400 ROUTE PROJECTION AND RECONNAISSANCE

410 ROUTE PROJECTION

411 ROUTE PROJECTION ON LARGE SCALE MAPS

411.1 INTRODUCTION. "Route projection" is the laying out of a route for a road on a topographic map or aerial photo. The route defines the narrow strip of land within which the field preliminary survey is made. "Large scale maps" are the 400 feet to the inch, 20 feet contour interval maps made by the Cartographic Section, Oregon State Office, Bureau of Land Management, or maps made by the method given in Chapter 220. Route projection on small scale maps, such as enlargements of U.S.G.S. quadrangles, is similar but less detailed.

Prior to starting the route projection, ascertain the proposed standard of the road. Assemble other pertinent basic data listed in Section 211, any logging plans which have been made, and soil or geological maps of the area served by the road. For economic analysis, collect data on timber volumes, annual cut, and road construction and log trucking costs. Obtain the aerial photos covering the routes for study for tone indications of granular soil and poorly-drained ground.

Review of Chapter 320 "Considerations in Route Selection," and Chapter 330 "Considerations in Road Location" before starting the route projection is recommended. The consecutive steps to follow in making a route projection are given in ensuing Articles 411.2 to 411.5. This procedure is also followed in paper location on strip topography (Section 522).

411.2 SELECTING CONTROL POINTS.

1. Determine the terminal control points: where to begin from an existing road or location survey, and where to end the present project. If the road may be extended in the future, the upper terminal should be at a point suitable for continuing the road. This may necessitate projecting the road beyond the present project, to insure that it does not "dead end." The lower terminal is usually the more flexible, and subject to change when intermediate control points are found, and the grade contour projected.

2. Look for major control points between the terminals. Possible control points are listed in Article 322.5. These are usually saddles or passes, benches for spur road junctions, and suitable crossings of large streams, where bridges or large plate culverts are required. If a logging plan is involved, landings along the road route may be control points. If projecting a main road from which stub spurs to landings will take off, suitable junction points for the spurs are controls. Work from the top down, as the valleys and control points tend to constrict at the higher elevations and to widen out at the lower elevations.

3. Look for minor control points along the probable route between major control points. These include points at which obstacles can be passed, such as above or below cliffs, rock outcrop or slides, and either side of the swamps. Mark these points with a red pencil for "danger". Look for evidence of soft or poorly drained ground, and the best places to cross or avoid them, and for the best crossings of side streams. Mark these with blue pencil for "water".

4. Where the route will follow a water grade along a main creek, study both sides of the valley to determine whether to project alternate routes paralleling the creek on each side of the valley, or, in the case of a meandering stream or a valley with cliffs or steep side slopes alternating from one side to the other, to project a route which would cross the creek at intervals. It may be necessary to project all three alternate routes and compare costs to determine the preferable route.

411.3 PLOTTING GRADE CONTOUR.

1. The next step is to plot a grade contour between control points. A grade contour is the line which follows the ground surface at the uniform grade between two control points. The grade contour is drawn as a guide to the projected route. Measure the approximate distance between control points. If the line is not reasonably straight, step off the distance with dividers or measure with a Hamilton map measurer. Interpolate the control point elevations, and compute the grade between them. Set dividers at the distance for one contour interval at this grade.

Example: Difference in elevation between control points 160 feet. Distance 2,000 feet, grade 8%. Set dividers at 20/.08 = 250 feet for 20 feet contour interval.

Starting at one control point, step off successive contours with the dividers. If the trial grade contour does not hit the elevation of the other control point, recompute distance and grade, re-set dividers and step off a second trial line.

2. When the required grade has been found, set pencil drawing compass at the correct distance for one contour interval. Step off the grade contour line, ticking each contour crossed on the map with the pencil point. In going around sharp ridges or narrow valleys, take care not to exceed the maximum degree of curve for the standard of road. Make a plastic curve templet with a radius at map scale equal to the radius of the maximum curve. Lay it on the map and step off around it with the compass. Keep track of the distance and compute the contour which the grade will hit at the estimated end of the curve.

If the topography is broken, or the grade percent low, it is preferable to set the compass at one-half the grade distance for one contour interval and mark every other tick half-way between the contour lines.

