CHAPTER 6 - LAYING OUT THE ROADLINE

6.0 INTRODUCTION

This chapter describes how to plan a road location on a topographical map, and locate its position in the field for construction. There are also sections which explain geometric road design, how to check for adequate sight distance, and the setting out of a designed road for construction.

The flow chart in figure 23 shows procedure which should be followed when planning and setting out a roadline in the field. The sight distance section (6.4.4) may be used separately when checking for available sight distance on existing roads.

6.1 PLANNING

The first step in harvest planning is to locate the landings, since their position is critical in ensuring an efficient harvesting operation. It is then assumed that the start and end points of the roads are known since the positions of the landings have already been planned. However, there may be occasions when it is not possible to get a road to a proposed landing at a reasonable cost. In this situation, the landing position will need to be changed, or an alternative harvesting system used (e.g. two staging).

6.1.1 Terrain Information

Terrain information is vital to road planning. There are several sources that are used in combination:

Field Work

There is no substitute for a physical inspection of the road settings. A first visit should take place before any detailed planning work has begun, The visual image gained from this inspection will make the interpretation of aerial photographs and maps much easier. The site should also be re-inspected during the planning process to check the feasibility of any proposed roads.

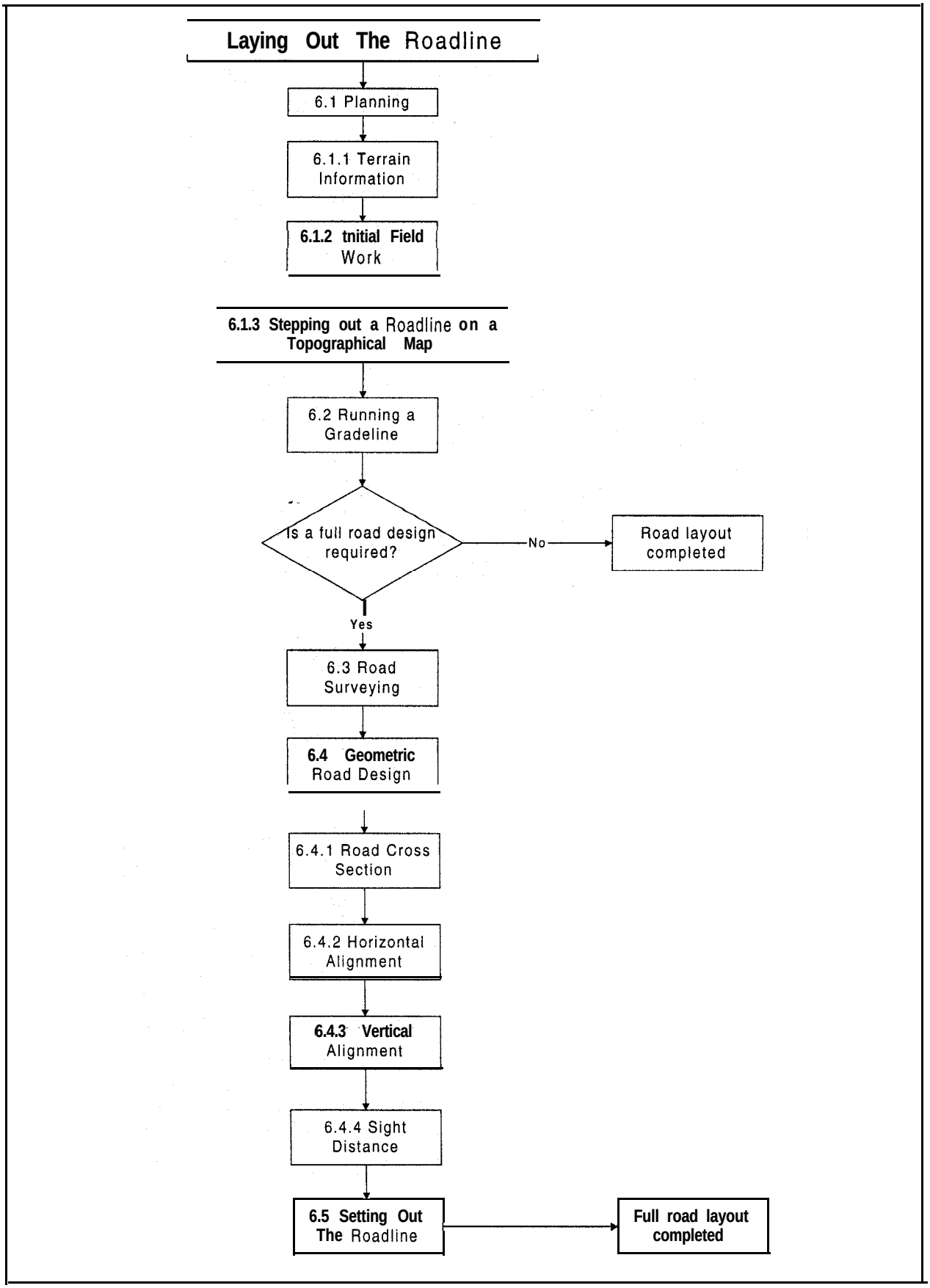

Figure 23 - Procedure for planning, designing and setting out a roadline

Note: the numbers refer to the sections of chapter 6

Aerial Photographs

Aerial photographs taken without extensive tree cover are used to show visible ground features, such as bluffs, swamps, and suitable stream crossings. Stereoscopic images, if available, are an ideal aid for locating suitable locations for roading. However, although aerial photographs show ground features in their relative positions, they do not allow accurate determination of areas or distances unless calibration measures are taken.

Topographical Maps

