Priority Programming for Highway Reconstruction

Charles V. Zegeer*  Rolands L. Rizenbergs†
PRIORITY PROGRAMMING FOR HIGHWAY RECONSTRUCTION

by

C. V. Zegeer and R. L. Rizenbergs

ABSTRACT

An adequacy-rating procedure was developed for use in priority programming for highway reconstruction. The procedure makes use of 15 roadway and traffic elements to rate highway sections in urban and rural areas based on 100 points. Condition elements (35 points) include a subjective rating of highway foundation, pavement surface, drainage, and maintenance economy. Safety elements (35 points) are stopping sight distance, highway alignment, skid resistance, accident experience, and traffic control devices. Service elements (30 points) include shoulder width, passing opportunity, rideability, surface width, volume/capacity ratio, and average speed.

Some of the advantages of the new procedure include computerized analysis of all input data with detailed output summaries. All highway sections are referenced by milepoints, reference points, and federal-aid route numbers. The procedure incorporates the 1978 design standards. New adequacy concepts include the use of the Rate-Quality Control method for accident analysis, a formal rating scheme for traffic control devices, and a rating of lane width based on design level of service. Other advantages include measured skid numbers and a roadway condition rating guide for subjective evaluations of six different roadway elements.
Research Report

508

PRIORITY PROGRAMMING FOR HIGHWAY RECONSTRUCTION

by

Charles V. Zegeer
Research Engineer Senior

and

Rolands L. Rizenbergs
Assistant Director of Research

Division of Research
Bureau of Highways
DEPARTMENT OF TRANSPORTATION
Commonwealth of Kentucky

offered for publication by the
Transportation Research Board

November 1978
INTRODUCTION

Virtually every state has a systematic procedure for periodic rating of highway sections for improvement programming. The procedure, known as adequacy ratings (or sufficiency ratings), was first developed and implemented by the Arizona Highway Department in 1946 (1). The rating of highway sections is generally based on a 100-point scale, where 100 points applies to a new section.

The adequacy rating includes the evaluation of several highway and traffic elements which may be classified as condition, safety, or service. Condition elements usually require subjective evaluation and may include foundation, surface, shoulder, and drainage. Safety elements may include more objective information such as surface width, accident information, stopping sight distance, alignment, and skid resistance. Service elements may refer to such descriptors as rideability, passing opportunity, shoulder width, traffic speed, or volume/capacity ratio.

A nationwide survey was published in March 1973 of the most commonly used variables considered in adequacy rating of highways (2). The point values most often used were 40 for condition, 30 for safety, and 30 for service. Over 80 different highway and traffic elements were found to be in use in the United States in adequacy ratings. The 16 most common elements were recommended for use with either 5 or 10 points assigned to each. No distinction was made between ratings for rural and urban highways (2).

Adequacy rating of highways in Kentucky is the responsibility of the Division of Systems Planning within the Office of Transportation Planning. The ratings were developed primarily for the purpose of locating deficient highway sections on the state-maintained system. Using adequacy-rating techniques, highway sections are assigned numerical ratings which indicate their relationship to established design standards. Priorities for construction or reconstruction are then based, in part, on the adequacy rating (3).

Approximately 16,000 km (10,000 miles) of state primary and secondary routes are included in Kentucky's adequacy rating program. Because the adequacy rating methods and procedures were last revised in 1963, an in-depth evaluation was made of the procedure. The purpose was to incorporate the latest engineering principles, design standards, and computer techniques.

A new adequacy-rating procedure was developed in Kentucky in 1976 to more effectively rate sections of highway. Because of operational differences between urban and rural areas, the new procedure incorporates some descriptors which best suit the
location type. The procedure was developed to improve accuracy and reliability of the adequacy ratings and to help insure optimal expenditure of safety-improvement funds.

CONDITION ELEMENTS

Subjective evaluation of many highway and traffic elements was made to determine which may be best suited for use in Kentucky. The variables used in other states and those currently used in Kentucky for rural and urban highways were considered. The elements were categorized as condition, safety, and service. A total of 100 points were allowed for rating of highways.

All elements are shown in Table 1 along with corresponding points values. The condition elements include foundation (10 points), pavement surface (10 points), drainage (8 points), and maintenance economy (7 points). The rating procedure and point allocation for condition elements is the same for rural and urban roads.

