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SOIL SURVEY, LAND CAPABILITY AND FLORA ASSESSMENT

OAKLEIGH WEST PIT: ML 4698

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1. INTRODUCTION

SCM Brisbane Pty Limited operates the Oakleigh Coal Mine near the town of Rosewood (Figure 1). Oakleigh provides steaming coal to a variety of domestic coal users in south east Queensland and the northern district of New South Wales.

The area is in the West Moreton Region, an established grazing, farming and coal mining region and is wholly within the Ipswich City Council. The principal land use in the area is coal mining and beef production. The Walloon series coals have previously been exported by Oakleigh Colliery, and are currently being exported by Ebenezer Mining Company and New Hope Coal Australia. Currently Oakleigh does not have export contracts.

The company wishes to continue its mining operation and is seeking access to additional coal reserves. The proposed West Pit development is located on ML 4698, approximately 1.5 km to the north west of the town of Rosewood, in relatively flat to slightly hilly terrain. The area proposed for mining is bounded by Urry Road in the south and Rosewood/Marburg Road in the east (Figure 1). The lease area proposed for mining is approximately 84 hectares.

Ison Environmental Planners was commissioned to assist in environmental planning by undertaking a soil survey, sampling and analysis program, provide recommendations for soil handling and treatment, determine land capability, record existing flora species and to prepare a report on the results.

Sufficient information on the quality and quantity of the existing soil resource and its treatment is required to allow adequate rehabilitation planning and, prior to site earthworks, the economic recovery of suitable plant growth material for use in the revegetation program. It is essential to avoid the time delays and additional costs of establishing vegetation in soil subsequently found to be unsuitable for plant growth. Where suitable material is not used a high standard of vegetative cover and growth can't be achieved.

Of equal importance is to identify material that is deleterious to the establishment and growth of the selected plant species and which will require special treatment to be acceptable or may require burial to avoid adverse problems with plant growth.

This report details the results of the survey and analysis of the chemical characteristics of the sampled soil, comments on their suitability for plant growth and recommendations on stripping, stockpiling, and the amendments required to promote plant growth. The assessment also determines the existing land capability and flora species.

2. SOIL SURVEY METHOD

The soil survey was conducted to obtain information to characterize the soils, identify the properties of the various soil horizons, their influence on the establishment of plants and to identify recoverable quantities of topsoil.

Standard soil survey procedures were adopted using field observations of the distribution of vegetation communities and topography to determine the sampling pattern, the ground referencing of the soil landscape and to map the distribution of the soils across the different landforms. To assist the field survey work, air photographs, topographical plan and ground observations were used. Where appropriate, the sampling pattern was modified to address local changes in topography and vegetation. Soil variability depended mainly on the nature of the parent material and on topography.

Sites were inspected and sampled using a Jarret hand auger to a maximum depth of 900mm or to auger refusal by hard rock or gravel. Soils were described horizon by horizon in terms of depth, colour (and munsell notation), texture, rock/stone and the presence of mottling, accumulations and pedogenic segregations. Field assessment of soil properties was supplemented by laboratory determination of key chemical properties. Field surveys were conducted in August 1994. Soils were classified in terms of Principal Profile Forms (Northcote 1979) and Great Soil Group (Stace *et al* 1968) where applicable.

Field pH tests were undertaken to provide a guide to the acidity levels in the profile. Samples were collected for laboratory analysis to represent the main soil types, their variation across the site and the various layers. Soils were analysed for pH, electrical conductivity, chloride, exchangeable cations and cation exchange capacity. Results were incorporated into the discussion of soil properties for this report.

Soil variability was mainly the result of differences in parent material (geology), topography and disturbance.

3. CRITERIA FOR TOPSOIL

The suitability for retaining topsoil to be used in rehabilitation is influenced by a range of soil factors. The criteria that have been used to assess whether a particular horizon in a soil profile is suitable for topsoil is presented in Table 1.

Table 1 Criteria for topsoil suitability, Oakleigh Colliery Extension.

