:

- the ability to demonstrate an aspect of the precincts significance. For example the fabric on the site could demonstrate how a site was used;

- the association of the precinct with an important event or a particular person. The association may not require physical evidence of the event; and

- the ability of archaeological remains in a precinct to answer relevant research questions.

This applies as much to archaeological remains as it does to the built environment or the landscape. It is conceivable that archaeological remains may not have any research potential but have strong historical associations or a high ability to demonstrate an aspect of history.

The relationship between item and its historical context underlies this assessment process. Historical themes provide a context within which the heritage assessment criteria are applied, especially if historical values are critical to an understanding of an item's heritage significance.

6.2 Significance of the Wentworth Hills Cultural Landscape

The approach to assessing the heritage significance of the various items found is to assess the broader cultural landscape first and then proceed to evaluate the individual items within the broader study area and then the area directly impacted on.

Criterion (a) – an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area);

The Wentworth Hills cultural landscape meets this criteria as it was an important centre for the dairy industry in the Illawarra region.

Criterion (b) – an item has strong or special association with the life or to works of a or person, or group of persons, of importance in NSW's cultural or natural history (or its the cultural or natural history of the local to area);

The Wentworth Hills cultural landscape has a number of strong associations with prominent historical figures, these are:

D'arcy Wentworth has a specific association for his creation of a large estate and then the convoluted method of passing the estate on to his heirs directly contributed to the form of the cultural landscape through the way the land was sub-divided. D'arcy Wentworth is well known for his prominence in NSW.

George Fuller who owned the northern section of the Wentworth Hills cultural landscape was prominent in the Shellharbour-Kiama area as a large land owner with a wide range of business interests.

The Dunster family who have used "the Hill" farm since the 1860s and have been prominent in the dairy industry and local affairs since then.

Criterion (c) – an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area);

Wentworth Hills cultural landscape does meet this criteria as the landscape is not a designed cultural landscape such as a garden.

Criterion (d) – an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons;

Wentworth Hills cultural landscape does not seem to meet this criteria.

Criterion (e) – an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area);

Wentworth Hills cultural landscape meets this criterion because it has the potential to provide information on the history and development of the dairy industry through analysis of the changing landscape and the built and archaeological sites within.

Criterion (f) – an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area);

Wentworth Hills cultural landscape does not seem to meet this criterion as similar landscapes are located in adjacent areas and in other regions.

Criterion (g) – an item is important in demonstrating the principal characteristics of a class of NSW's:

Wentworth Hills cultural landscape meets this criterion through its ability to demonstrate the principal characteristics of the dairy farm namely the dwelling, the dairy, outbuildings, fences, dams, shelterbelt plantings and the spatial relationships between them.

Statement of significance

The Wentworth Hills cultural landscape has heritage significance through association with nationally and locally important individuals who have at times owned the land, its role as in the dairy industry in the Illawarra, it's ability to demonstrate important characteristics of a dairy farm and its ability to provide information on the history and development of dairying through analysis of the landscape over time.

It should be noted that given the extent of the dairy industry on the south and north coasts the Wentworth Hills cultural landscape is unlikely to be unique. Similar settlement patterns for example can be observed in the hinterland of the NSW Central Coast in areas such as the Dooralong and the Yarramalong Valleys. Because of this the landscape is significant at the Local rather than State level of importance.

6.3 Significance of Sites Within the Landscape

Within this landscape "the Hill" farm, must be graded as high as it demonstrates the key attributes that makes the Wentworth Hills cultural landscapes significant. The Hill has been identified as being of heritage significance both in the Regional Heritage Study and in the Shellharbour Heritage Study.

In looking at this listing it seems that the statement of significance for the Shellharbour Heritage Study focuses primarily on the house rather than viewing the Hill as a farm and including the dairy, outbuildings and landscape elements. Both the Shellharbour and Illawarra Regional Heritage Studies rely on a National Trust listing for their primary information on the Hill rather than primary research.

Belmont and Kyawana farms can be considered to be graded of moderate significance as these farms were established at a later date and therefore cannot be expected to contain evidence of earlier dairying activity.

Although stone walls in the region are considered to be a distinctive but rare landscape feature in the area, associated with the pioneer nineteenth century farming communities (Illawarra Regional Heritage Study) these examples are practically poor examples. For this reason the stone walls A and B are graded as Moderate.

The other fences and dams are entirely typical of such features and although they contribute to the overall significance of the landscape as a dairying landscape they are graded as having little significance in themselves.

7.0 HERITAGE MANAGEMENT

7.1 Statutory Requirements

This section discussed the statutory requirements relating to the protection of items of heritage significance.

Commonwealth Legislation

Australian Heritage Commission Act 1975

This is Commonwealth legislation that established the Australian Heritage Commission and the Register of National Estate. Inclusion on the Register of the National Estate means that a site is subject to applicable provisions of the Australian Heritage Commission Act. Under Section 30 of the Act, the Commonwealth is constrained from taking any action, which may adversely affect the heritage significance of a place listed on the Register unless there is no prudent or feasible alternative. In addition, Commonwealth Authorities are required to seek the Australian Heritage Commission's advice if a Commonwealth proposal may affect the site.

Listing on the Register does not bind any State or local authority but may become an issue if a project requires action from a Commonwealth agency (e.g. purchase of land).

The Register of the National Estate was searched on the 5th March 2003. No items within the study area are listed on this register.

New South Wales

Heritage Act 1977 (as amended 1998)

The *Heritage Act* (1977 as amended 1998) was passed to conserve the environmental heritage of New South Wales. The Heritage Act is binding on all State Government agencies. Items of heritage significance are protected by the means of Interim Heritage Orders or by listing on the State Heritage Register.

The State Heritage Register was searched on the 30th March 2003 no items in the study area are listed on the State Heritage Register.

Section 139 of the Heritage Act also includes additional special provisions passed to protect "relics". A "relic" is defined as meaning "any deposit, object or material evidence:

(a) which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and
(b) which is 50 or more years old.

Section 139 states;

1) A person must not disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being

discovered, exposed, moved, damaged or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit.

2) *A person must not disturb or excavate any land on which the person has discovered or exposed a relic except in accordance with an excavation permit.*

There is no formal register of "relics" held by the NSW Heritage Office. Some of the sites listed on the State Heritage Register or on LEP's may either be "relics" or have relics associated with them. For items listed on the State Heritage Register, a permit is required to carry out activities to an item (Section 60) and a permit is required for excavation (Section 140).

EXEMPTIONS TO SECTION 139

If the proposed works are only minor in nature, and will have minimal impact on the heritage significance of the place, they may be exempted from the provisions of Section 139. On the 7 March 2003 the Minister for Planning revoked all existing standard exemptions and granted new exemptions. The new standard exemptions relate to a broader range of minor development and will result in a more streamlined heritage approval process. The exemptions are set out below.

"Excavation or disturbance of land of the kind specified below does not require an excavation permit under s.139 of the Heritage Act provided that the Director of the New South Wales Heritage Office (the Director) is satisfied that the criteria in (a), (b) or (c) have been met and the person proposing to undertake the excavation or disturbance of land has received a notice advising that the Director is satisfied:

(a) where an archaeological assessment has been prepared in accordance with Guidelines published by the Heritage Council of N.S.W. which indicates that there is little likelihood of there being any relics in the land or that any relics in the land are unlikely to have State or local heritage significance;

(b) where the excavation or disturbance of land will have a minor impact on the archaeological resource;

(c) where the excavation or disturbance of land involves only the removal of fill which has been deposited on the land.

A person proposing to excavate or disturb land in the manner described in paragraph 1 must write to the Director and describe the proposed excavation or disturbance of land and set out why it satisfies the criteria set out in paragraph 1. If the Director is satisfied that the proposed development meets the criteria set out in paragraph (a), (b) or (c) the Director shall notify the applicant."

Within the area of direct impact Wall B and fences and dams are impacted on and will require a permit under Section 139 or in the case of the fences and dams come under the exemptions provision.

Environmental Planning and Assessment Act (1979)

The Environmental Planning and Assessment Act requires that consideration be given to environmental impacts as part of the land use planning process. In NSW environmental impacts are interpreted as

including cultural heritage impact. Three parts of the EP&A Act are most relevant to Heritage. Part III relates to planning instruments including those at local, regional and State levels, Part IV controls development assessment processes and Part V refers to environmental assessment for activities (where development consent is not required).

Under the provisions of the EP&A Act local environmental plans (LEP) and Regional Environmental Plans (REP) can be made. Typically LEP and REPs have provisions that protect items of environmental heritage.

The Illawarra REP No 1 has provisions under Part 15 protecting items of environmental heritage. Under Section 126 Conservation of Items of the Environmental Heritage, the following provisions have been made.

> (1) A person shall not, in respect of a building, work, or relic or place that is an item of the environmental heritage:
>
> (a) demolish, renovate or extend that building or work,
>
> (b) damage or despoil that relic or place or any part of that relic or place,
>
> (c) excavate any land for the purpose of exposing or removing that relic,
>
> (d) erect a building on the land on which that building, work or relic is situated or the land which comprises the place, or
>
> (e) subdivide the land on which that building, work or relic is situated or the land which comprises that place,
>
> except with the consent of the consent authority.
>
> (2) The consent authority shall not grant consent pursuant to subclause (1) in respect of an item of the environmental heritage unless it has made an assessment of:
>
> (a) the significance of the item as an item of the environmental heritage of the local government area in which the item is situated,
>
> (b) the extent to which the carrying out of development in accordance with the consent would affect the historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance of the item and its site,
>
> (c) whether the setting of the item, and in particular, whether any stylistic, horticultural or archaeological features of the setting should be retained, and
>
> (d) whether the item constitutes a danger to the users or occupiers of that item or to the public.

(3) The consent authority shall not grant consent pursuant to subclause (1) to the renovation of a building that is an item of the environmental heritage unless it has made an assessment of:

(a) the colour, texture, style, size and type of finish of any materials to be used on the exterior of the building and the effect which the use of these materials will have on the appearance of the exterior of the building and of any other building in its vicinity,

(b) the style, size, proportion and position of openings for any windows and doors which will result from, or be affected by, the carrying out of the development, and

(c) the pitch and form of the roof, it any.

Under Section 128 "Development in the vicinity of an item of the environmental heritage" the following provisions is made:

"The consent authority shall not consent to the carrying out of development in the vicinity of an item of the environmental heritage unless it has made an assessment of the effect which the carrying out of that development would have on the historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance of the item of the environmental heritage and its setting."

The Hill is listed on the Illawarra REP as an item of environmental heritage.

Shellharbour LEP 2000

Similar provisions have been enacted in the Shellharbour LEP. Notable clause 72 protects heritage items, heritage conservation areas and relics. The provisions are as follows:

(1) The following development may be carried out only with development consent:

(a) demolishing, defacing, damaging or moving a heritage item, or a building, work, relic, tree or place within a heritage conservation area, or

(b) altering a heritage item, or a building, work or relic within a heritage conservation area by making structural changes to its exterior, or

(c) altering a heritage item, or a building, work or relic within a heritage conservation area by making non-structural changes to the detail, fabric, finish or appearance of its exterior, except changes resulting from any maintenance necessary for its ongoing protective care which does not adversely affect its heritage significance, or

(d) moving a relic, or excavating land for the purpose of discovering,

exposing or moving a relic, or

(e) erecting a building on, or subdividing, land on which a heritage item is located or which is within a heritage conservation area.

(2) When determining a development application required by this clause, the consent authority must take into consideration the extent to which the carrying out of the proposed development would affect the heritage significance of the heritage item or heritage conservation area.

(3) When considering applications for consent to the erection of a building within a heritage conservation area, the consent authority must make an assessment of:

(a) the pitch and form of the roof, if any, and

(b) the style, size, proportion and position of the openings for windows or doors, if any, and

(c) whether the colour, texture, style size and type of finish of the materials to be used on the exterior of the building are compatible with those of the materials used in existing buildings within the heritage conservation area.

Provision 75 "Development in the vicinity of heritage items or heritage conservation areas" requires that:

"The consent authority must take into consideration the likely effect of the proposed development on the heritage significance of a heritage item or heritage conservation area, and on its setting, when determining an application for consent to carry out development on land in its vicinity".

In Schedule 3 to the Shellharbour LEP CR1 "The Hill" is listed and is described as Part Lot 5, DP 3709, Dunsters Lane, Croom. It is listed as being of State significance although it is not listed in the State Heritage Inventory.

This means that for all "relics" a development consent will be required under clause 72 (1) d and due to the impact being adjacent to "the Hill" clause 75 applies.

7.1.1 Summary

To summarise the statutory situation is as follows:

- For all relics, not covered by exemptions a Section 140 permit from the NSW Heritage Office is required prior to disturbance or destruction.
- For all relics subject to exemption a report assessing their significance is required to be submitted to the NSW Heritage Office.

- Development consent is required for impacts on relics under the Shellharbour LEP
- Consent authority will have to take into account any impact on "the Hill" from the proposed development.

7.2 Impact of the proposal

The proposed works are as follows:

- Construct a haul road and associated sight bund from the existing quarry into the site.
- Construct and vegetate an earthen bund wall around the north-eastern corner of the site to limit views and restrict noise.
- Removed dilapidated rock walls on the property
- Install erosion and sediment controls
- Provide basic staff amenities
- Excavate topsoil and then extract the material

The precise details of these are discussed in the EIS for the project.

7.2.1 Direct Impacts

The direct impact will be the destruction of all heritage features in the study area as quarrying will remove the ground surface. This will involve removal of all fences in the study area.

The earthen bund will be 3m high and vegetated. It will be located along the crest of the ridge along to Belmont. The bund will therefore destroy the existing access road, Wall A and the row of trees at the entrance to the property.

The haul road is likely to impact on Kyawana farm and it is likely that this abandoned farm will be demolished. This will directly impact on the building and associated outbuildings.

