I. PREDESIGN

A. Introduction

Before the roadway designer can become actively involved in the manipulation of the data in the design process he or she must start by developing the analytical model discussed earlier. At this stage this work involves taking the field survey data and converting it to a graphical model of how the land surface is naturally shaped. In the process of establishing this model, the preliminary or "P" line is plotted. This line is the locator's best estimate of how the proposed road should occupy the land.

Of the four plots that will go to make up the complete design package, three will be begun during the predesign phase.

(**This manual has been written primarily as a teaching aid in the Basic Road Design Short Course. The coursework includes the design of a section of forest road. With the constraint of time and the length of the design section in mind, some of the steps in the design procedures can be eliminated in the course. The double asterisk ** indicates such steps. For the professional production design, these steps should be completed. Each has its own reason for being which will become apparent as the design progresses.)

B. Plan

The plan is the map or the "bird's eye" view of the terrain. Four different plots of the horizontal data can be considered. The first three are suggested as aids to the designer in his or her work at gaining an understanding of the ground. The fourth plot is required for the design process.

First, if air photos of known scale are available, the designer can learn a great deal from plotting the "P" line on the photos. (**)

The second alternative (if photos are not available) is to plot the "P" line data on any available map of known scale. These two alternatives provide the designer with information on the location of the roadway with respect to the land forms. (**)

The designer may be able to acquire either air photos or maps from the locator with the desired information already plotted or sketched. The drafting work is not needed in this case, but the work of understanding the road location has just begun.

On projects over about one mile in length, the designer is well advised to prepare a one inch to one thousand feet plot of the data. Such an area map will assist all of those individuals concerned with the plans. The relationship of the various sections of the project is easily determined. (**)

The fourth and necessary plot is usually made at a one inch equals one hundred feet scale. This will become both one of the basic tools and one of the basic products of the design process.

1. Cross hatched paper with spacing of ten divisions per inch both directions is recommended. If paper with non-reproducible lines is used, the design plot can be photo-transferred to mylar Federal Aid sheets with ease.
2. Plot tic marks every one thousand feet in either direction.
3. Plot the "P" line after computing the coordinates of each PI.
4. Check the plotted coordinates by using the bearing and distance information and a protractor and engineer's scale.
5. Identify the PI's with the small (.1 inch) diameter circle.
6. For clarity and neatness, do not letter the bearing or distance of the lines on the plot.
7. Because the "P" line is unchanged during the design, it can be drawn in ink. This eliminates having to redraw a penciled line repeatedly.
8. Establish the stationing of the "P" line by scaling from each PI. Each full station should be identified by a small but identifiable tic mark.
9. Plot and ink cross-section stations. The cross-section line should extend the same scale distance either side of centerline as the cross sections were taken. This will allow the designer to better visualize the available data. Care should be exercised that the cross-section lines are plotted with the correct relationship to the centerline. For example, a cross section taken along the centerline of a drainage may intersect the roadway centerline at some angle other than 90°. Cross-section lines should be plotted in ink. They are base data and will not change during the design.

10. Plot, in ink, all of the natural features that are reported in the field notes or that can be observed in air photos. These items should be drawn in sufficient detail that any reasonably knowledgeable individual could identify the feature. On the other hand, since the designer will be doing a considerable amount of additional work on the plan, excessive detail that would clutter or confuse the drawing should be avoided. Typical naturally occurring features include:

    a. creeks, bogs, marsh and swamp areas

    b. rock outcroppings, abutments, and cliffs

11. Following the same guidelines as above, plot all of the manmade or cultural features. These include:

    a. section lines, corners or other land survey data

    b. property boundaries, rights of way, mining claims, sale units, resource management units

    c. existing or planned roads, powerlines or other utilities, rights of way

12. A brief title block is often desirable.

    a. road name or number

    b. district, zone, division, etc.

    c. forest

    d. date box

    e. designer

    f. approval

The above data is required in order to carry out an efficient design. Depending on available space, personal preference and other factors, designers will often add other information for their convenience.

1. Indication of soil classifications and location of various soil zones.
2. Special design considerations and field notations.
3. Particularly good or bad timber stands.
4. Possible equipment landings, cold decks, turnarounds, or other timber harvest information.
5. Hydrologic or streamflow data.