The condition elements are rated based on a subjective evaluation by planning personnel in each of Kentucky's 12 highway districts. Each of the condition elements is rated as excellent, good, fair, or poor. There are three possible levels (high, medium, and low) for each of these four ratings, or 12 possible ratings. A guide with word descriptions was developed for use by field personnel which describes what is excellent, good, fair, and poor (Table 2). The relationship between rating and point value for foundation and surface condition was determined to be S-shaped as shown in Figure 1. A similar relationship was found for drainage condition (8-points maximum). Maintenance economy refers to the needed annual expense each year in maintenance costs. Curves for standard and substandard pavement types were developed based on a 7-point maximum.

A summary of point values for all subjective elements is given in Table 3.

SAFETY ELEMENTS

Rural Highways

For rural highways, the safety descriptors selected were stopping sight distance, alignment (vertical and horizontal), skid resistance, and accident experience. The rating for stopping sight distance (SSD) is based on a maximum of 8 points and is calculated by the formula:

\[ \text{Rating} = 8 - \frac{N}{L} \]

where \( N \) = number of stopping sight distance restrictions and \( L \) = section length in miles.
Sight distance restrictions are based on traffic speed conditions for various highway types as given in Kentucky's Basic Geometric Design Criteria (4). For example, for an 18 m/s (40 mph) design speed, the minimum SSD is 83 m (275 feet). Design speeds of 22 m/s (50 mph) and 27 m/s (60 mph) correspond to SSD restrictions of 105 and 143 m (350 and 475 feet) respectively. On an 8-km (5-mile) section with 10 SSD restrictions, the rating would be 6 out of 8 points.

The rating for highway alignment may receive a maximum of 8 points. Vertical and horizontal alignment may each receive up to 4 points based on the following formula:

\[
\text{Rating} = 4 - \frac{N}{L}
\]

where \( N \) = number of deficient curves and \( L \) = section length in miles.

Curvature limits for various volume ranges and design speeds are given in terms of maximum degrees of curvature allowed as listed in Kentucky's highway design standards. Allowable curvature ranges from 4 to 25 degrees depending on design speed and traffic volume. For the vertical alignment rating, if 2 deficient vertical curves exist in a 1.6-km (1-mile) section, the vertical alignment rating would be 2 points out of 4.

**Skid Resistance:** In rural areas, skid resistance of the pavement was selected as a safety element and assigned a maximum of 7 rating points. For survey and inventory purposes, skid tests are made at 17.9 m/s (40 mph) left wheel only, with two skid trailers meeting ASTM E 274 standards. Procedures also comply with ASTM E 274. Survey testing is limited to the period between July 1 and November 30. Frequency of repeated surveys or inventories may be involve testing every two years (5, 6).

Skid resistance has been assessed in terms of skid number groupings. Skid Numbers above 39 are considered to be skid resistant; 33-39 is considered marginal; 26 to 32 is slippery (5, 6).

For use in adequacy ratings, a relationship was derived between skid number and adequacy points. A Skid Number of 25 or less was assigned 0 points and SN of 41 or more was assigned the 7-point maximum. A linear relationship was assumed between these SN values. For example, Skid Numbers of 31 and 35 would correspond to 3 and 5 points, respectively (5, 6).

**Accident Experience:** Accident experience as a rating element of rural highway sections has received much attention within the Kentucky Bureau of Highways in recent years. A new method for identifying hazardous rural spots and sections is being
Zegeer and Rizenbergs

implemented in Kentucky (7). One of the criterion used for evaluating highways based
on accident data involves the Rate-Quality Control Method.

Average, statewide accident rates for highways of similar characteristics are needed
to use the Rate-Quality Control formula. The formula is based on the assumption that
accident occurrences on an annual basis are approximated by the Poisson distribution.
The equation is (7)

\[
CR = \lambda + k\sqrt{\frac{\lambda}{m}} + 1/2m
\]

where \( CR \) = critical accident rate for a particular
highway section in accidents per 1.6 million
vehicle-kilometers (million vehicle-miles),

\( \lambda \) = overall, average accident rate for sections
of like characteristics in accidents per
million vehicle-miles (1.6 million
vehicle-kilometers),

\( m \) = number of million vehicle-miles (1.6 million
vehicle-kilometers) on a highway section in
a 1-year period, and

\( k \) = probability factor determined by the level
of significance desired for the equation.

