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## Information Sheet

### Soil testing guidelines for intensive agriculture to guide recycled organics applications

#### Introduction

*Recycled organics products* refer to a range of organic products such as composted mulches and composted soil conditioners that are manufactured according to relevant standards such as Australian Standard AS 4454 (2003) *Composts, Mulches and Soil conditioners*.

Recycled organics products are a source of *organic matter* and nutrients for the soil. Benefits of organic matter in the soil are discussed in detail in the Recycled Organics Unit (2002) publication *Buyers Guide to Recycled Organics Products* Information Sheet No. 6.2.

When including recycled organics (RO) products in farm management practices, it is essential to consider specific crop requirements, properties of the soil, and characteristics of RO products. This informs the appropriate selection and application of RO products and supplementary fertiliser for nutrient budgeting.

Soil testing tells us about the condition of the soil, and guides what and how much we need to add to grow healthy productive crops. Regular soil testing helps to monitor changes in soil conditions resulting from the application of RO products and inorganic products such as mineral fertilisers and lime. This guides future soil management practices including reapplication time, and quantity and quality of RO product and inorganic product use.

Whilst soil testing results are a valuable management tool, the ongoing costs of regular soil testing are undesirable for all growers. Additionally, many growers find difficulties in identifying and interpreting appropriate soil testing requirements and cost effective soil testing services.

This information sheet identifies the minimum soil testing requirements to guide soil and nutrient management when using RO products. This guide helps growers to implement a cost

Figure 1: Soil sampling hand auger



effective and relevant soil analyses regime for their cropping systems.

Soil testing requirements vary for new farms, which are just establishing, in comparison to already established farms, which are already producing crops. New farms should conduct an initial/baseline site assessment and soil survey.

### **Baseline site assessment and soil survey for establishing new farms**

Baseline site assessment and soil survey is highly recommended when establishing new intensive agriculture enterprises, i.e. sites being developed for a new and/or specific agricultural purpose.

The purpose of site assessment and soil survey is to have knowledge of the site and soils, which helps in the planning of different farm activities. Best practice guidelines developed by NSW Agriculture (2002) provide a guide for new farm developments including basic techniques to carry out site assessment and soil survey.

It is suggested to hire a soil consultant to conduct initial/baseline soil assessment. This guide, however, provides a step-by-step procedure to conduct an initial soil survey of a new intensive agriculture enterprise considering the use of RO products. A hand auger used for soil sampling is shown in Figure 1. Important *soil morphological* and chemical properties to be considered as a part of such soil survey are also listed.

#### **Step by step procedure**

1. Firstly gather information on types of soils present at the property.
2. This can be obtained from soil landscape maps, which are available for most regions/areas of NSW from the NSW Department of Sustainable Natural Resources.

3. If soil landscape maps are available for the area covering your property, identify soil types present at the property using these maps. This will help to identify location and number of areas to be investigated for soil sampling.
4. There are several ways to select and estimate the number of areas required for soil sampling and several factors are considered including property size, landform, variation in soils across the property, and others.
5. Higher number of areas should be investigated for larger size properties and greater variety of soil types (if known prior to site assessment).
6. Soil sampling areas should be representative of production areas. Avoid areas where soils, drainage or other conditions are not suitable/useful for intended crop.
7. Estimate the number of soil sampling areas to be investigated.
8. Typically a minimum of one sampling area should be investigated in a 250 m interval in a 250 m grid (of production area).
9. Alternatively a minimum of one sampling area should be investigated for each soil type (for a small farm property) present at the property, therefore greater soil variety requires more sampling areas.
10. Mark soil sampling areas on the map of the property.
11. For each sampling area, select a central sampling point (Figure 2).
12. At central sampling point of each sampling area, extract the soil with a soil corer/auger up to a depth of at least 1 m or until hitting rock material.