7.2.2 Indirect Impacts

The major indirect impact is that of the visual impact on the landscape. This impact can best be explained by considering the views to the Wentworth Hills cultural landscape and views within the landscape.

The view of the Wentworth Hills cultural landscape from the surrounding areas will only be impacted on from the south-east, from the Dunmore area as the quarry will occur below the crest of the main ridge. Quarries in the area have been successful in screening their activity by selective plantings and there can be no doubt that this could occur on this site.

Of greater impact is the effect on views from farms along the main ridge, within the cultural landscape.. Belmont and Kyawana Farms are directly adjacent to the quarry. It will almost be impossible to mitigate this impact, although it should be noted that as Kyawana Farm is proposed to be demolished the indirect impact is irrelevant. Belmont will be screened from the quarry by a large bund although this is also visually intrusive. The current outlook and screening from Belmont is to the east and south, which the quarry will not impact on. "The Hill" is slightly further away and the farm is surrounded by a grove of fig

trees (probably *Ficus jacksonia*), which will act as a screen, although no doubt the quarry will be visible from Dunsters Lane.

The quarrying activities will also involve indirect impacts from noise, dust and vibration.

7.3 Mitigation Strategies

7.3.1 Mitigation of Direct Impacts

It has been proposed that the stone walls can be dismantled and relocated without affecting their heritage significance (Duggan 1997:21). This is an incorrect application of heritage principals. Relocation of the three stones walls will remove them from their context and position in the landscape (which enclose the land as a paddock and as a property boundary) and thus reduce their heritage significance. Without being in their position the dry stone walls will lack integrity as heritage items.

The walls are in any case only part of the overall fencing the created paddocks. A more appropriate mitigation strategy will be to undertake a comprehensive survey and archival recording of the walls and fences with the aim of recording all evidence of farming activities within the area of immediate impact of the quarry. Removal of the walls and fences will require a permit under Section 140 of the Heritage Act and it is likely that archival recording will be a condition of the permit being granted.

The impact on Kyawana farm is probably of greater importance than that on the stone walls, as this is one of the few farms on the main ridge line although of moderate rather than high significance. Demolition of this building and the associated outbuilding, vegetation and fences would only be acceptable if a thorough archival recording of the building by made following the NSW Heritage Office *Guidelines for Archival Recording*.

7.3.2 Mitigation of Indirect Impacts

The general impact of the quarrying activities in terms of noise, dust and vibration will be controlled in the usual manner using appropriate standards and guidelines. The standards also have performance criteria for heritage items and these should be used to ensure that the impact on Belmont and "The Hill" is within the criteria for items with heritage significance. It would seem prudent that a pre-disturbance survey is carried out on "the Hill" and possibly Belmont to establish base line criteria prior to any impact.

The visual impact of the quarry as viewed at a distance should be minimised by careful use of plantings to screen the quarry edge.

The visual impact of the quarry from the main ridge should be screened from "the Hill" and from Belmont possibly by boundary plantings and plantings along the drive into Belmont. The screenings may also help in alleviating any dust impacts. The precise siting and nature of such a screening planting would have to be set out by a landscape architect with regard to the nature of the Wentworth Hills cultural landscape as well as the desired screening affect.

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9.0 APPENDIX ONE: LANDSCAPE CHARACTERISTICS

The approach taken in this report has been to adopt the methodology of Keller and Keller (1987), Melnick (1984) and McClelland et al (1990) to the demands of this project. The three works cited are relatively compatible as it is clear that all the authors were interacting with each other as the joint authorship of McClelland et al shows. Their approach although orientated towards the requirements of the U.S. National Parks Service, is a useful methodology for gathering and organising information about a landscape.

This approach is a morphological one where landscape characteristics are identified and recorded as a static record of the cultural landscape. An important process was to evaluate the criteria they developed and see whether there were obvious omissions or useless criteria baring in mind both the research issues and the practicalities of data collection. Eleven landscape characteristics were identified by Melnick (1984) and McClelland (1990). These have been modified by removing the category of archaeological sites and small-scale elements. Archaeological sites were removed as they really fell under the category of buildings structures and objects, which is what they were prior to entering the archaeological record and logically should have been treated as such. The "small scale elements" category was an ambiguous category at best as it was not clear how the boundary between small-scale elements and anything else was to be drawn so it was dropped.

The category of Gardens has been added as gardens seemed separate from the broader category of vegetation relating to land use as they used not only vegetation but items such as paving, borders and statuary to create an effect which made an intentional statement about their owners.

The characteristics are divided into "processes" which are characteristic human behaviours that have been instrumental in shaping the landscape and into "components" which are physical remains on the current landscape (McCelland et al 1990:4).

The characteristics to be "read" are therefore:

Processes

5) Land Uses and Activities

   Land uses are the main forces shaping the landscape. The nature of land use is a mixture of interaction with the environment filtered through perceptions of the landscape at the historical period in which a land use is contemplated (see Jeans 1974).

6) Patterns of Spatial Organization

   The organization of land is critical to understanding a landscape and its elements. The landscape is organised in relation to its use and perceptions of its use, capability, risk ...etc. One factor needing consideration is the prior land use and its impact on how the successive landscapes were organised and how patterns of spatial analysis influence successive patterns of spatial organization. This is the concept of sequent occupance described by Whittlesey (1929).

7) Responses to the Natural Environment

The response to the natural environment is a critical factor in understanding land uses and patterns of spatial organization. The response is quite varied over time as the perceptions of Australia's natural environment have changed and therefore responses to the natural environment have changed. There are also likely to be competing or multiple responses to the environment at any given time (think of the responses to Kakadu by miners, environmentalists and the Aboriginal communities). Some of these responses are beginning to be studied and explained (see Bonhady 2000).

8) Landscape practice

This characteristic is known as "cultural traditions" and refers to traditions about the way the landscape is used, occupied and shaped (or perceived) (McClelland 1990). But in fact there is more than just tradition involved in using the landscape. There is also the body of information about how to use the landscape, which is passed on by education, technical information, tradition and the like. This is the practice of using the landscape. Practice in this sense is the body of ideas (technical information) in use at any particular time about how the landscape should be used, occupied and shaped.

As can be seen there is a considerable overlap in the "process" characteristics. However they form an essential basis for placing the landscape within its historical and cultural context.

Components

11) Circulation Networks

These are systems for transporting people, goods and raw material (including things such as electricity, water and steam) within and in and out of a landscape.

12) Boundary Demarcations

Boundaries mark areas of different land ownership, land use, public or private spaces and so on. Typically the boundaries are fenced or marked in other ways such as by ditches, hedges, blazed trees, streams or even intangible things such as lines between hills. Apart from obvious boundary markers such as fences, various signs or natural features sometimes mark boundaries.

13) Vegetation Related to Land use

Vegetation relating to land use can bear a direct relationship to patterns of land use and of spatial organization. It can include naturalised or introduced species as well as naturally occurring species. McClelland et al note, "while many features change over time vegetation is, perhaps, the most dynamic. It grows and changes with time, whether or not people care for it" (1990:5). This means that what may seem like a historical planting may in fact be the result of the lack of care rather than deliberate planting.

14) Buildings Structures and Objects (including Portable relics)

All these things relate the historical development of the landscape. They can be manifested in various states of completeness from the intact building to the archaeological remains of a building or structure.

15) Clusters and other patterning

The arrangement of clusters and patterns can tell something about the way the landscape was used or developed.

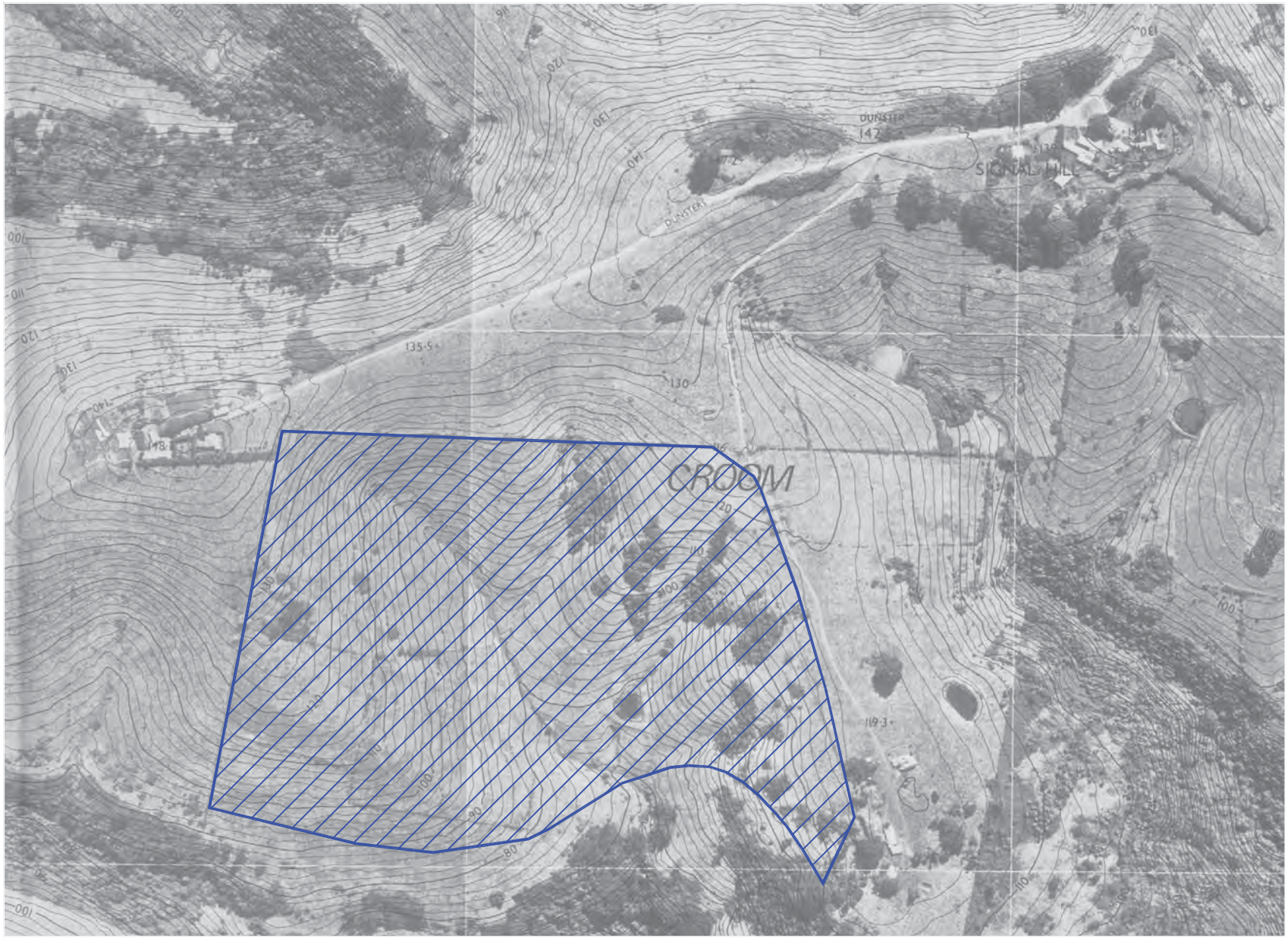
16) Gardens

Formal gardens are separate from the broader category of vegetation relating to land use as they are a more intentionally designed part of the landscape. Moore et al in *the Poetics of Gardens*, described gardens as rhetorical landscapes. "They are made of the same materials as all the rest, just as the rhetorician's words are those given by the language, but they are composed to instruct and move and delight...We can read gardens for content, and we can analyse the devices of structure and figure and trope by means of which they achieve their effects" (Moore et al 1993:49). Thus there is considerable depth to gardens that is not necessarily evident in other elements of landscapes.

FIGURES

LEGEND

AREA OF PROPOSED QUARRY



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61 2 9988 4422

STUDY AREA
(AERIAL PHOTOS AUGUST 1973)
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

