FACTORS AFFECTING SELECTION OF THE HIGHWAY ROUTE

We briefly review some of the main factors affecting selection of the route that can be discerned from available maps, photographs, and other sources. The basic philosophy underlying the relationship between costs and design levels is described to provide some perspective on the appropriateness of specific routes.

Examination of Natural and Man-Made Features

Selection of a possible route for a proposed highway is — apart from traffic considerations —determined largely by relating topographic features, human habitation, and environmental features of the area under consideration to geometric design controls. Therefore, before starting the route selection process, a review of the area's major topographic and other features likely to affect the route selection is needed. Several sources of information are available to assist the review. They include:

1. Topographic Maps. Usually the maps of the United States Geological Survey (USGS) at a scale of 1:25,000 and a contour interval of 3 m provide the minimum required detail for preliminary route selection. Larger scale maps may also be used if available.

2. Aerial Photographs. The two main types of aerial photographs employed in route design are stereographic and oblique. Stereographic photographs, usually at the same scale as the topographic maps, may assist in determining important geological, ecological, and cultural information. Also, with the assistance of appropriate measuring devices, they form the basis for automated route selection and design, including the use of computer aided methods. Oblique aerial photographs may be used to supplement the stereo photographs.

3. Geological and Soil Maps. These are available through the USGS, the U.S. Soil Conservation Service, or through state agencies, and may provide useful

information, particularly concerning pavement design, although more detailed information is usually necessary for preliminary design.
4. Ground Surveys. Reconnaissance or more detailed surveys should be made of the area, especially if the terrain is rugged or if additional details are required. As early as possible in the process, the design engineer should "walk the route," but practicalities may preclude this procedure early in the project. We will rely primarily upon the information that can be obtained from USGS topographic maps; in practice, the designer may use a combination of several sources of information. The items used and the major steps in the review may typically include the following:

Topographic Maps ~ Examine the terrain in general between the start and end points of the proposed route and make note of the following information, usually available from a topographic and geological maps. An inspection of the maps should include the following steps:

1. Identify unsuitable ground conditions such as wetlands, rock outcrops, areas subject to flash floods or avalanche, and other features of an obviously difficult terrain for highway

2. Examine the contour lines to obtain an initial estimate of the gradients that exist on undulating or mountainous parts of the potential route. The steepness of the terrain may be approximately determined by observing the number of contour lines and their vertical interval along a horizontal distance located at right angles to them. Slopes steeper than, say, approximately 10%, may be delineated on the map.

3. Define streams, rivers, ravines, or other topographic features that indicate the possible need for bridges or other extensive ancillary works to the highway itself.

4. List typical types of subsurface and soil conditions that may be expected, as indicated by the topographic features found on the topographic and geological map.
5. Summarize the findings of the examination of the above items on maps or overlays in order to guide the next steps in the route selection. Items 1 through 4 are described graphically in Figures 1-1 through 1-3 where, as an example, the route of a highway connecting points A and B is being considered.