## **Definitions**

### **Recycled Organics Products**

The term recycled organics has been adopted as a generic term for a range of Australian Standard AS 4454 (2003) for a range of products manufactured from compostable organic materials (garden organics, food organics, residual wood and timber, Biosolids and other organic materials). Specific recycled organics (RO) products are defined in the following Australian Standards:

AS 4454 (2003) Composts, Mulches and Soil Conditioners;

AS 3743 (2003) Potting Mixes;

AS 4419 (2003) Soils for Landscaping and Garden Use;

AS 4422 (1998) Playground Surfacing.

There are also many unprocessed RO products for which standards do not exist, such as raw leaf mulches and manures. No product standards or regulations govern the use of such undefined materials.

### **Soil morphological characteristics**

Soil features, which can be examined at the site without performing soil chemical analyses such as colour, layers of soil profile, texture, structure, drainage, mottling, etc.

### **Soil sampling area**

Defined area where soil is dug and/or excavated for examination and collection for chemical analyses.

### **Soil pH**

A measure of acidity or alkalinity, and characterises the chemical environment of the soil. It provides guide to likely deficiencies and/or toxicities and nutrient availability. The ideal pH for plant growth ranges between 5 to 8. Nutrient availability for plant use may be affected, and deficiency or toxicity of elements may occur outside this pH range.

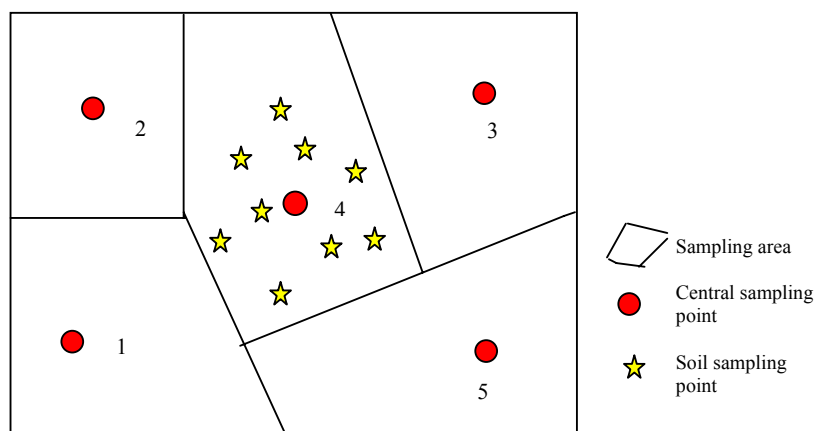
**Electrical conductivity (EC)** – is a measure of soil salinity which relates to the presence of water soluble salts in soil solution, mainly of chlorides, sulphates, carbonates and nitrates of sodium (Na), Ca, and Mg. The salinity of saturated extract is obtained by multiplying EC of soil water suspension with soil texture classes which ranges from 6 for heavy clays to 17 for sandy, loamy sand and clayey sand.

13. Carefully remove the soil from the soil corer without breaking or damaging it and place on a plastic sheet (Figure 3).
14. Document the soil layers of the soil profile, including depth of each soil layer.
15. Describe the soil for the following soil morphological properties for each soil layer: colour; soil structure; and soil texture; as per standard soil survey procedures (Department of Land and Water Conservation, 1996).
16. After documenting soil morphological characteristics, about 1-2 kg of soil from each soil layer (or at equal increments e.g. 0-20, 20-40, 40-60 and 60-100 cm), should be collected from the soil core or central sampling point for chemical analyses. Samples should be taken from the entire 1 m soil depth.
17. Soil samples should be placed in plastic bags that are tagged and labelled. Each bag should be clearly marked with the property name, date of sampling, sampling area and point, location, and soil depth.
18. To reduce the cost of soil analyses, soil samples from the same soil types, soil layers or soil depths (i.e. 0-20, 20-40, 40-60 and 60-100 cm) and preferably with same farm management practices from the property can be combined i.e. mixed together to make one “composite” soil sample.
19. Soil samples should be sent to a laboratory for analysis of *pH* ( $\text{CaCl}_2$ ), *electrical conductivity* (EC), *cation exchange capacity* (CEC), and *soil organic matter* (SOM).
20. If cropping is to begin immediately, soils should be tested for macro-nutrients as described in the next section.

