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A PROCEDURE FOR ANALYSING DOUBLE-LANE VERSUS SINGLE LANE ROADS

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INTRODUCTION

There are a number of agencies throughout the world which use single-lane roads where traffic volumes are low. The decision of whether to have a single-lane or a double-lane road is sometimes based on general guidelines. The USDA Forest Service considers single-lane roads to be best for less than 100 vehicles per day (VPD) and double-lane roads best for more than 250 VPD. When entering a new area, or considering upgrading an existing single-lane road to a double-lane standard, some analysis should be done.

This Technical Release discusses the various factors to consider in this type of analysis. Methods are addressed for obtaining values for the economic factors. An example project is worked through to show how the procedure can be used.

DECISION CRITERIA

There are three types of criteria which should be considered when doing a road standard analysis; environmental, political/managerial, and economic. An environmental consideration might be the additional sedimentation in streams by building a double-lane road instead of a single-lane road. Political/managerial considerations might include the level of comfort that users of the road have when using a given road or the desired use which management has in mind for the area served by the road.

This Technical Release focusses on the economic factors including: construction, maintenance, vehicle operating, and accident costs.

Construction and maintenance costs are likely to be readily available. Vehicle operating costs should be found for each vehicle type using the road. For each vehicle type, the travel time and hourly operating rate need to be determined.

Accident costs for single-lane roads are more difficult to obtain than other costs. No studies have been carried out which look at accident rates on single-lane roads. A number of studies have been carried out on double-lane roads with widths as narrow as 4.8 m. Many roads which are classified as single-lane roads are actually 4.8 to 5.4 m wide, with additional width in the turnouts. A procedure has been developed to obtain the estimated accident costs for a road if its geometry is known (Layton, 1981). The question becomes whether or not a wide single-lane road functions like a narrow single-lane road. Further research is needed in this area, but for this example, the assumption was made that the data for double-lane roads was applicable to wide single-lane roads.

EXAMPLE PROJECT

An analysis was carried out on a potential project as an example. The road considered (65 Road) is located on the Gifford Pinchot National Forest in the State of Washington. The portion considered is 16 km of single-lane paved road. Traffic volume averages about 150 vehicles per day during the summer months, but this builds to a maximum during the autumn hunting season.

Travel times were measured for four days. Predictions of travel time were also made using the Logging Road Handbook (BNG) method (Byrne, et al, 1960) and the Vehicle Operating Cost Model (VOCM) (Sullivan, 1977). The results of the travel time analysis are shown on Figure 1, with values shown as a percentage of the observed times.

