SOIL INVESTIGATION

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Natural burial ground site suitability

A brief investigation of the suitability of two sites, Vallances Rd Mullumbimby and Clunes cemetery, for use as natural burial sites based on their soil characteristics.

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Soil investigation

NATURAL BURIAL SITE SUITABILITY

SCOPE

Byron Shire Council is considering providing a natural burial ground to expand the options available for managing bodies after death. Josh Winter, Capital Works engineer at Byron Shire Council, requested Give Soil a Chance to investigate the soil characteristics at two sites under consideration.

The soil investigation utilized a mini excavator to dig soil pits at the proposed sites. Soil samples were collected from the soil pits and stored for future analysis if required. This report contains the field observations and interpretation of their relevance to the site's potential as natural burial grounds. The purpose of the report is to provide information to Council relevant to their decisions in progressing the development of either site as natural burial grounds.

This report does not propose specific regimes for soil amendments to support decomposition within graves.

SOILS FOR NATURAL BURIAL

Background

Natural burial is an ecological approach to the burial of human remains. A natural burial ground is a place where natural burial takes place.

The Australian Natural Burial Project provides these definitions:

Natural Burial: *Return of human remains as directly as possible to the earth, while adhering to all legal, cultural and practical requirements. Non-embalmed remains are contained within a minimal-resource, bio-degradable coffin or shroud, and buried at the minimum legal depth to promote natural decomposition.*

Natural Burial Ground: *A life-centred memorial place, not part of a traditional cemetery model, set aside exclusively for natural burial, and characterized by the existence or restoration of native vegetation. An eco-conscious, natural burial ground has a finite active life cycle. Once the burial ground capacity is reached, operational maintenance is replaced by minimal-cost, landscape preservation practices, and the site remains a natural flora and fauna reserve.*

Decomposition in soils

Natural burial intends that as much as possible of the body and grave goods decompose within the soil without any negative impacts on the site and its surrounds. Soil characteristics strongly influence the rate and degree of decomposition and processes for the movement of decomposition products. The presence of soil constraints could impair decomposition or affect the stability of the grave.

The key concerns that would reduce the suitability of a site for natural burial are:

- the possibility of decomposition products moving beyond the perimeter of the burial ground
- impaired decomposition of remains
- constraints that limit access or vegetation establishment and maintenance at the site.

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The location of the burial ground, in terms of its geological, soil and hydrological characteristics, is the best predictor and control of any potential negative impacts.

Natural burial eliminates concerns of contamination from embalming fluids and metals. The environmental risks attached to the natural products of decomposition are associated with increased concentrations of nutrients, not specific toxicity.

In the early stages of decomposition, the liquids and soft tissues of the body break down. A viscous liquid develops that could leach or migrate through the soil. The leachate affects the soil in the vicinity of the burial. There may be potential for the leachate to move through the soil and enter water bodies or aquifers.

Where a natural burial ground links to revegetation or conservation works, avoid too high a burial density, burial too close to established trees and consider nutrient-sensitive plants in planting design.

The natural burial ground is not intended to provide sequential burials in the same place. Some residual components of human remains, most likely parts of larger bones and teeth, may be present in the soil for an indefinite period. The management plan for the burial ground must:

- Sufficiently identify individual burial sites so their disturbance can be avoided, even without physical markers.
- Demonstrate care not to overload the capacity of the local environment by thoughtfully scaling, distributing, and timing burials.

Favourable soil conditions for natural burial

Soils suitable for a natural burial ground will support decomposition processes without allowing significant mobility of decomposition products and be capable of accepting an increased nutrient load.

- Healthy topsoil, rich in organic matter.
- >70% living groundcover, 100% living and non-living ground cover.
- No evidence of groundwater above 2.5 m within the soil.
- No evidence of historic waterlogging down to 2 m depth.
- Soil pH 5.5-6.5 (very slightly acid).
- Loam or clay texture with some infiltration capacity.
- >20 m from a natural watercourse.
- Mature trees are present on or adjacent to the site.

SOILS SUITABILITY FOR NATURAL BURIAL

Vallances Rd, Mullumbimby

The site at Vallances Rd Mullumbimby has moderate to serious soil constraints that make it sub-optimal for use as a natural burial ground. It is a biologically impoverished site that requires rehabilitation of soils as well as plantings to support native vegetation.

There is little to no risk of movement of leachate beyond the grave sites. The unstructured heavy clay soils at the site present a risk of anaerobic (waterlogged) conditions in graves for extended periods following high rainfall. Anaerobic conditions would lead to impaired decomposition and potential odour at the surface. Soil amendments, such as liming and carbon-rich organic materials included in the grave, could improve but not eliminate impaired decomposition.

