# Graphical Presentation Procedures

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REDUCING the details of computations and results to simplified charts, graphs and maps should be a part of every sufficiency rating plan. Graphic presentation of data has two main purposes: (1) engineering analysis and (2) interpretation for general use. In engineering work, graphics are essential to get quick understanding of facts, to aid in analysis of various relationships and to observe trends. Refinement and detail beyond that required for general understanding may be necessary.

For the second purpose, good graphics properly interpreting engineering data will provide quick reference material for administrators, reduce the mass of data and text in published reports, and greatly aid in gaining better public appreciation and acceptance of the facts so presented.

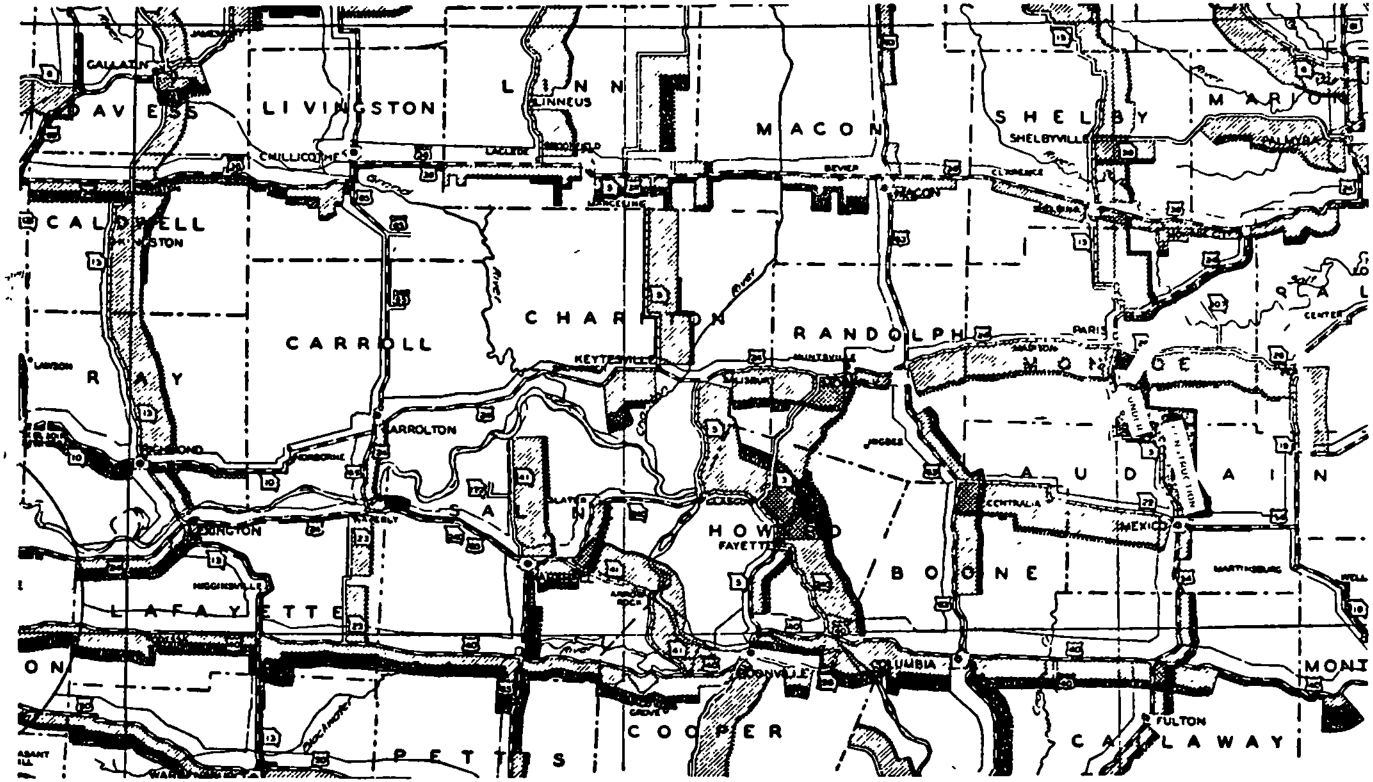
For both purposes, but especially the latter, the modern art of fisual aids, already carried to high levels in many fields, certainly needs to be more fully explored, understood, and developed for use of those concerned with highways.

Figures are presented showing some early and current means of depicting sufficiency-rating data. Obviously some are limited to detailed engineering use alone, and others combine that with the broader purposes. In some cases, it is practically impossible to combine the two.

If it is desired to obtain maximum utility not only for engineering analysis but also for administrators, legislators, user groups, and the public at large, then the samples shown still leave room for improvement. More imagination, experience, and study of techniques will find that need.

