Initial Soil Suitability Assessment

Of

Farms - 25 Additional
- 26 Additional
- 108 Additional

Approximately 359 ha

Initial Soil Suitability Assessment For Ethanol Plant & Dairy Development

April 2006

By

Roger Wrigley & Cliff Dillon

Table of Contents

1. INTRODUCTION

A combination of three farming properties (Farms 25 Additional, 26 Additional and 108 Additional) covering approximately 359 ha (886 acres), located approximately 12km north of Coleambally in New South Wales, is being considered for the development of a dairy feedlot and an ethanol plant. These properties are referred to herein as 'the site'. A copy of the Stannard (1970) Soil Map is provided in Appendix C and this delineates the relative locations of these farms.

This site investigation report derives from a scoping soil assessment to determine initial soil suitability for the proposed development with the intention that more detailed soil assessments for each enterprise will be undertaken prior to planning and design. The aims of this assessment are to determine what parts of the site are most suitable for the range of land uses associated with the proposed developments and to determine if there are any obvious soil related constraints for discrete land uses.

This report constitutes an initial study of the soils component of an EA (Environmental Assessment). The soil field assessments were undertaken on the 21st of December 2005 and on 16th March 2006; fine weather governing the former and slightly inclement weather the latter.

2. BACKGROUND

2.1 Setting

The site is located in an agricultural region on the Riverine Plain of New South Wales dominated by irrigated annual winter and summer cropping, irrigated rice production, some irrigated grazing and some dryland grazing and cropping. A Site Plan and aerial photograph are provided in Appendix A. On the eastern boundary the site has frontage to the Kidman Way (a main north south government road) and the northern section of this boundary abuts a water authority irrigation channel. To the south the site is bounded by an intermittent creek (Spillers Creek) and a water authority drain (DC 400). The northern boundary abuts a water authority main irrigation channel and further north beyond this are two government roads; Kook Road and Ercildoune Road. Irrigated agricultural properties adjoin the western boundary of the site. Access is gained off the Kidman Way in the southeast and northeast of the site. The site has access to irrigation water from the adjacent water authority irrigation channels through several large meter outlets (dethridge wheels) located in the northeast and central east of the site.

2.2 Layout & Land Use

While not all of the site is commanded and suitable for flood irrigation, approximately three quarters of the site have been irrigated at times in the past and these areas are still irrigable. A small proportion of the irrigation area on the site is set up for border check flood irrigation while much of the land is irrigated by contour banks. Earthen farm irrigation channels convey water across the site. Approximately 12% of the site is available for dryland cropping. It is assumed that all of these irrigation and cropping areas have been cultivated and cropped in the past. While a limited area is utilised for channels, drains and laneways etc., the remaining areas consist of remnant vegetation. While some of the remnant vegetation is located in the riparian zone along the creek in the south of the site, the majority is located on a sandy rise in the centre of the site. Along the creek the trees are predominantly Black Box (*Eucalyptus largiflorens*), on the sand hill they are predominantly White Cypress-pine (*Callitris glaucophylla)* and several small areas of Weeping Myall (*Acacia pendula*) also exist. Soil types are not readily mapped by remnant vegetation as little remains. There is little likelihood of soil contamination as no evidence exists of dwellings, stock yards, dumping grounds or prior horticultural practices. Some of the features are delineated on the Site Plan provided in Appendix A and further features can be distinguished on the aerial photograph also provided in Appendix A.

3. METHODOLOGY

3.1 Aim

The aims of this scoping soil assessment are to document the soils, map soil distribution and to provide land use recommendations and/or constraints for the various soil types, based mainly on soil physical attributes.

3.2 Soil Physical Assessment

The soil physical characteristics were assessed in a total of 21 soil profile inspection pits excavated to depths of approximately 3.0 metres. The location of these pits is delineated on the Site Plan in Appendix A.

At each soil inspection site a range of soil physical features were studied including the depth of each soil horizon (layer), soil texture, colour, structure, mechanical resistance to roots (hardness), porosity, infiltration status, drainage status, soil compaction, depth to and amount of lime (natural occurring calcium carbonate - $CaCO_3$) or gypsum (calcium sulphate - $CaSO_4$) and the presence of any layers that may restrict water penetration (e.g. heavy clay) or may be conducive to relatively free groundwater movement (e.g. shoestring sands).

3.3 Soil Classification, Description & Mapping

To provide for practical and effective interpretation, soils at each inspection site were segregated into broad soil types and these soil types form the basis for the Soil Plan in Appendix B. Detailed descriptions of a typical soil profile for each soil type are provided in the report, along with an assessment of the suitability of the soils for a range of pertinent land uses.

The Soil Plan provided in Appendix B details the approximate location of each of the soil types and it must be noted that the location of the soil type boundaries are an estimate only as these are based on extrapolations from the soil pits, surface features, the Stannard (1970) Soil Map provided in Appendix C and soil mapping experience in similar landscapes. In addition, soil class boundaries are often diffuse and typically occur gradually over an extended distance rather than at exact points.

3.4 Desktop Information

Coleambally Irrigation Co-operative Limited have compiled and provided a desktop study of information relating to the site. This information includes;

- A soil map - presumably sourced from Stannard (1970) & provided as Appendix C.
- EM 31 surveys of the site (with the exception of the central sand hill).
- EM31 survey ground truthing soil drilling data.
- Borehole texture logs on and in the vicinity of the site.
- Groundwater monitoring data on and in the vicinity of the site.

3.5 Soil Chemical & Geotechnical Assessment

No soil chemistry analysis or soil geophysical assessments have been undertaken at this stage.

3.6 Initial Site Development

As a basis for the planning and siting of the infrastructure that will required for the proposed developments, Booth Associates (Griffith) have provided an Initial Site Development Plan and this is provided as Appendix D.