Without remediation of soil conditions and the establishment of more deep-rooted vegetation, uptake of nutrients from the graves will be limited. Remediation would likely involve liming, contour/keyline ripping and substantial organic matter inputs. Remediation potential is limited, and it could take several years to reach conditions suitable to sustain larger vegetation communities and support the cycling of nutrients from decomposing bodies into the plant & soil system. The key issues are:

- lack of soil structure impairs drainage
- soil acidity will impair the biological decomposition
- low organic matter in the topsoil reflects a poorly resourced environment for soil microbes and plants.

The dense, heavy soil at the site will require more machine power to dig graves and create more wear and tear on equipment over the operating life of the burial ground.

Clunes cemetery

The site at Clunes cemetery has no soil constraints that make it unsuitable for use as a natural burial ground. It is a fertile site, promising for the establishment of native plants, decomposition and integration of nutrients from decomposition into the soil & plant system.

The well-structured soils present minimal risk of sustained anerobic conditions in graves. There is low risk of leachate movement beyond the immediate vicinity of the grave because of the loam texture. Soil pH is in a suitable range, although the inclusion of liming material within graves could still have some benefits. The presence of plant roots to well below the proposed burial depth of 1 m makes plant uptake of nutrients from the graves likely.

SOILS AT SITE1: VALLANCES RD

Site description

The Vallances Rd site proposed for a natural burial ground is a ridgetop north of Mullumbimby, with an outlook over the town. The property slopes steeply from the ridge down to a floodplain of the Brunswick River. Only a small proportion of the site is elevated with low slope. Two soil pits were investigated on the ridgetop, shown in figure 1. Soil pit 2 was at an elevation approximately 1 m below soil pit 1.

Figure 1. The Vallances Rd site is adjacent to the Brunswick River. The location of soil pits are marked with red spots. The white spot indicates the location of a previous soil investigation obtained from the NSW Land and Soil Information System (1004002).

Soil characteristics

The soils are heavy clays with minimal structure and consequently poor subsoil drainage. The topsoils have low fertility. The site may have suffered severe erosion of topsoil at some stage and can be considered a degraded site. The vegetation present is degraded pasture, mainly low and slow growing weeds.

The soil pits were 2.2 m deep. The soil material below 0.8 m was hard, proving difficult for the 5t excavator to dig. The sides of the pits were smooth clay with no visible pores. Plant roots were confined mainly to the upper 10 cm, with very few roots to 70 cm. No permanent water table was observed within the pit depth. Soils were in moist condition at the inspection with approx. 1 week since last rainfall. Water infiltration into the soil was extremely limited. Coloured mottles in the clay from 8 cm indicate anerobic conditions prevail within the soil.

Soil classification

Red Kandosol

Soil profile attributes

Horizon boundaries are gradual or diffuse.

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SOIL PIT 1

Horizon A1

Upper bound: 0 cm Lower bound: 8 cm

Colour: red-yellow in moist condition

Field texture: Silty clay

Field pH: 5

Structure: Weak pedality, peds 2–5 mm, sub-angular blocky, earthy.

Infiltration: Poor >5 min to absorb 100mL via infiltrometer, no bubbling.

Horizon B1

Upper bound: 8 cm Lower bound: 20 cm

Colour: red-brown

Field texture: heavy clay

Field pH: 5

Structure: Weak pedality, peds mostly <2 with some 2–5 mm, sub-angular blocky, smooth-faced.

Infiltration: not tested, no visible porosity, more constrained than A1, likely to be very poor.

Horizon B2

Upper bound: 21 cm Lower bound: 40 cm

Colour: red-brown in moist condition

Field texture: heavy clay

Field pH: 5

Structure: massive, smooth-faced

Infiltration: not tested, no visible porosity, very likely to be very poor.

Horizon B3

Upper bound: 40 cm Lower bound: 65 cm

Colour: red-grey in moist condition

Field texture: heavy clay

Field pH: 5

Structure: massive, smooth-faced

Give Soil a Chance

Infiltration: not tested, no visible porosity, more constrained than A1, likely to be very poor.

Horizon C1

Upper bound: 65 cm Lower bound: Possible boundary to C2 at 120 cm or could be continuous C1 to base of soil pit at 2.2m

Colour: grey-red in moist condition

Field texture: heavy clay

Field pH: 5

Structure: massive, smooth-faced

Infiltration: not tested, no visible porosity, more constrained than A1, likely to be very poor.

SOIL PIT 2

Horizon A1

Upper bound: 0 cm Lower bound: 7 cm

Colour: yellow-brown in moist condition,

Field texture: heavy clay

Field pH: 4.5

Structure: moderate pedality, peds 5–10 mm, granular, earthy.

Infiltration: Very poor no visible infiltration after 5 minutes.

Horizon B1

Upper bound: 7 cm Lower bound: 18 cm

Colour: red-brown in moist condition, with mottles

Field texture: heavy clay

Field pH: 5

Structure: Weak pedality, peds mostly 2–10 mm, sub-angular blocky, earthy.

Infiltration: not tested, no visible porosity, likely to be very poor.