However, the examples shown have merit in one way or another. No doubt there are some excellent ideas on the boards now or already published but not located for this brief review. In viewing slides and in planning graphic presentations, these points should be borne in mind: (1) Data should be attractively and interestingly presented, especially if for the general public for whose eye and mind there is great competition, but the general style should fit the "tone" or character of the report as a whole. (2) Production cost should be a minimum consistent with achieving the objectives. (3) Abilities of draftsmen, supervisors and printers may affect the type of presentation. (4) Use of two or more colors often provides greater clarity and interest than black and white but, of course, increases cost. On the other hand, color variation (instead of scale) to show degree sharply limits detail, and poor choice of colors or bad registration may hamper the viewer. (5) Scale should be chosen carefully to avoid distortion or crowding. (6) Charts and maps should be simplified, omitting extraneous detail and depicting only one thing or at most the minimum number of necessary relationships unless accomplished with progressive overlays; legends should be carefully chosen and adequate identification provided without over-doing it. (7) However, consideration should be given to various devices to attract interest, emphasize the point and improve understanding without misinterpretation. Depending on the purpose, then, there is choice of straight-forward graphics or a range of "dressed-up" style. (8) Finally there are the questions of how much language should be used within the chart, what kind of outside caption or head is needed and whether explanatory legends describing the chart or what it means are required. The graphics should be able to tell the story standing alone, but language in the chart may be required to show how to read it, to provide basic information not shown in the scale or legend, or to draw attention to a salient point. Dead or live captions may be used, the former being simply a title and the latter giving a message.

These factors, and others, in graphic presentation are well understood by specialists in that field. The highway engi-




SECTIONAL MAP INDICATING DEFICIENCIES ON RURAL TRUNK SYSTEM

LEGEND

- HIGH TYPE SURFACE
- INTERMEDIATE TYPE SURFACE
- GRANULAR TYPE SURFACE
- SCALE FOR DAILY TRAFFIC
- INADEQUATE SURFACE TYPE
- SURFACE CONDITION
- DEFICIENT GRADES SIGHT DISTANCE AND ALIGNMENT
- CONDITION AND DEFICIENCY SCALE
- INADEQUATE SURFACE WIDTH

SCALE MILES

Figure 1.