411.4 PLAN PROJECTION. Draw a plan of the road following the grade contour as a guide. In plan view a road consists of a series of straight lines, "tangents," connected by curves. The curves are geometrically tangent to the straight lines, the radii being perpendicular at the beginning and ends of the curves. With a transparent drafting triangle, draw a series of tangents through two or more tick marks which are in line. Fit curves to the tangents by trial. Curve fitting is facilitated by using a transparent plastic curve templet with curves at 5° or 10° intervals, to the scale of the map. Recommended templet design is shown in Figure 411-3.

411.5 TRIAL PROFILE. A profile is desirable as a check on the gradients as well as to indicate where heavy earthwork is involved, for use in construction cost estimating and locating culverts. Set the dividers at a convenient distance to map scale, as one-half inch or two stations for 400 feet to the inch scale, and step off along the projection line. Read off and tabulate the station and elevation at each divider point. Elevations can be easily interpolated to ¼ contour, or 5 feet on the 200 foot contour interval map. Number every 5th divider point, or every 10 stations. Plot the profile on profile paper. A convenient scale is 1 inch = 400 feet horizontal scale and 1 inch = 40 feet vertical scale. Plot the grade line on the profile.

If the grade between any two control points exceeds the allowable maximum, due to the projection line being shorter than the grade contour, revise the projection to increase the length, if possible. Plot a trial profile of the revision, and check the grade line. If it is not possible to develop sufficient length of road to keep within the maximum grade limit, then new control points and a new route must be found. Plot the trial profile for the most critical segments first. This may obviate waste of time in plotting other sections which have to be abandoned if the critical section proves to be unusable.

411.6 COST COMPARISON OF ALTERNATE ROUTES. If alternate routes are projected, a comparative cost estimate is made to determine the most economical route.

1. Construction cost estimate. Divide the road plan into sections of uniform side slopes to the nearest 10 percent. Scale the distance between contours adjacent to the projection line at sample points and divide into the difference in elevation to obtain slope percent. Estimate clearing and grubbing and grading costs. Figures 5 and 6, reference(2), Division 300 are useful for estimating quantities. Estimate the culverts needed and culvert costs. If sections of heavy grading are involved, such as deep cuts through ridges, or high fills, a rough estimate of the earthwork can be made by reading off cuts or fills from the trial profile, scaling side slopes, and

obtaining cubic yards per 50 feet from Calders' Tables 18 or 19. For cuts exceeding 13 feet or fills exceeding 5 feet, the limit of the tables, sketch cross sections and compute volumes. The costs of temporary bridges may be estimated from local experience. Cost estimates on permanent bridges should be obtained from the state office, since they will usually be designed by Bureau of Public Roads bridge engineers. The relative availability of surfacing rock may be an important cost consideration.

2. Transportation cost estimate. Comparative truck travel tires may be found from the tables given in Section 331. Log trucking costs may be computed by using cost data in reference(2/) Division 300.

3. Maintenance cost estimate. No comparison of alternate routes is complete without considering maintenance costs. A road which is cheaper in initial construction cost may be the more costly over a period of years, when maintenance is included. As maintenance costs vary with surfacing material and traffic, as well as gradient and curvature, local experience is the best guide to maintenance cost estimating.

4. A comparison of the totals of construction, maintenance, and trucking costs weighted by the volume of timber to be hauled over the road will indicate the economical route. Other factors such as recreational use may determine the preferable route.

411.7 FINAL CHECK. Transfer the projected route to the road key map or overall transportation plan map. Note whether the route fits in with the overall road system for the area. All work on maps and photos should be cross-referenced with field notebooks of reconnaissance and survey. All field books should be indexed as the work progresses.

412 ROUTE PROJECTION ON AERIAL PHOTOS

412.1 INTRODUCTION. In the open pine forests, road routes may be satisfactorily projected on aerial photos. In dense Douglas-fir forests, routes cannot be projected in as much detail. However, photo-projection may eliminate unfeasible routes and reduce the time spent in field reconnaissance.