Criteria	**Undesirable Characteristics**
Depth	< 100 mm - minimum grader/bulldozer selection
Particle Size Analysis	High fine sand content; high silt content
Structure	Coarse blocky or columnar subsoil structure; tough, massive subsoil clay
Moisture Retention	Very low moisture holding capacity
Salinity	EC (1:5) > 1.0 mS/cm; presence of salt tolerant plants
Sodicity	ESP > 6
Acidity	pH < 4.5 or > 8.0
Soil Variability	High, short distance variability
Stone, rock	High stone or rock content (> 30 % for sands and loams; > 50 % for clays)

4. DESCRIPTION OF PRINCIPAL SOILS

Soil boundaries and sites of detailed profile examination are presented in Figure 2.

4.1 GREY OR BROWN DERMOSOL (SITES 1, 4, 5, 6)

This area is dominated by soils that have a uniform textured profile (Uf 6.31, Uf 6.32, Uf 6.33), vegetation which was predominantly softwood species and was positioned on the hillslopes of the site surveyed (Grey Dermosol or Brown Dermosol - new Australian classification).

These soils have a very dark grey to dark brown, fine sandy light clay to light clay surface texture, pH neutral to slightly acid, with depth ranging from 140 to 250 mm. Topsoil is suitable for stockpiling.

Soils grade gradually to a dark grey to strong brown, light medium to medium clay, strong to moderate medium angular blocky structure, directly overlying substrate (siltstone) from 450 to 700 mm. The pH is alkaline to strongly alkaline. Slopes range from 2 to 20%. Runoff is moderate to slow.

Much of this area has moderate slopes and reasonable soil depths. Land capability is Class III, being suitable for cultivation with moderate restrictions.

4.2 GREY VERTOSOL (SITES 2, 3)

This area is dominated by soils that have a uniform textured profile and a cracking surface (Ug 5.24). Grey clay is the dominant Great Soil Group or Grey Vertosol from the new Australian classification. These soils were located on the terrace area, adjacent to the drainage lines.

These soils have a very dark greyish brown, light medium to medium clay surface with angular blocky structure, pH neutral to slightly alkaline. Depth to 100 mm.

Soils grade gradually to a dark greyish brown medium clay, strong medium to coarse lenticular structure with occasional faint orange mottling. The pH is strongly alkaline at depth. Runoff from this area and permeability would be slow.

Depth of stripping from these soils is dependent on the chemistry of the B horizons. Analysis of a subsoil sample showed that the top of the B horizon was low in salinity, chloride and had reasonable sodium levels with an ESP of 6.3% but a calcium: magnesium ratio of 0.5. Stripping could be increased to include some of this material.

This area has moderate to gentle slopes and reasonable soil depths but is contained in smaller pockets. Land capability is Class III (being suitable for cultivation with moderate restrictions) although areas of Class II (being suitable for cultivation with slight restrictions) exist close to the road.

4.3 ALLUVIAL

This is the drainage line area, draining the surrounding hills. When the soils on the site were described, this area was extremely wet and as a result, were not described in detail, apart from the identification of a coarse sandy surface horizon. This is underlain by layers of alluvial material deposited by water movement.

Surface horizons would be suitable for stockpiling, however access to machinery may be a problem.

This area has gentle slopes and reasonable soil depths but is subject to flooding and waterlogging for extended periods. Land capability is Class VII (being not suitable for cultivation but pastoral use possible with careful management). The area provides grazing in dry periods.

5. SOIL CHEMICAL ANALYSIS

Field pH (hydrogen ion concentration) was evaluated during the soil survey. For each soil type, selected surface (A horizon) and subsoil (B horizon) samples were collected of representative profiles during the field work and submitted for chemical analysis for pH, electrical conductivity, chloride and the principal exchangeable cations (calcium, magnesium, sodium and potassium) as well as the principal plant nutrients. Samples were submitted to a registered laboratory for accurate analysis under controlled laboratory conditions, in accordance with NATA registered procedures.