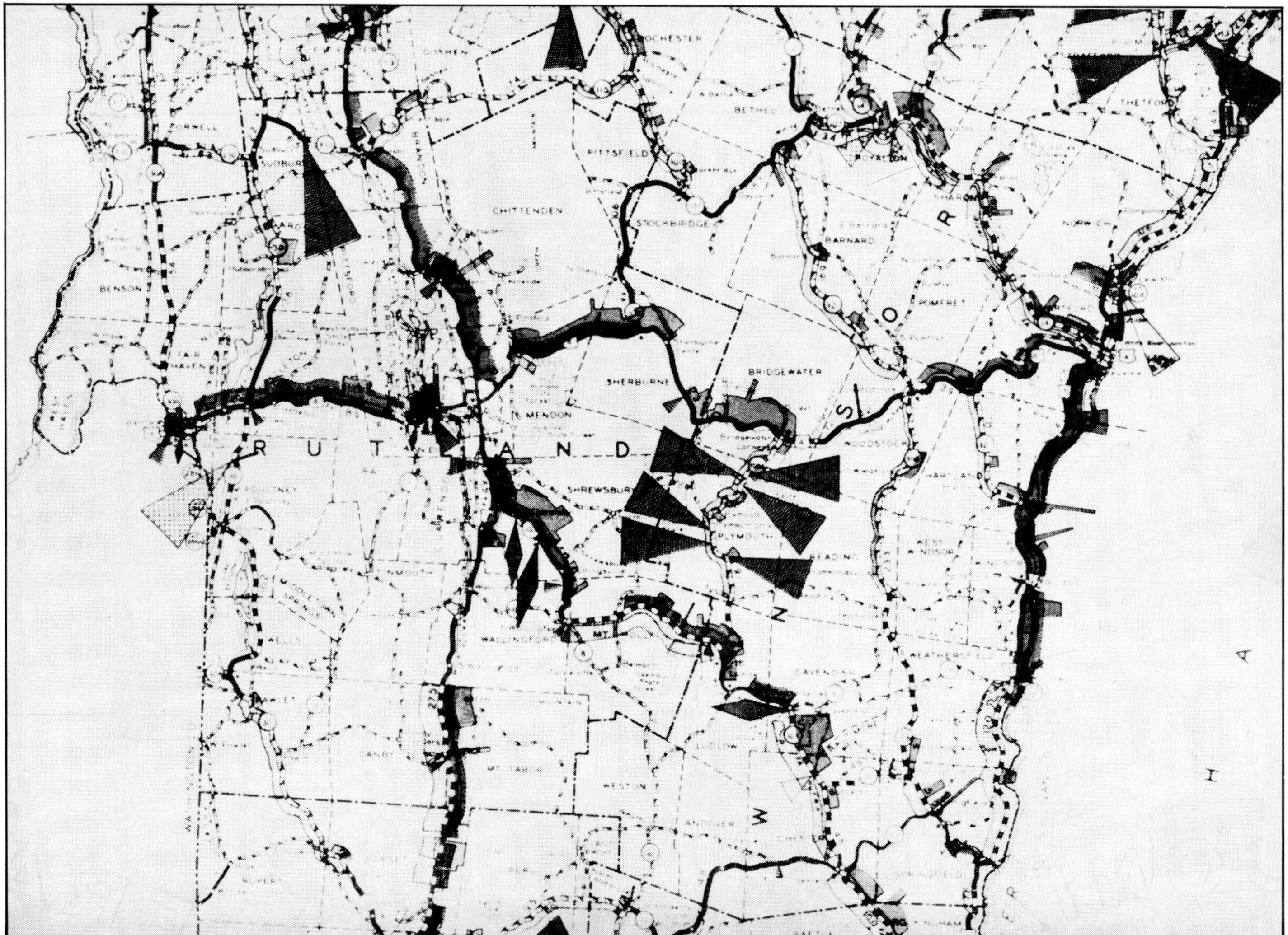

ROCHESTER
GOSHEN
BETHEL
THETFORD
ORWELL
PITTSFIELD
SUDBURY
ROYALTON
BRANDON
CHITTENDEN
STOCKBRIDGE
BARNARD
NORWICH
BENSON
POMFRET
BRIDGEWATER
SHERBURNE
MENDON
WOODSTOCK
R U T L A N D
SHREWSBURY
HARTLAND
PLYMOUTH
READING
WEST WINDSOR
WALLINGFORD
MT. HOLLY
CAVENDISH
WEATHERSFIELD
WELLS
DANBY
MT. TABOR
LUDLOW
WESTON
ANDOVER
SPRINGFIELD

Figure 2.

neer understands the engineering factors that need to be portrayed. Good graphics in highway work need both types of thinking and, to use a recently coined word, good "imagineering."

The graphic procedures for sufficiency ratings should be organized to: (1) record field data in permanent visual form; (2) permit easy revision at regular intervals; (3) permit easy comparison with other charted or mapped data; (4) give a "bird's-eye" view of the magnitude of each major element as well as the over-all rating on statewide systems, routes or sections; (5) provide for charted summaries.

Each of the following figures shows various elements of this five part program.

Figure 1: 1939 Missouri Map. This section of a Missouri rating map, shown in a 1939 report, is a pioneering example of graphic presentation of study results. The map meets many engineering needs. It condenses findings into understandable and useable form showing degree of deficiency, rather than sufficiency, by specific location. Note that the scale is plotted on one side of the road line used as a base, with a traffic volume scale on the other side. This technique magnifies the variations, making comparisons somewhat easier.

Two major elements of the rating plan, surface condition and combined geometrics, are shown separately by scale with the object of indicating higher priority by wider total bands. Inadequate surface width is shown by legend only.

However, for more general purposes, it is observed that the scale is small for the printed report, there is some non-essential material on the map and it lacks general attractiveness. Careful attempt to follow minor variations in road alignment is perhaps unnecessary.

In the Missouri report, this section is shown only as an example of a product. The statewide map was apparently made for office use only. No charted summaries of results were shown, although many tabular data were provided in the report which would appeal primarily to students of the subject.

Figure 2: 1939 Vermont Map. This is a partial section of another type of deficiency rating map included in a Vermont report, also made in 1939. In that report, which apparently was intended to have wider public appeal than the Missouri product, there is folded in a complete state map twice the report page size.

Use of color gives eye appeal and clarity which is partly defeated by the variety of material shown. The base map is apparently a general map (one not prepared especially for the purpose) and includes material not essential to display of ratings.

Each color is used to depict a single element of the rating plan, with a road-based scale to define degree of variation from standard. No combined rating was computed or shown on the map, but this manner of presentation does give some impression of combined sufficiency or deficiency, although overlapping colors obscure each other in some cases.

The scale and manner of showing bridges may be considered out of proportion to roadway elements, but the importance of structures may justify such treatment.

With this type of map, preparation time and production costs are relatively high and revision is more difficult. Nevertheless, it appears as an early and significant contribution to techniques.

Figure 3: 1949 Arizona Map. This statewide map is included in the 1949 report of "Numerical Ratings for Arizona Federal-Aid Highway System." It clearly portrays the combined sufficiency ratings alone, with nearly a minimum of extraneous detail.

Road location is shown diagrammatically, causing mileage scale adjustment to match actual mileage and possibly resulting in slight distortions in the length of ratings on curved sections compared to those on tangents. The rating scale is large enough to show variations at a glance but causes some difficulties at road junctions. To overcome this, offsets are used, and these may appear confusing. The rating is shown like a traffic-flow band, with the maximum rating of 100 indicated by uniform width of a line 50 points wide on each side of the road center line. Thus numerical values below 100 are somewhat difficult to determine.

The elements making up the combined rating are now shown, and the route numbers and place names are rather small in the scale of the printed map.

