SWEP PTY. LTD. ANALYTICAL LABORATORIES

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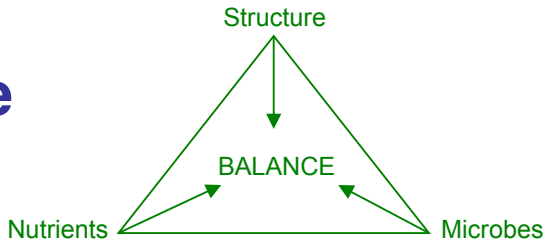
Complete Soil Balance Analysis



Sustainable Soil Management with the Mikhail Balance System

DATE ISSUED : 6/06/2011
DATE RECEIVED : 31/05/2011

FILE NO : EXAMPLE REPORT
CLIENT NAME
ADDRESS 1
ADDRESS 2

CLIENT ID : SWE001
PHONE : 03 9701 6007
REFERENCE :
REFERENCE PHONE :

E-mail: services@swep.com.au

SAMPLE ID : PADDOCK NO.1 (40HA)

LAND USE : LUCERNE

DEPTH OF SAMPLE (cm): 0 to 15

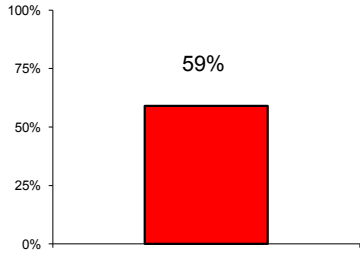
ANALYSIS REQUIRED : Complete (CT-1)

CONTENTS:

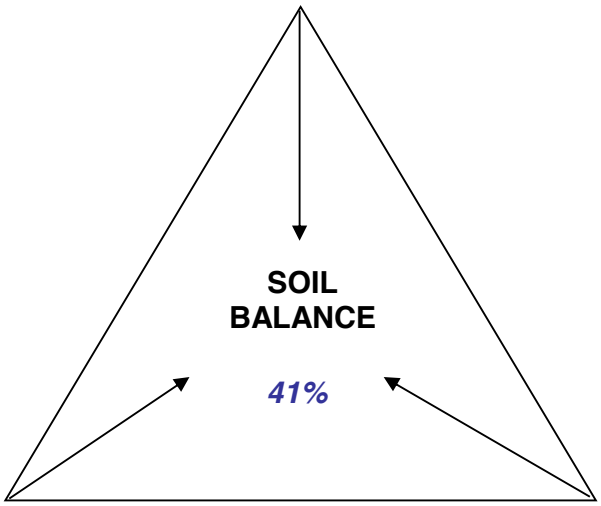
Summary of Complete Soil Balance Status

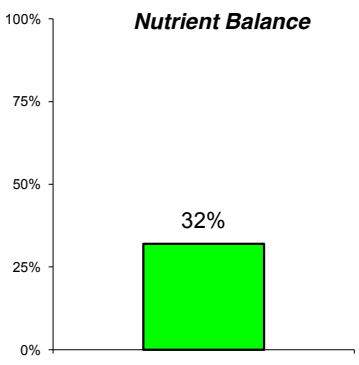
as at 31/05/2011

(Changes over time will indicate likely sustainability of production)