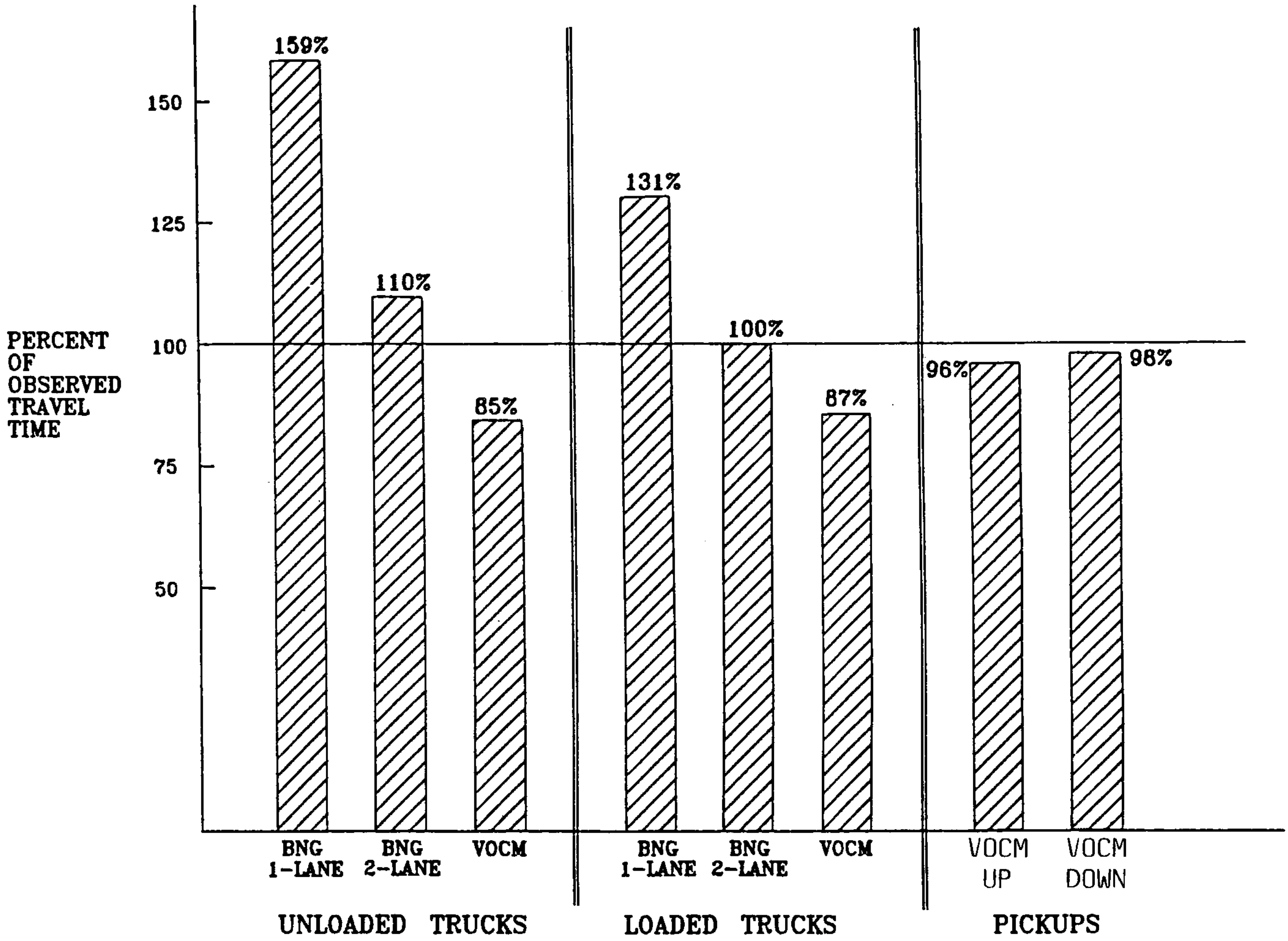


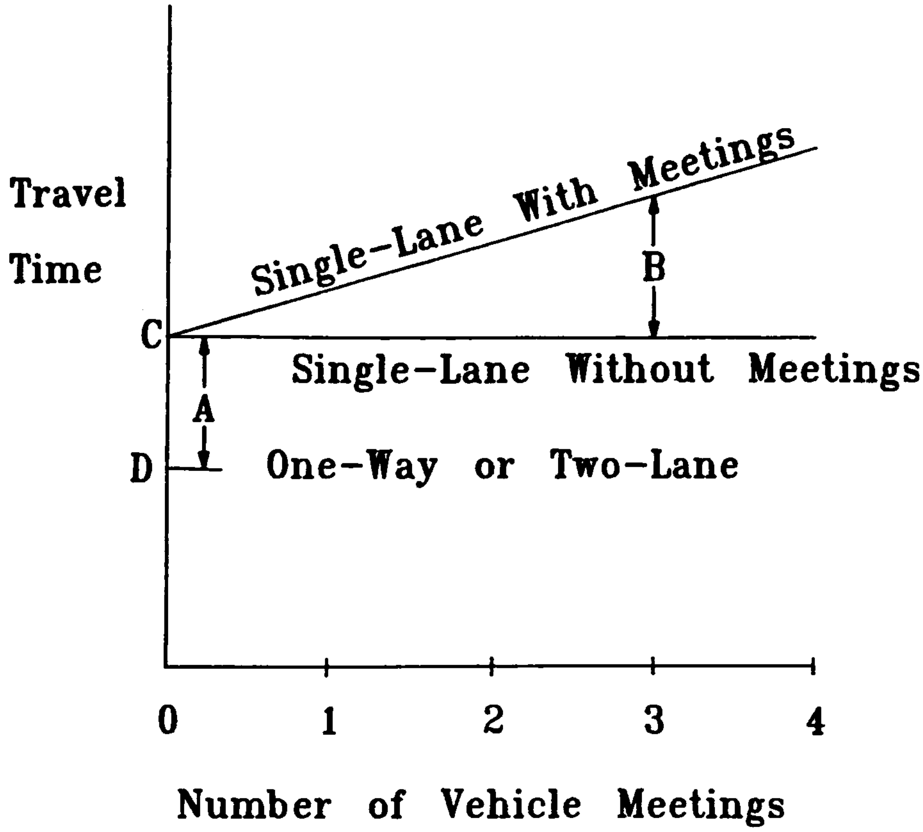
Figure 1 - Predicted versus Observed Travel Times