The consecutive steps in route projection are similar to those given in Section 411. Visible control points are located. The difference in elevation between each two control points are determined. The horizontal distances between the control points are measured. The average gradients between control points are computed. In dense forest cover, some control points may not be visible, and must be found by reconnaissance in the field. Control points which are usually visible on aerial photos are the terminals, saddles, benches, and crossings of the larger

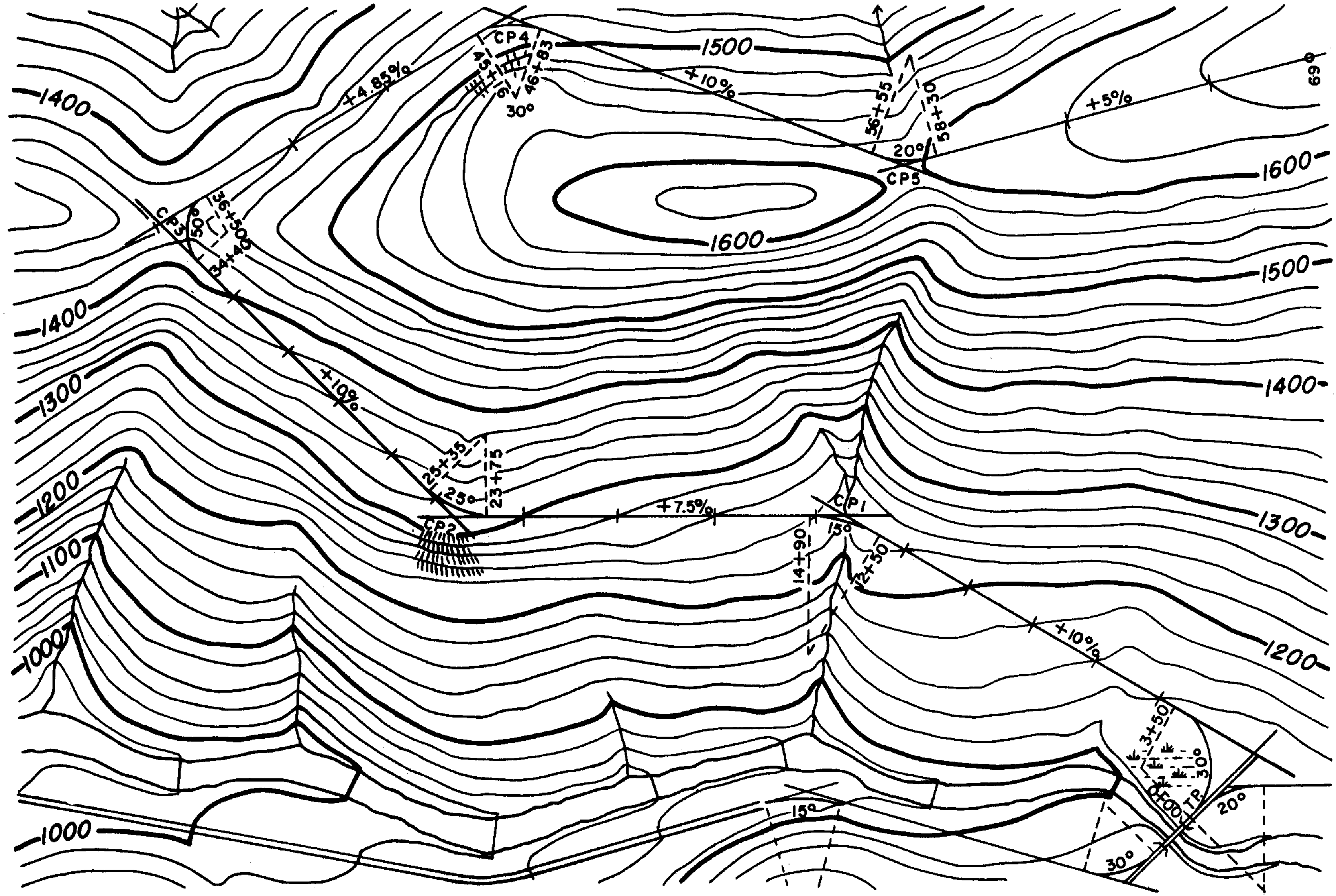
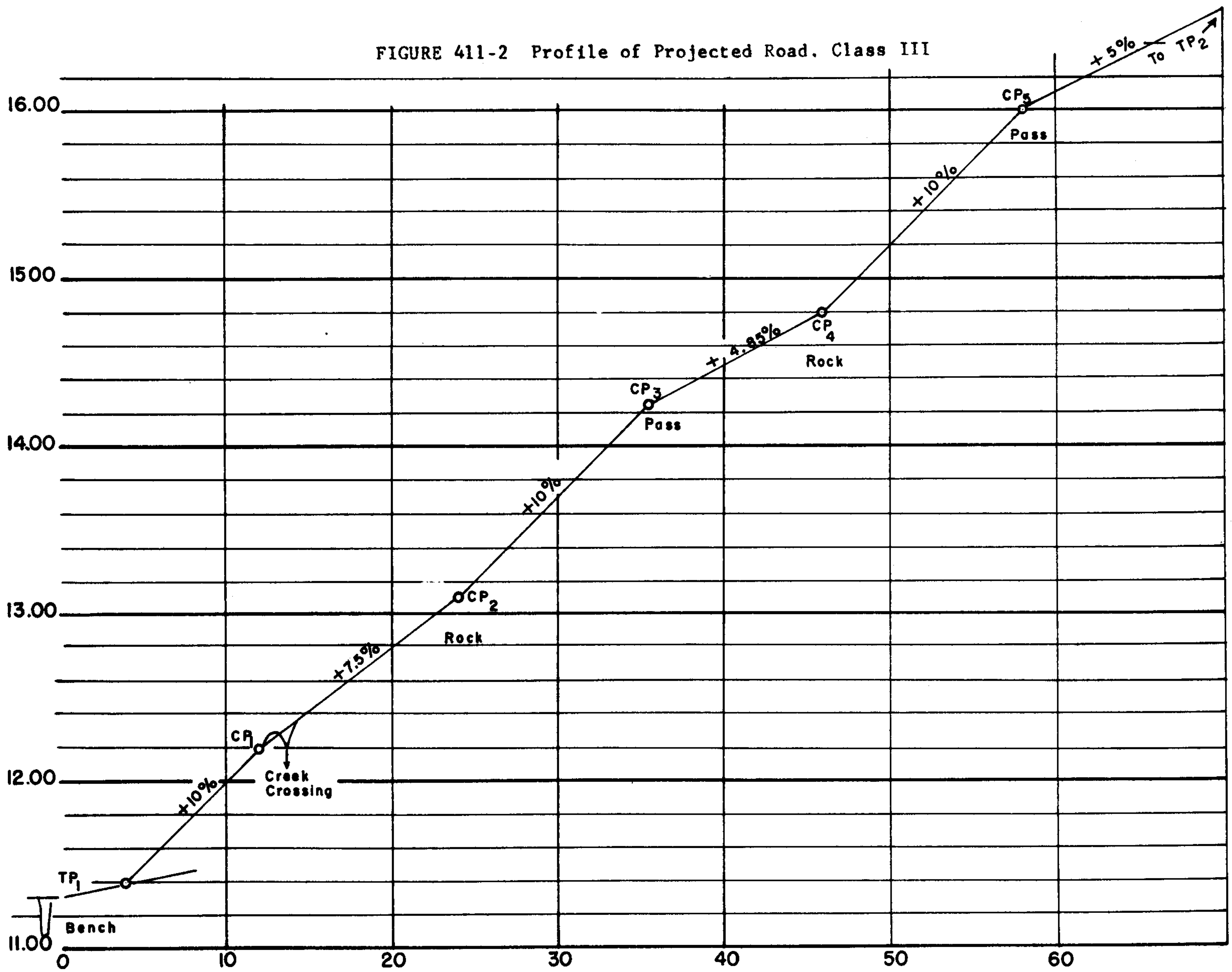


FIGURE 411-1 Plan of Projected Roads
Scale 1" - 400' C.I. 20'

FIGURE 411-2 Profile of Projected Road. Class III



streams in the open. Crossings of smaller streams are often obscured by the trees. Rock outcrops and slides may be visible or hidden. Where forest cover obscures the ground, it is necessary to know the average height of the trees in order to obtain ground elevations. The experienced photo-interpreter can detect swamps and poorly-drained soils which should be avoided. Gravel deposits suitable for embankment or surfacing may be detected by their light color tone and well-drained appearance. When verified on the ground, mark them with the symbol ⚒ on photo and map.