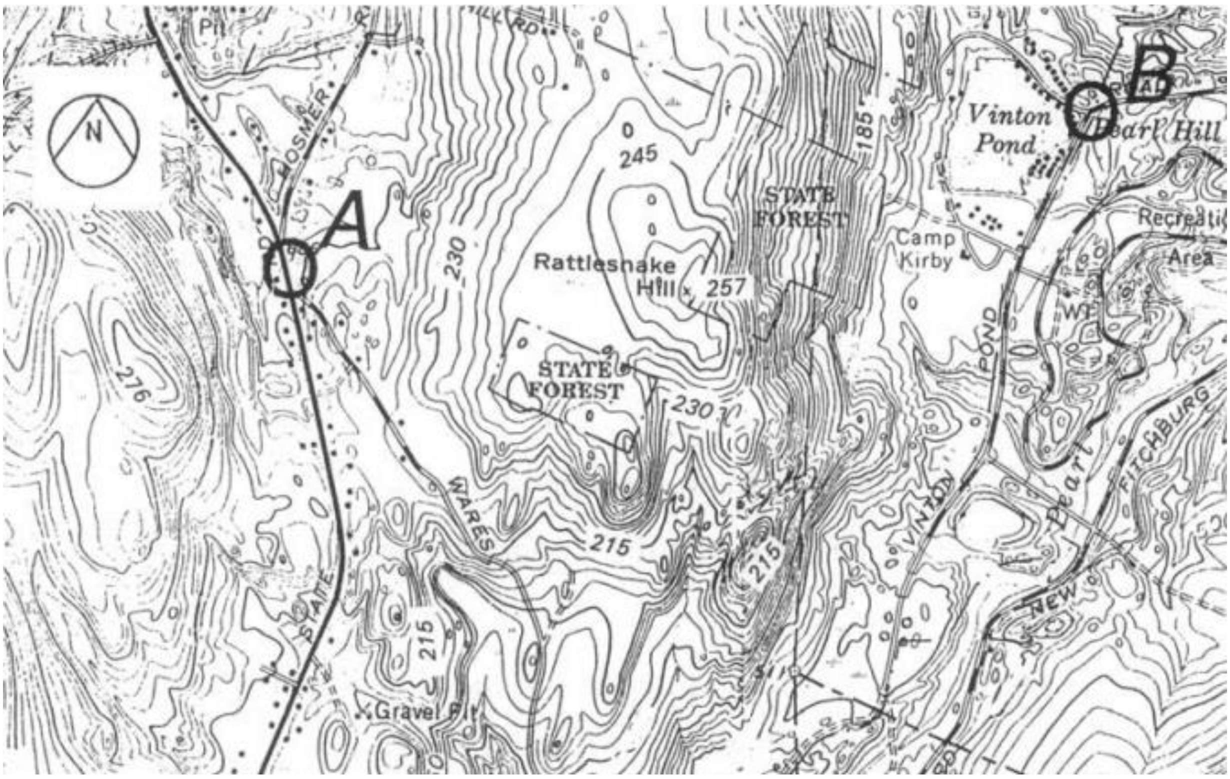
Other features that may be identified at this time, and that may be directly related to the effectiveness of the route, include consideration of sunlight availability to reduce the effects of snow and ice accumulations, avoidance of possible avalanche areas, and the effects of the route on habitation and other cultural activities such as schools and community Centers. The physical characteristics defined by these considerations can significantly affect the alignment of the route and its ultimate benefits to local and wider communities.

Aerial Photography ~ The next step is to examine available aerial and other photography, when available, to confirm or modify the information on the map. The following procedure is usually appropriate: Examine the stereoscopic aerial photographs to determine whether topographic and cultural features are different from those shown on the map. Document any changes on an overlay so this may be recorded on the map. The type of features found might include human activity, swamp or marsh areas that no longer exist, or areas that may be sensitive due to presence of wildlife or other ecological factors. In addition, conditions potentially hazardous to a highway such as avalanches, mudslides, or flooding may be evident. Aerial photography can provide excellent indications of anticipated ground conditions. Examples of the stereoscopic photographs are presented in Figure 1-4.

Examine the oblique photographs to obtain a sense of the developmental and esthetic features of the area and a general idea of the grades and other topographic characteristics. These, of course, should be cross-checked with those on the map to ensure correspondence. Figure 1-5 provides several oblique photographs of the project area.

Note in particular the presence of trees that may make identification of the ground surface features difficult on the aerial photographs.

In addition to the above considerations, make note of local features which may be environmentally sensitive to the presence of a proposed highway. Guidelines for identifying these features and mitigating the effects of potential highways on the environment are described in several documents listed in the bibliography.