The value of \( k \) is determined by the level of probability that an accident rate above \( \lambda \)
is abnormal, that is, large enough so that a high accident rate cannot be reasonably
attributed to random occurrences (7). Examples of \( k \) values for various probability levels
(P) are:

<table>
<thead>
<tr>
<th>P</th>
<th>0.995</th>
<th>0.975</th>
<th>0.950</th>
<th>0.925</th>
<th>0.900</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>2.576</td>
<td>1.960</td>
<td>1.645</td>
<td>1.440</td>
<td>1.282</td>
</tr>
</tbody>
</table>

Values of statewide, average accident rates (\( \lambda \)) were determined for five types of Kentucky
roads for 1971, 1972, and 1973 (8):

- \( \lambda \) (two and three-lanes) = 2.40 accidents per million
  vehicle-miles (1.6 million vehicle-kilometers)
- \( \lambda \) (four-lane, undivided) = 3.13 accidents per million
  vehicle-miles (1.6 million vehicle-kilometers)
- \( \lambda \) (four-lane, divided) = 1.56 accidents per million
  vehicle-miles (1.6 million vehicle-kilometers)
Zegeer and Rizenbergs

\[
\lambda \text{(interstate and parkway)} = 0.84 \text{ accidents per million vehicle-miles (1.6 million vehicle-kilometers)}
\]

The critical rate curves for two- and three-lane roads are given in Figure 2 and were prepared to illustrate the use of the formula. Each curve represents a highway section length of 1.6 to 32.2 km (1 to 20 miles). To apply the method, the accident rate for a one-year period is found using the formula:

\[
R = \frac{(N)(1,000,000)/(365)(\text{AADT})(L)}{}
\]

where

- \( R \) = accident rate of the section,
- \( N \) = number of accidents in one year,
- \( \text{AADT} \) = average annual daily traffic on the section, and
- \( L \) = section length in miles.

This accident rate is compared with the critical accident level as given in Figure 2 for any AADT and section length. The actual rate is then divided by the critical rate to give the critical rate factor (CRF). Sections with rates exceeding their critical values have a CRF above 1.0, which signifies a very hazardous section.

Curves for four-lane, divided and undivided were also developed in a similar manner but are not given here. Values for \( \lambda \) were substituted into the formula with various AADT and section lengths to develop each set of curves. A probability level of 0.995 was used for all curves. Short sections must have a higher accident rate than long sections to have similar critical rate factors.

One use of the Rate-Quality Control formula is to compare the degree of hazard of one section to another, regardless of their length or highway type. For example, consider the data for two highway sections:

<table>
<thead>
<tr>
<th>Highway Type</th>
<th>Section 1</th>
<th>Section 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Length</td>
<td>3.2 km (2.0 miles)</td>
<td>6.1 km (3.8 miles)</td>
</tr>
<tr>
<td>AADT</td>
<td>18,523</td>
<td>8,391</td>
</tr>
<tr>
<td>Annual Number of Accidents</td>
<td>24</td>
<td>27</td>
</tr>
<tr>
<td>Statewide Average Rate (( \lambda ))</td>
<td>1.56</td>
<td>2.40</td>
</tr>
<tr>
<td>Annual Traffic Exposure (m)</td>
<td>13.52</td>
<td>11.64</td>
</tr>
<tr>
<td>Accident Rate (R)</td>
<td>1.77</td>
<td>2.32</td>
</tr>
</tbody>
</table>
Zegeer and Rizenbergs

Critical Accident Rate (CR)  2.47   3.61
Critical Rate Factor (CRF)  0.72   0.64

Although Section 1 had the lower accident rate, it had a greater critical rate factor and is therefore more hazardous. Neither section is considered critical, since their critical rate factors are less than 1.00.

To apply this procedure to the adequacy rating of highways, a linear relationship was developed between adequacy points and critical rate factor. A point value of 0 (worst condition) represents a critical location for all sections with a critical rate factor of 1.0 or greater. A point value of 12 (safest condition) was given to sections with a 0 critical rate factor, which occurs when there are no accidents on a section in a 1-year period (an accident rate of 0). A critical rate factor of 0.50 (half of the critical level) corresponds to 6 points, and so on.

Urban Highways and Streets

Although there were four different elements selected for use in evaluating safety of rural highways, only accident experience and traffic control devices were chosen for urban safety rating. Skid resistance data is often difficult or impossible to collect in urban areas due to low vehicle speed, high traffic volumes, and stop-and-go driving conditions. The evaluation of stopping sight distance and vertical and horizontal alignment is not applicable to city streets because of urban street networks and generally low vehicle speeds.

Accident Experience: Accident experience was assigned 20 points because of the importance of this element. The method for evaluating accident experience for the adequacy rating uses the Rate-Quality Control formula in a slightly different way than for rural highways. Urban streets, intersections and midblocks are defined within each urban section. All rates are expressed in terms of accidents per million vehicles (A/MVM) instead of accidents per million vehicle-miles (A/MVM). At intersections, volumes and accidents on both intersecting streets are used.