4. GEOLOGY & SOIL FORMATION

4.1 Geology

The site is located in a region that is part of the Riverine Plain of the Murray-Darling Basin which is a flat depositional plain extending north and west from the highlands. The Plain is traversed by several rivers (e.g. Murray, Murrumbidgee etc.) that have cut themselves into shallow valleys over the last 10,000 years. The sediments deposited by these and by ancestral rivers gradually increase in depth with increasing distance from the surrounding uplands from which they are derived. The sediments in this district range from 150 to 250 metres deep above bedrock and are Tertiary and Quaternary non marine alluvial, fluvial and lacustrine sediments consisting of gravels, sands, silts and clays (Butler et al. 1973).

The main formations within the sediments are the deepest Olney Formation from which some beneficial water yields are extracted from deeper bores in the district. Above this is the Calivil Formation which can have significant beneficial yields of good quality water in this and in other districts. The uppermost deposits consist of the Shepparton Formation which are about 80 metres thick. The sediments of the Shepparton Formation chiefly result from prior stream and drainage depressions deposition but are also influenced by parna (a high clay content, calcareous aeolian material deposited over the riverine sediments) and by localised aeolian sand hill formation.

4.2 Soil Formation

The prior stream alluvial deposition of the Shepparton Formation sorted and deposited gravel, sands, silts and clays across the Riverine Plain. In addition, the aeolian parna described above, was deposited over these sediments. Further soil formation occurred through localised aeolian sand hill formation and alluvial floodplain and swamp deposition. Climatic effects then sorted the upper layers of these deposits - mainly by flooding, aeolian activity and the effects of leaching, the latter which washed lime and clay down through the profile. These complex soil formation processes have typically resulted in the upper (0-1.0m depth) soil layers consisting of lighter textured soils on sand hills and on prior stream levees, mid textured duplex soils on the flood plains and higher clay content self mulching clays in lower lying creeks, swamps and depressions. As a further result of these complex soil formation processes, the deeper soil layers (1.0 to 30.0m depth) can exhibit significant texture variation in both the vertical and horizontal planes.

5. SOIL CLASSIFICATION

The soils of the Coleambally district have been surveyed and described in detail, particularly for irrigation development, by Stannard (1970). Broad Soil Types (more akin to soil associations) have been defined and include;

- Sands
- Red-brown Earths
- Transitional Red-brown Earths
- Non Self Mulching Clays.
- Self Mulching Clays.

These catenas are consistent with other Riverine Plain toposequences.

6. SOIL TYPES & DISTRIBUTION

On this site four of the previously mentioned five Soil Types were identified and these are listed in Table 1. On this site the Transitional Red-brown Earths are a transition between the Red-brown Earths and the Self Mulching Clays. For the purpose of this investigation to help clearly identify each soil type, the name of the Transitional Red-brown Earths has been changed to Grey Transitional Soils and the Self Mulching Clays have been designated Black Self Mulching Clays. A Soil Plan, provided in Appendix B, details the approximate location of each of the Soil Types. This Soil Plan is approximate only as the Soil Type boundaries are based on extrapolations from the soil pits, surface features, the Stannard (1970) soil map and soil mapping experience in similar landscapes. In addition, EM drilling data and bore log texture data provided by Coleambally Irrigation has also been utilised. From this information the approximate extent of each Soil Type has been estimated and is provided in Table 1.

Table 1; The Soil Types and approximate distribution on the site based.

Soil Type	Approximate Coverage
Sands	12 %
Red-brown Earths	57 %
Grey Transitional Soils	25 %
Black Self Mulching Clays	6 %

While a range of soil variations can occur within these Soil Types, and these Soil Types can vary across the region, detailed descriptions of the soil profiles identified for the Soil Types on this particular site are provided hereunder, along with comments on their distribution. The soils evince considerable variation ranging from sands, to duplex soils to vertisols and typically contain natural lime and gypsum in the soil profile with the depth of these dictated by leaching and the solubility of the lime and gypsum.

7. SOIL DESCRIPTIONS

7.1 Sands

The Sands are located on a rise in the centre of the site and a thin strip is thought to extend to the western boundary. The Sands on this site typically consist of a thin (10cm) layer of red-grey-brown sandy loam - the grey coloring influenced by organic matter - and this is underlain by the remaining red-brown sandy loam topsoil to a depth of 100cm. This topsoil is underlain by a friable and permeable subsoil that is light sandy clay loam to sandy loam in texture and contains variable amounts of powdery and concretionary natural lime (calcium carbonate ($CaCO_3$) ranging from nil to 20% of the soil layer. Considerable red, orange, yellow and brown mottling also exists in these subsoil layers which extend to 320cm+ below natural surface. All of the profile to this depth is very permeable and has a relatively low water holding capacity.

Table 2; Typical Sand soil profile on the site.

Horizon	Depth (cm)	Description of Soil Layers
A1	0 - 10	Red-grey-brown very friable sandy loam with a weak loose or coherent structure
A2	10 - 100	Red-brown very friable sandy loam with a weak coherent structure
B1	100 - 200	Bright orange-red-brown light sandy clay loam with a slightly SAB (sub-angular blocky) but mainly coherent structure with traces to 20% powdery and concretionary $CaCO_3$ and 10-50% red, orange, yellow and brown mottling
B2	200 - 320+	Yellow-brown friable sandy loam with a weak coherent to massive structure with traces to 10% powdery and concretionary $CaCO_3$ and 30-70% red, orange, yellow and brown mottling

7.2 Red-brown Earths

The Red-brown Earths are distributed across the majority of the site and have a sandier topsoil texture in the vicinity of the Sand Soil Type and a clayier topsoil texture in the north of the site in the vicinity of the Grey Transitional Soils. The Red-brown Earths on this site typically consist of 12cm of brown to grey-brown topsoil which is typically a loam but can be a sandy clay loam or a clay loam. This topsoil is typically moderately structured and the soil is friable however, it can set hard where low organic matter and high proportions of sand or clay occur. The topsoil is underlain by a well structured, dull red-brown, medium clay subsoil. This grades into a medium clay with from 1-5% natural lime which is in turn underlain by a layer with from 1-10% natural lime and gypsum ($CaSO_4$) deposits. In most but not all cases a lighter textured layer is present within the soil profile, ranging from a sand to a sandy light clay. This layer was found at depths between 120 and 300 cm below the surface and ranged in thickness from 50 to >140cm. This lighter textured layer was often underlain by a well structured light to medium clay. The permeability in the topsoil and the lighter textured sandy layers at depth was generally good, in the first subsoil layer permeability was moderate to low and in the remaining clay layers permeability was generally low.