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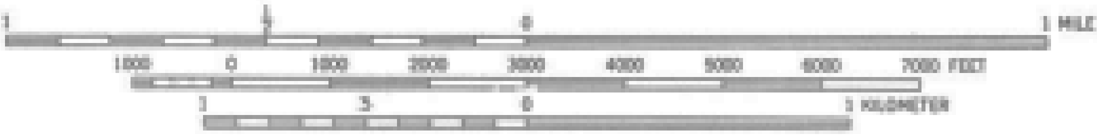


Contour interval 3 m

End points of proposed highway. A ◯ B ◯

FIGURE 1-1

SELECTED AREA OF INTEREST

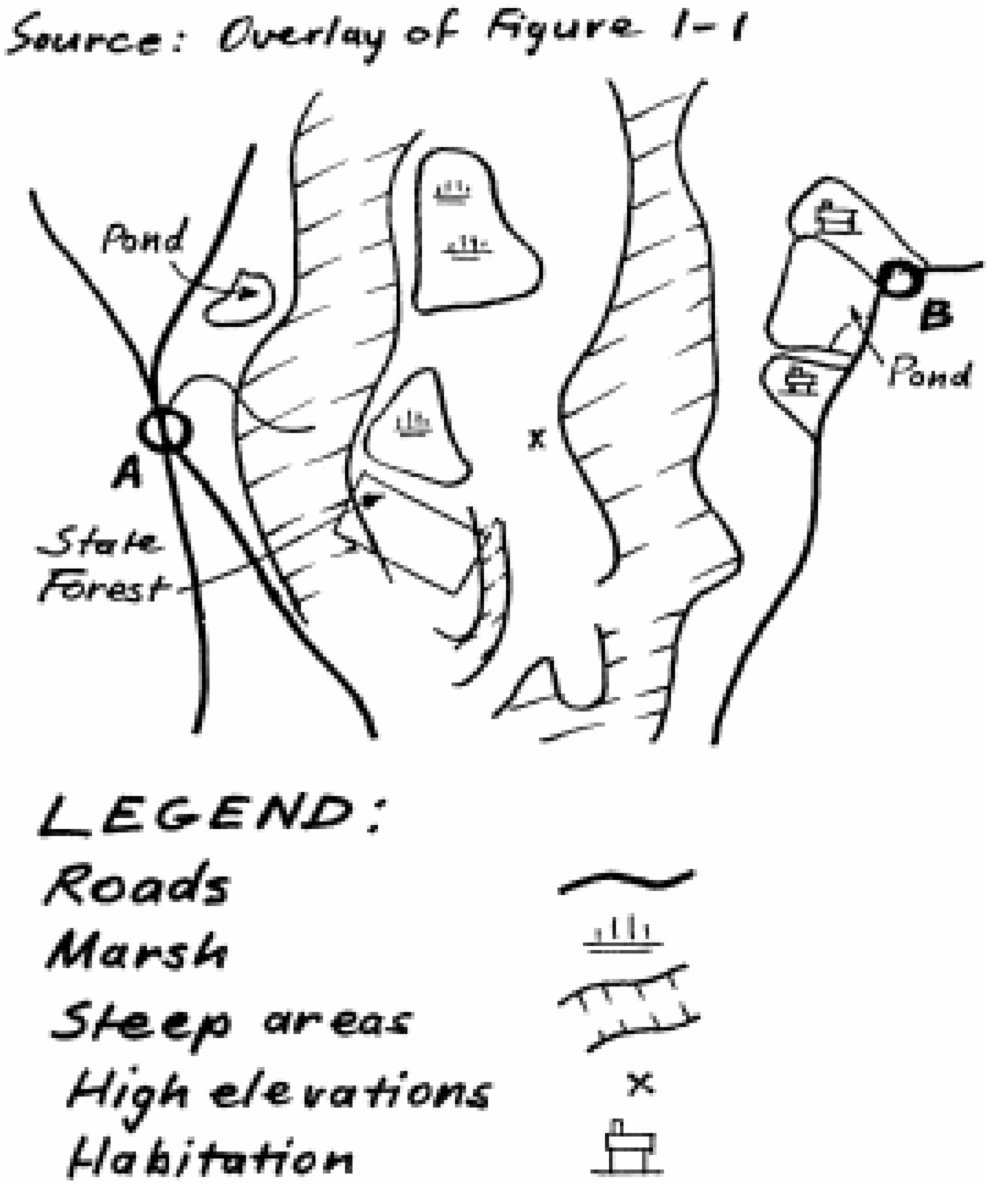


FIGURE 1-2

EXAMPLES OF TOPOGRAPHIC AND CULTURAL FEATURES

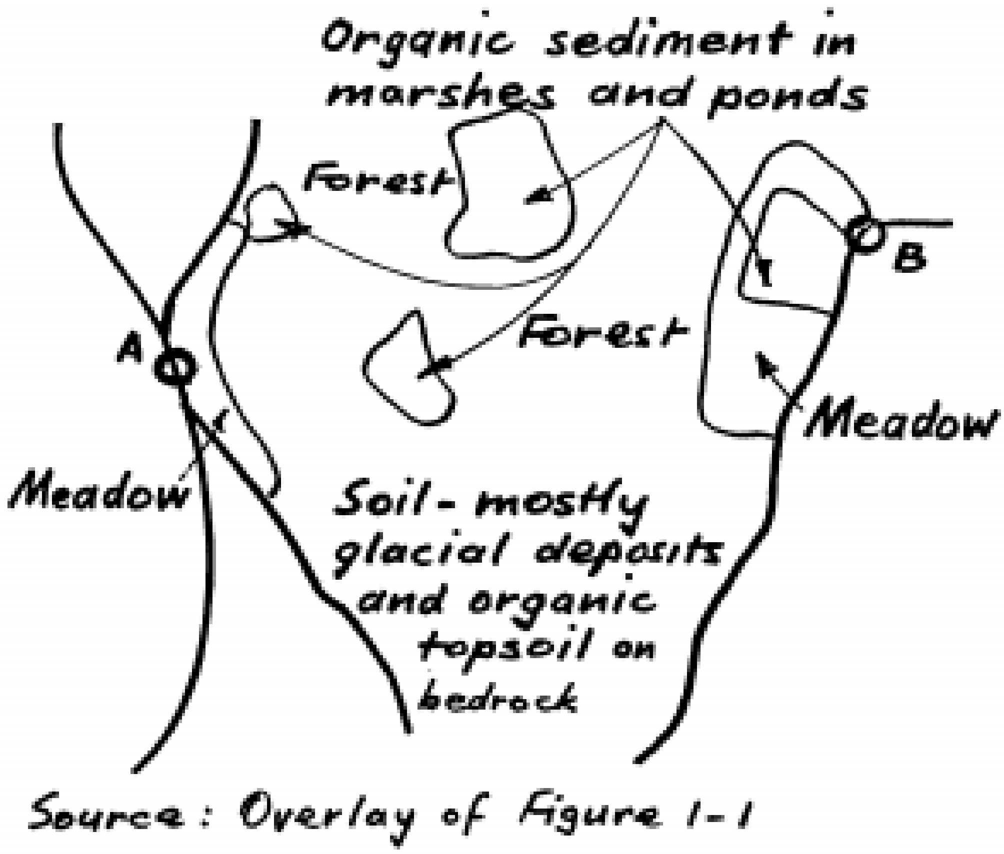


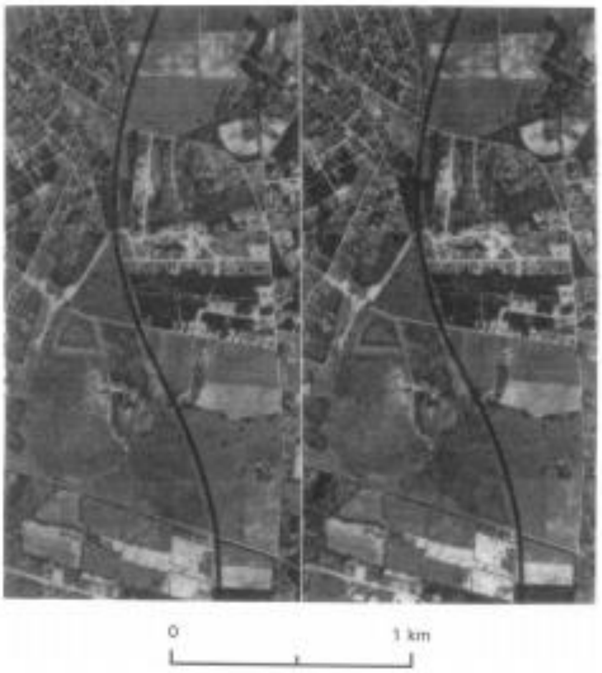
FIGURE 1-3

EXAMPLES OF SOIL AND VEGETATION FEATURES

Identification of Technically Feasible routes

The guiding principle in designing a possible route is to improve the transportation between specified points. Within the economic and social framework that typically applies, the term "improve" may be broadly interpreted as "to make less expensive and safer for the public in general as well as for the highway's users, while at the same time maintaining or contributing to the improvement of environmental quality." Furthermore, the route should be "technically feasible" in that no excessive construction or maintenance problems are envisaged, and such that the design controls and policy on geometric design of the highway agency having jurisdiction are adhered to. The policies of the American Association of State Highway and Transportation Officials (AASHTO) are generally used.

A highway improvement may be an upgraded existing highway or a completely new route and should always be considered as a component of the overall transportation system.



Source: Belcher, Donald J. "Photo Interpretation in Engineering." Manual of Photographic Interpretation. Ed. Robert N. Colwell. Washington, DC: American Society of Photogrammetry, 1960. page 425.