If locations in every city were considered under the same criteria, virtually no locations in small and medium cities would be identified as hazardous. Therefore, the rating procedure for cities was weighted according to population. Cities with over 2,500 population were categorized into six groups as shown in Table 4. Average, statewide accident rates were calculated for each city group for intersections and midblocks. Midblock average rates ranged from 0.55 to 1.25 accidents per million vehicles (A/MVM). Intersection rates range from 0.41 to 1.19 A/MVM. These values were calculated from 1974 accident
data and volume counts (Table 4) (9).

Using the statewide average accident rates and the Rate-Quality Control formula, a set of curves for critical rate were drawn for midblocks and intersections. They were based on a probability level, $P$, of 0.995 ($k = 2.576$) and give the critical accident rate for locations of a given city group and AADT. There are 44 approved urban areas which fall under Kentucky's Adequacy Rating Program.

To apply the procedure, critical rate factors are calculated and averaged for all intersections and midblocks within a study section. A linear relationship was developed between critical rate factor and rating points as for rural roads. However, a maximum of 20 points is assigned for critical rate factors of 0 (accident rate of 0).

Traffic Control Devices: The condition and effectiveness of traffic control devices are important in determining the adequacy of an urban section. A maximum of 15 points were allotted to this element. A method was developed which consists of rating the standardization, effectiveness, and maintenance of signs, signals, and markings as shown in Table 5. Detailed definitions of condition evaluation are given for each of the three categories. The point allocation for each category is 5, 4, 2, and 0 points for excellent, good, fair, and poor ratings, respectively (maximum 15 points).

The standardization of a device is based on its compliance with the Manual on Uniform Traffic Control Devices (MUTCD) (10). Such items considered are sign color and symbols, proper sign location; color, type, and visibility of pavement markings; and adequacy of size and indications on traffic signals.

The effectiveness of traffic control devices is the second category. This pertains to the clarity of information which is given to the driver related to destinations, upcoming dangers, and regulations (speed limits, stop signs, no passing, etc.). The effectiveness of the traffic signals to promote smooth traffic movement through the intersection is also considered. Inappropriate signal timing, inconspicuous or small signal heads, or lack of coordination between adjacent signals would result in poor ratings in this category.

The maintenance of traffic control devices requires that all signs and pavement markings are clearly visible, clean, and straight. All signal and street-light bulbs should be burning and lens faces are clean. Pavement delineators should all be in place and in good condition. Weathered or worn out traffic control devices can create hazardous conditions to the out-of-state motorist, particularly in the rain or at night.
SERVICE ELEMENTS

Rural Highways

The width and condition of the highway shoulder is important in providing adequate capacity and refuge for emergency stopping. A relationship was developed between shoulder width and adequacy points based on average annual daily traffic (AADT) as shown in Figure 3. Small values of AADT provide the most points for various shoulder widths. For example, for AADT ranges of 0 to 100, adequacy values range from 2 points for no shoulder to 7 points for shoulder widths of 1 m (2 feet) or more. For AADT values of 1,500 to 7,000, shoulders of 1.2 m (4 feet) are assigned 0 points, and 7 points are given only for shoulders of 3.8 m (12 feet) and above. For roads over 1,000 AADT, 2 points are deducted if shoulders are not paved or stabilized.

Another service element which was included for rural roads was passing opportunity (Figure 4). It is based on AADT and the percent of passing sight distance on two-lane roads. Again, roads with lower volumes are given more points than high-volume roads. For AADT values below 250, the maximum 8 points is assigned for roads with a passing sight distance (PSD) of only 15 percent. Roads with AADT's above 8,000 must have 100 percent PSD to obtain the 8 point maximum. Roads with more than two lanes get the maximum 8 points, regardless of volume.

Rideability is a rural service element which is related to the road roughness and is a subjective rating made while driving over the section. The rideability rating is based on an S-curve as was shown for foundation and surface condition and carries a 5-point maximum (Table 3).

Surface width is the most important service element (10-point maximum). Pavement widths of 2.5 to 7.2 m (8 to 24 feet) for two-lane roads were plotted against adequacy points as a function of AADT in Figure 5. A total of nine different volume ranges up to 10,000 were used for determining points. For two-lane roads with AADT values over 10,000, zero points were assigned. For multilane, rural roads, another figure (not given here) was developed based on median width.
Urban Highways and Streets

As discussed previously, there are differences in driving conditions between urban and rural roads. On rural roads, desirable attributes include the opportunity to pass, adequate pavement width, side shoulders, and a smooth pavement surface. On urban streets, the emphasis is on maintaining acceptable speeds, avoiding congested conditions, and an acceptable street width. The three service elements for urban areas include pavement width, volume/capacity ratio, and average speed.