The aim was to confirm field observations and measurements by determining the acidity/ alkalinity, the level of salinity and to evaluate the erosion potential from the level and proportion of the various cations present in the soils. The object was to enable identification of properties adverse to plant growth so that unsuitable material can be rejected or treated accordingly. The detailed laboratory results of selected sites (Figure 2) are presented in Appendix I with a summary of the key parameters presented as Table 2.

Table 2 Summary of results of the laboratory analysis of selected soil samples of the principal profiles at the Oakleigh Colliery Extension.

Soil Type	Site	Depth (mm)	Texture	pH (H_2O)	Salinity (mS/cm)	Cl (ppm)	CEC (meq%)	ESP (%)	Ca/Mg Ratio
Grey clay (area 2)	3	0- 100	light medium clay	6.5	0.11	35	37	1.7	1.7
		200- 300	medium clay	7.5	0.08	11	39	4.1	1.2
		500- 600	medium clay	7.4	0.36	288	44	9.4	0.9
Grey/brown clay (area 1)	4	0- 100	light clay	6.7	0.08	20	26	5.3	0.8
		200- 300	light medium clay	6.6	0.17	154	34	10.2	0.8
		500- 600	light medium clay	6.4	0.31	349	33	14.1	0.6
Grey/brown clay (area 1)	6	0- 100	light clay	6.6	0.07	21	21	1.4	3.7
		200- 300	light medium clay	7.3	0.10	18	31	5.1	1.6
		500- 600	light medium clay	7.8	0.14	33	32	8.9	1.1

5.1 pH

The pH of the surface soils varies from slightly acid (6.5) to neutral (6.7). The pH generally becomes increasingly acid although the difference is not marked. It should be noted that the pH was determined on a 1:5 soil: water extract.

The optimum pH for native plants varies with the species but a pH (water) of 6.0-7.5 is considered desirable for many species. The optimum pH for pasture grass is 6.5-7.5. With the use of fertilizers that tend to acidify the soil and leaching of basic cations by rain or irrigation, soil pH may be reduced further with time depending on buffering. The pH is considered acceptable and should have no potential direct detrimental effects on plant growth nor the more likely indirect effects by modifying the availability of some soil elements thereby creating an induced deficiency or toxicity for plant growth.

5.2 SALTS

The effect of high salts is to reduce the availability of water to the plant and may also affect the availability of some essential plant nutrients. Salinity is generally satisfactory. Salinity is low generally becoming moderate at depth and well within the tolerance levels of all but the most sensitive crops and is therefore unlikely to affect the growth of the plant species to be used on the site. Chloride levels are also low.

5.3 SUBSOIL CATIONS

A number of important soil physical parameters are affected by the proportion of the various cations in the soil. In particular, soil aeration, surface crusting, water infiltration, water holding capacity and bulk density are influenced by the quantity and relative proportions of the cations. Soil structure is adversely affected when sodicity or the proportion of sodium, as measured by the ESP (exchangeable sodium percentage) is high or the Ca/Mg (calcium/magnesium) ratio is low. It is important to note that salinity refers to the concentration of all soluble salts in the soil while sodicity refers to the amounts of sodium relative to the other cations.

All surface samples are non-sodic although they tend to increase with depth. ESP levels are likely to be the controlling factor in the suitability of the soils for use in rehabilitation, particularly given the high sodicity of much of the overburden. Use of sodic soils or overburden will result in a tendency for soils to lose aggregation and to develop impermeability, surface crusting and poor aeration through its influence on soil structure. However, the cracking characteristics of the clay soils allow water penetration despite their sodicity.

The moderately high ESP for the lighter textured soils is due to a higher proportion of sodium while the actual amount of sodium is low and reflects a loss of calcium and magnesium rather than a build-up of sodium. The impact of sodicity in these areas can be addressed by the provision of adequate soil amendment applied during topsoil stripping.