FIGURE 1-4

EXAMPLES OF STEREOGRAPHIC AERIAL PHOTOGRAPHS

Source: Federal Highway Administration, "I-70 In a Mountain Environment" Report No. FHWA-TS-78-208, Washington. D.C., 1978.

FIGURE 1-5

EXAMPLES OF OBLIQUE AERIAL PHOTOGRAPHS

Objectives in identifying acceptable routes

In defining a broadly acceptable route, therefore, the approach typically involves compromising between the user costs and construction costs while seeking the route and physical conditions that result in the least adverse environmental impact.

How is a balance struck between user costs and construction costs? A rather extreme example may be used to illustrate this problem: suppose the objective is to define a route between two points on existing highways separated by mountainous terrain. The least cost route for vehicle users on a "per vehicle kilometer" basis would clearly be a horizontal and vertical alignment permitting a high design speed (long sight distances, large radius curves, etc.) route with bridges and tunnels and extensive cuts and fills to overcome the rugged terrain. At the other extreme, a winding road following the contours of the terrain, with little or no cut and fill sections, few bridges, and no tunnels, would result in higher user costs due to sharp curves, resultant reductions in speed, and greater likelihood of accidents. However, such a road would undoubtedly cost less to build, even if it were somewhat longer than the first, because of the reduced amount of expensive excavation and filling and construction of bridges and tunnels.

In a more formalized way, as developed by the World Bank, the Highway Design and Maintenance Model states that (in selecting a particular highway) " .. .the basic task is to predict total life-cycle costs - construction, maintenance, and road user costs - as a function of the road design, maintenance standards and other policy options which may be considered", and adds that a broader definition of societal costs would include such examples as air pollution as it affects non-road-users.

For any given volume of traffic, the relationship between the user cost, construction cost, and total cost can be shown conceptually, as in Figure 1-6. The lower the design standards, the lower the construction costs (because of the reduced need for cut, fill, bridges, and tunnels). Conversely, the travel cost to users increases due to the reduced speed and increased travel time, and the increased likelihood of accidents due to the lower geometric design standards. Examples of higher and lower geometric design standards applied to highways are shown in Figure 1-7. It must be emphasized that both of these highways satisfy specified criteria in terms of their function and role within the overall system, and the terms "higher" and "lower" should not be construed as meaning "better" and "worse" designs.

The preferred route can only be determined by comparing the total costs for users and the construction and maintenance costs incurred by the implementing agency, for each technically feasible alternative, and selecting that alternative with the least monetary cost and acceptable non-quantifiable impacts.

