Site selection guidelines for *Eucalyptus globulus* plantations in SW Western Australia - April 1996

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1. Introduction

Land evaluation for commercial forestry is aimed at providing information to maximise returns on investment. This is done by identifying factors which limit tree productivity (growth and survival), and their variability across the land being offered.

Plantation profitability will be increased by not only avoiding sites where tree growth is sub-optimal but by applying inputs where they are needed rather than on a prescription basis. Examples include:

* application of silvicultural treatments (ripping, mounding and drainage)
* prediction of erosion hazards (water and wind) at plantation establishment
* trafficability at harvest
* reducing any environmental impacts on plantations (nutrients and herbicide leaching)

Similarly, where the trees are integrated into farming systems soil and land information is needed to maximise land conservation benefits, such as:

* the control of salinity and waterlogging
* wind breaks for soil, crop and livestock protection

These guidelines should be undertaken within the context of soil and land survey, using current Australian Standards (Gunn *et al.* 1988), using suitably trained staff. The guidelines apply to broad-scale and block plantations in areas where annual rainfall is assumed to be adequate (>600 mm).

The best *Eucalyptus globulus* growth occurs on sites which:

(a) are moderately to well drained with access to fresh water in the summer growing months, due to either storage or seepage,

(b) have moderate to high fertility built up under preceding pasture

(c) have no hazards due to salinity, shallow waterlogging or wind exposure

2. Guidelines

Guideline 1: Soils should be >2 m deep. Soil depth is defined as the depth to saprolite or rock (i.e. granite, gneiss, dolerite, spongolite, limestone), whichever is shallower. As saprolite may be penetrated by drill rigs, inspection via backhoe

pits is recommended to assess likely root penetration. Where the soil surveyor can reliably identify saprolite in the drill product, drill rigs can be used.

Laterite (ironstone, ferricrete) boulders and gravel are treated as soil and not basement rock. Laterite can, however, occur as a continuous sheet (duricrust, laterite cap) and backhoe inspections are necessary to determine whether this is root penetrable.

Guideline 2: Poor tree growth is expected on sand dunes with white-pale yellow sand horizons >2 m deep and these sites should be avoided. Sands in non-saline, water-gaining areas may in some areas be quite productive.

Guideline 3: Sites with waterlogging, within 1 m of the surface for more than 2 months a year should not be planted[1]. Indications of waterlogging problems include gleyed sub-soil clays and paperbark (*Melaleuca* spp) and rushes (*Juncus* spp).

Guideline 4: The current status of salinity should be assessed with an electrical conductivity meter, such as the Geonics EM38. Sites with EM38 values >25 mS m^{-1} on sandy soils and 50 mS m^{-1} on other soils are to be avoided (Bennett and George 1995).

Guideline 5: The future risk of salinity accompanying rising groundwater tables should be determined with drilling to 6-10 m. Drilling will be required on all properties where there is current expression of salinity (i.e. EM38 values >50 mS m^{-1}). Sites with saline (>2000 mS m^{-1}) water within 4-5 m of the surface should not be planted.

Guideline 6: The requirement of phosphorus and potassium fertilizers can be assessed via analysis of surface (0-10 cm) soil samples. Each bulk sample will consist of 15-20 sub-samples taken from an area of 1-2 ha. Fertilizer recommendations depend both on the soil test value, soil water relations and likely yield. Fertilizer recommendations will be provided in a separate memo.

Guideline 7: All of the above factors should be assessed via a soil survey, using accepted Australian standards, using suitably trained staff. A detailed procedure for undertaking these site surveys is attached (Appendix 1)

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[1] Waterlogging effects on tree growth and survival will mainly occur following very wet years; this is analogous to the situation with drought deaths occurring on shallow soils, following dry years. These sites may also be predisposed to windthrow.

Appendix 1.

3. Site survey procedure

3.1 All plantations

The recommended site evaluation procedure consists of three stages:

- *Initial reconnaissance*: In this stage all broad-scale attributes can be assessed, such as climate, broad landform, land-use zoning, drainage
- *Site survey*: This involves an on-site assessment of the property. This includes determining the distribution and properties of the major land management units. For each land management unit an array of information, such as soil depth, fertility, salinity (current status and future risk), hydrology and geomorphology (slopes) will be assembled.
- *Evaluation*: This involves the interpretation of the site survey information. For each of the mapping units a series of evaluations can be made, such as potential productivity, drought risk, silvicultural requirements (ripping, mounding etc), erosion hazards. These can be presented as either tables or maps of individual themes. For example, a map may be used to show the distribution of those soils likely to benefit from ripping, with an area summary, for use with budget calculations.

3.2 Special requirements for shelterbelts and integrated plantings

Apart from wood production, shelterbelts also have the aim of producing environmental benefits to farms, such as the reduction of salinity, waterlogging and wind erosion. To optimize the benefits of any tree plantings it is important that the pattern of potential land degradation is understood. Before any advantage can accrue it has to be clear that there is in fact a problem, and that trees can provide a solution.

Farmers do not however manage their farms for land degradation, but for the production of crops and livestock. Hence, tree plantings will also have to fit into a farm-plan, which takes into account several objectives. It is essential that the site-surveyors have expertise in farm-planning.