A topographical map is helpful in determining the feasibility of a proposed roadline. The roadline can be stepped out on the map at a known grade from a start point to a finish point. Section 6.1.3 describes this procedure.

6.1.2 Initial Field Work

Knowledge of the ground features is an essential part of locating a road.

Any features (either good or bad) of the topography and ground conditions which will affect road construction should be noted on the map. Use aerial photographs and any other information which will aid in determining locations that do not favour road construction.

Locate and mark on the map and areas which do not favour road construction, e.g:

- Rock bluffs
- Ponds and lakes
- Excessively steep terrain
- Unstable soils
- Slips
- Swamps
- Environmentally sensitive areas
- Culturally sensitive areas

Also, locate and mark features which will favour economical construction. These can be marked as possible control points (points which the road must pass through):

- Reasonable side slopes
- Desirable stream crossings
- Saddles (passes) in ridge lines

- Areas suitable for switchback construction
- Start and finish points (junctions and landings)

After a field inspection of the area, the roadline on the map can be re-worked either back at the office or while in the field. Careful attention must be given to ensure that the road is located in favourable areas, and not in areas which would be too expensive and difficult to road.

Figure 24 shows a roadline marked on a contour map, with control points at A, B, C and D.

6.1.3 Stepping Out A Roadline On A Topographical Map

This is a useful technique for testing the feasibility of a roadline of a given average slope. The average slope in steep terrain is usually the maximum grade that a logging truck can sustain over long distances. Typically this grade is 10%, but it can range from flat to as high as 16% for favourable grades (20% is the maximum legal grade). It is better to make the grade steeper on straights and considerably flatter on the curves giving an undulating grade (i.e. where steeper and flatter sections alternate) rather than to have a sustained single grade. Also, consider the season(s) during which the road will be used - during the winter, the road may be slippery, and the adverse grade may need to be kept below 10%.

