Attachment 1

Terms of Reference:

Soil Survey Requirements for Plantation Evaluation

1. *Soil survey tender*

Experienced soil surveyors are invited to provide tenders to undertake soil surveys for *Pinus radiata* plantations, during the 12 months from November 4, 1991. The soil surveys represent an integral part of the process of selection of properties for plantation establishment, and the preparation of management plans.

The properties to be assessed will be those offered by landholders during this period within the 600 mm rainfall isohyet, in south-western Australia. From past experience properties will be offered on a range of soils, and will range in size from 30 ha. Most properties to be assessed will be on cleared land.

2. *Aims of soil surveys*

The aims of the soil surveys are to:-

- Identify the major soils, and their areal extent, and present this information on a soil (not landscape) map.
- Identify those soils where tree performance will be impaired by soil and site conditions. These will generally be those factors which affect the moisture availability to the trees, and plant stability (i.e. Valentine 1986).
- Provide information so that CALM can produce parametric maps (i.e. hardpan distribution, waterlogging hazard).

3. *Context of soil survey*

It is proposed that the soil surveys be undertaken in two major phases:

- The description and mapping of the major soils (Surveyor).
- The excavation of backhoe pits at selected sites in the landscape (Surveyor/CALM).

The first phase should be considered as a stand-alone exercise, however in a proportion of the sites CALM personnel will use a backhoe to provide a better understanding of the soils (sect. 4.5).

4. *Soil survey criteria*

4.1. *Scale*

A mapping scale of 1:10 000 will be used.

4.2. *Mapping base and photography*

An aerial photographic enlargement at a scale of 1:10 000 will be provided, for use as a mapping base. Stereo-contact prints will also be provided, both of the most recent aerial photography, and also of historical runs if available, and if required. Where available colour photography will be provided.

4.3. *Field inspections*

4.3.1. *Field inspection strategy*

It is envisaged that the surveyor has control over the selection of sampling sites. Free survey, using interpretations of both aerial photography and the landscape is acceptable, provided adequate ground observations are made.

4.3.2. *Intensity of sampling*

A mean of one soil observation per hectare is required.

4.3.3. *Depth of sampling*

The depth of sampling will depend on the terrain. It is envisaged that a minimum sample depth of 1.2 m be adhered to, for 80% of the holes, with the remainder of the the holes to depths of 2.0 m, over the range of soils.

An indication of how the tender price will vary with variations in depth and number of soil observations is required.

4.3.4. *Method of sampling*

Soils can be examined in auger holes or pits. Probes pushed into the ground are not acceptable.

4.3.5. *Attributes recorded*

4.3.5.1. Soils

Soils will be described according to McDonald and Isbell (1990). A minimum data set is:-

- Depth of each major soil horizon.
- Texture and colour (Munsell or Japanese soil colour charts) of each major horizon. An indication of amount and intensity of mottling.
- Depth, thickness, and nature of any root impenetrable layers.
- Nature of any parent rock and segregations.
- Profile drainage (i.e. waterlogged, or well drained).
- Other hazards (salinity etc).

4.3.5.2. Geomorphology

Classification of landscape position (i.e. crest, midslope, lower slope), and geomorphological element (dune, ridge) according to Speight (1990).

4.3.5.3. Method of recording field data

Field data will preferably be recorded on the field description sheet (Figure 20) of McDonald *et al.* (1990).

4.4. Soil map and legend

4.4.1. Map presentation

Soil mapping delineations, and location of all sequentially numbered field observation sites will be drawn on a transparent overlay to the aerial photograph enlargement (overlay provided by CALM), and on a separate plain paper copy. The major soil classes will be coloured by pencil.

Computer drafting of the soil map is not required.

4.4.2. Minimum delineation

A minimum delineation of 1.0 ha is required. Each delineation exceeding this area will require a complete soil profile description.

4.4.3. Mapping Units

Soil map to comprise Soil Mapping Units (SMU), each preferably comprised of a single Soil Profile Class (SPC, Isbell, 1988). If complex mapping units have to be used, due to soil complexity, an indication of relative proportions, and nature of interrelationships between soil and landscape is required.

Soil Profile Classes will be analogous to the series and phases of the USDA (Soil Survey Staff 1975, Dent and Young 1981), however both the SMU and SPC will be defined by the surveyor in the field. The mapping units must be composed such that differences in drainage, depth of soil and texture can be recognised.

4.4.4. Legend (Field Classification)

The map legend will list each soil mapping unit, with an indication of aerial extent, composition (of SPC), landscape relationships and drainage.

4.5. Supplementary examination of soils

CALM may supply a backhoe, and Research Scientist, to examine the soils in more detail. This will allow:

- Verification of mapping units on the soil map.
- Inspection of subsoil structures, rooting patterns, the distribution and continuity of pans, and drainage.
- Sampling of profiles for physical and chemical analyses.
- Photography of type profiles.