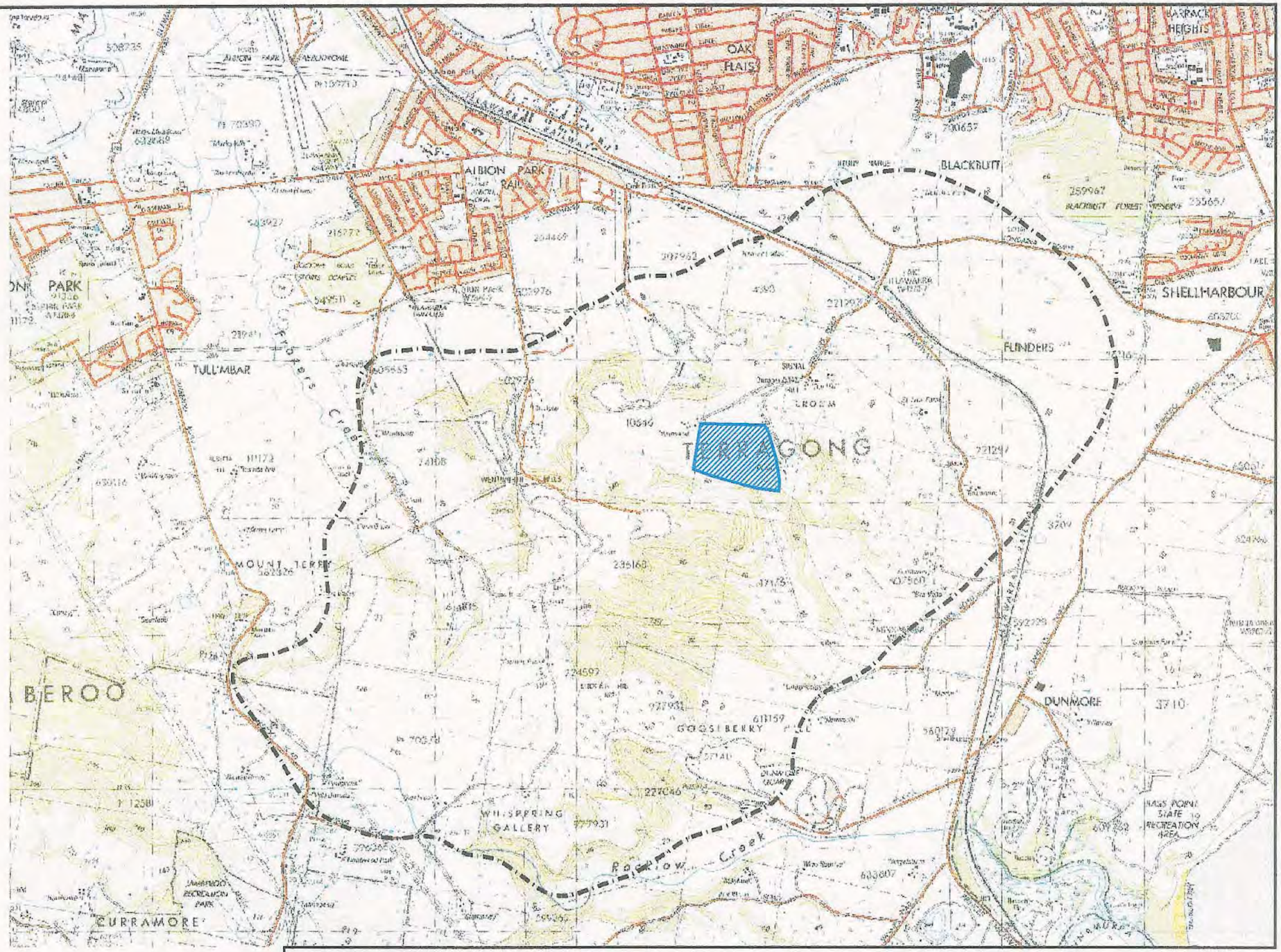
FIGURE
1

DRAWN	PROJECT-FILE NAME	APPROVED	DATE	REVISED DATE
LJE	W1336-011		April 2003	

LEGEND

AREA OF PROPOSED QUARRY

WENTWORTH HILLS CULTURAL LANDSCAPE BOUNDARY



0 0.5 1.0 1.5 2.0

metres

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PROJECT STUDY AREA
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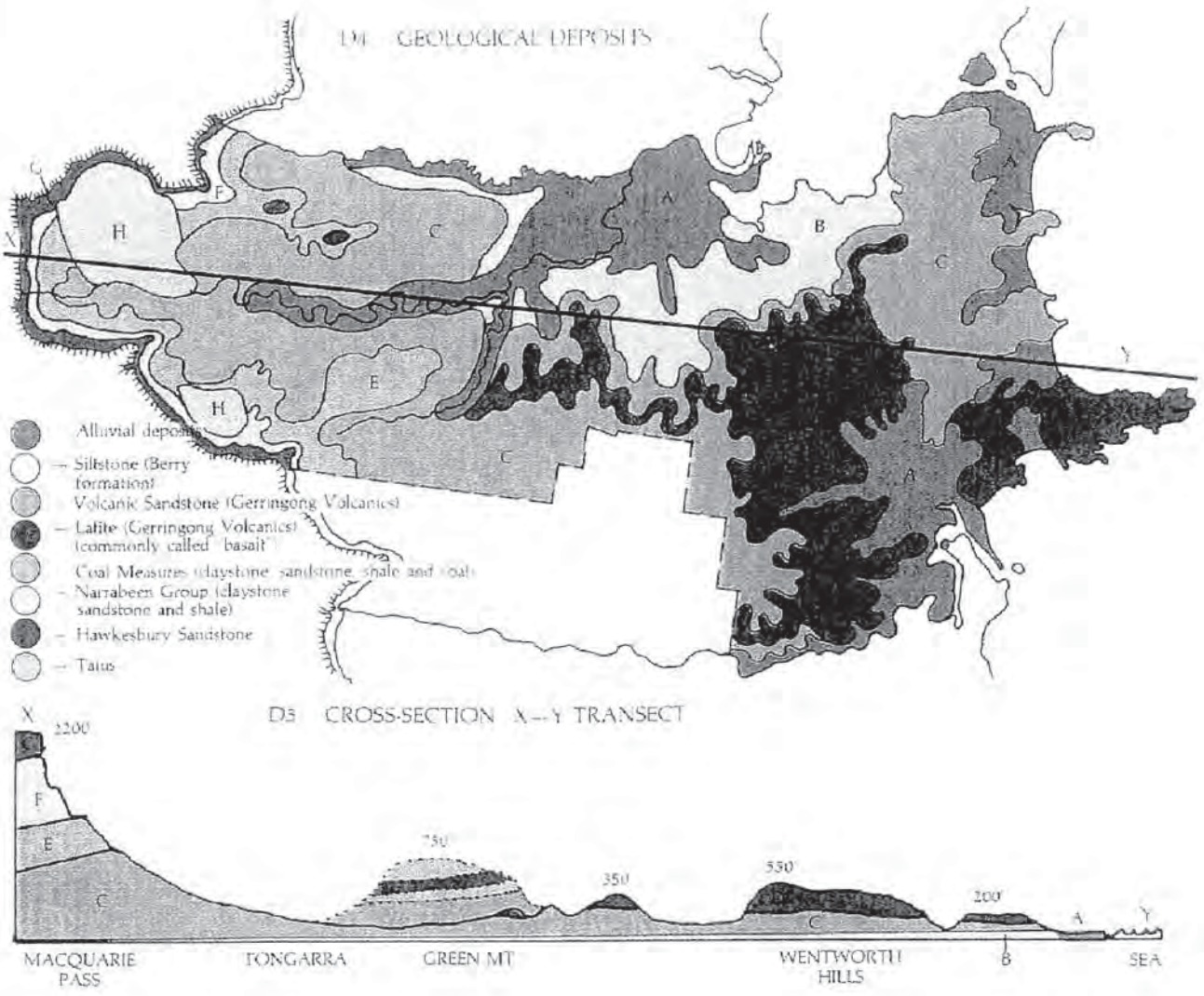
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE
2

DRAWN	PROJECT-FILE NAME	APPROVED	DATE	REVISED DATE
LJE	W1336-001	KM	April 2003	



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TOPOGRAPHY AND GEOLOGY OF WENTWORTH HILLS (AFTER DERBYSHIRE & ALLEN 1984)
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
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FIGURE **3**

DRAWN	PROJECT-FILE NUMBER	APPROVED	DATE	REVISED DATE
LJE	W1336-008	KM	April 2003	

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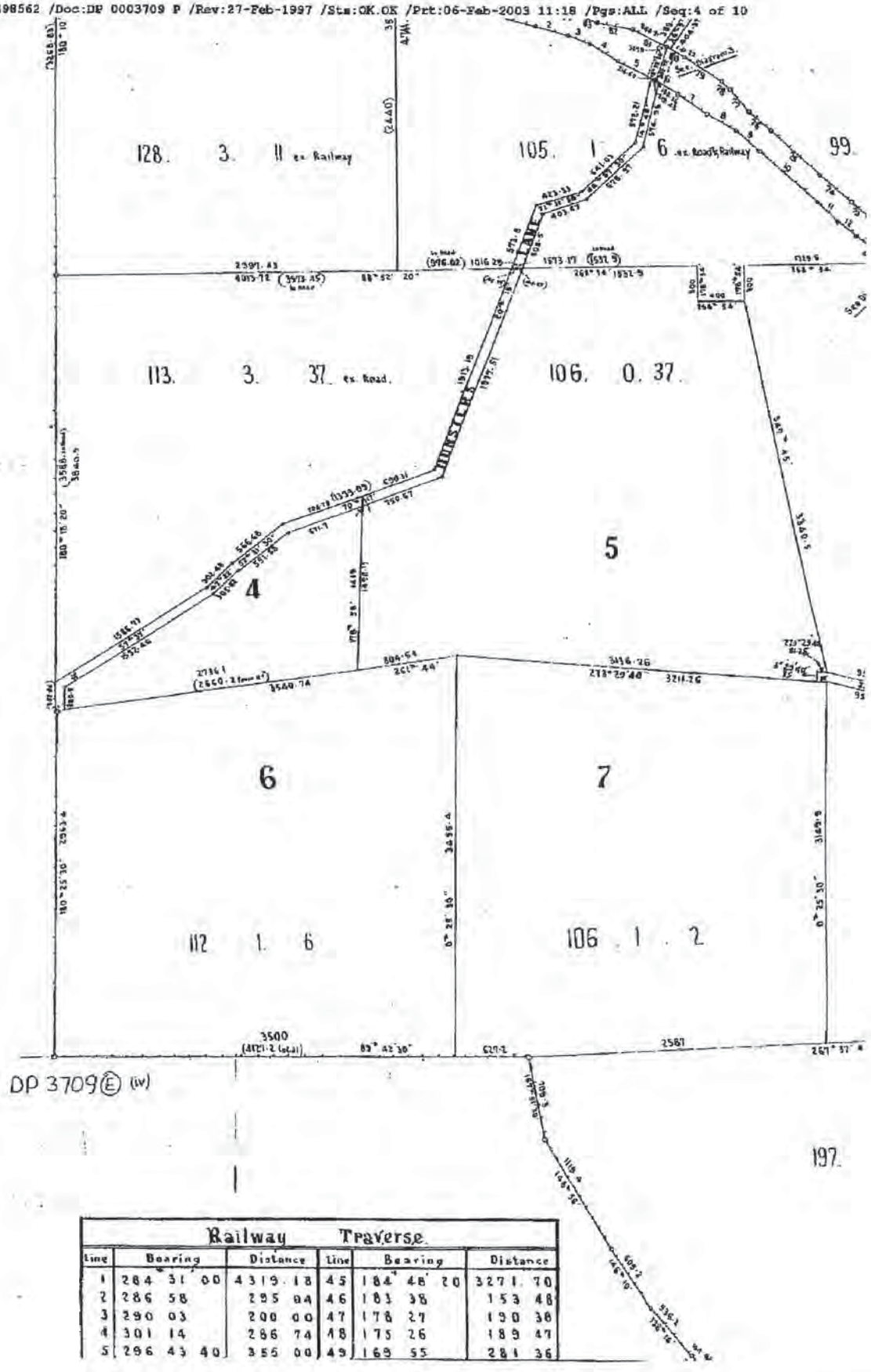
PARISH OF TERRAGONG 1887 SHOWING ORIGINAL SUBDIVISIONS PATTERNS
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE
4

DRAWN	PROJECT-FILE NAME	APPROVED	DATE	REVISED DATE
LJE	W1336-002	KM	April 2003	



Railway Traverse

Line	Bearing	Distance	Line	Bearing	Distance
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2	286 58	295 84	46	181 38	153 48
3	290 03	200 00	47	178 27	190 38
4	301 14	286 74	48	175 26	189 47
5	296 43 40	355 00	49	169 55	281 36

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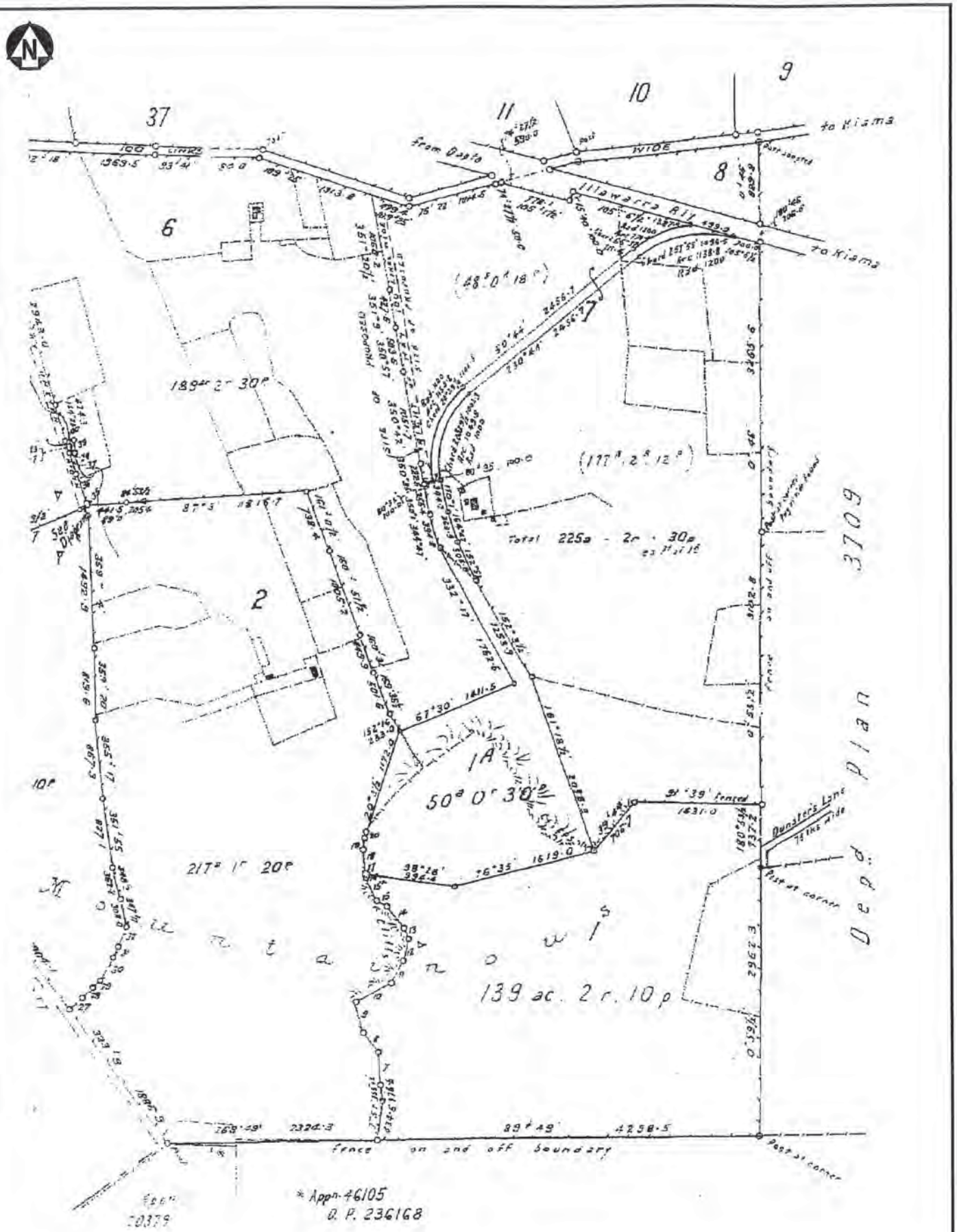
PLAN OF SUBDIVISION DP 3709 SHOWING LOTS 4 & 5 & LOT 6 PURCHASED BY THE DUNSTER FAMILY IN 1901
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE **5**