The procedure for stepping out a roadline is:

1. Mark known control points on the map

Control Points are points which the road must pass through (see 6.1.2) they include:

- The start point or area (usually an existing road)
- The finish point (landing)
- Any known stream crossing sites
- Any other points that the road must pass through (e.g. other landings)

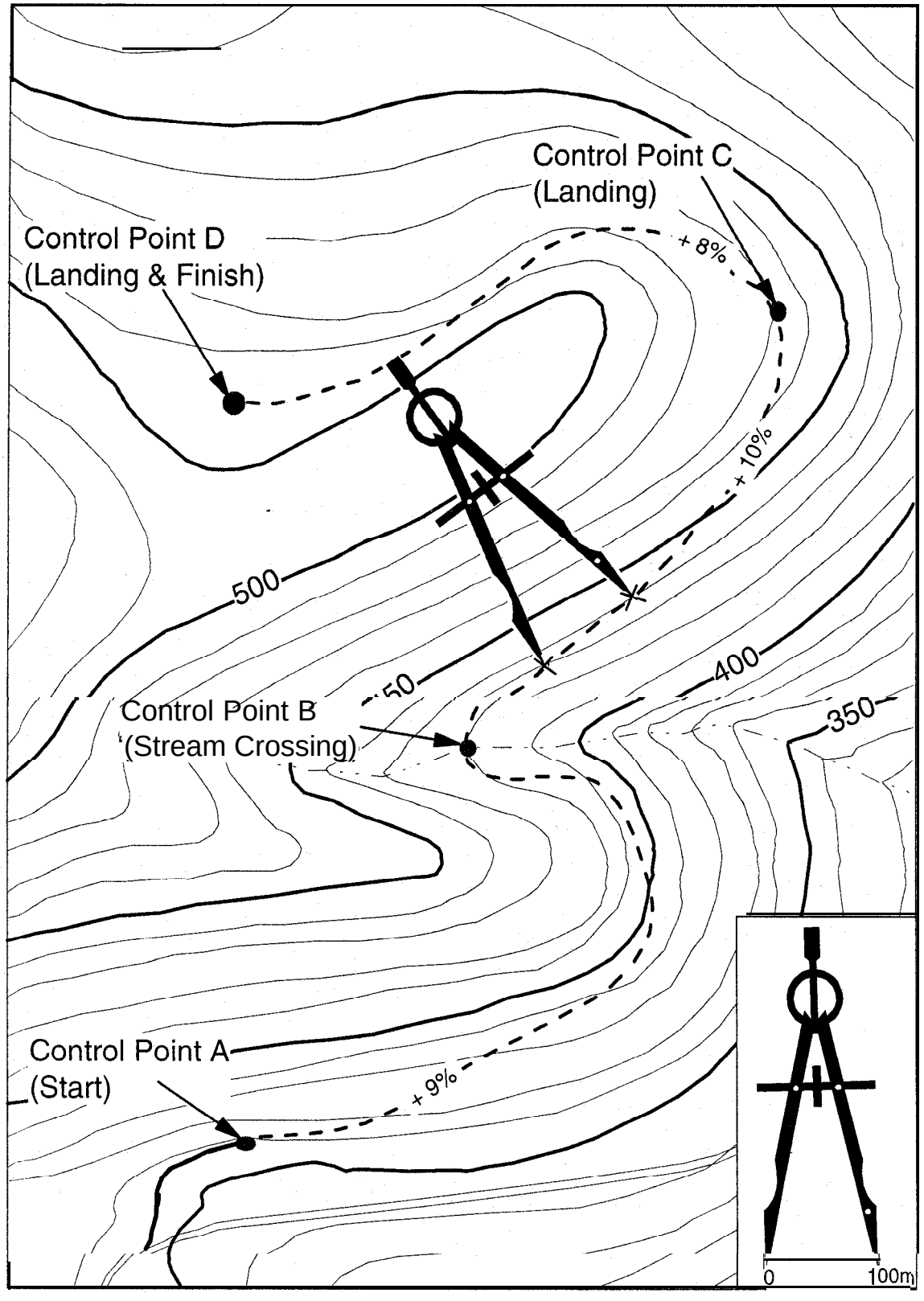

Figure 24 - Typical roadline stepped out on a topographical map through control points A, B, C and D.