Horizon B2

Upper bound: 19 cm Lower bound: 44 cm

Colour: red-brown in moist condition with mottles.

Field texture: heavy clay

Field pH: 5

Structure: Weak pedality, granular peds 2–5mm, smooth-faced.

Infiltration: not tested, no visible porosity, very likely to be very poor.

Horizon C1

Upper bound: 45 cm Lower bound: continues to base of pit at 2.2m

Colour: orange-grey in moist condition with mottles

Field texture: heavy clay

Field pH: 5

Structure: massive, smooth-faced.

Infiltration: not tested, no visible porosity, likely to be very poor.

SOILS AT SITE 2: CLUNES CEMETERY

Description

The site at Clunes is a ridgetop sloping gently to the north, adjacent to an existing traditional cemetery. Soil pit 2 was at an elevation approximately 2 m below soil pit 1.

The soils are fertile, well-structured loams with water stable aggregates, appearing to be high in organic matter. The vegetation present is healthy pasture.

The soil pits were 1.8 m deep. The soil material was easy for the 5t excavator to dig. The sides of the pits were coherent with earthy fabric and visible pores. There were dense plant roots throughout the upper 15 cm, with some roots to the base of the pits.

Soils were in moist condition at the inspection with approx. 1 week since last rainfall. Topsoil appeared high in organic matter. Water infiltration into the topsoil was limited but at depth was good. The presence of weathered basaltic core stones below 40 cm and the absence of mottles indicates aerobic conditions prevail in the subsoil. No permanent water table was observed within the pit depth.

Figure 2. Location and surrounds of Clunes cemetery site. Soil pits are indicated with red dots.

Soil characteristics

Soil classification

Red Ferrosol

Soil profile attributes

Horizon boundaries are diffuse.

SOIL PIT 1

Horizon 0

Upper bound: 0 cm Lower bound: 1 cm

Colour: dark red-brown

Field texture:

Field pH: 5.5

Structure: Strong pedality, crumbly, peds 2–5 mm crumbs, earthy, self-mulching at the surface

Infiltration: Not tested because pasture and roots could not be cleared without too much disturbance of the soil layer.

Horizon A1

Upper bound: 1 cm Lower bound: 8 cm

Colour: red-brown

Field texture: Loam

Field pH: 6

Structure: Strong pedality, crumb peds up to 200-500 mm

Infiltration: fair, 20 minutes to infiltrate 500 mL water via the infiltrometer tube.

Horizon B1

Upper bound: 8 cm Lower bound: 42 cm

Colour: dark red-brown

Field texture: Loam

Field pH: 6

Structure: strong pedality, peds 2–5 mm crumbs

Infiltration: Poor, 15 minutes to infiltrate 150 mL water via the infiltrometer. Note that soil structure indicates the potential for good infiltration, the current high level of soil moisture is likely to be impairing further infiltration at the time of testing.

Horizon C1

Upper bound: 42 cm Lower bound: continues to base of pit at 1.8 m

Colour: red-brown

Field texture: loam

Field pH: 6

Structure: moderate pedality, peds <2 mm, basaltic corestones present.

Infiltration: At 45cm depth, infiltrated 300 mL in 20 minutes, at 1.2 m 200 mL in 20 minutes.

SOIL PIT 2

Horizon 0

Horizon A1

Upper bound: 1 cm Lower bound: 8 cm

Colour: red-brown in moist condition

Field texture: Loam

Field pH: 6

Structure: Moderate pedality, peds 5–10 mm crumbs, self-mulching at the surface.

Infiltration: poor, 20 minutes to infiltrate 50 mL water via the infiltrometer tube. Note that soil structure indicates the potential for good infiltration, the current high level of soil moisture is likely to be impairing further infiltration at the time of testing.

Horizon B1

Upper bound: 0 cm Lower bound: 42 cm

Colour: dark red-brown

Field texture: Loam

Field pH: 6

Structure: strong pedality, peds 2–5 mm crumbs, rough-faced.

Infiltration: Poor, 15 minutes to infiltrate 150 mL water via the infiltrometer. Note that soil stuucture indicates the potential for good infiltration, the current high level of soil moisture is likely to be impairing further infiltration at the time of testing.

Horizon B2

Upper bound: 8 cm Lower bound: 37 cm

Colour: red-brown

Field texture: loam

Field pH: 5.5

Structure: moderate pedality, peds 2–5 mm crumbs, rough-faced.

Infiltration: Not tested.

Horizon C1

Upper bound: 37 cm Lower bound: continuous to base of pit.

Colour: red-brown

Field texture: loam

Field pH: 5.5

Structure: moderate pedality, peds 2–5 mm crumbs, rough-faced. Basaltic corestones present.

Infiltration: Good. At 45 cm and 120 cm depth, 7.5 minutes to infiltrate 500 mL of water via the infiltrometer. Radial saturation pattern to 10 cm around the infiltrometer tube perimeter.

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