Over all, however, this method is eco-

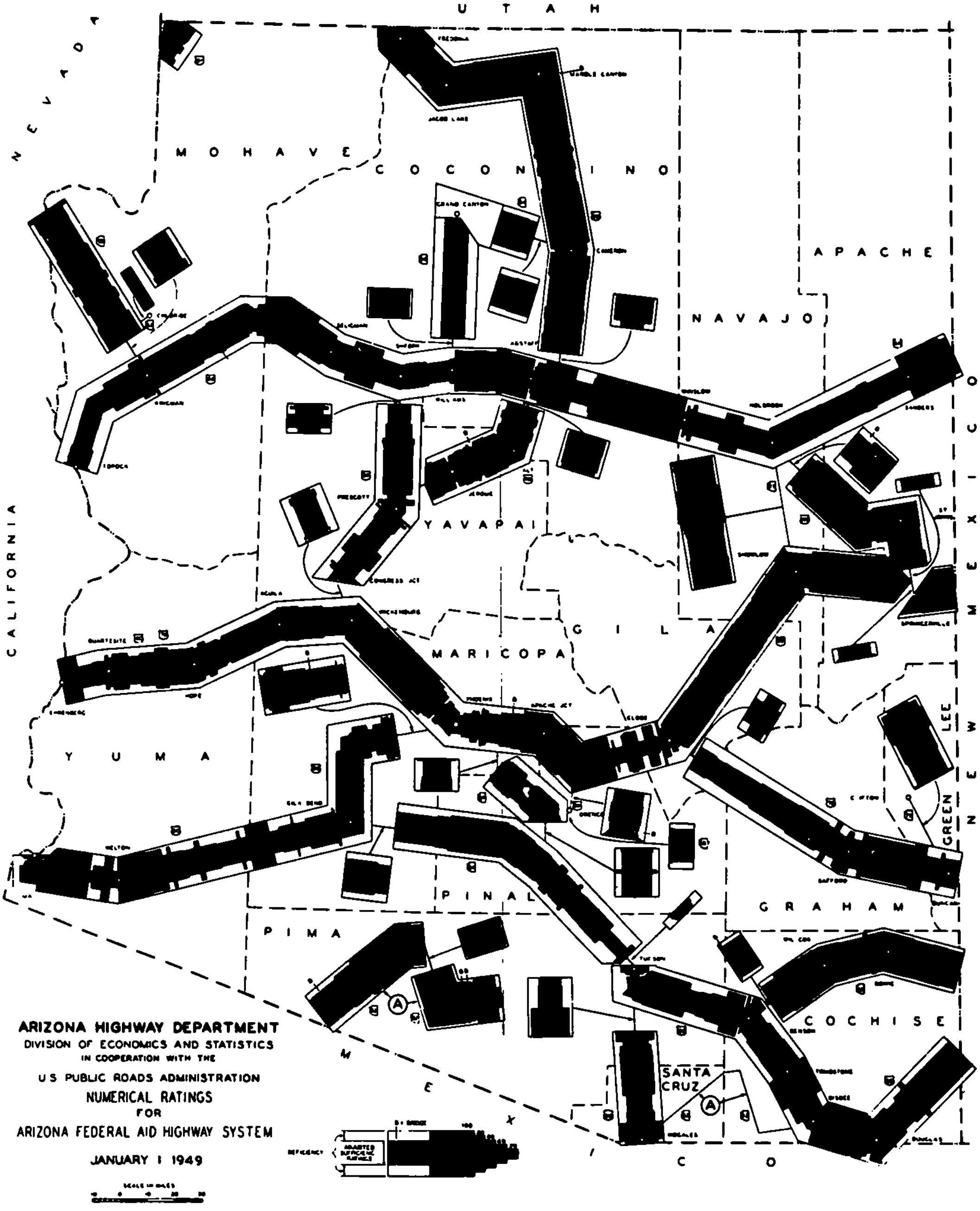

UTAH
NEVADA
MOHAVE
COCONINO
APACHE
NAVAJO
CALIFORNIA
YAVAPAI
GILA
MARICOPA
YUMA
PINAL
PIMA
GRAHAM
GREENLEE
COCHISE
SANTA CRUZ
NEW MEXICO
MEXICO
ARIZONA HIGHWAY DEPARTMENT
DIVISION OF ECONOMICS AND STATISTICS
IN COOPERATION WITH THE
U S PUBLIC ROADS ADMINISTRATION
NUMERICAL RATINGS
FOR
ARIZONA FEDERAL AID HIGHWAY SYSTEM
JANUARY 1 1949

Figure 3.

# SUFFICIENCY STATUS - INSET AREA
## FEDERAL AID PRIMARY SYSTEM
# STATE OF OREGON
## 1950

LEGEND

OREGON F A PRIMARY SYSTEM
(1W) STATE PRIMARY HIGHWAY NUMBER
SUBSECTION NUMBERS
CONTROL SECTION NUMBERS

TRAFFIC ADJUSTED RATING (Ts=1400VPD)