2. Determine an appropriate grade

Use either:

- Maximum grade for steep terrain (e.g. 10%) or
- The average grade between adjacent control points. This can be calculated using the following formula:

$$G = \frac{100 \times (E_B - E_A)}{D_{AB}}$$

Where:

G is the average gradde between control points A and B (%)
E_A, En are the elevations of A and B
D_{AB} is the distance between A and B

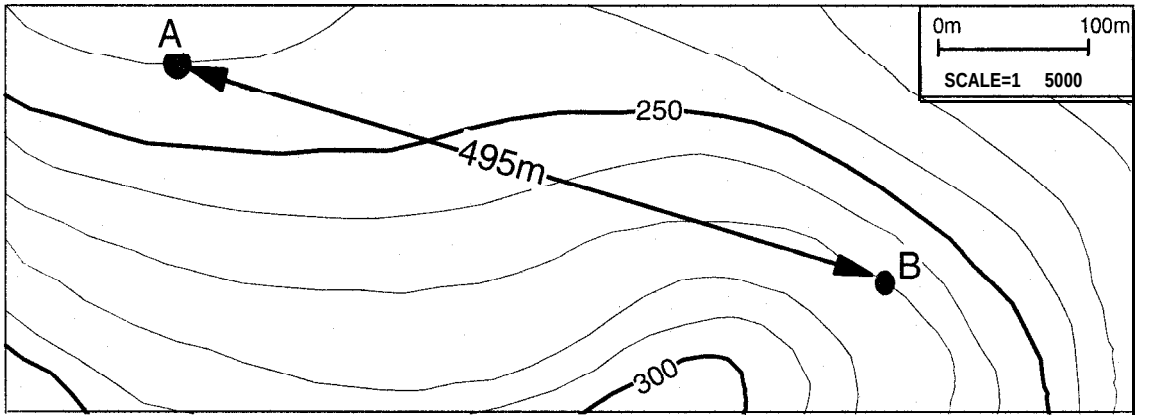

Figure 2.5 - Measuring distance on a topographical map.

The elevations of the control points are estimated from the contours on the topographical map. The distance between the control points is measured with a ruler on the map, and then the map scale is used to determine the actual distance. Alternatively a scale rule can be used, and the distance read directly from it.

Note: If G > Maximum grade (e.g. 10%) then use the maximum allowable grade.

Example (see figure 25)

The elevation of control points A and B are read from the topographical map as: E_A = 240m, E_B = 270m. The distance between A and B is measured and scaled as: D_{AB} = 495m. The average grade can then be calculated:

$$G = \frac{100 \text{ x } (270 - 240)}{495} = 6.1\%$$

Table 7 can be used to convert between the different methods of measuring grade.

Percent	1 in x	Degrees
0.0	-	0.0
0.5	200.0	0.3
1.0	100.0	0.6
1.5	66.7	0.9
2.0	50.0	1.1
2.5	40.0	1.4
3.0	33.3	1.7
3.5	28.5	2.0
4.0	25.0	2.3
4.5	22.2	2.6
5.0	20.0	2.9
5.5	18.2	3.1
6.0	15.7	3.4
6.5	15.4	3.7
7.0	14.3	4.0
7.5	13.3	4.3
8.0	12.5	4.6
8.5	11.8	4.9

Percent	1 in x	Degrees
9.0	11.1	5.1
9.5	10.5	5.4
10.0	10.0	5.7
10.5	9.5	6.0
11.0	9.1	6.3
11.5	8.7	6.6
12.0	8.3	6.8
12.5	8.0	7.1
13.0	7.7	7.4
13.5	7.4	7.7
14.0	7.1	8.0
14.5	6.9	8.3
16.0	6.7	8.6
16.5	6.5	8.8
16.0	6.3	9.1
16.5	6.1	9.4
17.0	5.9	9.6
17.5	5.7	10.0

Table 7 - Grade relationship-converting percent to degrees

3. Step out the road between the control points using dividers

It is often sensible recommended to start from the log landing at the end of the road and work backwards, since the log landing is usually fixed but the start of the road (usually an intersection with an existing road) can change.