DRAWN	PROJECT-FILE NUMBER	APPROVED	DATE	REVISED DATE
LJE	W1336-003		April 2003	



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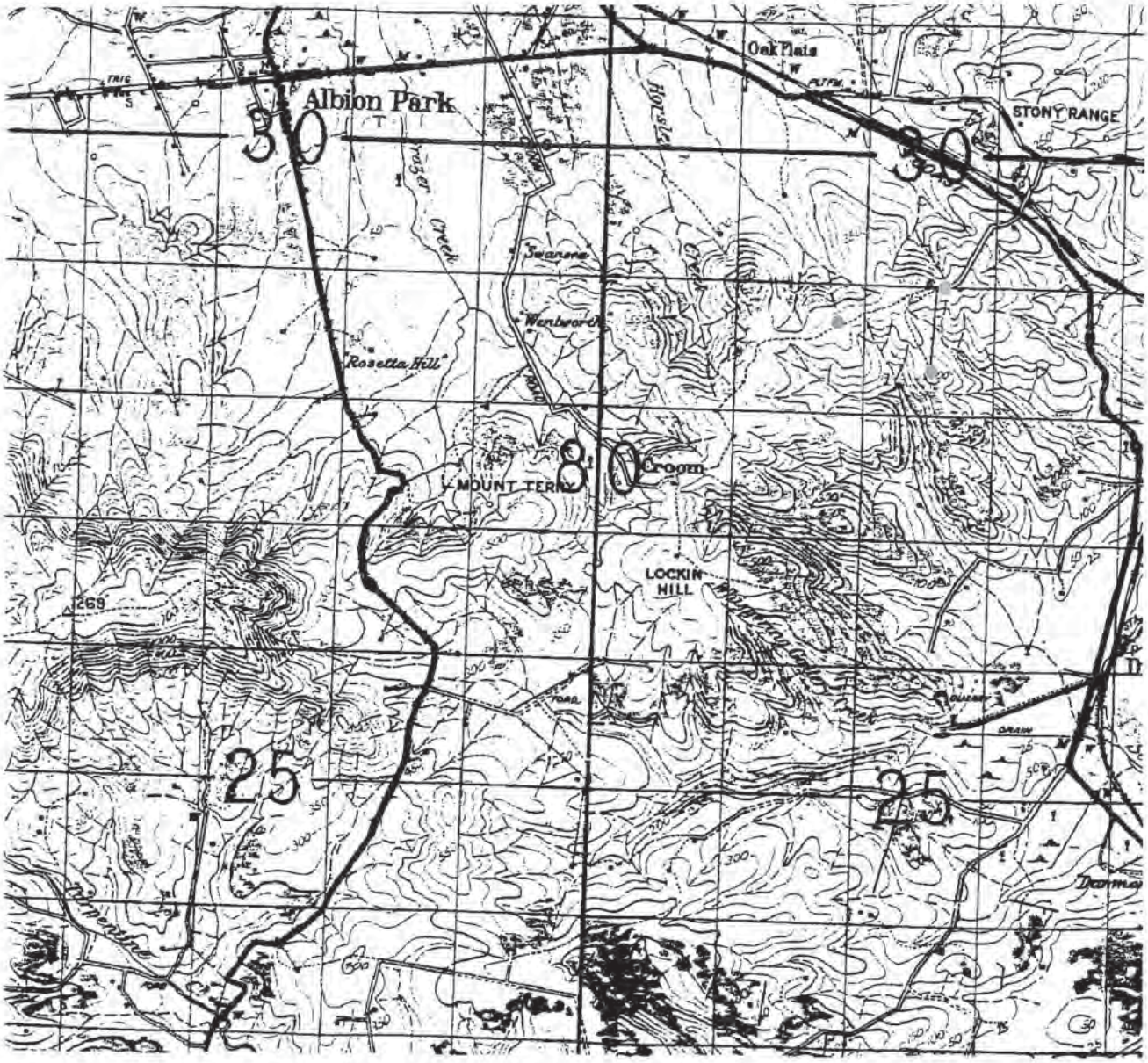
PART OF DP 10646 SHOWING THE AREA SOLD TO FORM KYAWANNA, DEC 1920
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE **6**

DRAWN	PROJECT-FILE NUMBER	APPROVED	DATE	REVISED DATE
LJE	W1336-004	KM	April 2003	

A4



LEGEND

- THE HILL
- BELMONT
- KYAWANA

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DETAIL OF WENTWORTH HILLS FROM KIAMA
1:63 360 MAP 1932
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE **7**

DRAWN	PROJECT-FILE NUMBER	APPROVED	DATE	REVISED DATE
LJE	W1336-005		April 2003	

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STUDY AREA c1970, KIAMA 1:25000 MAP
(1st ed PUBLISHED 1975)
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE
8

DRAWN	PROJECT-FILE NAME	APPROVED	DATE	REVISED DATE
LJE	W1336-006	KM	April 2003	

LEGEND

- THE HILL
- BELMONT
- KYAWANA

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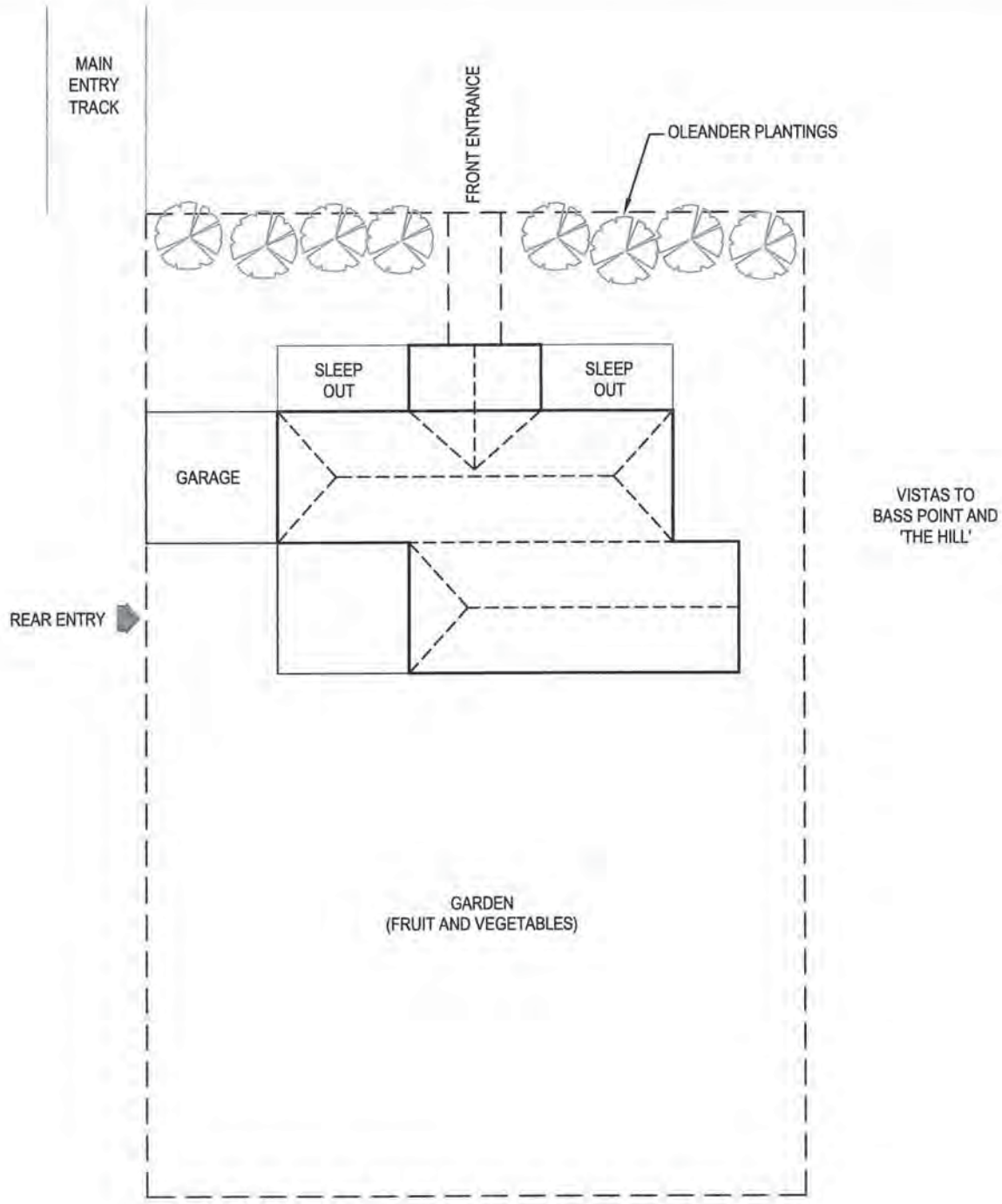
ORTHOPHOTO MAP OF STUDY AREA
(AERIAL PHOTOS AUGUST 1973)
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE **9**

DRAWN	PROJECT-FILE NAME	APPROVED	DATE	REVISED DATE
LJE	W1336-007	KM	April 2003	

A4



NOT TO SCALE

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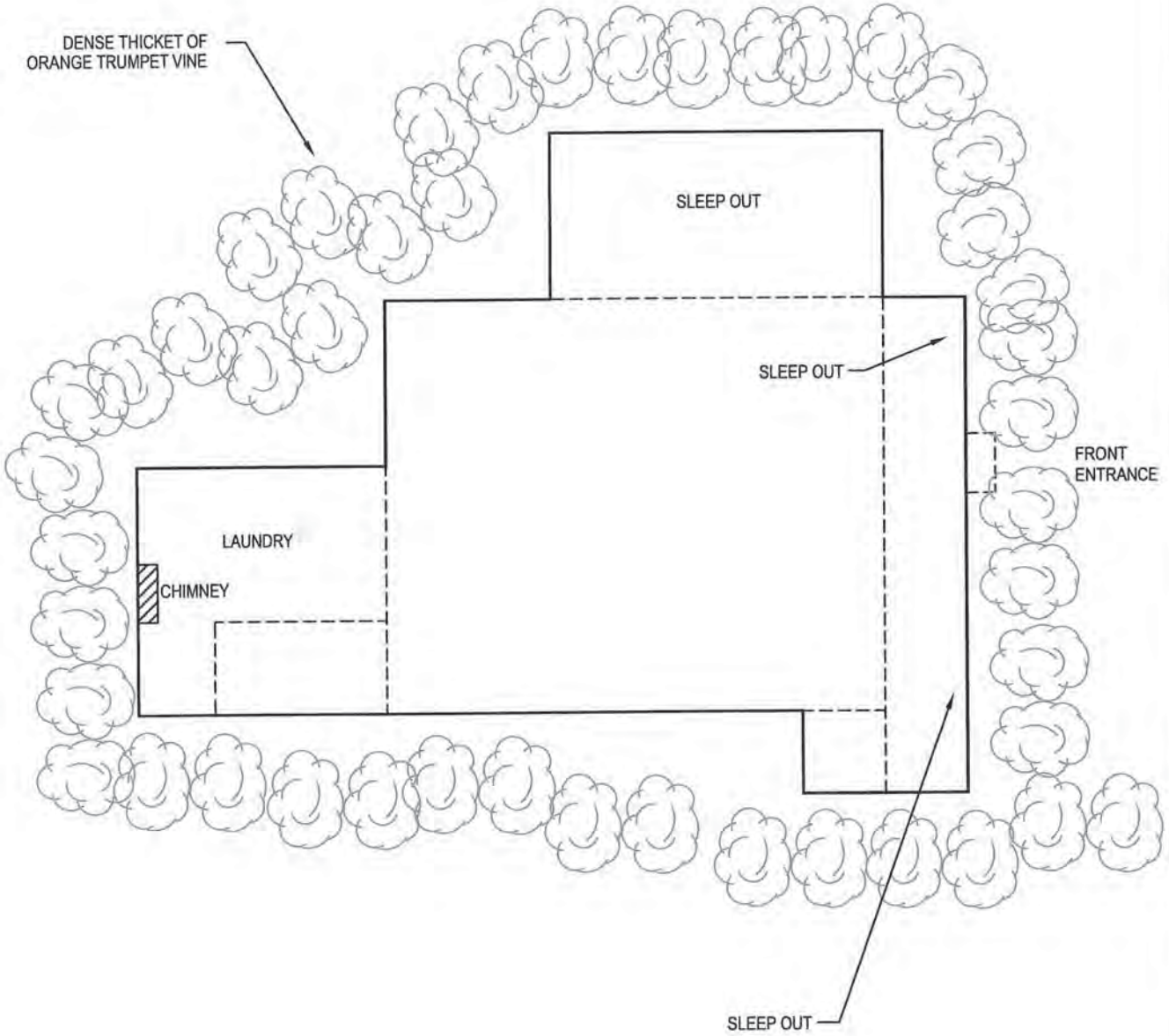
SKETCH PLAN OF 'BELLMONT'
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE
10