In addition the soils have a low to very low exchangeable Ca/Mg ratio especially with depth. This ratio has been used for an assessment of the physical performance of soils. Ca/Mg ratios of < 1, even if associated with low ESP, can cause clay dispersion. The calcium to magnesium ratio is only marginal in the surface layers and unsatisfactory at depth and potentially will adversely affect soil structure and hence plant growth. It is likely that the very high relative amounts of magnesium will contribute to dispersion although additional calcium will improve the ratio.

5.4 OTHER NUTRIENTS

The essential plant nutrient status of these soils are generally satisfactory, especially in the surface.

The levels of major plant nutrients are generally satisfactory although additional nitrogen and phosphorous are required. Additional calcium as gypsum would be useful to improve the calcium/ magnesium ratio as well as correct the low ESP.

Of the trace elements, levels are generally satisfactory and no response to applied nutrients is likely.

The level of nutrients will change between now and the end of mining especially during earthworks and the handling process and hence further detailed chemical analysis of plant nutrients will be required at this stage. Fertilizer requirements can be made immediately prior to planting taking into account current soil fertility levels, plant species to be used, time of the year and seasonal conditions.

6. TOPSOIL RECOVERY AND STORAGE

The topsoils available on site are generally satisfactory for use as a plant growth medium although they lack some essential plant nutrients.

The existing topsoil will have better biological properties compared to overburden material as it will contain soil microorganisms and plant propagules as well as being easier to work and form a reasonable seedbed. It is strongly recommended that all of the nominated topsoil materials (mainly the A horizon) should be stripped and recovered prior to the commencement of site earthworks or disturbance and stockpiled separately for use in the rehabilitation program particularly to ensure the rapid revegetation of critical areas. Care must be exercised over all areas to be disturbed where a soil resource exists to optimize the volume and quality of topsoil recovered and hence to minimize the shortfall of topsoil.

The soil profiles are variable but generally contain a surface layer of quality topsoil overlying less desirable subsoil material. The B horizon material has poorer chemical properties that will affect its physical properties and should be stripped separately and used as replacement subsoil.

Details of the soil profile will vary over short distances and it is not practical to survey to the detail required to identify these minor changes. It is imperative that the removal and separate stockpiling of soils should be carefully monitored and closely supervised on site during the earthworks by a competent technician to accurately determine recovery depths and to identify suitable soils. This technician must have adequate powers or authority to direct and control the recovery, handling and management of site soils.

Soil as a medium for plant growth is a dynamic resource and not a mechanical object that can be roughly handled without loss of its important properties. Care is required in stripping, stockpiling and rehandling of the soil to protect its structure. Soil material on site will be subjected to transport and manipulation by heavy machinery with the potential for compaction and the subsequent loss of structure. In compacted soils water and air movement is reduced and root penetration restricted, resulting in reduced plant establishment and growth. This will result in reduced water infiltration, poor grass and tree growth and hence increased risk of erosion.

Soil handling and preparation should therefore aim to manipulate the soil to protect its structure and optimize its suitability as a plant growth medium. Compaction and loss of structure should be avoided by minimizing heavy traffic with high ground pressure. Only vehicles with low ground pressure should be allowed to traffic the soil. Soil should not be handled when excessively wet or dry. In practical terms it may be difficult to limit handling soils to the correct moisture status.

Vegetation should be slashed and recovered with the soil as a source of organic matter unless the existing plant species are a potential weed problem.

To improve the cation balance, the following soil amendment at the rate nominated below should be incorporated into the topsoil during pre-stripping operations. This should be done by broadcasting the required amendment over the soil surface following slashing of the vegetation but prior to soil recovery so that the material can become incorporated during soil handling.

Gypsum ($CaSO_4$) 5 t/ha *

* The actual rate used will need to be adjusted depending on the depth of topsoil at that location.

The aim is to provide a soluble calcium supply to improve soil structure as well as increasing plant available calcium.

Detailed chemical analysis of essential plant nutrients was undertaken on 3 profiles and while natural fertility is satisfactory, correct fertilizer additions will enable a higher level of soil fertility to promote revegetation to be achieved. It will be necessary to sample and test the soil once the areas are prepared but prior to the establishment of the plants. Fertilizer requirements can then be established taking into account current soil fertility levels, plant species to be used, time of the year and seasonal conditions.