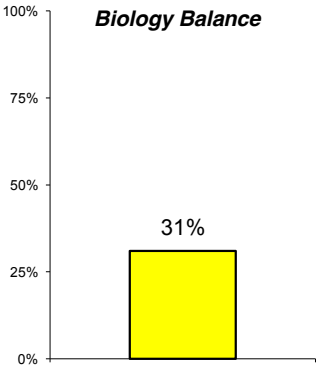


Cation Balance





Nutrient Balance



Biology Balance

Overall Soil Balance Rating

Poor	Below average	Average	Above average	Good
<20%	20%-40%	40%-50%	50%-80%	>80%

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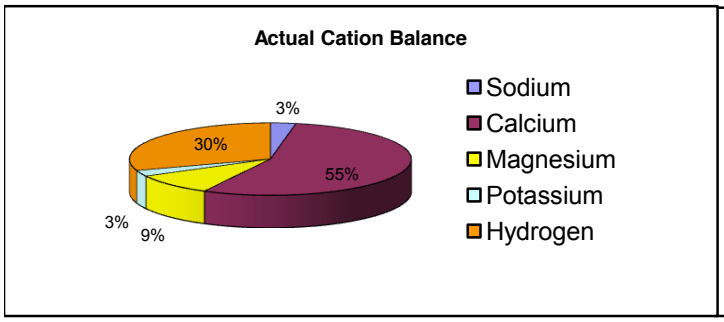
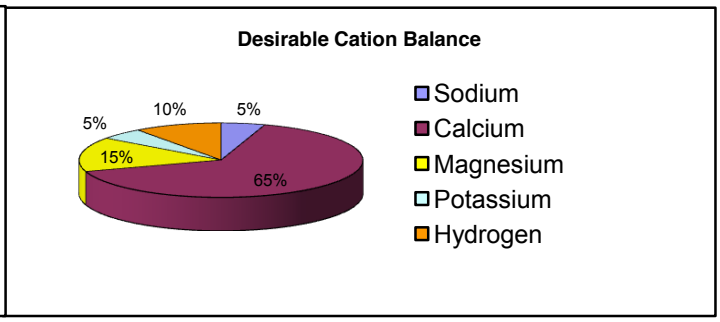
Cation Balance

ITEM			RESULT	DESIRABLE
pH(1:5 Water)			6.4	6.5-8.0
pH(1:5 0.01M $CaCl_2$)			5.9	
Electrical Conductivity	EC	µS/cm	27	< 500
TOTAL SOLUBLE SALT	TSS	ppm	89.1	< 1650
TOTAL ORGANIC MATTER %			0.11	3 - 4
TOTAL ORGANIC CARBON %			0.06	1.5 - 2

EXCHANGEABLE CATIONS			RESULTS	DESIRABLE LEVEL
CALCIUM	Ca	meq/100 of soil	2.27	2.69
MAGNESIUM	Mg	meq/100 of soil	0.39	0.62
SODIUM	Na	meq/100 of soil	0.12	< 0.21
POTASSIUM	K	meq/100 of soil	0.11	0.21
HYDROGEN	H	meq/100 of soil	1.3	
ADJ. EXCH. HYDROGEN	H	meq/100 of soil	1.25	< 0.62
CATION EXCHANGE CAPACITY	CEC	meq/100 of soil	4.19	
ADJUSTED CEC	Adj.CEC	meq/100 of soil	4.14	
SATURATION BASE PERCENTAGE	BSP		71	

EXCHANGEABLE CATION BALANCE		% OF ADJUSTED CEC	DESIRABLE
CALCIUM PERCENTAGE		54.9	65-70%
MAGNESIUM PERCENTAGE		9.4	12-15%
SODIUM PERCENTAGE	ESP	2.9	0.5-5%
POTASSIUM PERCENTAGE		2.7	3-5%
ADJ. HYDROGEN PERCENTAGE		30.1	<20%
CALCIUM / MAGNESIUM RATIO	Ca/Mg	5.79	2 - 4





CATION BALANCE CORRECTIONS *(To optimise the soil structure & condition)*

84 Kg of Calcium is needed to raise the Available Calcium to 68% and/or Exchangeable Calcium to 65%

28 Kg of Magnesium is needed to raise the Available Magnesium and Exchangeable Magnesium to 15%

GYPSUM REQUIREMENT	0 t/ha				
LIME REQUIREMENT	0.1 t/ha				
DOLOMITE REQUIREMENT	0.4 t/ha				
MAGNESIUM SULPHATE	0 kg/ha	or	MAGNESIUM OXIDE	0 kg/ha	