- 80 to 100%
- 70 to 79%
- 60 to 69%
- 59% Minus
- Not Rated

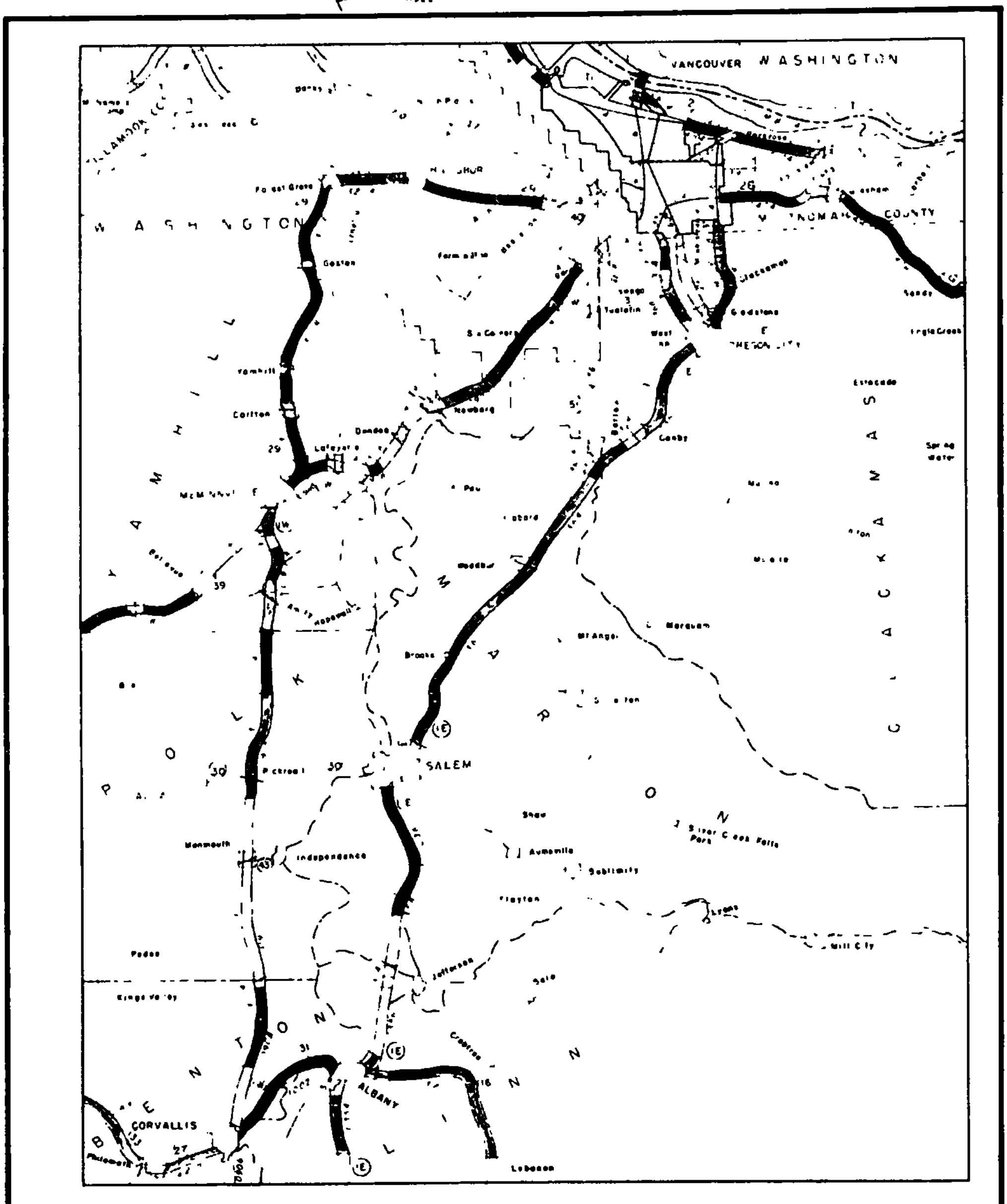



Figure 4.