DRAWN	PROJECT-FILE NUMBER	APPROVED	DATE	REVISED DATE
LJE	W1336-009	JCM	April 2003	

A4



NOT TO SCALE

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SKETCH PLAN OF 'KYAWANA' HOUSE
Cleary Brothers Bombo
Non-Indigenous Heritage Assessment
Proposed Quarry Croom, New South Wales

FIGURE
11

DRAWN	PROJECT-FILE NUMBER	APPROVED	DATE	REVISED DATE
LJE	W1336-010		April 2003	

PLATES

DISTRIBUTION

Non-Indigenous Heritage Assessment of the impact of the proposed quarry (Lot 1 DP 858245) near Signal Hill, Croom

April 2003

2 copies	Cleary Brothers (Bombo) P.O. Box 210 Port Kembla
Original	Project File

Quality Control Reviewer

Phil Jones BAppSc
Senior Environmental Planner

PLATE 1
Wall A

PLATE 2
Wall A showing barbed wire fencing

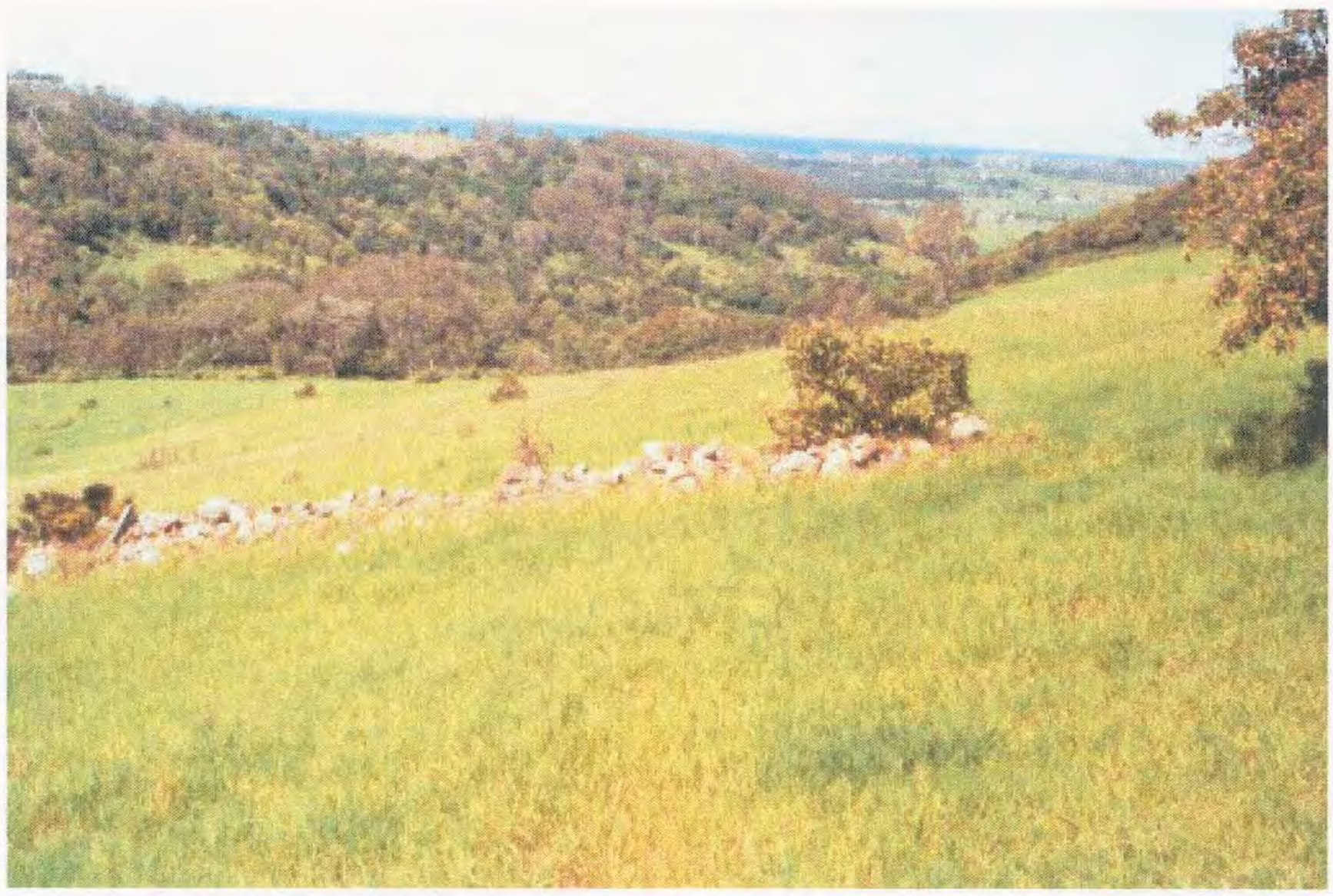

PLATE 3
Detail of Wall B

PLATE 4
'Belmont House'

PLATE 5
'Belmont' Outbuilding

PLATE 6
Former Dairy at 'Belmont'

PLATE 7

Entrance road to 'Belmont' looking north-west
Towards Signal Hill

PLATE 8

'Kyawana' Farm surrounded by vines

PLATE 9
'Kyawana' Farm Dairy

PLATE 10
View of vegetation screening around "The Hill"

Appendix R

ASSESSMENT OF DRY STONE WALLS

REPORT ON

DRY STONE WALLS

ON THE CODY'S AND LYNDSAY

LANE PROPERTIES

ALBION PARK

FOR

CLEARY BROS.

PREPARED BY

GEOFF DUGGAN

August '97

TABLE OF CONTENTS

Dry Stone Walling Australia

Geoff Duggan

Prestige Construction Works * Consultation * Tuition
Landscape Design

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The following report has been prepared for Cleary Bros (Bombo) PTY LTD, c/o Davron Engineering PTY LTD, requested by David J Slack. This report follows a sight inspection on 30th July, 1997, where a survey and assessment was carried out on Dry Stone Walls on the Cody's and Lindsay Lane properties, Albion Park.

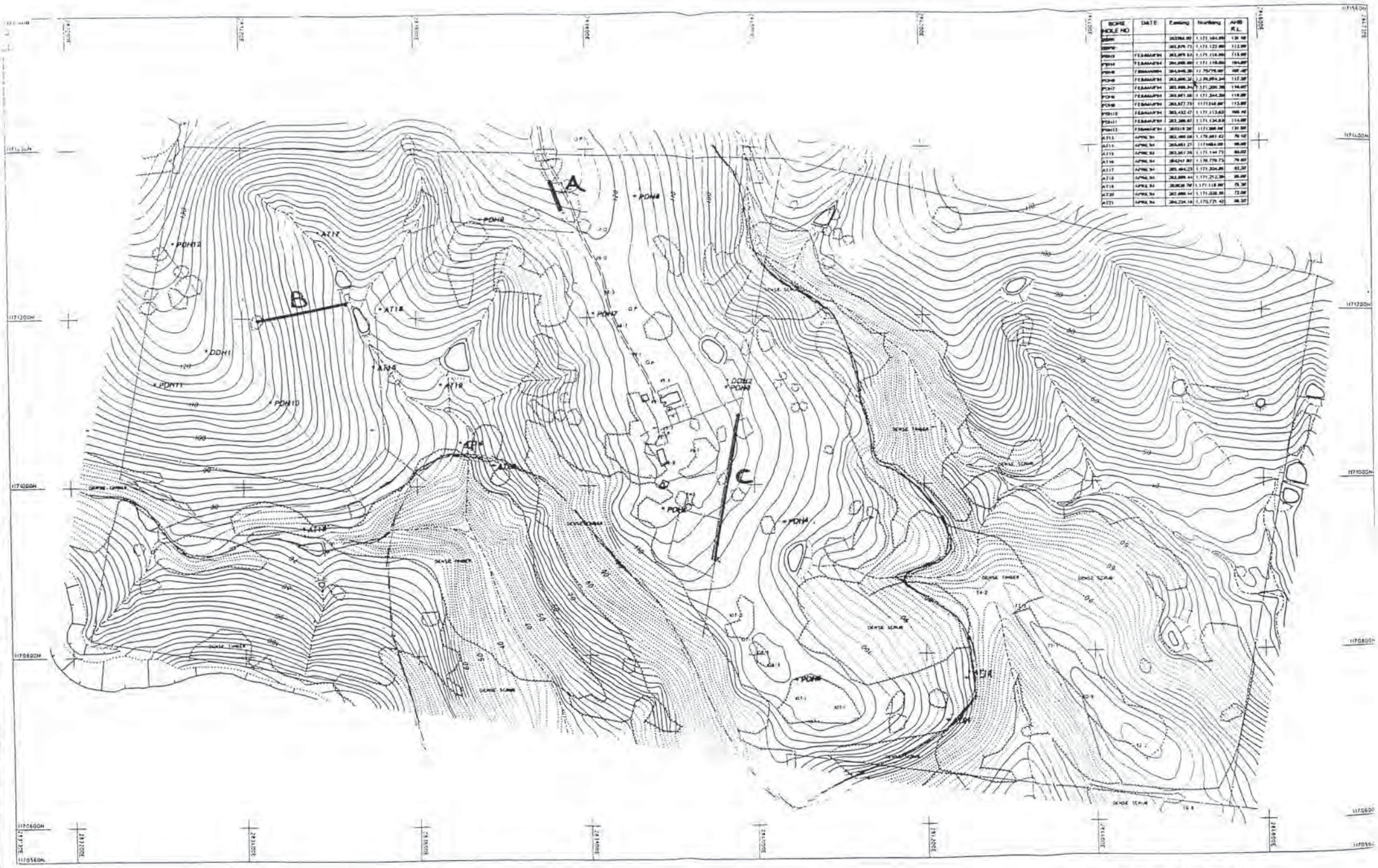
As requested the report will detail:-

- **The present condition**
- **Feasibility of relocation**
- **Method of construction**
- **Specifications for rebuilding.**

Walling survey documents have been prepared by The Dry Stone Walling Association of Great Britain, and are used throughout Britain as a means assessing the Dry Stone Walls which are an integral part of the British agricultural landscape. Published specifications used are also prepared by the Association.

For the purpose of this report, the Dry Stone Walls have been divided into three sections (A, B & C) according to their location. (see site map).

Geoff Duggan



BORE HOLE NO	DATE	Easting	Northing	AHD R.L.
PDH3	11 SEPTEMBER 94			
PDH4	11 SEPTEMBER 94			
PDH5	7 SEPTEMBER 94			
PDH6	11 SEPTEMBER 94			
PDH7	11 SEPTEMBER 94			
PDH8	11 SEPTEMBER 94			
PDH9	11 SEPTEMBER 94			
PDH10	11 SEPTEMBER 94			
PDH11	11 SEPTEMBER 94			
PDH12	7 SEPTEMBER 94			
AT11	APRIL 94			
AT12	APRIL 94			
AT13	APRIL 94			
AT14	APRIL 94			
AT15	APRIL 94			
AT16	APRIL 94			
AT17	APRIL 94			
AT18	APRIL 94			
AT19	APRIL 94			
AT20	APRIL 94			
AT21	APRIL 94			

APQ-COOY-002

BHP Engineering

CLEARY BROS (Bombo) Pty Ltd
BELMONT (COOYAL) 1:2000 TOPOGRAPHIC MAPPING
RESOURCE ASSESSMENT

SHEET 1 OF 1
REV. 1.

Level A Survey: Length and Condition Survey

Date of survey (include year) 30 / 7 / 97

Surveyor name GEOFF DUGGAN

Location (Parish and County) ALBION PARK N.S.W. AUSTRALIA

Grid Reference (2 letters and 6 figures) SEE ENCLOSED TOPOGRAPHIC MAP

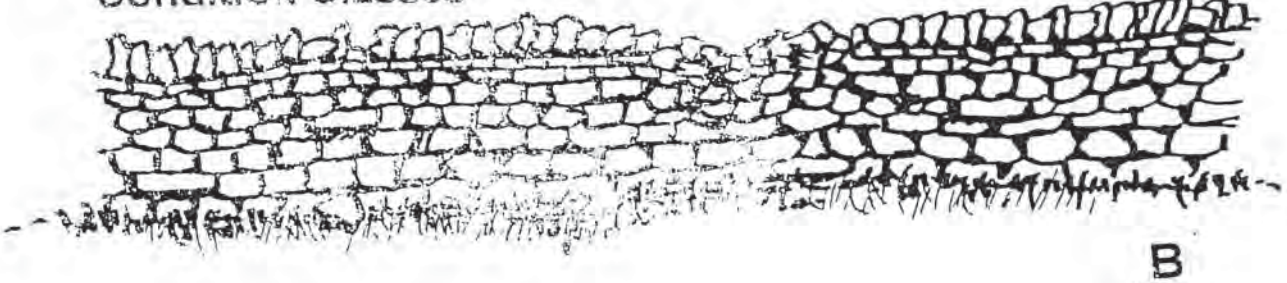
Wall Section number	Section Description Beginning	End	Length metres	Wall Divider	Furniture	Fencing	Condition Class
A			25	X AA	X	4 STRANDS BARB & STAR PICKET F2	D
B			109	X AA	X	X	F
C			136	X AA	X	75 M OF 3 STRAND BARB. F2	C