Table 3; Typical Red-brown Earth soil profile on the site.

Horizon	Depth (cm)	Description of Soil Layers
A1	0 - 12	Brown to grey-brown mostly friable loam (occasionally sandy loam or clay loam) with a weak SAB to coherent structure (very occasionally with rusty staining in root channels)
B1	12 - 40	Dull red-brown semi friable/semi plastic medium clay with a moderate to strong SAB structure
B2	40 - 100	Orange-red-brown mostly plastic medium clay with a moderate SAB structure, slickensides and 1-5% $CaCO_3$
B3	100 - 170	Grey-brown semi friable/semi plastic medium clay with a moderate SAB structure, slickensides, 5-10% $CaCO_3$ and $CaSO_4$ and 50% mottling
B4	170 - 220	Grey mostly friable light to medium clay with a moderate to strong fine SAB structure, trace of $CaCO_3$ and 80% mottling
B5	220 - 280	This layer not always present Yellow-brown to yellow-grey-brown friable sandy clay loam to sand with a weak to moderate SAB to coherent structure, occasionally a trace of $CaCO_3$, and 60% mottling
B6	280-320+	Grey friable light to medium clay with a moderate to strong fine SAB structure and 90% mottling

7.3 Grey Transitional Soils

The Grey Transitional Soils were identified across the north and northwest of the site and also in several other small areas on the site. The topsoil of the Grey Transitional Soils on this site appears slightly gilgaied and typically consists of 10-20 cm of grey, friable, light clay or occasionally clay loam that has variable but typically significant self-mulching and cracking characteristics. The cracking typically extends into the first subsoil layer which is typically a grey or dark grey, tough, dense, plastic heavy clay sometimes with traces of powdery and nodulated natural lime deposits. This is in turn underlain by a light grey, orange-grey or yellow-grey, slightly friable medium clay with up to 5% powdery and nodulated natural lime deposits. The subsoil layers beneath this are typically similar colors but are more friable and contain considerable mottling and traces of natural gypsum also occur in conjunction with the natural lime. As with the Red-brown Earths, lighter textured layers can occur within the soil profile however, these layers to not appear to be as prevalent in the Grey Transitional Soils. The permeability in the topsoil and in any lighter textured sandy layers at depth was generally good, permeability in the first two subsoil layers is poor and in the medium clay layers at depth, permeability is generally moderate.

Table 4; Typical Grey Transitional Soil profile on the site.

Horizon	Depth (cm)	Description of Soil Layers
A1	0 - 15	Light grey friable clay loam to light clay with a moderate SAB structure with self-mulching, cracking & gilgai characteristics
B1	15 - 60	Dark grey, tough, dense, plastic heavy clay with a moderate to strong SAB to columnar structure and occasionally traces (<1%) of powdery and nodulated $CaCO_3$
B2	60 - 120	Light grey, orange-grey or yellow-grey, slightly friable but mostly tough, dense, plastic medium clay with a moderate to strong SAB structure, slickensides and traces (<5%) of gypsum and powdery and nodulated $CaCO_3$
B3	120 - 200	Orange-grey- brown, mostly friable medium or light to medium clay with a moderate SAB structure, up to 5% gypsum and powdery and nodulated $CaCO_3$ and considerable (50%) mottling
B4	200 - 300+	Grey, friable medium or light to medium clay with a moderate SAB structure, traces (<1%) gypsum and $CaCO_3$ and significant (80%) mottling

7.4 Black Self Mulching Clays

The Black Self-mulching Clays occur in a limited area of the site on lower elevations adjacent to the creek along the southern boundary. The Black Self-mulching Clays on this site have a pronounced gilgai micro-relief and typically consist of 25cm of relatively friable, dark grey, medium clay surface soil. This surface soils evinces significant self-mulching characteristics - self-mulching is a characteristic found in certain soils, and typically in high clay content soils, whereby the surface soil is highly structured and either breaks up very easily into natural soil pieces or the soil naturally falls apart as the soil dries to form a loose surface layer. The surface soil and the first subsoil layer have shrink-swell potential and hence significant cracking that extends from as deep as 100cm depth to the surface.

The surface soil is underlain by a tough, dense, plastic, strongly structured, dark grey heavy clay with traces of small natural lime nodules. This is in turn underlain by a light yellow-grey, mostly plastic medium clay with up to 5% powdery and nodulated natural lime deposits. While it is suspected that the deeper subsoil layers below this vary, in the profile examined, the next subsoil layer consisted of a yellow-grey, well structured, friable silty light clay and this was underlain by a grey, well structured, friable light to medium clay. Considerable mottling occurs in these deeper subsoil layers.

Table 5; Typical Black Self-mulching Clay soil profile on the site.

Horizon	Depth (cm)	Description of Soil Layers
A1	0 - 25	Dark grey friable medium clay with a moderate to strong SAB structure (occasionally with rusty staining in root channels). Significant self-mulching and cracking with a gilgai micro-relief.
B1	25 100	Dark grey tough, dense, plastic, heavy clay with a moderate to strong SAB to columnar structure, slickensides and traces (<1%) of $CaCO_3$ nodules (0-2mm in diameter).
B2	100 - 160	Light yellow-grey, mostly plastic medium clay with a moderate SAB structure, slickensides, 1-5% $CaCO_3$ powder and nodules (0-2mm in diameter) and 20% mottling.
B3	160 - 200	Yellow-grey, friable silty light clay with a moderate SAB structure, traces (<1%) of $CaCO_3$ powder and nodules (0-2mm in diameter) and 50% mottling.
B4	200 - 340	Grey friable light to medium clay with a moderate to strong fine SAB structure and 70% mottling.

8. COARSE SUBTERRANEAN LAYERS

As mentioned earlier, because of the geology and complex soil formation processes, the deeper soil layers (1.0 to 30.0m depth) can exhibit significant texture variation both vertically and horizontally, regardless of Soil Type. These coarse subterranean layers can be confined between relatively impermeable clay layers and are often interlinked across the landscape and can also be interlinked vertically down the soil profile. These coarse subterranean layers are likely to provide preferential pathways for groundwater movement.