The relationship between lane width and adequacy points on urban streets bears no resemblance to the curve for rural highways. The relationship was developed from level of service information provided in the Highway Capacity Manual (11). Up to 10 adequacy points are assigned to lane width from 2.4 to 3.6 m (8 to 12 feet) as shown in Figure 6. Five different curves corresponding to levels of service A to E are provided. Kentucky's current design level of service is C for urban areas. Since design levels of service change, the figure provides for any such changes. As design level of service is lowered (such as from C to D), more adequacy points would be assigned for a given lane width.

The second service element for urban areas is the volume/capacity (V/C) ratio during peak traffic periods, which is worth up to 12 adequacy points (Figure 7). Again, information from the Capacity Manual was utilized in the allocation of points (11). The S-shaped curve gives a high rating to V/C values below 0.7 (corresponding to levels of service A and B). Between 0.7 and 0.8, the points drop from about 10 to 4. When the volume equals or exceeds capacity (level of service E or F), no points are given.

Average traffic speed is the final urban service element and is based on 8 points maximum (Figure 8). For business and downtown streets, speeds over 11 m/s (24 mph) correspond to the maximum 8 points, while speeds of 5 m/s (10 mph) or less get no points. For intermediate and residential streets, average speeds of 13 m/s (30 mph) are necessary to receive 8 points. Speeds of 7 m/s (15 mph) or below get no points.

**OUTPUT FORMAT FOR ADEQUACY RATINGS**

Computerization of all information appearing in the figures and tables was a major recommendation for improvement of accuracy and efficiency of the rating program. The only input into the computer program is the raw data collected for each highway section. The output consists of a listing of assigned and maximum points for each element of the section along with the final adequacy rating.
To facilitate the implementation of such a computer printout, each of the 15 highway elements were assigned a letter code (A to P) as given in Figure 9. Examples of printouts for a rural and urban highway sections include

1. each element used (designated by letter code);
2. assigned points for each element;
3. maximum points for each element (number in parentheses);
4. subtotal points for condition, safety, and service; and
5. final adequacy rating.

The example for rural highways (Figure 9) shows that the section received 18 of the 35 condition points. The breakdown of the 18 points were 6 points for foundation, 5 points for surface, 4 points for drainage, and 3 points for maintenance. The section also showed 21 out of 35 points for safety and 23 out of 30 points for service. The final adequacy rating was 62.

The example of an urban highway section cited in Figure 9 shows a rating of 82. The point distributions show that most elements rated high except for the foundation element which received only 4. A final adequacy rating of below 70 may indicate a need for improving the highway.

The capabilities for an additional computer printout were also recommended which would contain raw data used to compute adequacy points. Included would be such information as lane width, accident rate, AADT, skid number, passing sight distance, volume-capacity ratio, average speed, annual maintenance cost, and a word description of all subjectively-related elements.

SUMMARY AND CONCLUSIONS

A number of advantages may be expected from the use of the adequacy-rating techniques described in this report. Computerization of the procedures will permit the coding of numbers from forms without referring to tables, graphs, and charts. Rating of traffic control devices in urban areas can be done quickly and easily. The inclusion of accident and skid resistance data will be accomplished by merging computer tapes with those of the adequacy rating.

The total cost of the rating program will be reduced; much of the work will be done more quickly and efficiently with the aid of the computer. Faster updates of adequacy ratings will be possible.
Improved reliability of the results can also be expected from the revised techniques. Conversion from tables, charts, and graphs will no longer be done by hand. Human error, therefore, will be reduced. Skid resistance will be a measured determination rather than a subjective rating. Several important elements such as accident experience, traffic safety features, and traffic control devices add to the overall data base of the adequacy ratings and, therefore, improve reliability of the rating. Another improvement is the revision of the figures and tables to meet current design criteria in Kentucky. The revisions incorporate 1978 standards.

The revised procedure involves simple addition of numbers for each element to obtain the final adequacy rating. Maximum points and assigned points may be printed on the output format so that the specific deficiencies can be quickly noted. Another simplification is the use of mileposts, reference numbers, and federal-aid route numbers for each section. This will permit easier site identification. The revised technique uses only two classifications of highway instead of three, since “intermediate” highway sections are to be designated as either urban or rural.

The addition of accident experience, traffic efficiency measures, and traffic control devices was judged to be important. Skid resistance data (measured values) will also be added to replace the subjective evaluations. The revision of the lane-width factor will allow for modification of the adequacy rating for urban sections if the design level of service were to be changed.