# Deficiencies on State Highway System

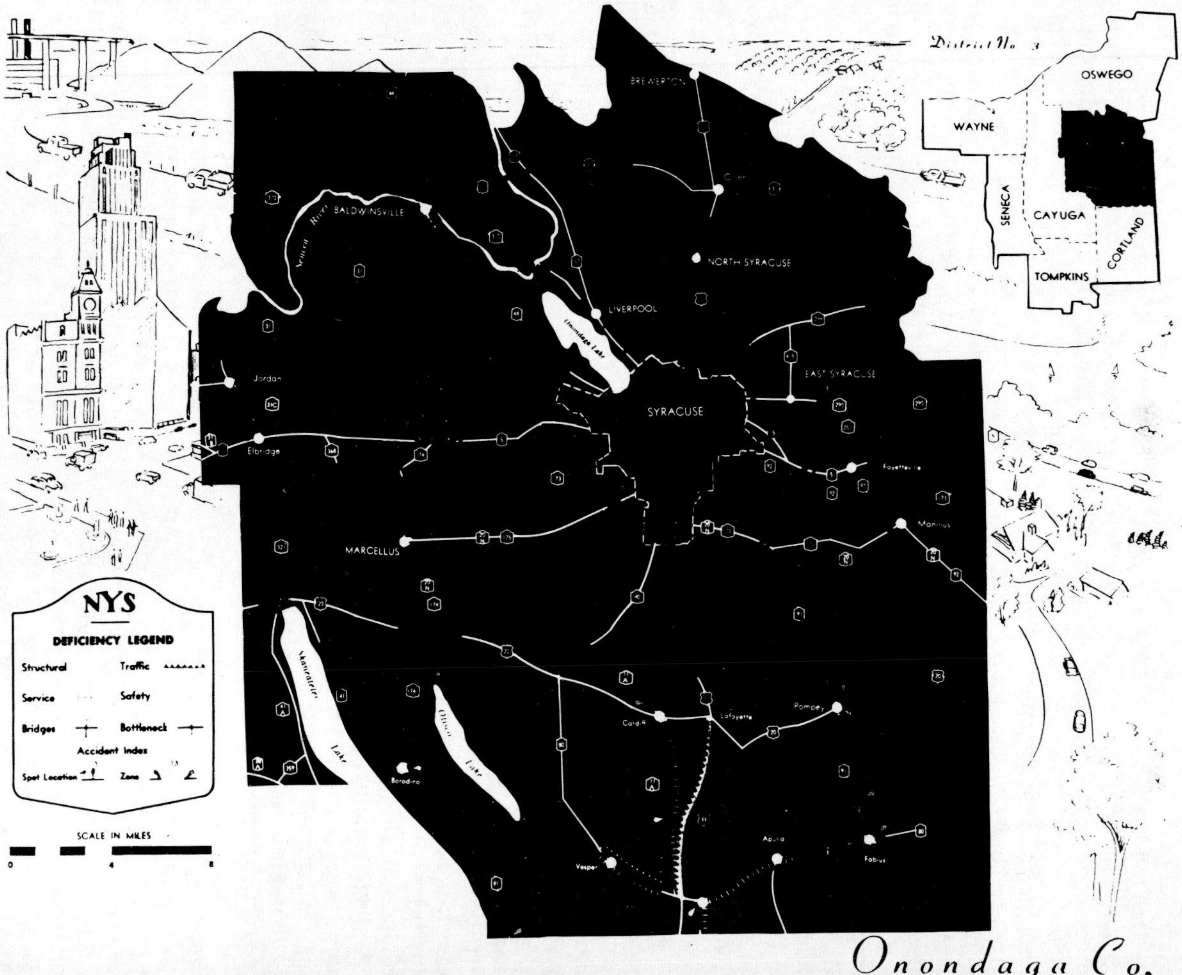



Figure 5.

nomical, easy to duplicate, relatively simple to grasp, and can be readily revised. Its value is indicated in its adoption, with some modifications, by several states.

Figure 4: Oregon Map. Another technique in portraying sufficiency ratings is shown in this section of a large state map of the Oregon highway system. The map was printed separately, folded and inserted in an envelope in the detailed rating report of 1950.

Various colors identify road sections according to a small number of rating ranges, with all miles having a combined rating below 60 shown in red. The obvious advantage of this method is quick identification and simplicity, although one must correctly remember the legend while viewing it.

Detail of magnitude is limited, and again the rating of elements comprising the combined rating is not shown. In this scale, however, it would be easy to match other mapped data, such as proposed improvement programs, to the rating results.

Figure 5: Connecticut Diagram. Curtis Hooper reported, in the Highway Research Board Proceedings of 1948, an excellent graphical procedure used in Connecticut. Although it is not a graphic picture of sufficiency ratings as the term is now being used, it is included here to show a diagrammatic picture of many of the elements composing such ratings.

Hooper states: "It is recognized that the straight line diagrams (previously discussed) were primarily designed for use in engineering offices. Only infrequently was the device used to portray details in a report which might reach the public...." In (planning reports) it was...our attempt to present data in a form understandable to interested laymen.... In pursuit of this goal many changes were made (in previous engineering diagrams).... It is believed that this...graphical means...did much to crystallize the modernization problem...."

Hooper also points out the need for portraying the many interrelationships which exist and concludes that the straight line diagram, modified as shown here, coupled with a recognizable map, serves that purpose.

This amount of graphical detail is superior for engineering analysis, but it is obvious that there are still obstacles to publication and to lay understanding which can be partially overcome in portraying results of analysis through sufficiency rating procedures.

Figure 6: Virginia Field Work Sheet. This sufficiency rating field work sheet, used by the Virginia State Department of Highways in a 1951 study, is designed to show graphically as many of the factors considered in the rural sufficiency rating study as possible. It is used exclusively for rating analysis and is the first step in the graphic presentation.

The sheet is another form of straight-line diagram which directly converts physical data to the point values of the rating plan. Thus it differs from the usual diagram which records existing dimensions, etc., whose point values may be determined and recorded separately.