4. Specifications for site evaluation for farm forestry

4.1 Aims

Aims of the site surveys are to:

- Identify the area of plantable land via a map of major soils, presented as a series of Land Management Units (LMU).
- For each LMU identify potential productivity, any constraints to tree performance and necessary management inputs.
- Produce parametric maps (i.e. productivity, hardpan distribution, waterlogging hazard) so that management decisions can be made for each LMU.

4.2 Site survey guidelines

4.2.1 Initial reconnaissance

When a property is initially offered for tree planting the general suitability can be derived from local knowledge, and regional soil-landscape mapping, climate and distance from mill or port.

Land availability will also be determined by attributes such as:

- areas with slopes <15%
- streams, roads, powerlines and other easements
- patently unplantable areas such as lakes, salt flats, rock outcrops
- mineral claims and other land tenure issues
- visual impact
- land-holder preference

After these attributes have been determined, the soil survey can proceed if suitable areas of land are considered available.

4.2.2 Site survey

All site survey work should be undertaken using current Australian standards (McDonald *et al.* 1990). This will allow an interface with the spatial information collected by other agencies (i.e. DOLA, Agriculture WA) and the with GIS based management systems under development within CALM (PMAP, PMIS).

- A mapping scale of 1:10 000 will be used, using an aerial photographic enlargement (scale 1:10 000) as a base. If possible this will have been digitally corrected for distortion.
- Mapping will occur using a free survey approach rather than grid technique. Free survey relies both on field observations and an interpretation of both aerial photography and landscapes. Stereo-contact prints are used for air-photo interpretation of major mapping units, based on landforms, prior to field work.
- An observation density of at least 1 hole/ha is required; in some areas (i.e. shallow soils) more observations will be required, in others (i.e. laterite with deep weathering profiles), less. Each observation point will be encoded using a GPS.
- The depth of sampling will be to a depth of at least 2 m. A drill rig will be used.
- At each site observations will be made of the depth of each soil horizon, texture and colour, the nature of any root impenetrable layers, parent rock type, drainage and likely salinity hazard. The will be recorded using Australian standard methods (McDonald *et al.* 1990).
- Salinity will be assessed using a Geonics EM 38 meter, at each field observation point. As the readings from this meter are also affected by soil moisture content, and depth of sand horizon, it should be calibrated for each property surveyed. For a range of 8-10 drill holes across the property, samples should be taken, at 50 cm depth intervals, and submitted to the laboratory for salinity (EC) analysis. Using this calibration, the EM38

readings can be corrected for local variations induced by moisture content, sand horizon depth and other factors. Sites with EM38 values of >25 mS m^{-1} on sandy soils, and >50 mS m^{-1} on other sites should not be planted.

- The risk of future salinity will be determined by reference to landscape position, clearing history and if necessary examination of ground waters. Detailed drilling is not possible at all sites. As a guide sites where the watertable is within 4-5 m of the surface and salty (>2000 mS m^{-1}) should not be planted. Hydrological advice should be sought where considered necessary.

- A back-hoe examination of soils will be required in some instances. Although a drill rig will be used, this will be inadequate in some situations, such as determining if ferricrete (ironstone) pans are continuous, or the nature of sub-soil clays. Both situations may affect tree growth and survival .

- Land Management Units will be developed from this information and air-photo interpretation. These will comprise groups of soils which are likely to perform in a similar manner. Hence, for each mapping unit it will be expected that there will be differences in likely tree performance or management inputs. A minimum management area of 1 ha will be used.

4.2.3 Interpretation

- The LMU will be interpreted for a number of aspects such as likely tree survival and productivity, silvicultural requirements, environmental considerations. These interpretations will be summarized as specialised maps and summary tables. From these economic analysis of plantation can proceed. Similarly, an estimate of the suitable planting area can be prepared, and a proposal made to the land-holder.

- For those properties where a plantation will be proceeded with, the site survey information will be entered onto a geographic information system (GIS). Information Management Branch are developing plantation management information systems (PMAP, PMIS), which will contain all relevant information about the property.

- Specialized interpretations will be required for the integration of strips and blocks of trees onto farms, to take into account farm infrastructure, water movement and optimising land conservation benefits of tree planting. This may proceed in a different way to the selection and planting of a large traditional plantation. Particular soils, for example, may be unproductive under agriculture (i.e. deep sands) but be nominated for forestry. Specialized skills are required for such interpretations.

- Soil samples (0-10 cm deep, 20 sub-samples) will be taken from each of the LMU which will be planted and assessed for available phosphorus (bic-P), potassium and organic carbon. These will provide the basis for fertiliser recommendations.

5. Further reading

Bennett, D. L. and George, R. J. (1995). Using the EM38 to measure the effect of soil salinity on *Eucalyptus globulus* in south-western Australia. *Agricultural Water Management* 27, 69-86.

Gunn, R. H., Beattie, J. A., Reid, R. E. and van de Graaff, R. H. M. (1988). 'Australian Soil and Land Survey Handbook — Guidelines for Conducting Surveys.' (Inkata Press: Melbourne.)

McDonald, R. C., Isbell, R. F., Speight, J. G., Walker, J. and Hopkins, M. S. (1990). 'Australian Soil and Land Survey Field Handbook.' 2nd Edn. (Inkata Press: Melbourne.)