The BNG single-lane model consistently predicted travel times much longer than those actually observed (159% for unladen trucks and 131% for laden ones). The BNG double-lane model was much closer (110% for unladen trucks and 100% for laden ones).

Because VOCM does not take into account either the width of the roadway or the amount of traffic on the road, it was used for predicting double-lane travel times. VOCM predicts travel times for vehicles other than log trucks, and was used to predict pickup travel times for this study. VOCM consistently predicted travel times shorter than the times observed in the field. This is consistent with the assumption that it predicts double-lane travel times. These results are similiar to the findings of Jackson (1987). He also found that the single-lane BNG model was very conservative.

The travel time on a single-lane road varies with the traffic volume. Figure 2 shows the relationship between the number of vehicle meetings and the travel time for both single-lane and double-lane roads. The difference in travel time between a single-lane and double-lane road is due to the Sight Distance and Meeting Delays. The Sight Distance Delay is the portion shown as distance A and is due to reduced speeds around blind corners on single-lane roads. This delay does not occur on double-lane roads where opposing traffic travels in its own lane. The meeting delay is the time which is lost each time a vehicle is met on a single-lane road.

A double-lane travel time can be estimated if there is an existing single-lane road on the same location with the same surface type by making the road into a one-way road. This can be done by requiring the use of an alternative route for traffic flowing in one of the directions and was done in this project. A two mile segment of road was made into a one-way road for one day.



A=Limited Sight Distance Delay

B=Meeting Delay

Figure 2 - Travel Time versus Vehicle Meetings

Prediction of the single-lane travel times requires that the slope and intercept of the travel time versus vehicle meetings line be known. These were determined for this project by doing regression analyses for the data obtained in the field. Traffic count data was available for each hour during the year, and the theoretical number of meetings could be calculated for each vehicle per hour (VPH) category. These allowed calculation of the total number of vehicle meetings for a year. Multiplying this by the delay per vehicle meeting gives the total Meeting Delay. The Sight Distance Delay is found by subtracting the one-way travel time from the undelayed single-lane travel time (the intercept from the regression analysis). This is called the Field Method of obtaining single-lane and double-lane travel times. It was used for the analysis.

When determining the hourly vehicle operating costs, it is important that those costs which are distance dependent rather than time dependent be excluded since the distance travelled is likely to be the same for either road. Tyre costs were not included in the example analysis. Also, it is important to determine how many people are in each non-recreational vehicle so that their wages can be accounted for. For recreational vehicles, the cost of the recreationist's time is assumed to be zero. This is because part of the recreational experience is driving on forest roads (Layton, 1987).

Accident costs were also calculated using Layton's method. Road construction and maintenance costs were calculated using local cost guides and a recently completed evaluation with the reconstruction calculations.

SUMMARY OF PROJECT

Figure 3 compares the costs of a single-lane road with those for a double-lane road on a cost per vehicle basis. The benefits of building the double-lane road are a reduction in the vehicle operating cost by \$0.30 and the accident cost by \$0.07, i.e. \$0.37/vehicle. The reconstruction cost is \$0.79 and the road maintenance cost increases \$0.38 (\$1.17/vehicle). The double-lane road is therefore more expensive than the single-lane road by \$0.80/vehicle. Its benefit/cost ratio is 0.3. The user costs for vehicle operation and accidents will,