### Soil testing requirements to guide RO application on established farms

The following advice is for farms already established for a specific agricultural purpose, where baseline soil assessment has been done as a part of farm development and planning.

**Figure 2.** Farm property showing soil sampling area and sampling points



## Definitions

### Cation exchange capacity (CEC)

CEC is the capacity of the soil to hold and exchange cations. It is a major controlling agent of stability of soil structure, nutrient availability for plant growth, soil pH and soil's reaction to chemical fertilisers and other amendments.

### Soil organic matter (SOM)

Carbon based materials of animal and plant origin, which are present in the soil in all stages of decomposition.

Excess or insufficient nutrient availability can have negative impacts on plant growth, health and yield.

Excess nutrients can also result in a range of negative environmental impacts from leaching, runoff and volatilisation, as well as being a waste of money for growers.

It is therefore important to test surface soils to guide correct application of RO products and/or inorganic soil amendments (e.g. fertilisers, lime). The following tests are recommended:

- Soil pH ( $\text{CaCl}_2$ ),
- Soil organic matter (SOM),
- Electrical conductivity (EC),
- Nitrate-Nitrogen,
- Available phosphorus,
- Available potassium.

For this purpose sampling of the top (surface) soils at 0-10 cm depth is sufficient for most crops and composted products applied as surface mulch as well as incorporated as soil conditioners.

Figure 3. Soil sampling



However in the case of soil conditioners for deep rooted crops, if incorporation depth is deeper, topsoils should be sampled to the depth of incorporation.

Areas with deep soils (if present at the property), topsoil samples should be preferably sampled to the depth of 0-15 or 0-30 cm depending upon the depth of the topsoil layer. (Note: there is no separation into layers, the entire sample is mixed together).

**Step by step procedure**

1. Identify the location and estimate the number of soil sampling areas to be investigated as discussed in “baseline site assessment and soil survey” step by step procedure 1 to 10 (see previous section).
2. Alternatively, choose sampling points for investigation within the sampling areas defined in the

baseline soil sampling survey.

3. For each sampling area (see Figure 2) select representative central sampling point in the production area.
4. Within a ~10 m radius (for a small sampling area of about 1 ha) of the central sampling point, collect 6-12 surface soil samples from representative sampling points (Figure 2) within the defined area (DLWC, 2002).
5. For larger sampling areas, collect 12-24 surface soil samples from a larger radius (i.e. >10 m).
6. For each soil sampling area, tip all collected soil samples into a clean bucket and mix thoroughly.
7. Take a 1-2 kg composite sub-sample of the mixed soil from the bucket, and place into a plastic bag for testing. Bags should be

tagged and labelled.

8. The label should be marked clearly with the property name, sampling area location, sampling date and soil depth.
9. Where samples are to be tested for nitrates, samples should be refrigerated in an esky with ice bricks soon after collection and sent to laboratory in an esky to maintain refrigerated conditions.
10. Soil samples for other tests can be send to the laboratory in a cardboard box.

A nutrient budget calculator (ROU, 2003a) is available from the internet at [www.recycledorganics.com](http://www.recycledorganics.com) (see references). The nutrient budget calculator provides a guide to combined application of mineral fertilisers and RO products.

**Table 1 Schedule for soil monitoring (Source: modified from NSW EPA, 2002)**

Chemical test	Frequency of sampling	
	Surface (top) soil	Soil profile at 4 depth increments
pH (no units)	Annually	Every 3-5 years
Electrical conductivity (EC) (dS/m)	Annually	Every 3-5 years
Nitrate-N (mg/kg)	Annually	Every 3-5 years
Total-N (%)	Every 3-5 years	Not required
Available-P (mg/kg)	Annually	Not required
Total-P (%)	Every 3-5 years	Every 5 years
Cation exchange capacity (cmol(+)/kg soil)	Annually	Every 5 years
Organic matter (%)	Annually	Not required