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NOTES ON CORRECTING THE EXCHANGEABLE CATION BALANCE

The recommendations on page 3 are essential to the process of achieving optimum soil balance. All other recommendations in this report have been formulated on the assumption that they have been applied and given sufficient time for their effects to develop. In most cases, six months will be required between application of cation balance correction and fertilisers, however, more time may be required in lower rainfall zones or dry seasons. In areas with shallow saline watertables and NO subsurface drainage, no Gypsum should be applied (even if recommended here) until adequate drainage can be provided. It should also be noted that the amounts recommended depend, in part, on the stated sample depth.

The notes, below, provide additional information relating to the applications recommended. If you require more information on any aspect of these recommendations, please contact: **SWEP on (03) 9701 6007.**

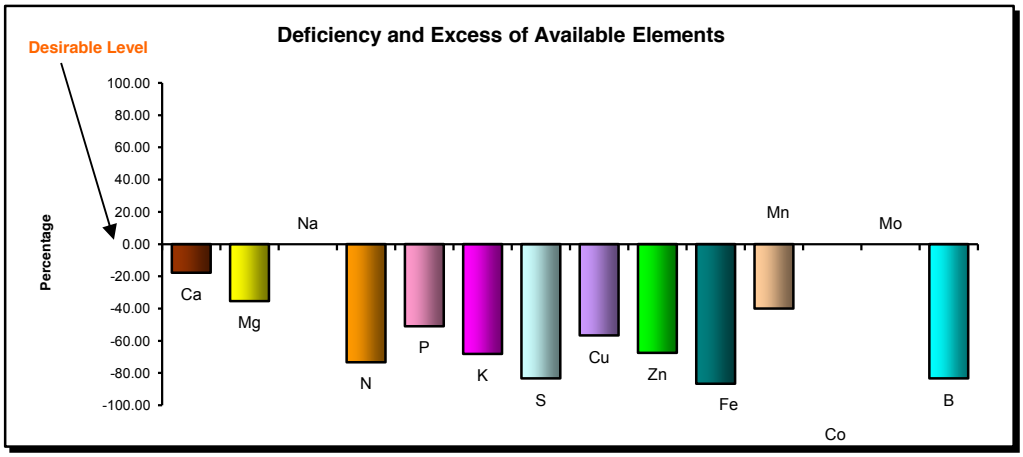
For all required materials - Gypsum/Lime/Dolomite/Magnesium Sulphate/Magnesium Oxide (where surface application is necessary and irrigation is not available), the total application should be limited to roughly 2.5 t/ha per year. This limitation does

Lime is recommended to replace any excess of exchangeable Hydrogen with exchangeable Calcium. The calculated application rate is based on Lime containing 40% Calcium (ie. pure Calcium Carbonate). Due to the high level of variation in available materials, this is the only standard we can apply. In practice, any Lime with an ENV of 70 or more should be adequate to apply at the recommended rate, while materials with an ENV of less than 50 may be ineffective even with an adjusted rate of application. However, if you wish to adjust the application rate according to the actual quality of the material you intend to use, call SWEP for a copy of our "Soil Ameliorant Calculator".

Dolomite is recommendation in order to replace any excess of exchageable Hydrogen with Calcium & Magnesium. The application rate is calculated to provide the Magnesium requirement. Any additional Calcium not provided by this application will be added as Lime. The calculated application rate is based on material containing 11% Magnesium and 25% Calcium, which is the minimum legal requirement for materials labelled as Dolomite in Victoria. Again, adjustments to the rate according to the actual levels in locally available material can be made using our "Soil Ameliorant Calculator".