Key -

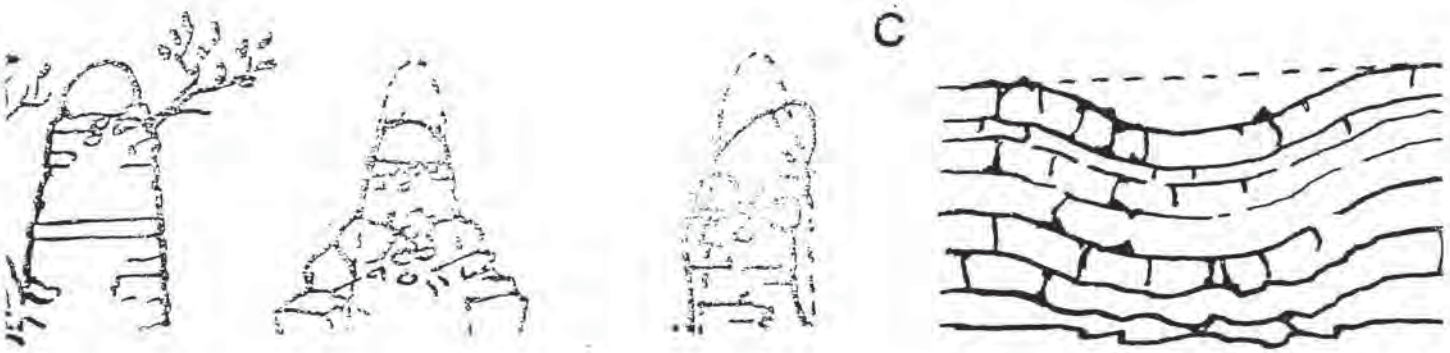
Survey location	Please ensure that this page of the form can be traced back to a specific survey.	
Section description	Beginning and end should be specified by physical location such as a field corner, gate, barn and also the number of any adjacent section.	
Wall divider	Two letters to indicate the land use on the two sides (e.g. GA, AA)	
	A	Arable
	B	Building, house, garden, farmhouse.
	F	Rough grazing, moor, down, fell etc.
	G	Permanent grass.
	R	Metalled road (with asphalt or similar surface) or railway.
	S	Sea, river or lake.
	T	Unsurfaced track.
	W	Wood
Furniture found in section	SS	Sheep smoot (hole for sheep)
	S	Stile.
	WS	Water smoot (hole for water)
	See separate charts for more detailed codes and descriptions in Level B survey.	
Fencing along the section	F1	Single wire strand near the top.
	F2	Stockproof and continuous post and wire fence.
	F3	Electric fence
	F4	Other

Condition Class	Wall farming value	Description of condition of the wall section
A	Stockproof	Excellent condition. Topstones nearly all in place. All sides smooth and straight. No sign of bowing, bellying or slumping. Almost no fallen stones.
B	Stockproof	Some structural defects but effective. A few fallen stones and occasional top stones missing. Obvious temporary repairs such as gap filled with single width of rubble.
C	Stockproof	Almost complete but signs of future problems,bellying, slumping, bowing. Extensive tree growth at wall base or shrub growth in wall.
D	Not stockproof	Boundary still used as stockproof boundary but the wall plays a secondary or negligible role to a fence.
E	Not stockproof	Boundary not maintained stockproof in any way Large gaps and reduced wall height. Most stone still present.
F	Not stockproof	Very derelict along its entire length with apparent large loss of stone, removed or buried. Apparent mainly because of a raised bank.

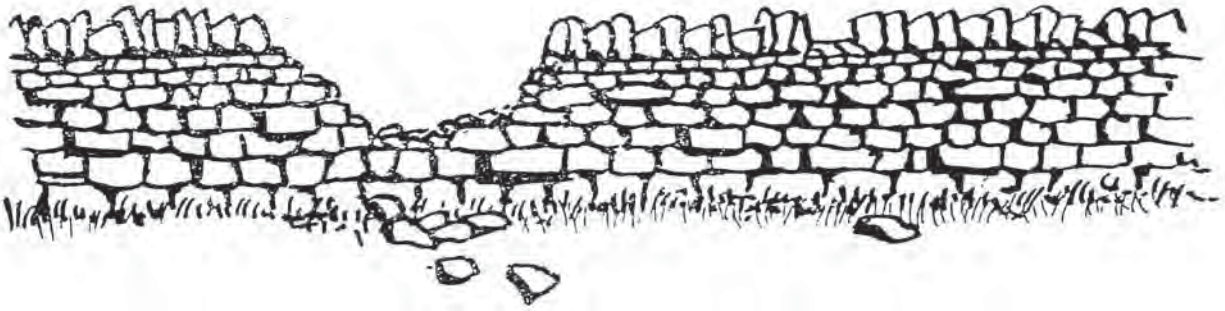
Condition Classes



B



C



D

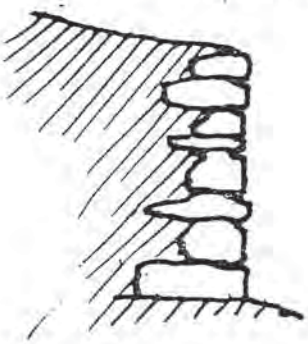
E

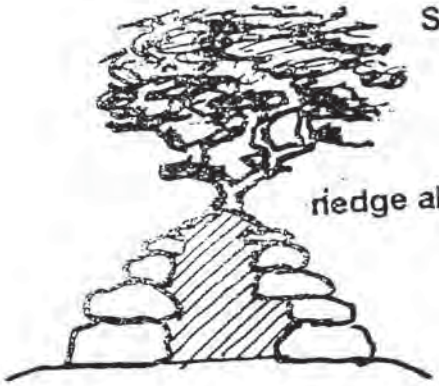
F

Double

Single above Double

Retaining

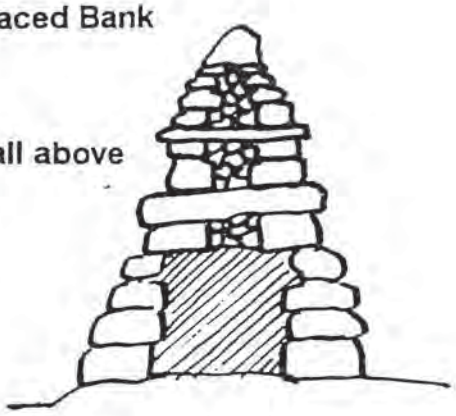




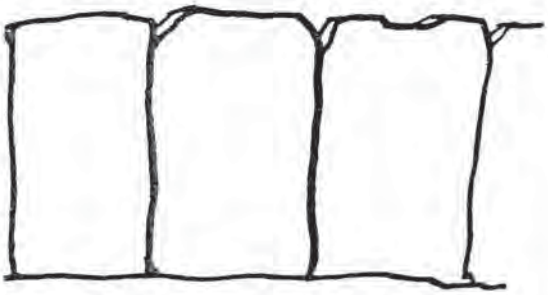
Stone-faced Bank

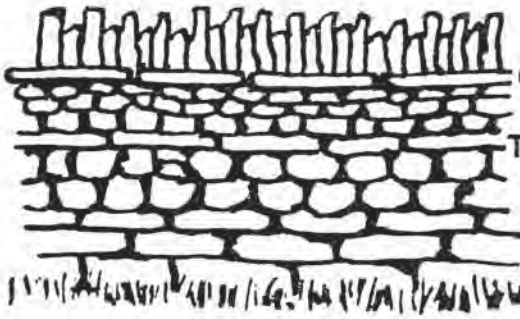
ridge above

wall above



Vertical slab wall

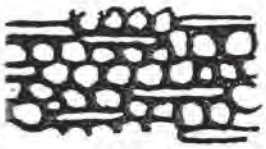




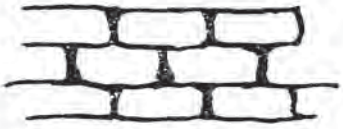
Cover-ba

Throughs

Round

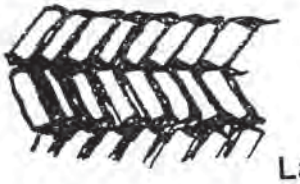


Almost square



Laminar horizontal

Laminar vertical



Laminar angled

Laminar horizontal

Laminar vertical

Laminar angled

High-low

P STONES

Dressed

Square

Triangular

Level B Survey: Wall Style and Features Survey

In another level of survey the same wall sections can be surveyed and information can be recorded on the height, width and style of construction together with a record of the features found. Several sections can often be recorded together if there are no special features. Make sure that the Level B survey can be related to the Level A survey.
A key is attached with sketches of each feature.

Date of survey: 30/7/97 Wall section number A
Surveyor name: GEOFF DUGDALE
Location (Parish and County) ALBION PARK
Grid Reference (2 letters and 6 figures)

SIZE
Total Height (metres within 0.1 m) High side/Low side..... [1]metres
Width near base.....about 0.8m [ ] Other (give width). [1.2]metres

STYLE
Double..... [✓] Single..... [ ] Single above double.....[ ]
Retaining..... [ ]
Stone-faced bank. with wall above.....[ ] with hedge above....[ ] by itself.....[ ]
Vertical slab wall..... [ ]

DETAIL
Number of through-bands 0....[✓] 1.....[ ] 2..... [ ] 3.....[ ] 4.....[ ]
Coverband Yes..... [ ] No..... [✓]
Stones thoroughly dressed Yes..... [ ] No..... [✓]
Coursed.....[ ] Random..... [✓]
Stones Round..... [ ]
Irregular..... [✓]
Almost square..... [ ]
Laminar: Horizontal.... [ ] Vertical..... [ ] Angled..... [ ]
Top Stones Laminar: Horizontal.... [ ] Vertical/even.... [ ] Vertical/high-low.[ ]
Angled uphill.... [ ] Angled downhill.[ ]
Boulders....[✓]
Dressed; Square...[ ] Triangle..... [ ] Semi-circular.....[ ]
Mortared Yes..... [ ] No..... [✓]

FEATURES
Smoots; Sheep....[ ] Water... [ ] Rabbit..... [ ]
Wall head Within wall length..... [ ] At wall junction [ ]
At gate/stile with stoup..... [ ] without stoup.... [ ]
Stile Squeeze [ ] Steps to top..... [ ] Step/sqeeze..... [ ] Other..... [ ]
Wood over wall..... [ ] Wood over stone stile..... [ ]
Gate Farm vehicle.... [ ] Horse... [ ] Person..... [ ].
Bridge Arch..... [ ] Slab..... [ ] Not stone..... [ ]
Niche, bee-bole etc. ..... [ ] Brief description.....
Inscription..... [ ]

TYPE OF STONE
Slatey (laminar,hard,smooth)..... [ ]
Granity (round,hard,smooth)..... [ ]
Limestone (laminar/round,lumpy,hard/soft)..... [ ]
Sandstone (fine compressed grains)..... [ ]
Other BASALT FIELD STONE

Level B Stone Wall Style and Features Survey

In another level of survey the same wall sections can be surveyed and information can be recorded on the height, width and style of construction together with a record of the features found. Several sections can often be recorded together if there are no special features. Make sure that the Level B survey can be related to the Level A survey.
A key is attached with sketches of each feature.

Date of survey 30/7/97 Wall section number B
Surveyor name GEOFF DUGGAN
Location (Parish and County) ALBION PARK
Grid Reference (2 letters and 6 figures)

SIZE
Total Height (metres within 0.1 m) High side/Low side..... 0-700MM [ ]metres
Width near base.....about 0.8m [ ] Other (give width). [1 · 2]metres

STYLE
Double..... [✓] Single..... [ ] Single above double.....[ ]
Retaining..... [ ]
Stone-faced bank. with wall above.....[ ] with hedge above....[ ] by itself.....[ ]
Vertical slab wall.....[ ]

DETAIL
Number of through-bands 0....[✓] 1.....[ ] 2..... [ ] 3.....[ ] 4.....[ ]
Coverband Yes..... [ ] No..... [✓]
Stones thoroughly dressed Yes..... [ ] No..... [✓]
Coursed.....[ ] Random..... [✓]
Stones Round..... [ ]
Irregular..... [✓]
Almost square..... [ ]
Laminar: Horizontal.... [ ] Vertical..... [ ] Angled..... [ ]
Top Stones Laminar: Horizontal.... [✓] Vertical/even.... [ ] Vertical/high-low.[ ]
Angled uphill.... [ ] Angled downhill.[ ]
Boulders....[✓]
Dressed; Square...[ ] Triangle..... [ ] Semi-circular.....[ ]
Mortared Yes..... [ ] No..... [✓]

FEATURES
Smoots; Sheep....[ ] Water... [ ] Rabbit..... [ ]
Wall head Within wall length..... [ ] At wall junction [ ]
At gate/stile with stoup..... [ ] without stoup.... [ ]
Stile Squeeze [ ] Steps to top..... [ ] Step/sqeeze..... [ ] Other..... [ ]
Wood over wall..... [ ] Wood over stone stile..... [ ]
Gate Farm vehicle.... [ ] Horse... [ ] Person..... [ ].
Bridge Arch..... [ ] Slab..... [ ] Not stone..... [ ]
Niche, bee-bole etc. ..... [ ] Brief description.....
Inscription..... [ ]

TYPE OF STONE
Slatey (laminar,hard,smooth)..... [ ]
Granity (round,hard,smooth)..... [ ]
Limestone (laminar/round,lumpy,hard/soft)..... [ ]
Sandstone (fine compressed grains)..... [ ]
Other BASALT FIELD STONE

Level B Survey: Wall Style and Features Survey

In another level of survey the same wall sections can be surveyed and information can be recorded on the height, width and style of construction together with a record of the features found. Several sections can often be recorded together if there are no special features. Make sure that the Level B survey can be related to the Level A survey.
A key is attached with sketches of each feature.