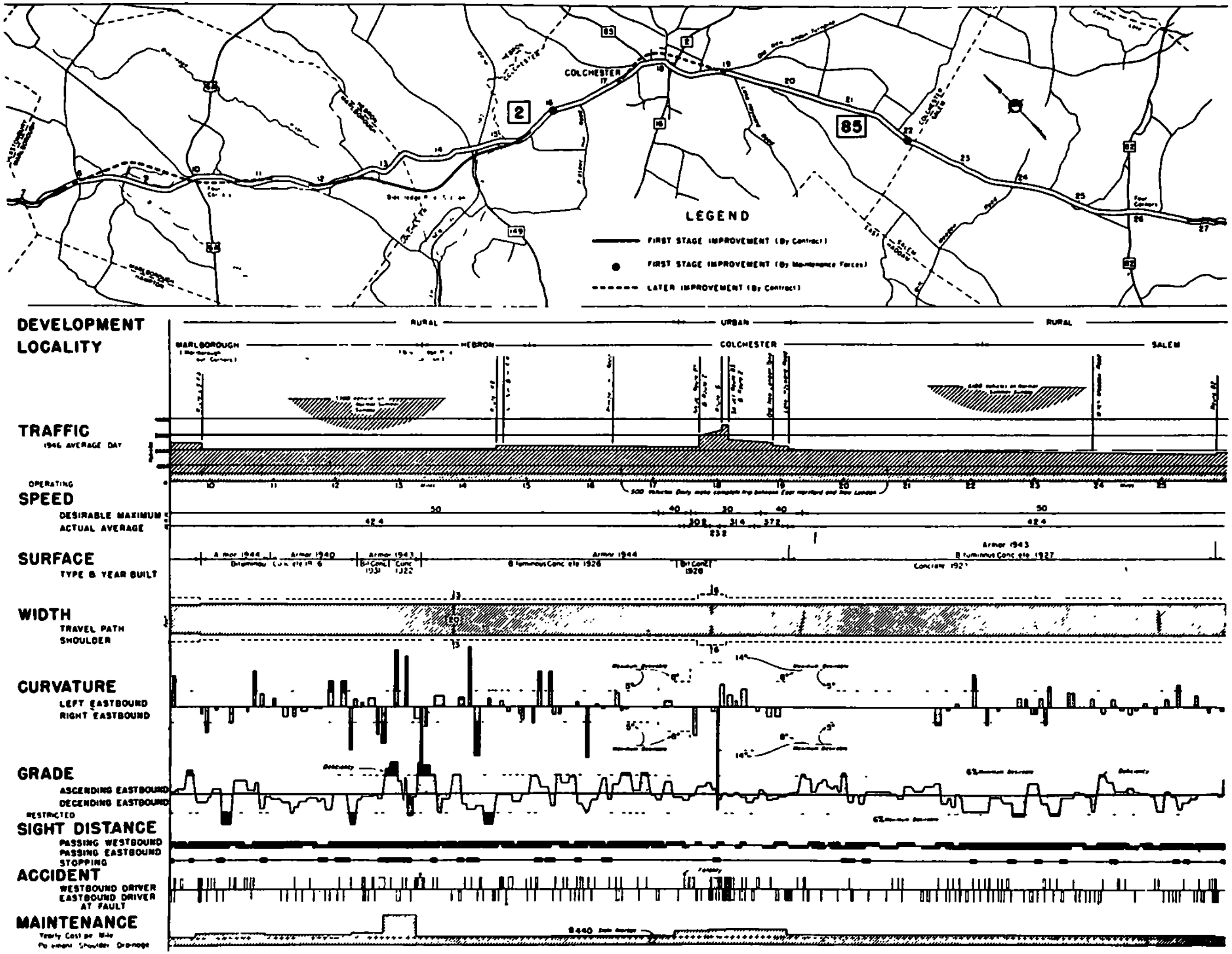
The Virginia work sheet is used mainly in engineering analysis but does provide a relatively simple visual picture of variations in the several features contributing to the final rating. It is therefore useful in general study of particular road sections. Some revision of data can be done on the original sheet, but it does not fully meet this need, nor does it permit easy comparison with existing diagrammatic data.

Figure 7: Virginia Mileage Rating Chart. A technique which combines detailed engineering and more general uses is shown in this chart of a section of US 29 in Virginia. The magnitude of the sufficiency ratings for each of the three major elements and their weighted combination is shown on a mile-by-mile basis in a straight-line diagram.

The profiles are easily interrelated and comparisons with tolerable standards and proposed programs are quickly noted. This chart is relatively easy to prepare, once data are available and the base is reproduced in quantity. Note the "live" caption which makes a statement. Explanatory text and legend are shown in the printed report.

The method is perhaps too cumbersome for display of an entire system in a printed report. It fails to identify quickly the commonly recognized map location or to give quick relationships of routes on a statewide basis.

Figure 8: Virginia Rating Map. To over-



COLCHESTER
2
85
LEGEND
FIRST STAGE IMPROVEMENT (By Contract)
LATER IMPROVEMENT (By Contract)
DEVELOPMENT
RURAL
URBAN
RURAL
LOCALITY
MARLBOROUGH
HEBRON
COLCHESTER
SALEM
TRAFFIC
1946 AVERAGE DAY
OPERATING
SPEED
DESIRABLE MAXIMUM
ACTUAL AVERAGE
SURFACE
TYPE & YEAR BUILT
WIDTH
TRAVEL PATH
SHOULDER
CURVATURE
LEFT EASTBOUND
RIGHT EASTBOUND
GRADE
ASCENDING EASTBOUND
DECENDING EASTBOUND
RESTRICTED
SIGHT DISTANCE
PASSING WESTBOUND
PASSING EASTBOUND
STOPPING
ACCIDENT
WESTBOUND DRIVER
EASTBOUND DRIVER
AT FAULT
MAINTENANCE


Figure 6.