This Soil Assessment - With the exception of pits 1, 9, 10, 15, 17, 18, 19, 20 and 21 various coarse (sandy) soil layers were identified in the remaining soil profile inspection pits excavated to depths of approximately 3.0m as part of this scoping soil assessment. As would be expected, in the Sand Soil Type sandy layers extended to the full depth. In the remaining Soil Types the coarse layers typically ranged from sand to fine sand veins in light to medium clay and occurred at depths of 2.0 to 3.0 metres however, in pits 7, 8 and 16 sandy clay loam and sandy light clay occurred as shallow as 1.6, 1.2 and 1.3m respectively.

EM 31 Survey Drilling - As part of the EM survey undertaken across the site (with the exception of the sand hill in the centre of the site), drilling was undertaken to assess soil textures down the soil profile. Approximately 69 sites were drilled across the site to a depth of 3.6m. The drilling logs from these sites also indicate the presence of various coarse soil layers. Again, as would be expected, at the margins of the Sand Soil Type, sandy layers occur as shallow as 0.9m. In the remaining Soil Types the coarse layers typically ranged from sand to fine sandy clay and occurred at depths of 2.0 to 3.6 metres with the occasional layer at a depth of 1.5m. 19 of the sites did not indicate the presence of coarse material to a depth of 3.6m and these appear to be located randomly across the site.

Borehole Texture Logs - As part of separate work, presumably to identify sites for groundwater monitoring or extraction, borehole texture logs from bore holes on and adjacent to the site have been provided by Coleambally Irrigation.

Nineteen bores to depths ranging from 3.0 to 30.0 metres were located in a transect traversing the site from north to south. This transect is in line with groundwater monitoring bores 1775 and 1701 depicted on the Soil Plan in Appendix B. A further thirty bores to similar depths were located around the periphery of the site. With the exception of the bores in the Sand Soil Type, sandy layers were identified at depths of 1.8 to 6.3m and extended in depth up to 13.0m.

9. HYDROGEOLOGY

A full hydrogeological assessment of the site will be required prior to development however, at this preliminary stage some observations relating to hydrogeology and hydrology can be made, especially as soils and hydrogeology are often closely linked.

Watertables - While the results of this site investigation represent a snapshot only, no water tables were encountered in any of the soil profile inspection pits. However, it must be noted that the site is likely to have been in receipt of minimal irrigation over recent seasons and watertables would be depressed as a result of the previous 8 - 10 years of drier than average climatic conditions.

Shallow Groundwater - As mentioned in the previous section, while this regions Shepparton Formation deposits are dominated by silts and clays layers, lenses and pockets of coarse material typically occur throughout the deeper subsoils and these shoestring sands often offer preferential pathways for the flow and/or accumulation of groundwater. While the depth, amount and quality and groundwater can vary considerably, shallow groundwater quality in the Shepparton Formation is generally very poor precluding its employment for beneficial purposes.

Groundwater Levels - General regional groundwater contour mapping provided by Coleambally Irrigation indicates that in the vicinity of the site, groundwater levels in the Upper Shepparton Formation are in the range of 4 to 10 metres below natural surface. Two groundwater monitoring bores (numbers 1701 and 1775) are located on the site and a further six groundwater monitoring bores (numbers 208, 806, 1596, 1780, 12166 and 12171) are located around the site periphery and the locations of these are detailed on the Site Plan provided in Appendix A. While regular monitoring of these bores has been undertaken since approximately 1970, levels since 1990 indicate that generally the depth to groundwater has been between 5.0 and 9.0 metres below natural surface and is currently 7.0 to 15.0 metres below natural surface.

Deep Lead Groundwater - Deep lead groundwater is extracted from aquifers of the Olney and Calivil Formations in this and surrounding regions. The Calivil Formation provides considerable beneficial use of groundwater over a large area and consists of variable levels of strata that yield varying quantities and quality of groundwater.

Surface Water - The dominant surface water feature on the site is the adjacent Spillers Creek and the associated water authority drain (DC 400) located along the southern boundary. The regularity of flows in the creek are unknown however, by observation flows are thought to be very ephemeral and even an annual flow appears unlikely. Due to the proximity and topographically lower status of the creek and drain, it is envisaged that extraction and drainage inflows in the district are likely to readily affect the creek and its associated riparian zones. It is therefore recommended that a buffer of 100 metres be maintained between the creek and/or its associated vegetation and any land uses that have the potential for adverse environmental impacts such as effluent storage, manure stockpiling or stock housing or handling.

While topographical levels for the site were not available, it appears that the southern half of the site slopes south towards Spillers Creek and the northern half slopes to the centre of Farm 108 Additional and surface drainage could then be precluded.

10. SOIL FEATURES & LIMITATIONS

10.1 Sands

The biggest limitation to land use for the Sand Soil Type is the fact that the majority of this soil type supports significant scattered remnant vegetation and any site development will need to preserve this. Because of the stable well drained nature of this soil type, it would readily provide sites for the construction of buildings or infrastructure. However, the highly permeable nature of the soil limits its use to practices that are not likely to contribute to leaching losses and groundwater impacts. In instances where vegetation is removed, the Sand Soil Type is liable to erosion, mainly from wind and rabbits favour this soil type for their warrens.

10.2 Red-brown Earths

From a siting and construction perspective, the Red-brown Earths offer varying potential depending on a range of factors. One such factor is surface drainage as areas with poor surface drainage could become excessively wet and may therefore not be suitable for some land uses. It is envisaged that in some cases land forming or grading could overcome this however, a limited depth of topsoil limits the prospects of excessive soil movement without top-soiling.