Set the dividers to a distance which will achieve the required grade between adjacent contours. This distance is given by the following formula:

$$D_{Divideer} = \frac{D_{Cont} \times 100{,}000}{(G \times X)}$$

Where:

$D_{Divider}$ is the spacing that the divider is to be set to (min)
D_{Cont} is the map contour interval (m)
G is the average grade determined in step 2 (%)
X is the map scale (1:X)

The dividers are then used to step out a trial road between the two control points. Starting at the most critical control point e.g. the landing at the end of the road, step from one contour to the next until you reach the end control point. Sketch the roadline along the points that were marked by the dividers on the contours. Figure 26 illustrates this process.

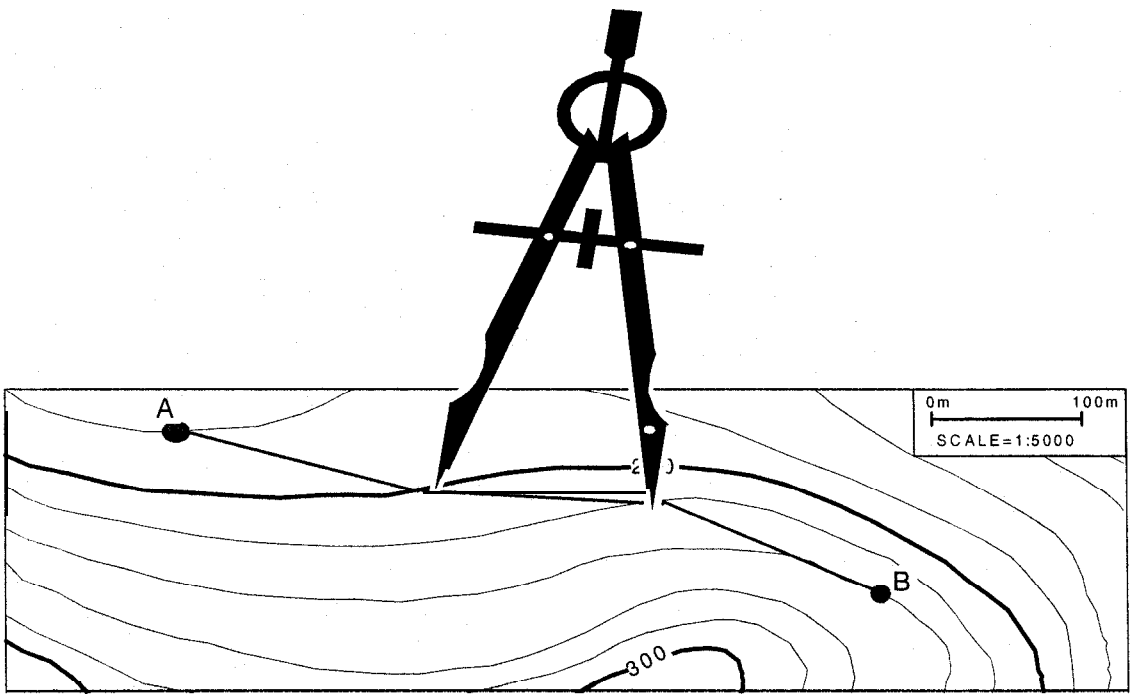

Figure 26 - Using dividers to step out a roadline.

There are cases where the grade needs to be made flatter by drawing the roadline by hand parallel to the contours, these are listed below:

- Crossing streams (0%)
- Crossings saddles (0%)
- Crossing gullies (0%)
- On curves (use 0%)
- Around tight ridges (0%)
- Approaching landings and road intersections (<6%)

Plotting a roadline on the topographical map is only an initial step to ensure that the proposed road is feasible. This roadline must be checked onsite, re-marked on the topographical map, and then correctly set out in the field by running a grade-line.