The economic analysis involved in this process is described in several publications. See the bibliography for these. In the examples provided in this book, however, we are concerned primarily with establishing the technical feasibility of each alternative, and its capital cost. In the worked example in (will be given later) also include approximate maintenance costs and approximate vehicle operating cost as an aid to indicating the relative merits of the alternatives.

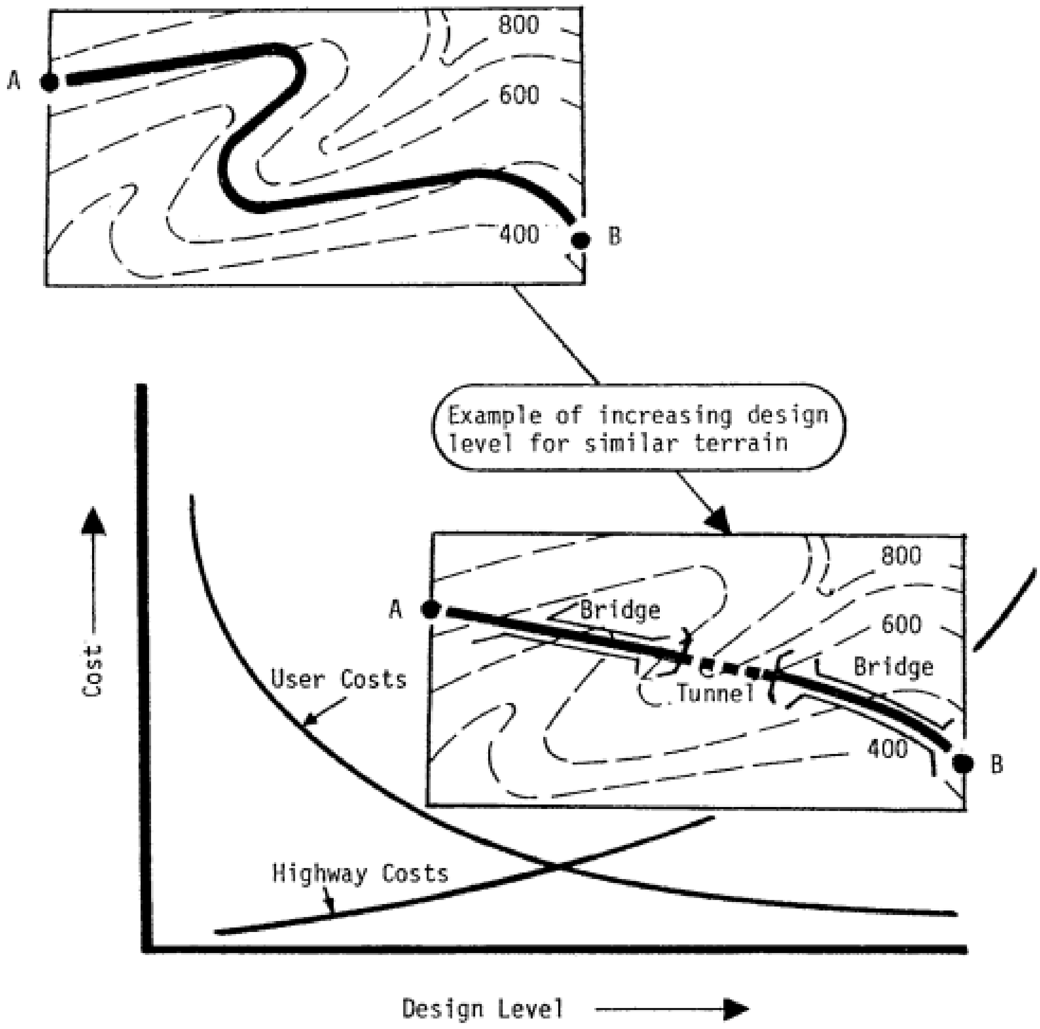


FIGURE 1-6

COST AND DESIGN LEVEL RELATIONSHIPS

Lower design standard

Higher design standard

FIGURE 1-7

EXAMPLES OF HIGHWAYS BUILT TO DIFFERENT DESIGN STANDARDS

Source: U.S. Department of Transportation, Federal Highway Administration