Exposure of the clay subsoil is not recommended as the initial B1 subsoil has a high clay content and is sticky and plastic when wet. This initial subsoil layer typically extends to a depth of 0.4m and is highly structured and is not therefore likely to be the most suitable material for water storage or foundation construction. However, deeper subsoil layers, typically extending from depths of 0.4 to 2.0m, contain natural lime and are more stable and contain sufficient clay for water storage or foundation construction. While coarser sandy layers are typically found at depths of 2.0+m, in some instances, these types of layers can occur at shallower depths, practically in the central western area of the site, and this latter feature could limit some land uses such as water storage construction unless more suitable foundation material was imported to enhance soil properties or create pads or liners. Where the Red-brown Earths are in proximity to the Sand Soil Type, relatively shallow coarse soil layers also occur.

10.3 Grey Transitional Soils

From a siting and construction perspective, the Grey Transitional Soils have some potential however, this would be subject to adequate surface drainage as this is a limitation of this soil type and the Grey Transitional Soils are therefore not as attractive as the Red-brown Earths for some land uses. It is thought that these soils typically occur in areas of precluded drainage and/or have limited surface slope and this fact combined with a slowly permeable soil profile, results in these soils being liable to waterlogging. While land forming could help to improve surface drainage, the texture of this soil type is such that it will be difficult to manage when excessive moisture is present. While sandy layers can occur at depth, it is envisaged that the soil layers in the 0.5 to 2.0m depth range of this soil type would be suitable for water storage construction or lining. Prospects for water storage or effluent storage are enhanced by the fact that this soil type is thought to occur on lower lying areas. As this soil type is prone to minor cracking, construction and earthworks must take into account the shrink swell potential of the soil.

10.4 Black Self Mulching Clays

There are some limitations for the use of the Black Self Mulching Clays including the proximity of this soil type to remnant vegetation, to the creek and to the site boundary, and the possible susceptibility of the soil to flooding. However, despite these limitations the high clay content of this soil type could provide opportunities for storage or storage lining providing the strong structure of the upper soil layers is considered. This soil type is very prone to high shrink swell behaviour which can limit its utility for construction purposes.

11. PROPOSED INFRASTRUCTURE SITING RECOMMENDATIONS

11.1 General Siting Considerations

In selecting suitable locations on the site for the infrastructure required for the proposed developments, some of the initial constraints include access, remnant vegetation and the required scale of the infrastructure. It is presumed that these factors have been considered in the formulation of the Initial Site Development Plan provided by Booth Associates (Griffith) and included as Appendix D. Implementation of this initial scoping soils study has provided details of soil characteristics and consideration of these, along with hydrogeology, surface drainage and topography, aspect, prevailing wind direction and exposure allow for further recommendations to be made on infrastructure siting. It must be noted that once a site infrastructure layout has been adopted, further confirmation of soil suitability, specific to the location and type of infrastructure, will be required.

11.2 Working With Soil Type and Topography

Based on the Initial Site Development Plan provided in Appendix D, the majority of the proposed infrastructure location is compatible with the soils however, it is considered to be critical to work in wherever possible with the existing site topography and soil type. Not only will this help to limit the earthworks required and limit the associated soil disturbance, but because soil type is closely related to topography on this site, it will help to ensure infrastructure is sited on the better drained topographically higher soil types and water runoff and storage is confined to the poorly soil types at lower elevations. This is considered to be important because effluent and stormwater yielded from the animal production and ethanol processing facilities will need to be collected, conveyed, treated, stored and re used to protect surface waters and groundwater. Further advantages in the limitation of pumping and piping infrastructure and easier storage construction that is less likely to require clay lining could also be achieved by working where possible with the existing site topography and soil type. It must be noted that the majority of soils, and especially the soils where major infrastructure is proposed, have a high clay content and will therefore require considerable modification to ensure adequate trafficability when conditions are wet.

11.3 Specific Infrastructure, Soil Type & Topography

Farm 108 Additional in the north of the site is topographically lower through the central area running east west and this lower area is commensurate with the Grey Transitional Soil Type. The northern side of Farm 108 Additional and the southern boundary of this farm and further south into Farm 26 Additional are topographically higher areas commensurate with the Red-brown Earth Soil Type. A more elevated area free of remnant vegetation and again consisting of the Red-brown Earth Soil Type exists in the vicinity of soil inspection pits 14, 15 and 16. To fit in with these topographical and soil features it is recommended that;

1. Runoff from the ethanol plant, cattle yards, feed sheds, grain bunkers and diary sheds is directed to the centre of Farm 108 Additional and to the west end of this farm.
2. The dairy and grain bunkers are aligned more to take advantage of the higher area in the vicinity of soil inspection pits 14, 15 and 16 and runoff from these facilities is directed to the north.
3. Clean rainfall runoff from the administration buildings, visitors centre and associated car parks is diverted south to the 'runoff storage' which it is assumed will take the form of an ornamental lake and wetland environment linked to the adjacent creek to the south.
4. The dry pens and sick animal facility are moved to the more elevated area in the vicinity of soil inspection pit 8 where the proposed aerobic and anaerobic ponds are currently sited in the plan in Appendix D.
5. The liquid waste management facilities are relocated to the topographically lower and more clay dominant northwest of the site.

These recommendations aim to relocate the liquid storage and treatment facilities to a topographically lower area to utilise gravity conveyance of wastes. It is also believed that this will provide for easier reuse of the liquid wastes in the dairy sheds and/or the diary. Further, the soil types in the northwest of the site are more conducive to earthen storage construction by comparison with areas where the proposed aerobic and anaerobic ponds are currently sited in the plan in Appendix D. Contaminated runoff from the dry pens and the sick animal facility could then take advantage of the gradient from the topographically higher area in the vicinity of soil inspection pit 8 to the topographically lower area in the vicinity of soil profile inspection pit 7.