The recommended adequacy rating procedures in this paper are currently being implemented by the Kentucky Department of Transportation.

REFERENCES


<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>RURAL POINTS</th>
<th>URBAN POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOUNDATION</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>PAVEMENT SURFACE</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>DRAINAGE</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>MAINTENANCE ECONOMY</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>STOPPING SIGHT DISTANCE</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>ALIGNMENT</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>SKID RESISTANCE</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>ACCIDENT EXPERIENCE</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>TRAFFIC CONTROL DEVICES</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>SHOULDER WIDTH AND CONDITION</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>PASSING OPPORTUNITY</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>RIDEABILITY</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>SURFACE WIDTH</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>VOLUME/CAPACITY RATIO</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>AVERAGE SPEED</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL POINTS</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>TABLE 2. ROADWAY CONDITION RATING GUIDE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BASE</strong></td>
<td><strong>CONDITION</strong></td>
<td><strong>EXCELLENT</strong></td>
</tr>
<tr>
<td>Base (as distinguished from surface) is considered to be in very satisfactory condition. Rare situations of imperfect smoothness but no evidence of base failure.</td>
<td>Occasional evidence of minor base failure, fully correctable by spot repairs. Extensive reworking not absolutely necessary.</td>
<td>Frequent evidence of base failure, correctable only by heavy maintenance. Road should be considered for reconstruction. Traffic speeds reduced somewhat.</td>
</tr>
<tr>
<td><strong>SURFACE</strong></td>
<td><strong>CONDITION</strong></td>
<td><strong>EXCELLENT</strong></td>
</tr>
<tr>
<td>Surface (as distinguished from base) is considered to be in very satisfactory condition. Pavement smoothness very satisfactory. No surface failure.</td>
<td>Occasional spots of surface failure, spalling, or roughness, correctable to a satisfactory extent through maintenance and minor patching. Resurfacing not absolutely necessary.</td>
<td>Frequent spots of surface failure, spalling, etc. Rough surface in need of heavy maintenance. Should be considered for resurfacing. Traffic speeds reduced somewhat.</td>
</tr>
<tr>
<td><strong>DRAINAGE</strong></td>
<td><strong>CONDITION</strong></td>
<td><strong>NO surface drains satisfactorily during heavy rains; no ponding, no flooding.</strong></td>
</tr>
<tr>
<td><strong>DITCH DRAINAGE OR URBAN DRAINAGE FACILITIES</strong></td>
<td><strong>EXCELLENT</strong></td>
<td><strong>GOOD</strong></td>
</tr>
<tr>
<td>Ditch drainage (or urban drainage facilities) are completely adequate under conditions of heavy rainfall. No corrections needed other than normal light maintenance.</td>
<td>Ditch drainage (or urban drainage facilities) generally adequate except under conditions of very heavy rainfall. Frequent light maintenance required. No need for substantial improvement.</td>
<td>Ditch drainage (or urban drainage facilities) only partially adequate. Excessive maintenance required. Consideration should be given to substantially improving and/or extending ditches or other facilities.</td>
</tr>
<tr>
<td><strong>MAINTENANCE ECONOMY</strong></td>
<td><strong>EXCELLENT</strong></td>
<td><strong>GOOD</strong></td>
</tr>
<tr>
<td>No expenditures, other than strictly routine. Patching rarely required.</td>
<td>Some expenditures, but not excessive. Some patching required annually or at intervals. Resurfacing would help but not absolutely necessary.</td>
<td>Considerable expenditures of money and material. Considerable patching required annually or continually. Road should be considered for resurfacing or reconstruction.</td>
</tr>
<tr>
<td><strong>RIDEABILITY</strong></td>
<td><strong>EXCELLENT</strong></td>
<td><strong>GOOD</strong></td>
</tr>
<tr>
<td>No driver strain whatsoever under normal conditions. Crown, superelevations, transitions, etc., provide for excellent operation of vehicles. No undue hazards or side entrance friction. Smooth riding conditions. No width or clearance restrictions.</td>
<td>Moderate driver strain due to minor geometric deficiencies, occasional side entrance friction and hazard. Good riding comfort. Operations or driver strain alone do not justify major improvements.</td>
<td>Considerable driver strain due to geometric deficiencies, side entrance friction, maneuvering vehicle. Substantial riding discomfort. Some improvements should be considered to improve quality.</td>
</tr>
</tbody>
</table>
### Table 3. Points for Condition Rating