- Follow up observations to those made by the surveyor in the field.

Surveyors are invited to provide a separate quote for this phase of the work, on a daily basis.

4.6. *Report*

A report is required which will be an extension of the field legend, and be around 4-5 A4 pages in length. It will include:

- Description of each mapping unit, with an indication of the relationship to the landscape.
- Description of modal Soil Profile Classes, with horizons classified according to McDonald and Isbell (1990), and an indication of the range in individual attributes.
- Classification of the SPC according to Northcote (1979), Stace *et al.* (1968) and an estimate made of the Orders and Sub-Orders in Soil Taxonomy (Soil Survey Staff 1975).
- Brief notes to be made, for each soil, of the factors which are likely to limit the growth of plantation trees, and any recommendations for management. Notes on any other factors which are relevant for soil survey.

4.7. *Soil analysis*

Soil sampling and analysis will not be required in the general soil survey.

5. *Other*

5.1. *Field Assistance*

CALM may be able to provide labour assistance in the field. An indication is required as to how such assistance will affect the cost of undertaking the work.

5.2. *Equipment*

Contractor will supply own equipment and vehicles, apart from that specified in these notes.

5.3. *Accommodation and travel expenses*

Accommodation and travel expenses are the responsibility of the contractor.

5.4. *Liaison with landholder*

Once locations of properties have been provided, property access arrangement will be made between the CALM Field Manager and the surveyor.

5.5. *Filling of inspection holes*

The surveyor is responsible for filling in those inspection holes that he/she may has dug.

5.6. *Quality Control*

Soil mapping units will have at least 70% purity.

Mapping may be checked by CALM using a backhoe.

5.7. *Technical expertise*

The successful tenderer will state the names of those staff who will undertake the field mapping, together with an indication of their qualifications and field experience. Examples of completed large scale soil surveys, using techniques similar to those proposed in these terms of reference, will be provided if requested.

5.8. *Data ownership*

All data collected will remain the exclusive property of CALM. All original field data and maps will be provided to CALM on completion of the survey.

5.9. *Time frame*

Several properties are available to be surveyed immediately. It is envisaged that a period of 1 week will elapse between the provision of aerial photographs and survey completion. Notification of properties that are available to be surveyed will be made immediately that they have passed an initial assessment by CALM (i.e. aerial photographs will be ordered at the same time).

Most properties will be available during the period November - March.

6. *Quotation*

6.1. *Soil mapping*

Quotation on a per hectare surveyed basis:

1 For the provision of a soil map, description of modal SPC and preparation of final report of cleared agricultural land.

2 An indication is required as to how this quotation will vary with the number and depth of the examination holes.

3 An indication as to how the quotation will vary with the provision of a field assistant.

4 An indication of the variation in cost if uncleared land is surveyed.

6.2. *Soil mapping and supplementary profile examination*

Quotations as above, however modal profiles described in pits prepared by backhoe (supplied by CALM or surveyor). The soil mapping component will be on a per hectare

basis, as above, and should be less than that quoted in section 6.1.1, as that quote includes both mapping and profile description. Quotation for supplementary soil profile examination in soil pits should be on a daily basis.

6.3. *Additional work*

An indication of additional studies that the surveyor might consider to be essential is required, together with the cost.

7. *References*

Dent, D. and Young, A. 1981. *Soil Survey and Land Evaluation.* George Allen and Unwin, London. 278 pp.

Isbell, R.F. 1988. Soil classification. In *Australian Soil and Land Survey Handbook – Guidelines for conducting surveys.* R.H. Gunn et al. (eds), pp 20–37, Inkata Press, Melbourne.

McDonald, R.C. and Isbell, R.F. 1990. Soil Profile. In *Australian Soil and Land Survey Handbook – Field Handbook,* 2nd ed. McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. (eds), pp 103–152, Inkata Press, Melbourne.

Northcote, K.H. 1979. *A Factual Key for the Recognition of Australian Soils.* Rellim, Adelaide. 124 pp.

Soil Survey Staff. 1975. Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys. USDA Handbook N° 436. Govt Printer, Washington.

Speight, J.G. 1990. Landform. In *Australian Soil and Land Survey Handbook – Field Handbook,* 2nd ed. McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. (eds), pp 9–57, Inkata Press, Melbourne.

Stace, H.C.T., Hubble, G.D., Brewer, R., Northcote, K.H., Sleeman, J.R., Mulcahy, M.J. and Hallsworth, E.G. 1968. *A Handbook of Australian Soils.* Rellim, Adelaide.

Valentine, K.W.G. 1986. *Soil Resource Surveys for Forestry. Soil, terrain, and site mapping in boreal and temperate forests.* Monographs on Soil and Resources Survey N° 10, Clarendon Press, Oxford. 147 pp.

R.J. Harper

Research Scientist

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