12. FURTHER INVESTIGATIONS

Further geotechnical investigations will be required for;

- Building foundations and structural footings
- Roads and parking areas
- Fodder storage areas
- The feedpad, calving pad and loafing pad areas
- Wastewater treatment and storage facilities
- Runoff sumps or wetlands

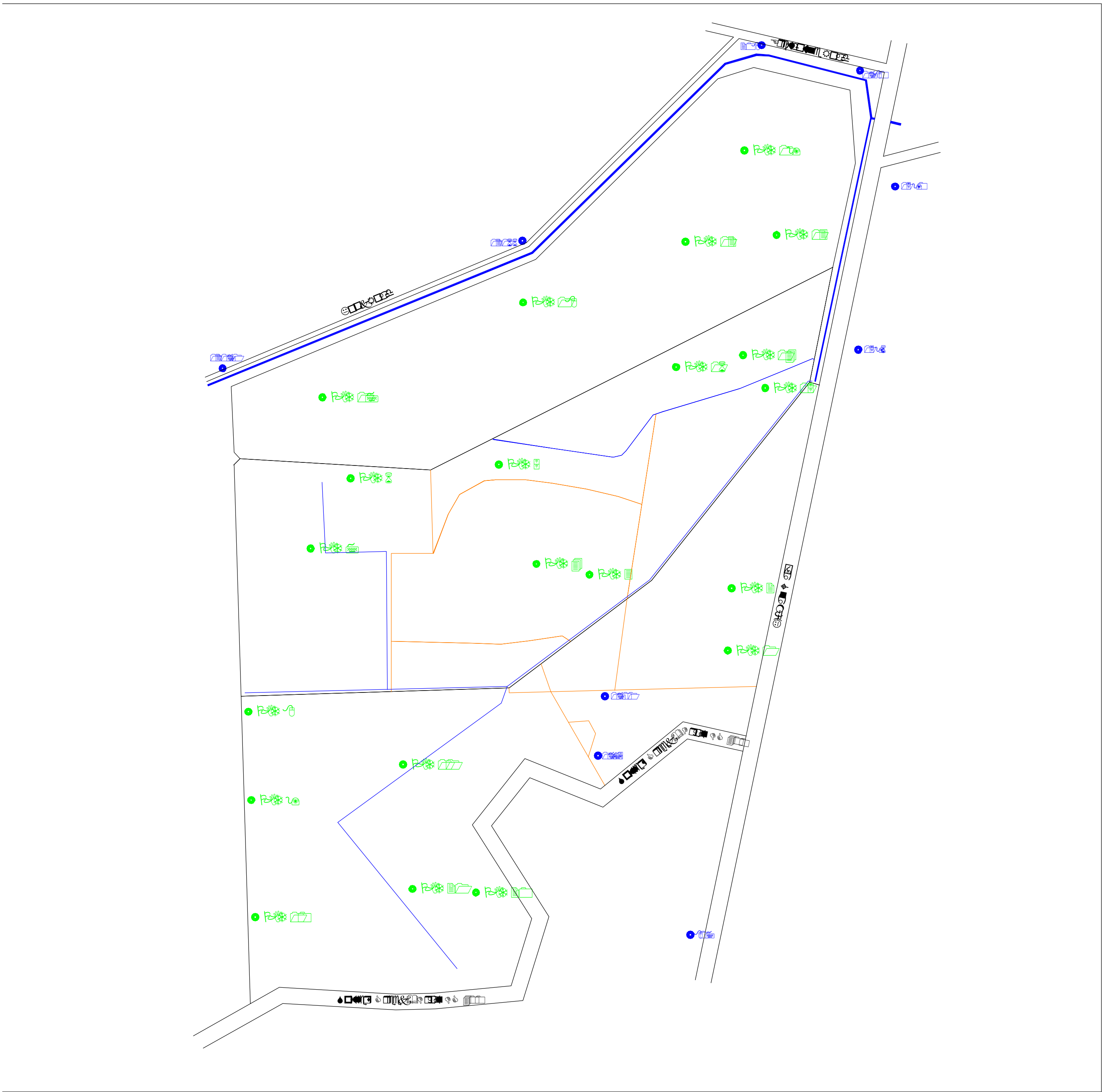
While it is presumed that solid manure will be removed, stored and reused off site and that there will not be a need for on-site liquid effluent reuse; soil agronomic investigations will be warranted for any land that will be in receipt of reclaimed water irrigation, manure solids or bio-solids. It is presumed that stock exclusion and vermin control in the areas of existing remnant vegetation, along with additional plantings will help enhance and preserve these important areas.

13. CONCLUSIONS

While further investigations will be required to confirm suitability, the results of this initial scoping soils assessment indicate that the site is suitable for the intended developments.

14. APPENDICES

14.1 Appendix A - Site Plan



4 Arrows

Coleambally

WRIGLEY DILLON REFERENCE 255

WARNING

The location of underground services, where shown, are approximate only and the exact location should be verified on site prior to any works being undertaken. All relevant authorities must be contacted prior to works being undertaken and notwithstanding the information contained in this or any associated plans, reports or recommendations, any persons undertaking works shall be responsible for satisfying themselves as to the nature and extent of the specified works and the physical and legal conditions under which the works will be carried out, including access, site conditions, nature of material to be excavated, type, size & quantity of materials required and any like matters effecting the construction and/or related works.