C. Profile

If the plan view is the bird's eye view of the roadway, the profile view is the worm's eye view. If a loaf of bread were cut vertically from end to end rather than from side to side, a profile view would result.

Only one profile view is prepared. Unlike the plan view, different scales are used for the vertical and horizontal dimensioning. This is done to exaggerate the change in elevation aspects of the design. Different designers and experienced engineers will recommend the use of different scale combinations depending on their experience.

For roads in relatively flat, even terrain with low grades and generally moderate design conditions, tradition has it that the scales are one inch equals one hundred feet horizontally and one inch equals ten feet vertically. For the common forest road with high grades and often undulating terrain, this level of exaggeration is excessive.

Some engineers recommend a 1" = 50' horizontal scale with a 1" = 20' vertical scale. This combination provides a more easily grasped profile.

For a variety of reasons, there are advantages in maintaining the horizontal scale the same as that used in the plan. Scales of 1" = 100' horizontally and 1" = 40' or 1' = 50' could be recommended in this case.

For the purposes of the basic road design course, the student is welcome to pick a scale that he or she (1) is comfortable with, (2) knows to be the standard in his or her home office, (3) feels gives the best representation of the design situation, or (4) wishes to experiment with. In any case the scale must be well documented on the profile drawing.

1. Select a scale.
2. Plot the elevations at each known station.
3. Connect the plotted points with a series of inked straight lines.
4. If because of space limitations the profile must be broken, overlap the matchline by a minimum of 500'. If the ground line is particularly broken, an overlap of 1000' or more may be required.
5. Plot, in ink, all of the natural features that are pertinent to the profile.
   a. rock outcroppings or other geologic structures
   b. stream and drainage channels including bogs or other poorly drained zones
6. Plot manmade or cultural features.
   a. existing culverts, bridges, or fords
   b. overhead transmission lines
   c. underground utilities
   d. known mining operations

In some cases the design work is done on plan/profile paper which allows for the plotting of both views on a single sheet. When two separate sheets are used, many experienced designers will reproduce many of the special design notes from the plan to the profile. While this is redundant and time-consuming, the time is usually recovered by avoiding searches from one sheet to another for design information.

D. Cross Sections

Cross sections are the third major type of drawing the designer will produce. Returning to the analogy of a loaf of bread, the cross-section drawings are comparable to looking at each individual slice of bread.

The process of developing the numerous cross sections needed for the design process is tedious at best. The importance of accurate cross section work both in the field and in the office is understated. As will be seen, the cross sections are closely related to the earthwork computations which, in turn, determine some of the major cost elements of the project.

1. The most commonly used scale for the cross section is 1" = 10' both horizontally and vertically.
2. Using 10x10 cross-section paper, carefully plot the ground line points from the field survey notes. Connect the points with inked lines.
3. Where several cross sections are to be drawn on each sheet start at the bottom of the page and work up. When viewing the finished work, the designer will be better able to view the cross sections and develop a mental image of looking down the roadway.

4. Plot the centerline elevation at the proper elevation.

5. Plot all of the available cross-section information. For the typical forest road design, a corridor 100' wide is sufficient. Field data that extends past 50 feet on either side of centerline needs only to be noted on the cross section. If the designer needs to go beyond the plotted corridor, the data should be readily available.

6. Each cross section must be identified by its "P" line station. The centerline elevation should also be noted on the cross sections.

7. All natural and manmade features that may lie along or near a particular cross section should be noted on that section. If appropriate the feature should be added to the drawing and elevations, if available, should be included.

   a. existing culverts, bridges, or other drainage structures including rock drains and similar earth or rockwork structures

   b. utility crossings above or below ground

   c. existing roads

   d. geologic features such as rock outcroppings, bogs, marshes, or problem soils

   e. if a centerline has been taken along a stream or drainage line, it should be so noted.

8. Again, many experienced designers will add notes concerning soils, hydrology or other field data that is pertinent to the particular cross section. These notes serve as flags during the design

process. They remind the designer of a design consideration that may otherwise be inadvertently overlooked.

E. Summary

At this stage, the designer has completed the foundation upon which the road design will be built. Before moving forward with the design process, the designer should review the drawings. Are they correct to this point? Are there any obvious discrepancies or discontinuities that may reveal bad field data? Is the data complete? Are there sufficient cross sections along the horizontal plan?