Soil should be recovered to the required depths using a grader to form windrows. Loaders/excavators should then be used to load trucks that will transport the soil to the required location. Where feasible, topsoil should be placed directly onto the reshaped landform rather than being stored in heaps.

Where it is necessary to create stockpiles, the soil will require careful management to protect its agronomic qualities and where feasible to optimize its value as a plant growth medium. The soil should be block dumped and the stockpiles should be constructed to a maximum height of 2 m with suitable side slopes to enable access by agricultural machinery. Placing soils in stockpiles greater than 2 m results in significant deterioration of soil quality due to compaction and subsequent loss of soil structure. There is a loss of the soil biota due to a change in aerobic and moisture status and a change in soil chemistry.

The surface of the soil dumps should be fertilized and seeded to a suitable cover crop to suppress undesirable weeds, to increase soil organic matter levels and to promote soil structure and maintain soil microfauna and microbial activity.

It is important to note that the soil resource is limited and even the material identified as topsoil has limitations. Structure can be encouraged by the use of organic matter and soil amendments such as gypsum. Organic mulch could be prepared from on-site materials. Any vegetation could be put through an industrial mulcher to form woodchips and debris, and then incorporated into the surface of the topsoil.

Where soil is placed in layers it is important that each layer is keyed into the layer below. Layering of soils can act as a barrier to the penetration of roots even if the subsoil is suitable for plant growth. Layering on slopes especially with soils with a high clay content can result in geotechnical instability and the resulting slumping of the soil down the slope. Deep ripping or tyning should be judiciously used to provide a suitable base on which to apply subsequent layers.

7. FLORA

The majority of ML 4698 has been cleared and grazed for many years. The only two areas of tree cover on the site are situated to the north of the railway line where surface disturbance is not proposed. The remainder of the site has only occasional small trees or shrubs scattered across grazing paddocks. Most of these are Sally wattle *Acacia salicina* and Black teatree *Melaleuca bracteata* growing along the drainage lines. The grasses are predominantly exotic species, with Blue couch, Rhodes grass and Green panic being the most common. There are also a number of weeds present that are typical of overgrazed pastures.

The forested patch in the north east of the lease is a plantation plot of Hoop pine. In the west of the site and north of the railway line there is a small remnant patch of semi-evergreen vine thicket covering approximately 1 ha. The canopy is broken and exotic weeds are present. A plant species list for this forest remnant is provided in Appendix 2. Less than 10% of the original extent of this vegetation type remains and it is listed by the Department of Environment and Heritage as an endangered ecosystem.

No mining is planned in this section of the lease. The remnant forest can be retained and provide seed for rehabilitation of the surrounding area.

None of the plants observed there are listed as rare or threatened. The rare species *Callitris baileyi* is found on some of the nearby slopes with the same aspect and may have been present originally on this site. It has been used in rehabilitation in the Oakleigh mine further east and could be used on this site as well.