Date of survey (dd/mm/yy) 30/7/97 Wall section number C
Surveyer name GEOFF DUGGAN
Location (Parish and County) ALBION PARK
Grid Reference (2 letters and 6 figures)

SIZE
Total Height (metres within 0.1 m) High side/Low side..... [1]metres
Width near base.....about 0.8m [ ] Other (give width). [1-2]metres

STYLE
Double..... [✓] Single..... [ ] Single above double.....[ ]
Retaining..... [ ]
Stone-faced bank. with wall above.....[ ] with hedge above....[ ] by itself.....[ ]
Vertical slab wall..... [ ]

DETAIL
Number of through-bands 0....[✓] 1.....[ ] 2..... [ ] 3.....[ ] 4.....[ ]
Coverband Yes..... [ ] No..... [✓]
Stones thoroughly dressed Yes..... [ ] No..... [ ]
Coursed.....[ ] Random..... [ ]
Stones Round..... [ ]
Irregular..... [✓]
Almost square..... [ ]
Laminar: Horizontal.... [ ] Vertical..... [ ] Angled..... [ ]
Top Stones Laminar: Horizontal.... [✓] Vertical/even.... [ ] Vertical/high-low.[ ]
Angled uphill.... [ ] Angled downhill.[ ]
Boulders....[✓]
Dressed; Square...[ ] Triangle..... [ ] Semi-circular.....[ ]
Mortared Yes..... [ ] No..... [✓]

FEATURES
Smoots; Sheep....[ ] Water... [ ] Rabbit..... [ ]
Wall head Within wall length..... [ ] At wall junction [ ]
At gate/stile with stoup..... [ ] without stoup.... [ ]
Stile Squeeze [ ] Steps to top..... [ ] Step/sqeeze..... [ ] Other..... [ ]
Wood over wall..... [ ] Wood over stone stile..... [ ]
Gate Farm vehicle.... [ ] Horse... [ ] Person..... [ ].
Bridge Arch..... [ ] Slab..... [ ] Not stone..... [ ]
Niche, bee-bole etc. ..... [ ] Brief description.....
Inscription..... [ ]

TYPE OF STONE
Slatey (laminar,hard,smooth)..... [ ]
Granity (round,hard,smooth)..... [ ]
Limestone (laminar/round,lumpy,hard/soft)..... [ ]
Sandstone (fine compressed grains)..... [ ]
Other BASALT FIELD STONE

Other observations made at each wall section include -

Section A

This small length has been walled over a rock outcrop and has slight plant invasion. It is possible that it is a remnant of a much longer wall along this fence line but has been left intact where fence posts could not be driven into the ground.

Section A, 25 metres long with slight plant invasion.

Section A, showing rock outcrop in foreground.

Section B

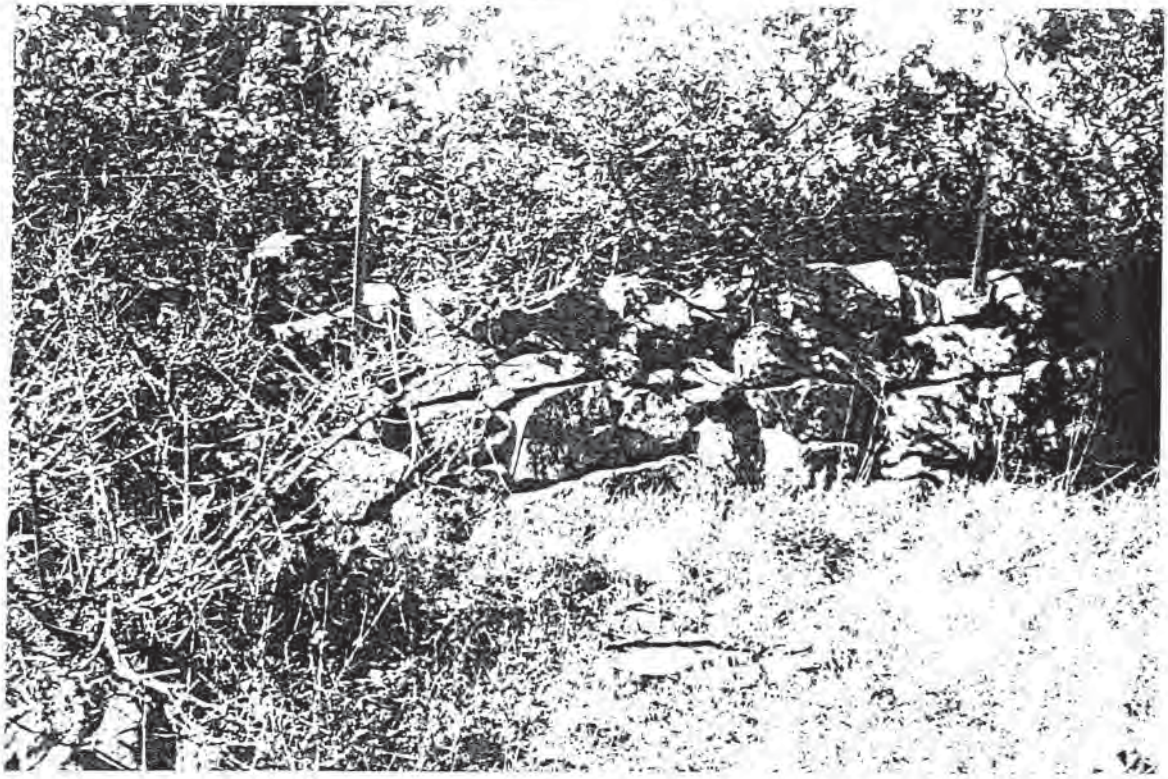
This 109 metre section is not stock proof, there are tracks through the wall along several points of its length used by cattle and is situated on a fairly steep hillside. The wall is suffering from fairly heavy plant invasion and has low accessibility except by 4WD.

Section B, showing plant invasion.

Section B, ranging from 0 - 0.7 metres in height showing cattle tracks.

Section C

The longest section at 130 metres is built along a ridge line. Possibly built on this site due to the shallow soil, therefore unable to drive fence posts into the ground. It is the most intact of all sections observed and is still in use as a stock boundary, although it suffers from the most plant invasion and is prone to rapid deterioration.



Section C, still intact in most places.

Showing rock outcrops and heavy plant invasion.

THE PRESENT CONDITION

A Dry Stone Wall is a very durable structure if built correctly. Field walls such as these should have a life expectancy of 100 - 150 years or more when the work is carried out by a skilled waller. However, this is not to say that a Dry Stone Wall does not require maintenance during its life. A good general guide to maintenance requirements is to spend 1 Day / Mile / Year. Maintenance usually involves repairing small sections or replacing top stones. These may become dislodged by livestock, excessive plant growth, tree root invasion, foundations undermined by burrowing animals etc.

The present condition of the walls covered in this report suggest that they have been neglected, and as a result would all need major repairs to restore them to being a functional and lasting structure. This would include removal of the vegetation which would in turn involve dismantling and rebuilding from foundations up, in approximately 90% of the survey area. Other factors which may have contributed to its present state could have involved some poor workmanship where basic principles in Dry Stone Walling have not been observed (this will be covered later in construction techniques) and will result in further deterioration.

Although still intact this section of wall at Section C shows areas of weakness including running joints

FEASIBILITY OF RELOCATION

Characteristically a Dry Stone Wall uses no mortar in its construction. This has many advantages including, saving on the cost and transport to the site, increased drainage and flexibility of the completed wall, aesthetics and ease of dismantling for repair, alteration or removal.

Relocation of a Dry Stone Wall is very a feasible alternative when a wall is to undergo major repairs, if costs can be met in transporting the stone to an alternative site. As outlined in Construction Techniques, when building or rebuilding a Dry Stone Wall, the entire wall is "stripped out". This process involves dismantling and sorting the available stone.

As pointed out the walls surveyed require major repairs. The extent of repairs would also be compounded by the vegetation removal as branches and roots would inevitably dismantle the wall during their removal.

Relocation of the Dry Stone Walls would involve the following steps:-

- Removal of vegetation and disposal
- Dismantling of walls by hand into bucket of front-end loader (to keep stone clean and free from soil)
- Loading suitable vehicle to transport dismantled wall (vehicle must be able to cope with site inaccessibility)
- Transport to new site
- Backhoe to prepare site for foundations
- Sort stone and commence construction following guidelines given in this report

The length of walls covered in this report total 270 metres. This would total approximately 300 tonne of stone for removal and transportation, which would also incorporate stone stockpiles in the vicinity to make up for the expected shortfalls in stone supply. Costs for construction could be given at a per metre rate x 270 and could be expected to be between $120 - $170 per metre.

METHOD OF CONSTRUCTION

The following points are the basic principles used in building a Dry Stone Wall as outlined by The Dry Stone Walling Association of Great Britain (DSWA). The DSWA is believed to be the only body in the world devoted entirely to this skill, and since its formation in 1968 has overseen a dramatic improvement in the state of the craft.

1) Stripping Out or Sorting

This process involves careful dismantling of the old wall and sorting stone into selected sizes for the rebuild. Old walls as far as practicable should be dismantled by hand not by machine as this could result in soil mixing in with stone supply and valuable longer stones could be broken. Careful sorting saves much time when building.

2) Foundation

Should be laid on a solid ground surface where all turf or organic matter has been removed, using largest stones available. All stones should lay end in - end out, butt tightly together and should not move or wobble when walked on. If ground is soft or waterlogged a wider base or foundation may be necessary. All voids between opposing foundation stones should be filled or hearted up using the largest stones possible.

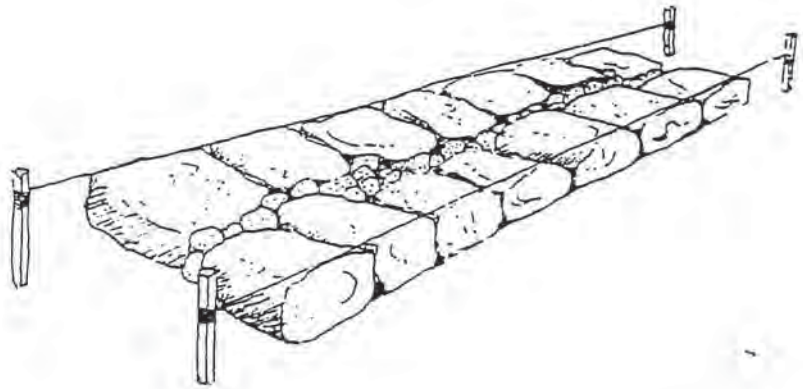


Fig. 1 Foundations

3) Building the First Lift

It is advisable at this stage to have 2 walling frames or profile bars on which string lines can be attached to ensure the correct batter and straightness of the wall is maintained. In general a standard field wall is usually 1.4 m above ground level, however a wall may be more or less any height providing the base width is at least ½ the total wall height. At this stage the wall can be built up keeping stones level, length in and ensuring all joints in the courses below are crossed, ie. one stone over two and two stones over one, locking stones beneath in place. Ensure the middle is filled using the largest stones possible (note do not use loose gravel or soil). If rebuilding or repairing a wall always try to ensure that mosses and lichens are kept to the outside of the structure. Continue this process until half the finished height is attained.

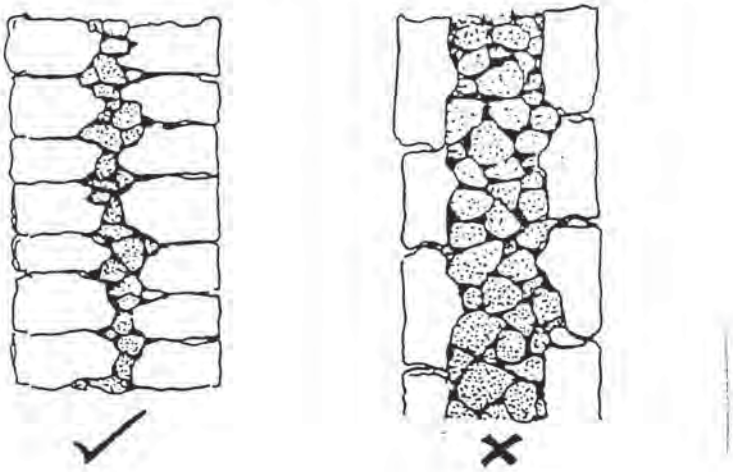


Fig. 2 Length of stone running into the wall - not traced walled

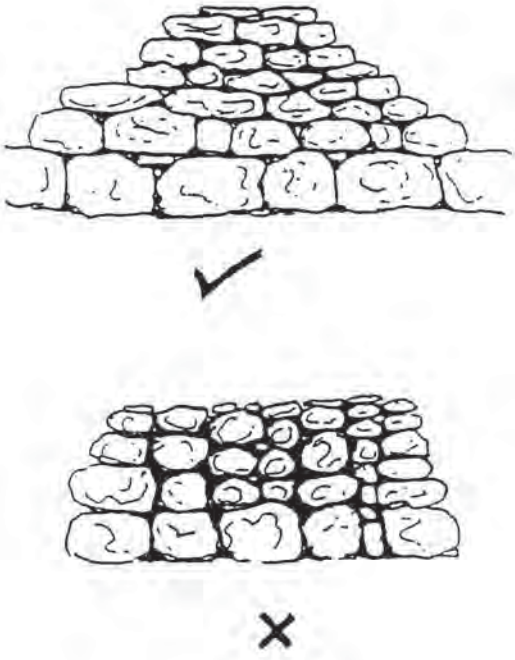


Fig. 3 Ensure joints in courses below are crossed - no running joints

4) Through Stones

Through stones are placed on the wall at this stage approximately 1m apart. They should extend across the wall tying both sides together and should not project more than 5cm out from the side. If there are no suitable stones to use for this process, over and under throughs or side by side throughs can be used or alternatively import longer stones from elsewhere.