**Table 2 Soil chemical test results interpretation (Source:DLWC, 2002)**

Chemical test	Ranking				
	Very low	Low	Moderate	High	Very high
pH (no units)	<4 (very strongly acidic)	4-5 (strongly acidic)	5-8 (ideal for plant growth)		
Electrical conductivity saturated (ECe) (dS/m)	<2 (non-saline)	2-4 (slightly saline)	4-8 (moderately saline)	8-16 (highly saline)	>16 (extremely saline)
Cation exchange capacity (CEC) (cmol(+)/kg soil)	<6 (very low)	6-12 (low)	12-25 (Moderate)	25-40 (high)	>40 (Very High)
Organic matter (%)	0.5-1.0 (very low)	1.0-2.0 (low)	2.0-3.0 (Moderate)	3.0-5.0 (High)	>5.0 (Very high)
Exchangeable sodium percentage (%)	<5 (non-sodic)		5-10 (marginally sodic)	>10 (highly sodic)	
Total N (%)	<0.05 (very low)	0.05-0.15 (low)	0.15-0.25 (Medium)	0.25-0.5 (High)	>0.5 (very high)
Nitrate-N (ppm) (0-30 cm soil depth)		<30 (Deficient)	30 (Adequate)		
Phosphorus (Bray for acidic soils) (mg/kg)	<5 (very low)	5-10 (low)	10-30 (moderate)	30-60 (High)	>60 (very high)
Phosphorus (Lactate for alkaline soils) (mg/kg)	<5 (very low)	5-10 (low)	10-17 (moderate)	17-25 (High)	>25 (very high)

Use the soil test results and this calculator to select suitable RO products and application rates and complimentary soil amendment application (e.g. fertiliser, lime) to match the nutrient requirements of crops.

### Soil testing to monitor soil nutrient levels

Recycled organics products may only be applied every 2-5 years. Soils should be tested regularly (i.e. annually) between application of RO products to show changes in soil and nutrient management, including the application of inorganic amendments such as fertilisers.

A schedule for monitoring of surface as well as sub-surface soils is provided in Table 1.

Central sampling points should be close to and in the same sampling area as previous central soil sampling points, and procedures discussed in previous section should be applied.

A soil test results interpretation guide is provided in Table 2.

Important aspects of soil monitoring are to ensure salts and excess nutrients do not build up in the soil. After soil has been monitored for 3 to 5 years, the soil testing results should be reviewed to determine the frequency of sampling required and the range of test parameters relevant for future soil monitoring.

### On site soil testing

Commercial soil testing services are expensive and growers are often uncertain as to what soil chemical tests should be performed, which analytical laboratories to use and how to interpret and use the test results.

A range of soil testing equipment is available on the market that can be used on-site by growers to test soil in the field. On-site soil testing laboratories can reduce the cost of regular soil analyses. Soil testing equipment available includes pH meters, phosphorus test kits, electrical conductivity meters, etc.

Comprehensive soil testing kits are also available on the market. These

kits can be used by growers to perform the complete range of soil tests recommended here. These kits also provide guidance manuals for lime and fertiliser applications corresponding to soil test results. For example LaMotte Soil testing kits AST-5 and AST-15 which cost about \$A1000 and \$A2000 respectively perform all soil tests recommended here and several others. The supplier of these kits in Australia is Vendart Pty Ltd ([www.vendart.com](http://www.vendart.com)).

The price range for different soil tests per soil sample charged at major analytical laboratories in Australia is provided in Table 3. The ROU is currently evaluating the use and value for money of the La Motte kits and a user guide will be available on-line (ROU, 2004) in March 2004.

## Guide to reapplication of recycled organics products based on soil test results

Results of soil testing should be used to plan the application of recycled organics products (surface mulch or soil conditioners) and complimentary inorganic amendments specific to the requirements of each crop.

It should be noted that soil test results, soil composition, drainage, climate, crop type and age should all be considered in relation to soil management.