8. REFERENCES

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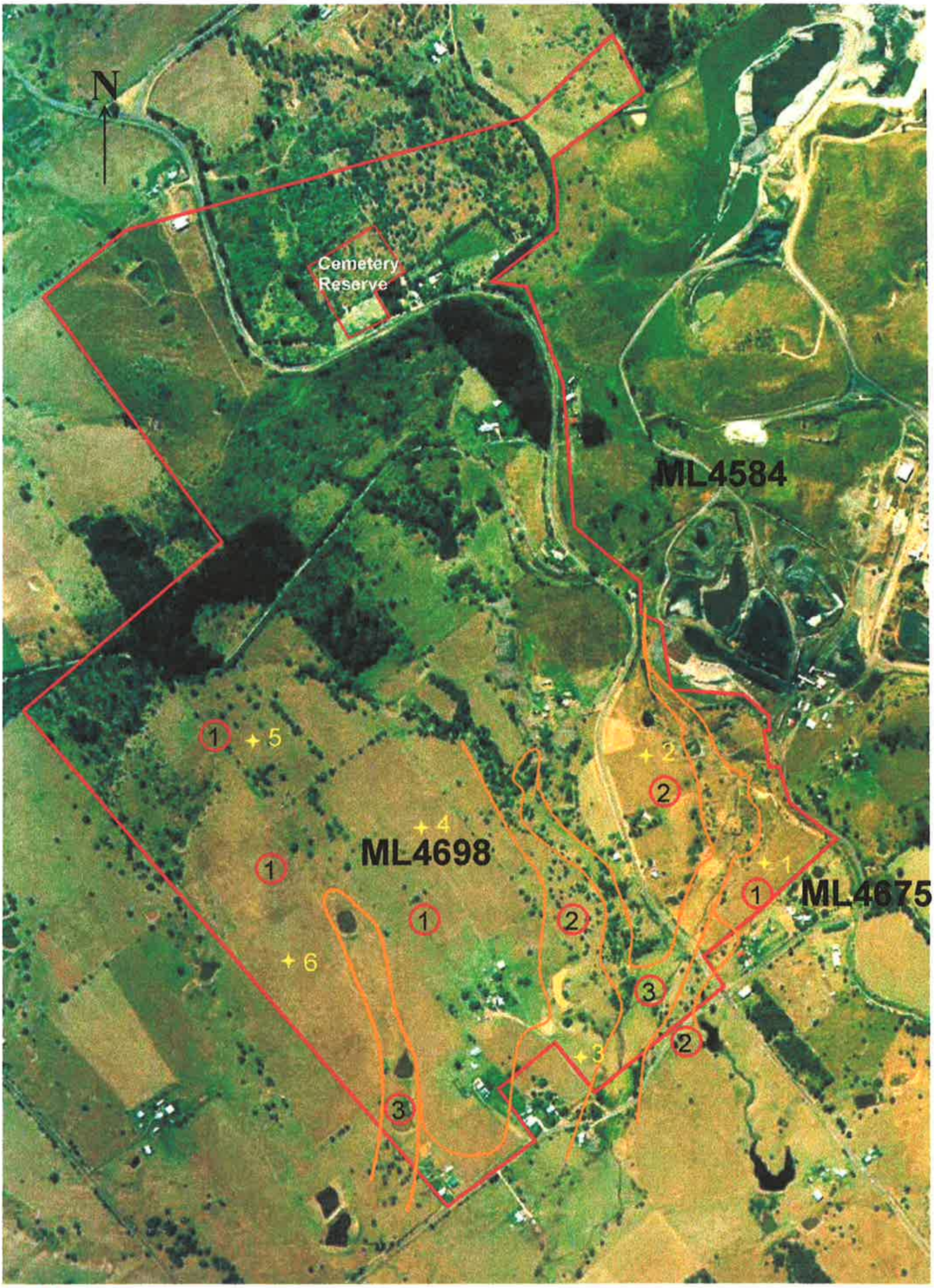
ML 4698 Location

Figure 1



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Soil type boundaries
3 Soil sample sites
3 Soil type