<table>
<thead>
<tr>
<th>Condition</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Condition</td>
<td>10 10 9</td>
<td>8 7 5</td>
<td>4 3 2</td>
<td>1 0 0</td>
</tr>
<tr>
<td>Pavement Surface Condition</td>
<td>10 10 9</td>
<td>8 7 6</td>
<td>4 3 2</td>
<td>1 0 0</td>
</tr>
<tr>
<td>Drainage Condition</td>
<td>8 8 7</td>
<td>7 6 5</td>
<td>3 2 2</td>
<td>1 0 0</td>
</tr>
<tr>
<td>Maintenance Economy: Standard Pavement</td>
<td>7 6 5</td>
<td>5 4 4</td>
<td>3 3 2</td>
<td>1 1 0</td>
</tr>
<tr>
<td>Maintenance Economy: Substandard Pavement</td>
<td>7 5 4</td>
<td>3 2 2</td>
<td>1 1 0</td>
<td>0 0 0</td>
</tr>
<tr>
<td>Rideability</td>
<td>5 5 5</td>
<td>4 4 3</td>
<td>2 1 1</td>
<td>0 0 0</td>
</tr>
</tbody>
</table>

### Table 4. Accident Rate for Arterial-Collector Locations

<table>
<thead>
<tr>
<th>Group</th>
<th>Average Annual Daily Traffic</th>
<th>Accidents per Location</th>
<th>Accident Rate (Accidents per Million Vehicles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mid-Blocks Sections</td>
<td>Inter-Blocks Sections</td>
<td>Mid-Blocks Sections</td>
</tr>
<tr>
<td>OVER 200,000</td>
<td>11,781 23,562</td>
<td>5.0 10.2</td>
<td>1.16 1.19</td>
</tr>
<tr>
<td>50,001 - 200,000</td>
<td>8,990 17,980</td>
<td>4.1 6.6</td>
<td>1.25 1.01</td>
</tr>
<tr>
<td>20,001 - 50,000</td>
<td>6,520 13,040</td>
<td>2.7 4.5</td>
<td>1.13 0.95</td>
</tr>
<tr>
<td>10,001 - 20,000</td>
<td>5,800 11,600</td>
<td>1.5 2.4</td>
<td>0.71 0.57</td>
</tr>
<tr>
<td>5,001 - 10,000</td>
<td>4,811 9,622</td>
<td>1.0 1.9</td>
<td>0.57 0.54</td>
</tr>
<tr>
<td>2,500 - 5,000</td>
<td>4,002 8,004</td>
<td>0.8 1.2</td>
<td>0.55 0.41</td>
</tr>
<tr>
<td>TABLE 5. EVALUATION OF TRAFFIC-CONTROL DEVICES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EXCELLENT</strong></td>
<td><strong>GOOD</strong></td>
<td><strong>FAIR</strong></td>
<td><strong>POOR</strong></td>
</tr>
<tr>
<td>All existing traffic-control devices meet regulations in the Manual on Uniform Traffic Control Devices. Signal heads and indication displays are sufficient. Sign colors and symbols are correct. Proper sign distances exist. Colors and type of pavement markings are correct and visible.</td>
<td>Most traffic-control devices meet MUTCD regulations. Signal heads and indication displays are sufficient in nearly all cases. Most signs and markings are correct. A few sign distances may be too short. Pavement markings are generally adequate.</td>
<td>Many traffic-control devices do not meet MUTCD regulations. Several signal heads and indication displays are inadequate. Sign colors and symbols are incorrect in many cases. Inadequate signing distances exist. Pavement markings are quite worn.</td>
<td>Traffic-control devices were installed with no regard to the MUTCD. Signal heads and indication displays are totally inadequate. Signs are often conflicting and unclear, and inadequate signing distances exist. Pavement markings are misleading, incorrect, or worn.</td>
</tr>
<tr>
<td><strong>STANDARDIZATION</strong></td>
<td><strong>EFFECTIVENESS</strong></td>
<td><strong>MOUNTING</strong></td>
<td></td>
</tr>
<tr>
<td>Existing traffic control devices convey sufficient information to the driver. No additional signs are needed. Destinations are clear. Regulations and warnings are adequately signed and marked. Traffic flows freely through signalized intersections.</td>
<td>Most traffic-control devices convey sufficient information to the driver. A few additional signs may be needed. Destinations are clear in most cases. Regulations and warnings are usually adequate. Traffic flows through signalized intersections.</td>
<td>Many traffic-control devices do not convey sufficient information. Several additional signs are needed. Unclear destination signs exist. Regulations and warnings are often inadequate. Traffic flow is often congested through signalized intersections.</td>
<td>Traffic-control devices are unclear. More signing is needed. Destinations are unclear, regulations and warnings are unclear or conflicting. Traffic is greatly congested through the signalized intersections.</td>
</tr>
<tr>
<td>Signs and pavement markings are clearly visible, clean, and straight. All signal and street-light bulbs are burning and lens covers are clean. Delineators are all in place and in good shape.</td>
<td>Signs are slightly weathered or dirty. Pavement markings are slightly worn or dirty. One or two bulbs in signals or street lights may need replacing. Some delineators are missing, but they are still adequate for nighttime visibility.</td>
<td>Signs and pavement markings will soon need replacing. Several bulbs in signals or street lights need replacing. Many signal faces need cleaning. No delineators exist and nighttime drivers may be difficult.</td>
<td>Signs are weathered or dirty and need to be replaced. Several signal and street light bulbs need replacing. Delineators and pavement markings are mostly worn away or missing.</td>
</tr>
</tbody>
</table>
Figure 1. Point Values for Rating Foundation and Surface Condition.
Figure 2. Critical Rate Curves for Rural, Two- and Three-Lane Highway Sections (7).
NOTE: WHERE AADT = 1000, REDUCE RATING BY 2 POINTS IF SHOULDERS ARE NOT STABILIZED OR PAVED.