Nutrient Balance

ITEMS			RESULTS	DESIRABLE LEVEL
AVAILABLE CALCIUM	Ca	ppm	486	591
AVAILABLE MAGNESIUM	Mg	ppm	50.4	78
AVAILABLE SODIUM	Na	ppm	29.9	< 50
AVAILABLE NITROGEN	N	ppm	4	15
AVAILABLE PHOSPHORUS	P	ppm	14.7	30
AVAILABLE POTASSIUM	K	ppm	46.8	147
AVAILABLE SULPHUR	S	ppm	0.5	3 - 5
AVAILABLE COPPER	Cu	ppm	1.3	3
AVAILABLE ZINC	Zn	ppm	1.3	4 - 6
AVAILABLE IRON	Fe	ppm	4	> 30
AVAILABLE MANGANESE	Mn	ppm	12	> 20
AVAILABLE COBALT	Co	ppm	0.6	0.5-0.7
AVAILABLE MOLYBDENUM	Mo	ppm	0.1	0.1-0.2
AVAILABLE BORON	B	ppm	0.1	0.6-1.0
TOTAL PHOSPHORUS	TP	ppm	152	
TOTAL NITROGEN	TN	%	0.086	



Notes:

- Phosphorus fixation effects if Iron is more than 300 ppm
- Manganese will be at toxicity level if it reaches 500 ppm

PLANT NUTRITION REQUIREMENTS

(For the specified Land Use over the period of its growing season)

TOTAL FERTILIZER REQUIREMENT (kg/ha)	N	P	K	S
	11	20	100	26

WITH	COPPER	1.13 kg	IRON	3.5 kg
	ZINC	4.5 kg	MANGANESE	2.5 kg
	COBALT	0 - 0.1 kg	BORON	0.45 kg
	MOLYBDENUM	0 kg		

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NOTES ON ACHIEVING BALANCED PLANT NUTRITION

The recommendations on page 5 are for provision of Balanced Plant Nutrition to the stated Land Use, but it is important that neither the major elements nor Trace Elements are supplied at the same time as the Cation Balance Corrections (page 3) could limit the availability of nutrients to the crop or pasture.
SWEP does not recommend or promote specific products, so all recommendations are given in kg/ha of actual nutrient. These must be converted into applications of fertiliser. For assistance in doing this, consult your local supplier.

The notes, below, provide additional information relating to the applications recommended. If you require more information on any aspect of these recommendations, please contact: **SWEP on (03) 9701 6007.**

For Pasture, it is important to maintain the proper relationship between Copper (Cu) and Molybdenum (Mo). Where 'Moly' is required, you may see we have also recommended Cu, even though the soil test may not indicate Copper requirement. This will protect against the risk of any subsequent animal health problems. If you wish to avoid applying this Copper (when soil levels are adequate), you MUST ensure AT LEAST 6 WEEKS between the application of Molybdenum and the re-introduction of livestock.

If the soil pH (water) is below 5.7, Trace elements should not be applied until the Lime &/or Dolomite applications have had time to raise the pH above this level.

For soils with a pH (water) of 8.0 or more, apply Trace Elements as a foliar spray only.

TOTAL FERTILISER RECOMMENDATION APPLICATION FOR SPECIAL LANDUSE

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Indicators of Soil Biological Activity

The biological community in the soil is extremely diverse. To get a proper understanding of its 'health' we look at a few so-called "Indicator" groups. These have important functions upon which plants and other organisms depend.

The first thing to remember is that SWEP results are for ACTIVE micro-organisms only. This means only those that will immediately grow under ideal conditions (generally about 7-10% of total soil biomass). This allows us to analyse samples year round, since the microbes that are active in spring will still be present in summer or winter, but at very reduced levels of activity. Given the ideal conditions in our cultures, they will spring back to life and grow much more quickly than others.

Also in assessing the results from your test, bear in mind that the soil is a complex ecosystem, but ecosystems are more than just biological communities, they are the product of environmental factors, available resources AND biology, disturbance in one or more of these areas will effect what happens in the biological community. The greater the disturbance, the more potentially variable the results, with higher total populations, dominated by one or two groups.