Guidance principles for RO product applications are provided in Table 4. The general principle, however, is to

**Table 3 Approximate costs of soil analyses at major analytical laboratories**

Chemical test	Approximate cost per soil sample
pH, EC	\$ 5-10
Organic carbon	\$10-15
Various forms and total -N	\$15-20
Phosphorus	\$10-15
Exchangeable cations (K, Ca, Mg, Al, Na)	\$10-20
Cation exchange capacity	\$20-25
Phosphorus sorption capacity	\$100-150

identify the application rate and general product type (e.g coarse mulch, fine mulch, soil conditioner) that provides maximum benefit for your agricultural activities (i.e. weed suppression, moisture retention), and use the test results to specify an RO product with suitable nutrient profile,

EC and pH levels.

### Equipment

Details for suppliers of suitable soil auger and soil testing kits are available on line at [www.recycledorganics.com](http://www.recycledorganics.com)

**Table 4 Guide for RO products application**

Soil chemical property	Why is it important?	Choosing suitable RO products
<b>pH</b>	pH is a measure of soil acidity or alkalinity. It influences availability of nutrients and provides guidance to deficiencies and toxicities of elements. Plants also have different preferences in terms of pH range.	Application of very low (<5) and high (>7.5) pH products should be avoided unless there is a specific reason for choosing a product outside this range.
<b>EC</b>	EC is a measure of soil salinity. Different plants have different preferences for soil salinity. Most plants thrive on low saline soils, some are salt tolerant plants i.e can grow on saline soils.	Application of high salinity RO products should not be applied to any soils particularly saline soils.
<b>SOM</b>	SOM strongly influences soil's chemical and physical fertility of the soil particularly structural conditions, stability and CEC.	RO products with high organic matter should be selected as organic matter can provide significant benefits to soils with low SOM.
<b>CEC</b>	CEC is the capacity of the soil to hold and exchange cations. It controls stability of soil structure, nutrient availability for plant growth, soil pH, and soil's reaction to fertilizers and other ameliorants.	RO products with high organic matter should be selected for soils with low CEC.
<b>Soil nutrients (N, P, K)</b>	Excess or insufficient nutrient availability can have negative impact on plant growth, health and yield. Excess nutrients can also result into negative environmental impacts from leaching, runoff and volatilization.	Nutrients are released from compost over time (ROU, 2003a) Total amount of nutrients available per unit time via compost application should not exceed total nutrient requirements of crops.
<b>Boron</b>	Excess B causes toxicity to plants.	Generally RO products do not contain high boron levels. Products with >200 B mg/kg dry mass can increase B levels in the soil hence may cause toxicity to plants.
<b>Sodium</b>	Excess of exchangeable sodium can cause severe soil structural problems such as surface crusting, low infiltration and water percolation.	Generally RO products do not contain high sodium levels. Application of high Na RO products should be avoided.
<b>Phosphorus</b>	Some plants are P sensitive such as native plants.	Products with >5 mg/L soluble P or >0.1 % dry mass of total P are not suitable for application on native plants, or plants of known P sensitivity.

## *Important references*

- LaMotte U.S.A (2000). Soil testing products.
- NSW DLWC (1996). Soil sampling handbook.
- NSW DLWC (2002). Guide to the use of soil test results. Internet publication: <http://www.dlwc.nsw.gov.au/care/soil/ssu/tests/tests1.htm>
- NSW Agriculture (2002). Best Practice Guidelines-Horticulture in the Sydney Drinking Water Catchment.
- NSW EPA (2002). Draft Environmental Guidelines: The Utilisation of treated Effluent by irrigation.
- Recycled Organics Unit (2002) 2<sup>nd</sup> Ed. Buyers Guide to Recycled Organics Products. Information sheet No. 6.2:Benefits of organic matter in soil. Recycled Organics Unit, internet publication: [www.recycledorganics.com](http://www.recycledorganics.com)
- Recycled Organics Unit (2003a) Product Specifier and Nutrient Budget Calculator for Organic Mulch application in Vineyards and Orchards. Recycled Organics Unit, internet publication: [www.recycledorganics.com](http://www.recycledorganics.com)
- Recycled Organics Unit (2004) Field Testing Kit Interpretation Guide to Inform Organic Mulch and Soil Conditioner Application. Recycled Organics Unit, internet publication: [www.recycledorganics.com](http://www.recycledorganics.com)

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