Figure 3. Point Values for Rating Shoulder Width and Condition.
Figure 4. Point Values for Rating Passing Opportunity on Two-Lane Roads.

NOTE: ROADS WITH MORE THAN TWO LANES GET 8 POINTS.
Figure 5. Point Values for Rating Pavement Width on Two-Lane Roads.
Figure 6. Point Values for Rating Lane Width on Urban Streets.
Figure 7. Point Values for Rating Volume/Capacity Ratio on Urban Streets.
Figure 8. Point Values for Rating Average Speed of Traffic on Urban Streets.
### Table 1: Adequacy Ratings

<table>
<thead>
<tr>
<th>Code</th>
<th>Element</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>FOUNDATION CONDITION (R, U)</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>SURFACE CONDITION (R, U)</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>DRAINAGE CONDITION (R, U)</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>MAINTENANCE ECONOMY (R, U)</td>
<td>7</td>
</tr>
<tr>
<td>E</td>
<td>STOPPING SIGHT DISTANCE (R)</td>
<td>8</td>
</tr>
<tr>
<td>F</td>
<td>ACCIDENT DATA (R, U)</td>
<td>12 OR 20</td>
</tr>
<tr>
<td>G</td>
<td>SKID RESISTANCE (R)</td>
<td>7</td>
</tr>
<tr>
<td>H</td>
<td>ALIGNMENT (R)</td>
<td>8</td>
</tr>
<tr>
<td>I</td>
<td>SHOULDER WIDTH AND CONDITION (R)</td>
<td>7</td>
</tr>
<tr>
<td>J</td>
<td>PASSING OPPORTUNITY (R)</td>
<td>8</td>
</tr>
<tr>
<td>K</td>
<td>RIDEABILITY (R)</td>
<td>5</td>
</tr>
<tr>
<td>L</td>
<td>SURFACE WIDTH (R, U)</td>
<td>10</td>
</tr>
<tr>
<td>M</td>
<td>TRAFFIC CONTROL DEVICES (U)</td>
<td>15</td>
</tr>
<tr>
<td>N</td>
<td>VOLUME/CAPACITY RATIO (U)</td>
<td>12</td>
</tr>
<tr>
<td>P</td>
<td>AVERAGE OVERALL SPEED (U)</td>
<td>8</td>
</tr>
</tbody>
</table>

#### Rural Highway Section

\[
6(10)A + 5(10)B + 4(8)C + 3(7)D = 18(35)\text{CONDITION}
\]
\[
2(8)E + 10(12)F + 4(7)G + 5(8)H = 21(35)\text{SAFETY}
\]
\[
6(7)I + 8(8)J + 2(5)K + 7(10)L = 23(30)\text{SERVICE}
\]

62(100)\text{TOTAL}

#### Urban Highway Section

\[
4(10)A + 8(10)B + 6(8)C + 7(7)D = 25(35)\text{CONDITION}
\]
\[
18(20)F + 13(15)M = 31(35)\text{SAFETY}
\]
\[
11(12)I + 5(8)P + 10(10)L = 26(30)\text{SERVICE}
\]

82(100)\text{TOTAL}

R = RURAL, U = URBAN
Number in first position indicates the rating
Number in ( ) indicates maximum points allocated to the element
Letter indicates the element (see above and Table 1)

Figure 9. Example of Computer Output of Adequacy Ratings.