APPROXIMATE NORTH

TOTAL PROPERTY AREA = 359 HA

Groundwater Monitoring Bore

Soil Profile Inspection Pit

Sand

Red-brown Earth

Grey Transitional Soil

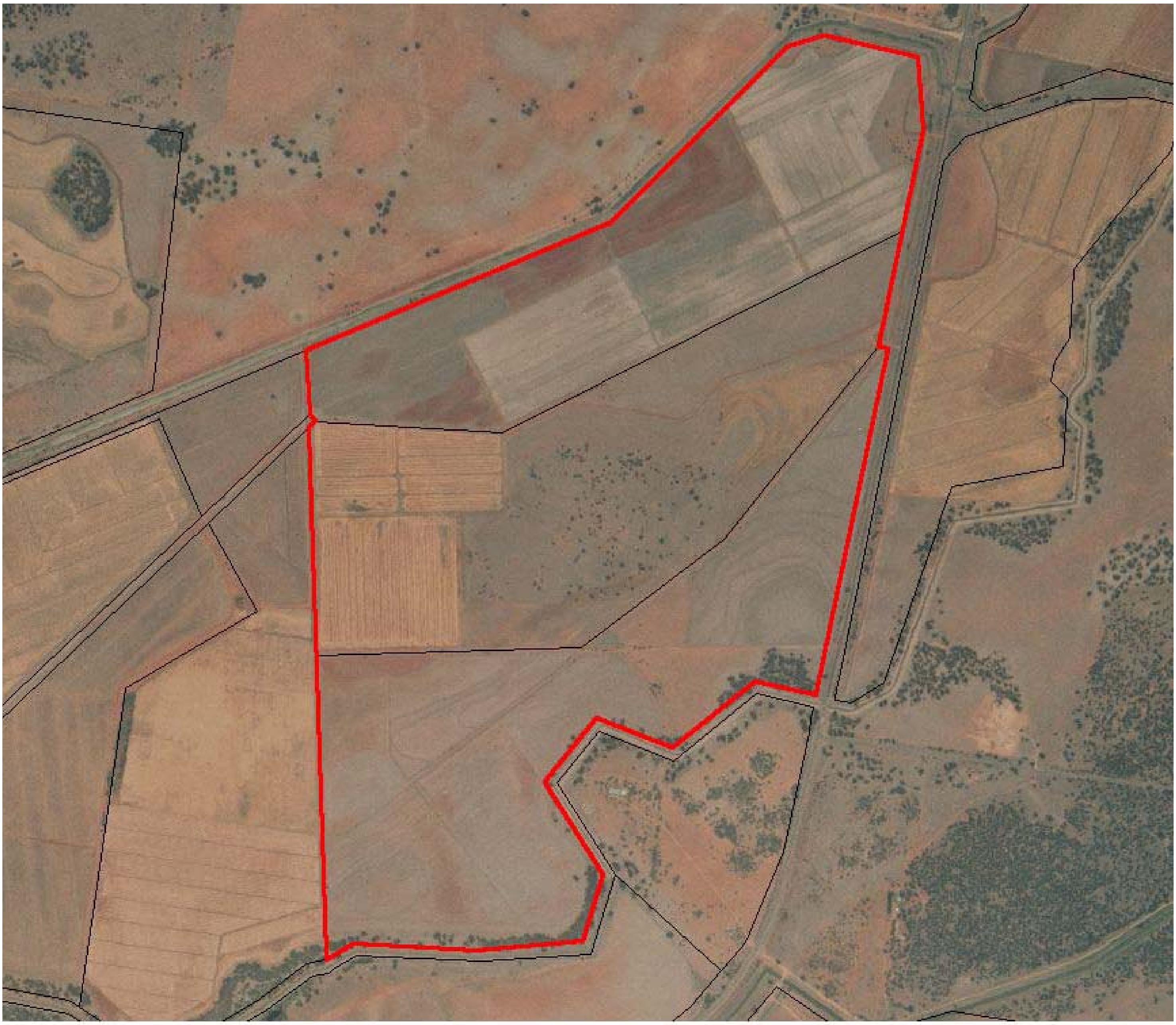
Black Self Mulching Clay

Wrigley Dillon - Site Investigations, Soil Suitability & Solutions for

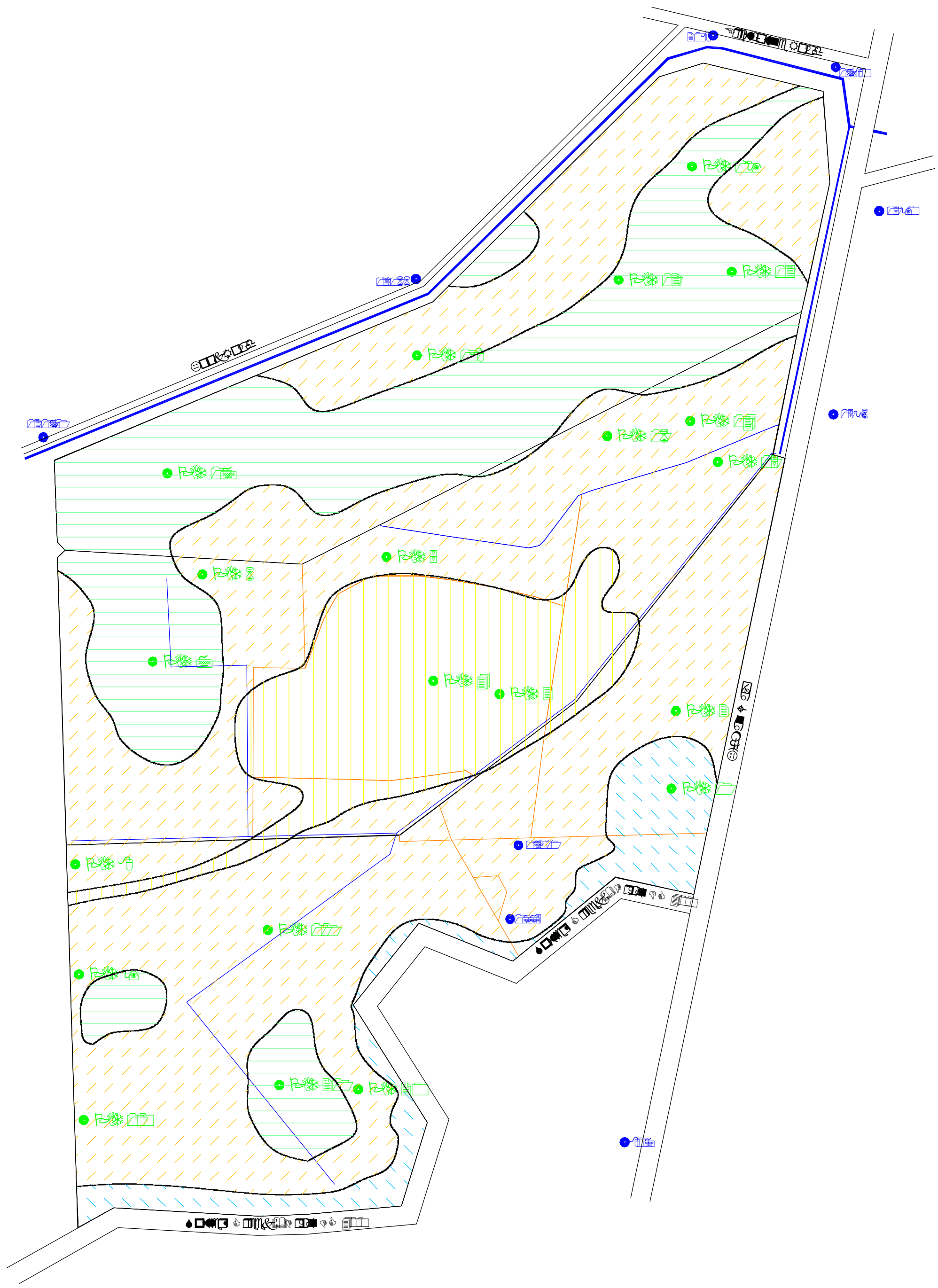
Agriculture Horticulture Geotechnical Structures Environmental Impacts Sustainable Developments