Soil Survey

Figure 2

APPENDIX 1

Detailed results of soil analysis

SOIL SURVEY, LAND CAPABILITY AND FLORA ASSESSMENT

OAKLEIGH WEST PIT: ML 4698

LABORATORY DATA: Oakleigh Extension

	Depth	pH(1:5)	EC(1:5)	Cl	P	S	Exchangeable Cations (meq/100g)				CEC	ESP	Ca/Mg	Cu	Zn	Mn	B	Fe
	(mm)		(mS/cm)	(mg/kg)	(mg/kg)	(mg/kg)	K	Ca	Mg	Na	(meq/100g)	%	ratio	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
3	0-100	6.5	0.11	35	30	20	1.60	22.0	13.0	0.6	37	1.7	1.7	4.40	5.70	38.00	0.72	153.0
	200-300	7.5	0.08	11	4	14	0.58	20.0	17.0	1.6	39	4.1	1.2	3.50	0.29	8.80	0.73	54.0
	500-600	7.4	0.36	288	2	37	0.54	18.0	21.0	4.1	44	9.4	0.9	4.70	0.25	2.00	0.70	81.0
4	0-100	6.7	0.08	20	7	19	1.00	11.0	13.0	1.4	26	5.3	0.8	2.70	3.20	57.00	0.61	92.0
	200-300	6.6	0.17	154	2	22	0.68	13.0	17.0	3.5	34	10.2	0.8	3.40	0.87	9.30	0.45	136.0
	500-600	6.4	0.31	349	19	15	0.66	11.0	17.0	4.7	33	14.1	0.6	3.40	1.70	11.00	0.35	161.0
6	0-100	6.6	0.07	21	11	11	0.75	16.0	4.3	0.3	21	1.4	3.7	2.60	6.00	65.00	0.75	53.0
	200-300	7.3	0.10	18	2	13	0.48	18.0	11.0	1.6	31	5.1	1.6	2.30	0.35	1.80	0.20	53.0
	500-600	7.8	0.14	33	1	11	0.51	15.0	14.0	2.9	32	8.9	1.1	2.70	0.34	4.50	-BG-	40.0

APPENDIX 2

Plants recorded during the Study

SOIL SURVEY, LAND CAPABILITY AND FLORA ASSESSMENT

OAKLEIGH WEST PIT: ML 4698

Growth Forms

E	Epiphyte
F	Fern
G	Grass
H	Herb
S	Shrub
T	Tree
V	Vine

Family	Species	Common Name	GF
Adiantaceae	*Adiantum hispidulum*	Rough maidenhair	F
Apocynaceae	*Alstonia constricta*	Bitterbark	T
Apocynaceae	*Alyxia ruscifolia*	Chainfruit	S
Araucariaceae	*Araucaria cunninghamii*	Hoop pine	T
Bignoniaceae	*Pandorea pandorana*		V
Caesalpiniaceae	*Cassia tomentella*	Velvet cassia	S
Capparaceae	*Capparis sarmentosa*		V
Celastraceae	*Cassine australis*	Red olive plum	T
Celastraceae	*Maytenus bilocularis*	Orange bark	S
Celastraceae	*Siphonodon australis*	Ivorywood	T
Ebenaceae	*Diospyros gemminata*	Scaly ebony	T
Euphorbiaceae	*Acalypha nemorum*		S
Euphorbiaceae	*Alchornea ilicifolia*	Native holly	T
Euphorbiaceae	*Breynia oblongifolia*	Coffee bush	S
Euphorbiaceae	*Bridelia exaltata*	Scrub ironbark	T
Euphorbiaceae	*Carissa ovata*		S
Euphorbiaceae	*Croton insularis*	Silver croton	S
Euphorbiaceae	*Excoecaria dallachyana*	Scrub poison tree	T
Euphorbiaceae	*Malaisia scandens*	Burney vine	V
Euphorbiaceae	*Mallotus claoxyloides*	Green kamala	T
Euphorbiaceae	*Mallotus philippensis*	Red kamala	T
Fabaceae	*Austrosteenisia blackii*		V
Fabaceae	*Derris involuta*		V
Flindersaceae	*Flindersia australis*	Crows ash	t
Flindersiaceae	*Flindersia collina*	Leopard ash	T
Meliaceae	*Melia azedarach*	White cedar	T
Meliaceae	*Owenia venosa*	Crows apple	T
Meliaceae	*Turraea brownii*	Turraea	S
Mimosaceae	*Acacia fasciculifera*	Rosewood	T
Mimosaceae	*Acacia harpophylla*	Brigalow	T
Moraceae	*Ficus macrophylla*	Moreton Bay fig	T
Moraceae	*Ficus obliqua*	Small-leaved fig	T
Moraceae	*Ficus opposita*	Sandpaper fig	S
Moraceae	*Maclura cochinchinensis*	Cockspur thorn	V
Moraceae	*Streblus brunonianus*	Whalebone tree	T
Myrsinaceae	*Rapanea variabilis*	Muttonwood	S