Active Indicator Organisms

Photosynthetic bacteria like *Rhodopseudomonas spp* and *Bradyrhizobium spp* require only sunlight, carbon dioxide and mineral nutrients to survive. They are important in recycling organic matter, particularly compounds that are difficult to break down - such as pesticide and petrochemical residues. They are also important for synthesis of bio-active compounds that are known to stimulate plant growth.

Yeasts such as *Saccaromyces spp, Debaryomyces spp, Torulopis spp* and *Rhodotrula spp* synthesise plant growth substances from amino acids and sugars that are produced by photosynthetic bacteria. These substances also promote the growth of Lactic acid bacteria and Actinomycetes.

Lactic acid bacteria such as *Lactobaccillus spp, Leuconostoc spp, Lactococcus spp* and *Pediococcus spp* produce Lactic Acid from sugars and carbohydrates. Lactic acid is a strong bio-suppressive compound that helps control harmful micro-organisms. This effect, together with other trace nutrients produced by members of this group, is particularly beneficial to the growth of Photosynthetic bacteria and Yeasts.

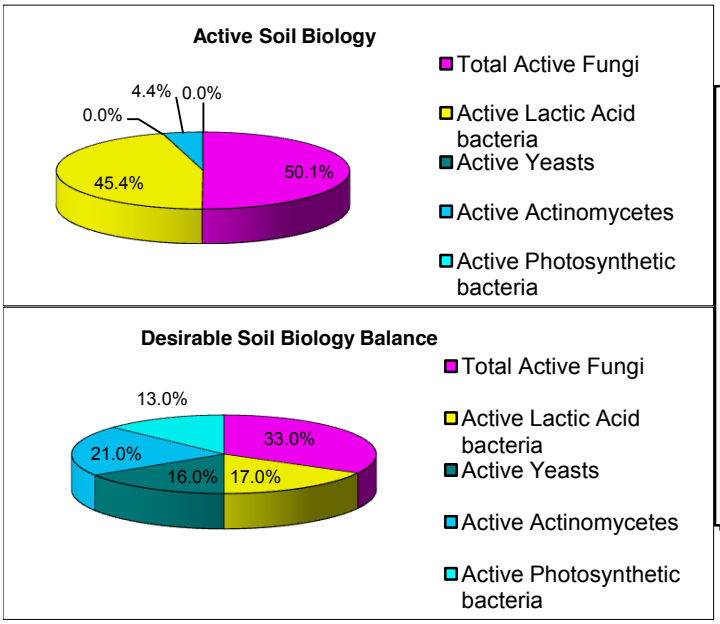
Actinomycetes such as *Actinomyces spp* and *Streptomyces spp* produce antibiotic compounds that are effective suppressants of pathogenic organisms. They have also been shown to produce plant hormones - especially when treated with kelp extracts.

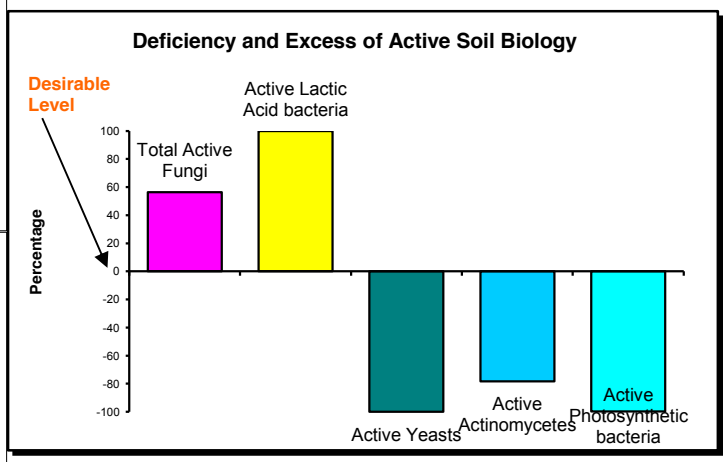
Fungi such as *Aspergillus spp, Penecillium spp, Mucor spp* and *Rhizopus spp* have many beneficial effects on plant growth. These include the production of enzymes, antibiotics and various growth regulators. They are also important in the conversion of organic matter to humic substances. Some of the less complex compounds produced from this process are also important food sources for some bacteria.