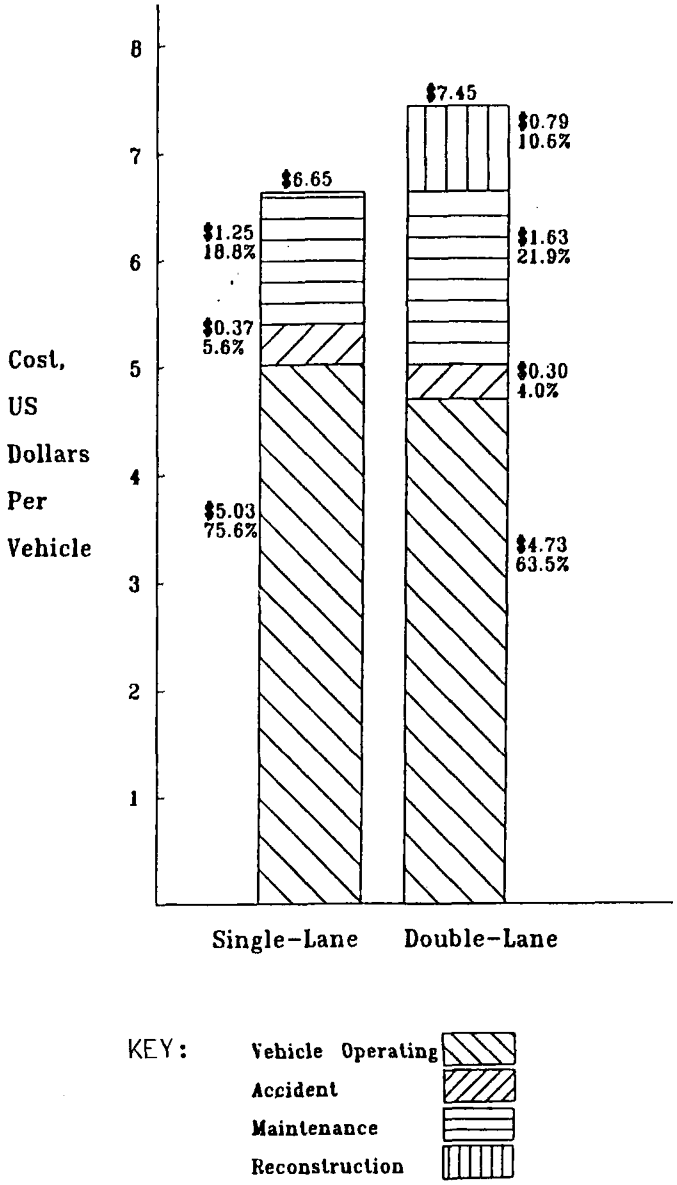


Figure 3 - Single-lane and Double-lane Cost Comparison

however, decrease by going to a double-lane road. This results in higher traffic volumes because more people are willing to pay this price. Traffic would be attracted from less suitable roads.

The accident cost is a minor factor compared to the other costs. Its estimation could be in error by a large percentage and still not significantly affect the total cost. The vehicle and road maintenance and construction costs are more significant. The vehicle operating cost is over 60% of the total cost. This is where the effort should be placed, to ensure accurate values are obtained. Road maintenance costs are next in importance, followed by reconstruction costs.

Once these economic factors have been accounted for, the non-economic factors need to be combined with the economic analysis and presented to the decision maker. In the case of this project, it is not unlikely that non-economic factors would be considered significant. If the costs were closer, however, they could affect the choice between single or double-lane roads.

LIRA NOTE

A National Roads Board Road Research Unit Technical Recommendation (TR9) entitled "The Economic Appraisal of Roading Improvement Projects" (I.H. Bone) is recommended reading for New Zealand conditions. This publication is available from the National Roads Board, P.O. Box 12-041, Wellington, or on loan from LIRA's library.

REFERENCES

Layton, R. (1981), "Manual for Analysis, Evaluation, and Selection of Highway Safety Improvements in Local Jurisdictions", Transportation Research Report 80-14, Oregon State University, Corvallis, Oregon.

Byrne, J.; Nelson, R.; Googins, P. (1960), "Logging Road Handbook - The Effect of Road Design on Hauling Cost", Handbook No. 183, USDA Forest Service, Washington, D.C.

Sullivan, E. (1977), "Vehicle Operating Cost Model - User's Guide, Second Edition", Transportation Analysis Group, Berkeley, California.

Jackson, R. (1987), "Log Truck Performance on Curves and Favourable Grades", LIRA Technical Release, Vol. 9 No. 5.

Layton, R. (1987) "Personal Communication", Associate Professor of Civil Engineering, Oregon State University, Corvallis, Oregon.

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