Office 115 Euroa Road, Shepparton East, VIC., 3631 **Phone** (03) 5829 1011 **Fax** (03) 5829 2666 **Email** wrigley.dillon@bigpond.com

Aerial Photograph of Site



14.2 Appendix B - Soil Plan



4 Arrows

Coleambally

WRIGLEY DILLON REFERENCE 255

WARNING

The location of underground services, where shown, are approximate only and the exact location should be verified on site prior to any works being undertaken. All relevant authorities must be contacted prior to works being undertaken and notwithstanding the information contained in this or any associated plans, reports or recommendations, any persons undertaking works shall be responsible for satisfying themselves as to the nature and extent of the specified works and the physical and legal conditions under which the works will be carried out, including access, site conditions, nature of material to be excavated, type, size & quantity of materials required and any like matters effecting the construction and/or related works.

APPROXIMATE NORTH

TOTAL PROPERTY AREA = 359 HA

Groundwater Monitoring Bore

Soil Profile Inspection Pit

Sand

Red-brown Earth

Grey Transitional Soil

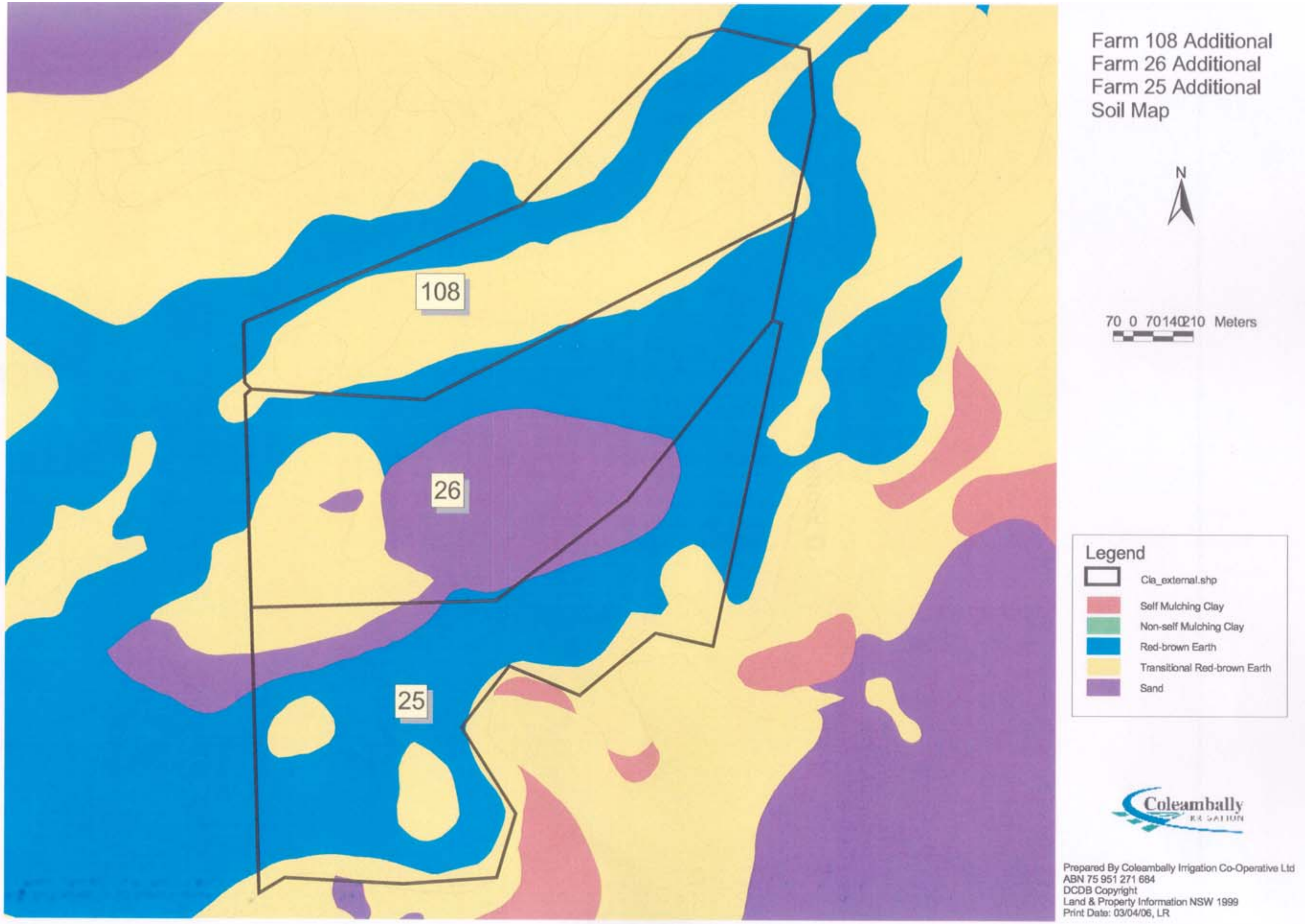
Black Self Mulching Clay

Wrigley Dillon - Site Investigations, Soil Suitability & Solutions for

Agriculture Horticulture Geotechnical Structures Environmental Impacts Sustainable Developments

Office 115 Euroa Road, Shepparton East, VIC., 3631 **Phone** (03) 5829 1011 **Fax** (03) 5829 2666 **Email** wrigley.dillon@bigpond.com

14.3 Appendix C - Stannard (1970) Soil Plan



14.4 Appendix D - Initial Site Development Plan