Cellulose Utilisers like *Trichoderma spp* require only minerals and cellulose for growth. These fungi break down plant remains into organic materials that are beneficial to other micro-organisms such as Protozoa.

Biology Balance

ITEM			Result	% of TAP	Desirable	% Desirable
ACTIVE LACTIC ACID BACTERIA	cells/g soil		180,000	45.4%	65,344	17.0%
Active Fungi	cells/g soil	153,000				
Cellulose utilisers	cells/g soil	45,500				
TOTAL ACTIVE FUNGI	cells/g soil		198,500	50.1%	126,845	33.0%
ACTIVE YEASTS	cells/g soil		100	0.0%	61,501	16.0%
ACTIVE ACTINOMYCETES	cells/g soil		17,500	4.4%	80,720	21.0%
ACTIVE PHOTOSYNTHETIC BACTERIA	cells/g soil		100	0.0%	49,969	13.0%
Total Active Population (TAP):	cells/g soil		396,200		384,379	
CARBON/NITROGEN RATIO			0.6		10-15	





SOIL BIOLOGY MANAGEMENT

(To help accelerate changes in soil structure and nutrient availablility)

Kelp extract	5 litres/ha	To encourage Actinomycetes, Yeast, Photosynthetic and/or discourages Fungi
Molasses	0 litres/ha	
Worm leachate	10 litres/ha	To encourage Photosynthetic bacteria, Fungis and/or Actinomycetes
Fish emulsion	2 litres/ha	Helps improve the C:N ratio & discourages Lactic Acid Bacteria
Liquified humate	0 litres/ha	
Mulch or Green Manure	***Beneficial***	To encourage various Fungi

NB. Use only good quality materials & for best results, apply twice annually.

PREVIOUS APPLICATIONS		DATE OF APPLICATION
GYPSUM APPLIED	t/ha	
LIME APPLIED	t/ha	
DOLOMITE APPLIED	t/ha	

Trace elements	Cu	Zn	Fe	Mn	Co	Mo	B
kg/ha							
Date of application							

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PREVIOUS BIOLOGICAL APPLICATIONS	DATE OF APPLICATION
Kelp extract	litres/ha
Molasses	litres/ha
Worm leachate	litres/ha
Fish emulsion	litres/ha
Liquified humate	litres/ha
Mulch or Green Manure	

NOTES ON IMPROVING SOIL BIOLOGY MANAGEMENT

The recommendations on page 8 are not intended to directly adjust the numbers of microbes in the soil, but rather to encourage the activity of particular groups in order to help accelerate cation balance changes and optimise nutrient availability.

The notes, below, provide additional information relating to the applications recommended. If you require more information on any aspect of these recommendations, please contact: **SWEP on (03) 9701 6007**.

Kelp extracts contain high concentrations of plant hormones (auxins, cytokinnins, etc.). These have been shown to significantly increase the biological activity in soils, and especially that of Actinomycetes and Cellulose utilisers. Cellulose utilisers (as the name suggests) are important in the breakdown of cellulose and certain other resistant materials, thus increasing the formation of humus and helping to improve soil structure. Actinomycetes also help provide protection against soil-borne pathogens.

Molasses provides a readily metabolisable carbon and energy source for soil organisms. Although most soil organisms can utilise this, it is of particular value to fermenters like Yeasts and Lactic Acid Bacteria. However, being quickly utilised, it will provide only a short-term benefit unless other actions have been taken to improve the soil environment.