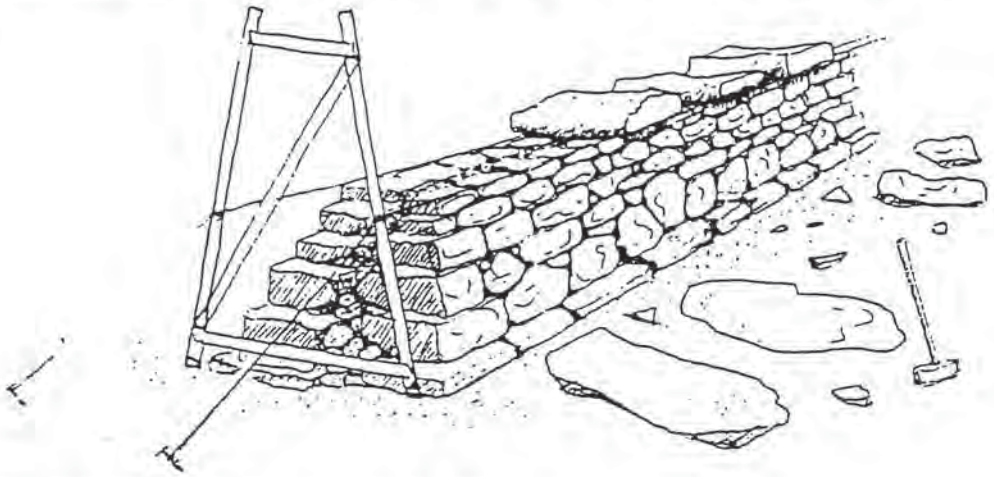


Fig. 4 First lift, levelled and ready for Through Stones

5) Second Lift

Building the second lift - keep raising the string lines and continue building up to finished height using the previous process described.

6) Copestones

Copestones are used to finish the wall off, giving it an attractive and well built look. their purpose is the same as that as through stones, to tie both sides of the wall together and to prevent damage from above. The cope or finish of a wall varies from area to area, but their purpose is the same ie. to hold the top of the wall together.

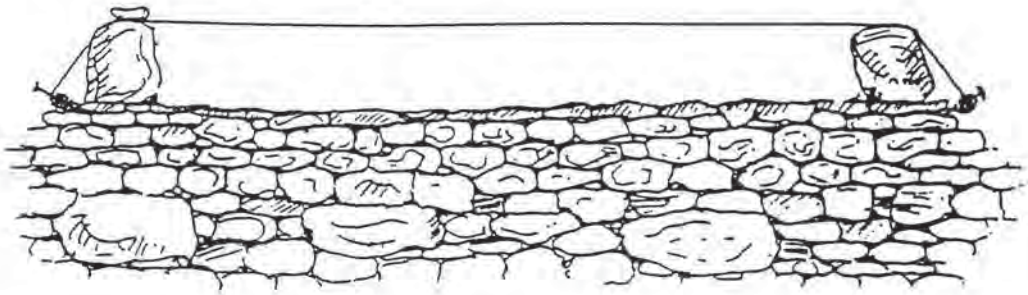


Fig. 5 Second lift, levelled and ready for copes

Always obey these basic rules where possible when building a Dry Stone Wall :-

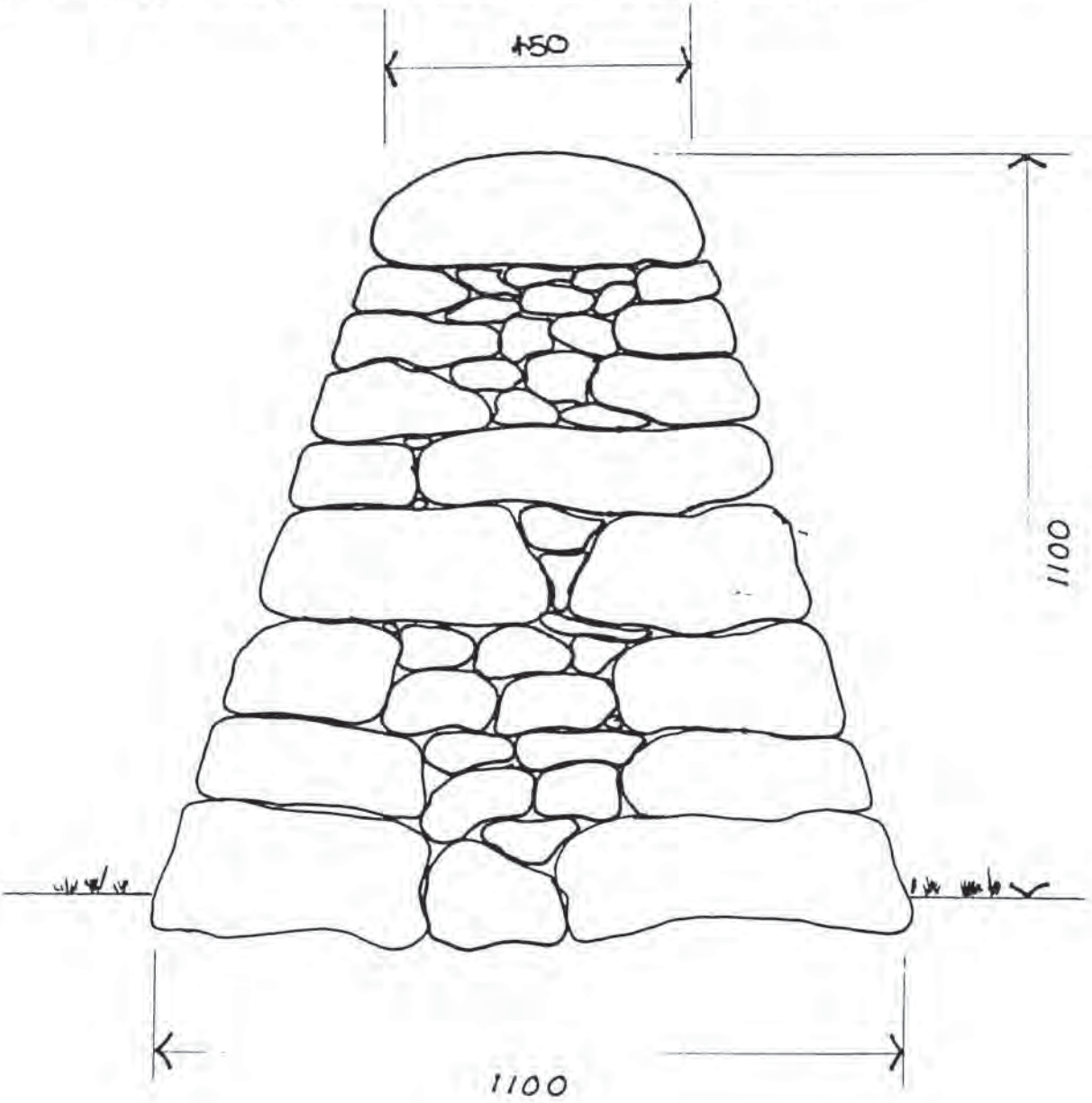
- Cross joints
- Keep the middle filled and level with larger rather than small stones
- Keep stones level
- Place stones end in - end out
- Use through stones to tie both sides of the wall together
- Use larger stones at the bottom working up to smaller stones
- Ensure stones are free from movement by correct pinning

SPECIFICATIONS FOR REBUILDING

The included Technical Specifications for Dry Stone Walls brochure, details specifications for a typical British, standard, field Dry Stone Wall. Throughout Britain and indeed the world, these specifications can vary greatly, however the basic principles as outlined in the Method of Construction are universal.

Basalt field walls in this region of the South Coast and the Southern Highlands of NSW, do have a regional style. Their dimensions are fairly similar and if any work is carried out on repairing, preserving or rebuilding these walls it is good practice that their construction should reflect the regional style.

The following dimensions given are taken from the most intact sections of the walls observed and have allowed for some settlement of the structure over the period of its life. Also over and under Through stones have been incorporated into the structure at around half its height to give added stability and strength throughout its lifetime. All dimensions are given in millimetres and serve as an approximate guide only to the dimensions of the regional style.



- When dismantling walls for re-use later, it is imperative that no soil or other foreign material whatever is mixed with the stone. This usually inhibits the use of machinery. The best course of action is to place a mechanical digger "bucket" against the wall and hand load. Aim to keep the various components separate (i.e. top stones, throughstones, building stones, etc).

- It is important to bear in mind that the waller can obviously only work with the material supplied. surprisingly, it is not at all uncommon for the commissioning body to provide a specification similar to the drawings above, yet supply stone which makes faithful execution of that specification impossible. Some stone can be coursed, some is only suitable for random walling. Where an *exact* reproduction is not essential, allowances must be made according to materials and conditions.

Note: Separate specifications are available from DSWA for a number of regional or distinctive styles of dry stone walling including single walls and simple retaining walls.

FURTHER INFORMATION

The Association endeavours to respond to all requests for specific information regarding dry stone walling. The DSWA offers a mail order service on books - which includes a number of technical manuals which would make useful reading - and produces a register of working wallers which is free of charge. Full details are available upon request and a stamped, self-addressed envelope is much appreciated.

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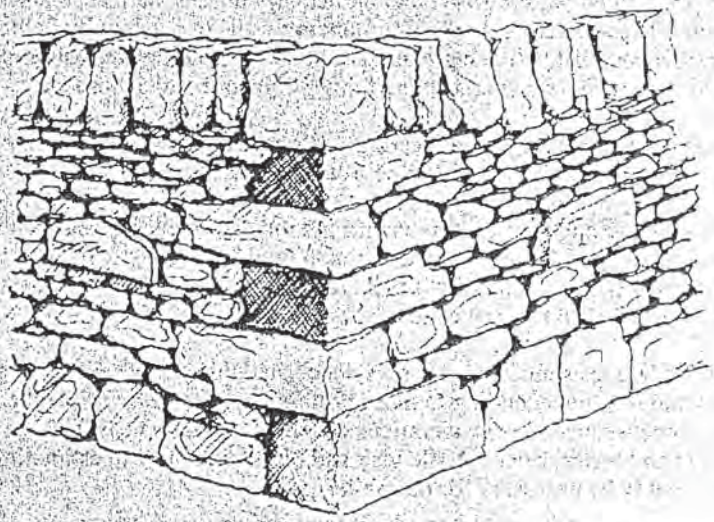
The Dry Stone Walling Association
of Great Britain

TECHNICAL SPECIFICATIONS FOR DRY STONE WALLS



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TECHNICAL SPECIFICATIONS FOR DRY STONE WALLS

PREAMBLE

These notes have been prepared to assist professional decision makers: local authorities, architects, civil engineers, landscape designers, etc. in drawing up specifications for dry stone walling work. Before giving the most common measurements, a number of important points should be understood:

- There are three key areas in the use of dry stone: *free standing walls* which are by far the most common application of the craft in the United Kingdom; *Load bearing retaining walls* and *domestic structures* particularly houses, barns and ancient monuments. These notes deal with free standing walls of a generally found type. However, there are distinctive regional variations. All walling work should take into consideration the type, stone and style of other dry stone walls close by.

- The specifications relating to load bearing walls are far more complex. *Specifications for Simple Retaining Walls* are available from DSWA.

- Matters appertaining to ancient monuments are too variable to be dealt with in short note form and should be handled by discussion between a dry stone walling consultant and the relevant bodies. In all cases, the Association will endeavour to match the inquirer with the best available specialist.

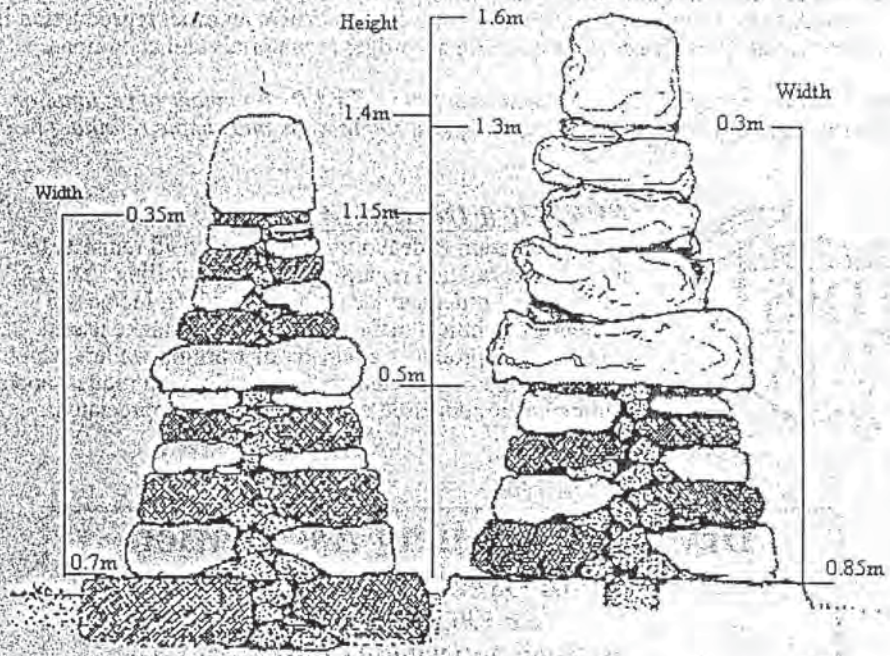
- Dry stone walling is as much an art as a science, and this can occasionally give rise to frustration and misunderstanding to those professionals not fully acquainted with it. Seemingly inconsequential considerations can quite substantially affect the ease of construction and hence, price. A site visit and discussion prior to estimating will almost invariably be necessary for the waller.

- The difference in standards between good and bad work are probably greater than in any other skill. This, combined with the need to recognise the inexperience of those professionals commissioning dry stone walling in judging the quality of the product makes it essential to obtain the services of a qualified waller and with prestigious work, this is particularly so. Again, the Association will help if asked. To emphasise the point: work should last 100-150 years when carried out by a skilled waller, yet failure in 5 or less is frequent.

GUIDELINES

- Quite apart from statutory requirement, it is good practice to match walls to those in the immediate area both in style and in materials used. There are distinctive local variations - often in relatively small areas.

- A standard, free standing wall usually stands 1.4m (4ft 6in) above ground level. Boundary walls (perimeter walls to farms, estates, etc) are more commonly 1.6m (5ft 3in).



Cross-sections of (left) standard "double" dry stone wall and (right) a March Galloway dyke. (Measurements are as a guide only)

- A wall may be more or less any height, *providing* this is reflected in the base width.

- A foundation course is required for all work not built on rock.

- When restoring walls after ground disturbance (e.g. pipeline works) care should be taken to backfill with subsoil or similar material avoiding organic matter, followed by mechanical compacting.