Worm leachate contains a range of growth promotants that are of particular benefit to Photosynthetic Bacteria and Actinomycetes. Photsynthetic bacteria are of particular importance in the breakdown of highly resistant organic compounds (including some pesticides). They can exist to some depth in soil as they utilise different wavelengths of light to green plants. It is this energy source that allows them to perform their vital role in the soil.

Fish emulsions are a source of readily available organic Nitrogen and can be especially useful when this is needed to improve the carbon-nitrogen ratio in the soil. They are also beneficial in stimulating growth and activity of many micro-organisms, but especially Yeasts and Bacteria. The net effect is an increase the potential for nitrogen cycling and so also a somewhat reduced requirement for nitrogen inputs to some crops and pasture. For this potential to be realised, however, other corrective measures must be applied first.

You should also be aware that some fish emulsion products contain other added nutrients to render them appropriate for use as conventional fertilisers and that the concentration of products can vary significantly. For best results with these products talk to your supplier about any adjustments to our recommended application rates and/or changes to your nutrient applications that may be appropriate.

Liquified humate adds carbon to the soil in the form of humic substances. It is a useful material where adjustment of the carbon-nitrogen ratio is required. It is also important in releasing bound nutrients into plant available forms and helping to improve soil structure. The direct effects on soil biology are similar to those of Kelp extracts in that many humic substances appear to have an auxin-like activity. Like Fish Emulsions, concentration and inclusion of added nutrients may need to be taken into account for specific products.

Mulching or Green Manuring is an effective means of improving organic matter levels and protecting soil structure in cultivated soils. The breakdown of this material is initially conducted by soil Fungi (especially in clay soils). For pasture, alternatives include regular light harrowing (after grazing) and adjustments to normal grazing practices, etc.

ANALYTICAL METHODS

Items	Methods
pH (1:5 Water)	4A1
pH (1:5 $CaCl_2$)	4B1
Electrical conductivity (1:5 Water)	3A1
Total Soluble Salts	Calculation from Electrical conductivity
Exchangeable Calcium	15D3 or 15A1
Exchangeable Magnesium	15D3 or 15A1
Exchangeable Sodium	15D3 or 15A1
Exchangeable Potassium	15D3 or 15A1
Exchangeable Hydrogen	Barium Chloride-Triethanolamine method*
Available Nitrogen	Calcium Chloride-Brucine method (colorimetric)
Available Phosphorus	Olsen extractable, 9C1
Available Sulphur	Ammonium Acetate extraction
Available Copper	EDTA, 12B1
Available Zinc	EDTA, 12B1
Available Iron	method of E.H. Mikhail (1981)
Available Manganese	method of E.H. Mikhail (1981)
Available Cobalt	EDTA, 12B1
Available Molybdenum	Ammonium Oxalate-Oxalic acid-di-iso propyl ether
Available Boron	12C2
Total Organic Matter	modified Walkley & Black, 6A1
Total Phosphorus	Acid digestion
Extractable Aluminium	15G1
Total Nitrogen	Dumas method, 7A5
Total Calcium	Acid digestion, ICPAES
Total Magnesium	Acid digestion, ICPAES
Chloride	5A1
Available Silica	Dithionite-Citrate method**

NB. For available Iron and Manganese, SWEP uses the method developed by E.H. Mikhail (1980) due to the tendency for the standard EDTA method to produce erroneously high results.

For numbered test methods:
Rayment, G.E. & Lyons, D.J. (2011). Soil Chemical Methods - Australasia. CSIRO Publishing, 150 Oxford Street, Collingwood Vic 3066, Australia.

*Peech, M., Cowan, R.L. & Baker, J.H. (1962). Soil Science Society American Procedures, A critical study of the Barium chloride-Triethanolamine and ammonium acetate methods for determining exchangeable Hydrogen of soils.

** Ross, G.J. & Wang, C. (1993). Soil Sampling and Methods of Analysis, CRC Press, Boca Raton, Florida, USA.