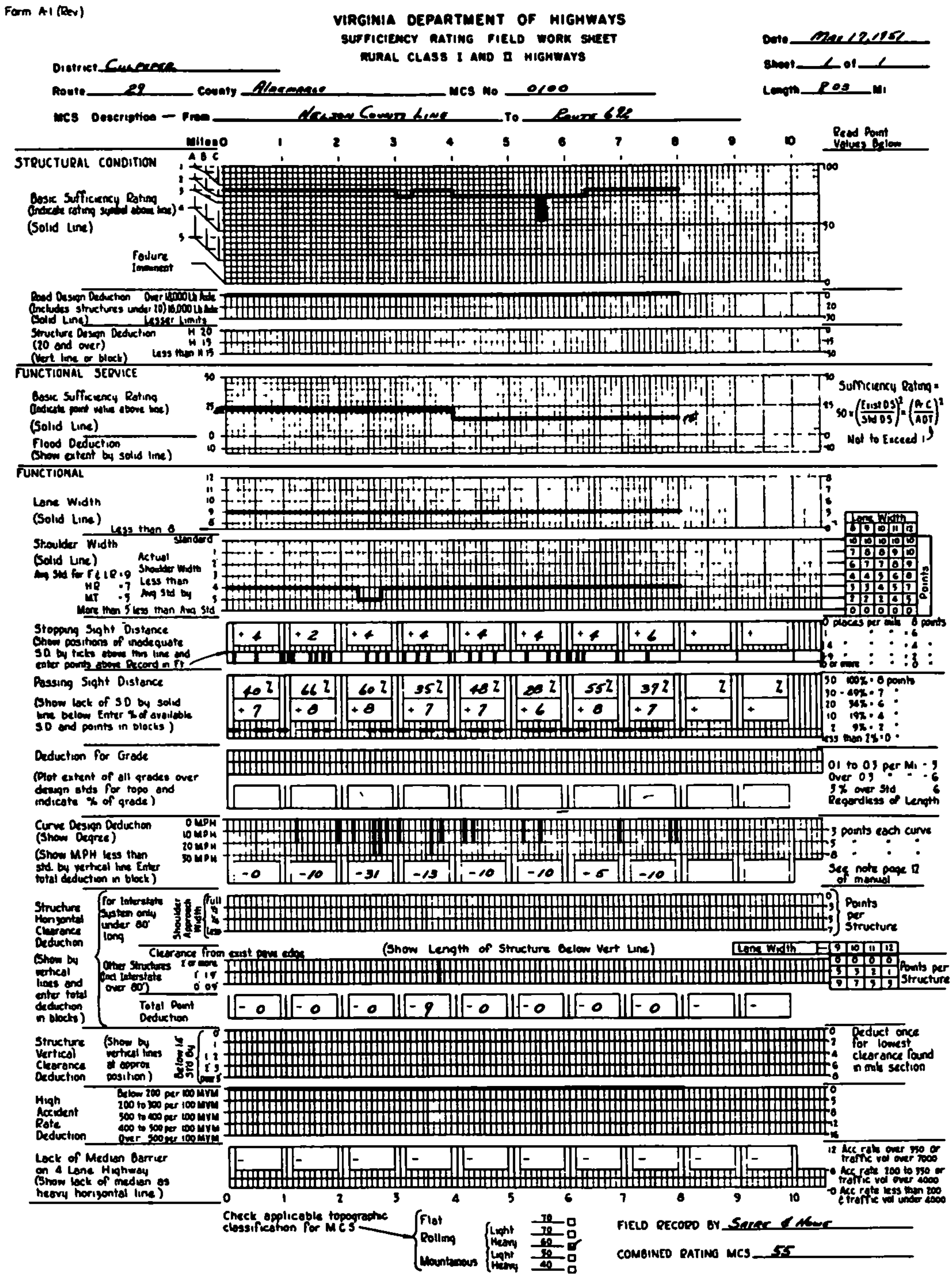

Form A-1 (Rev)
VIRGINIA DEPARTMENT OF HIGHWAYS
SUFFICIENCY RATING FIELD WORK SHEET
RURAL CLASS I AND II HIGHWAYS
Date
Sheet 1 of 1
District Culpeper
Route 29 County Albemarle MCS No 0100
Length
MCS Description — From Nelson County Line To Route 692
Miles 0 1 2 3 4 5 6 7 8 9 10
Read Point Values Below
STRUCTURAL CONDITION
Basic Sufficiency Rating (Indicate rating symbol above line)
(Solid Line)
Failure Imminent
Road Design Deduction
Structure Design Deduction
FUNCTIONAL SERVICE
Basic Sufficiency Rating
Flood Deduction (Show extent by solid line)
FUNCTIONAL
Lane Width (Solid Line)
Shoulder Width (Solid Line)
Stopping Sight Distance
Passing Sight Distance
Deduction for Grade
Curve Design Deduction (Show Degree)
Structure Horizontal Clearance Deduction
(Show Length of Structure Below Vert Line)
Total Point Deduction
Structure Vertical Clearance Deduction
High Accident Rate Deduction
Lack of Median Barrier on 4 Lane Highway (Show lack of median as heavy horizontal line)
Check applicable topographic classification for MCS
Flat
Rolling
Mountainous
FIELD RECORD BY
COMBINED RATING MCS 55

Figure 7.

# SUFFICIENCY RATINGS ARE INDICATORS OF RELATIVE NEEDS

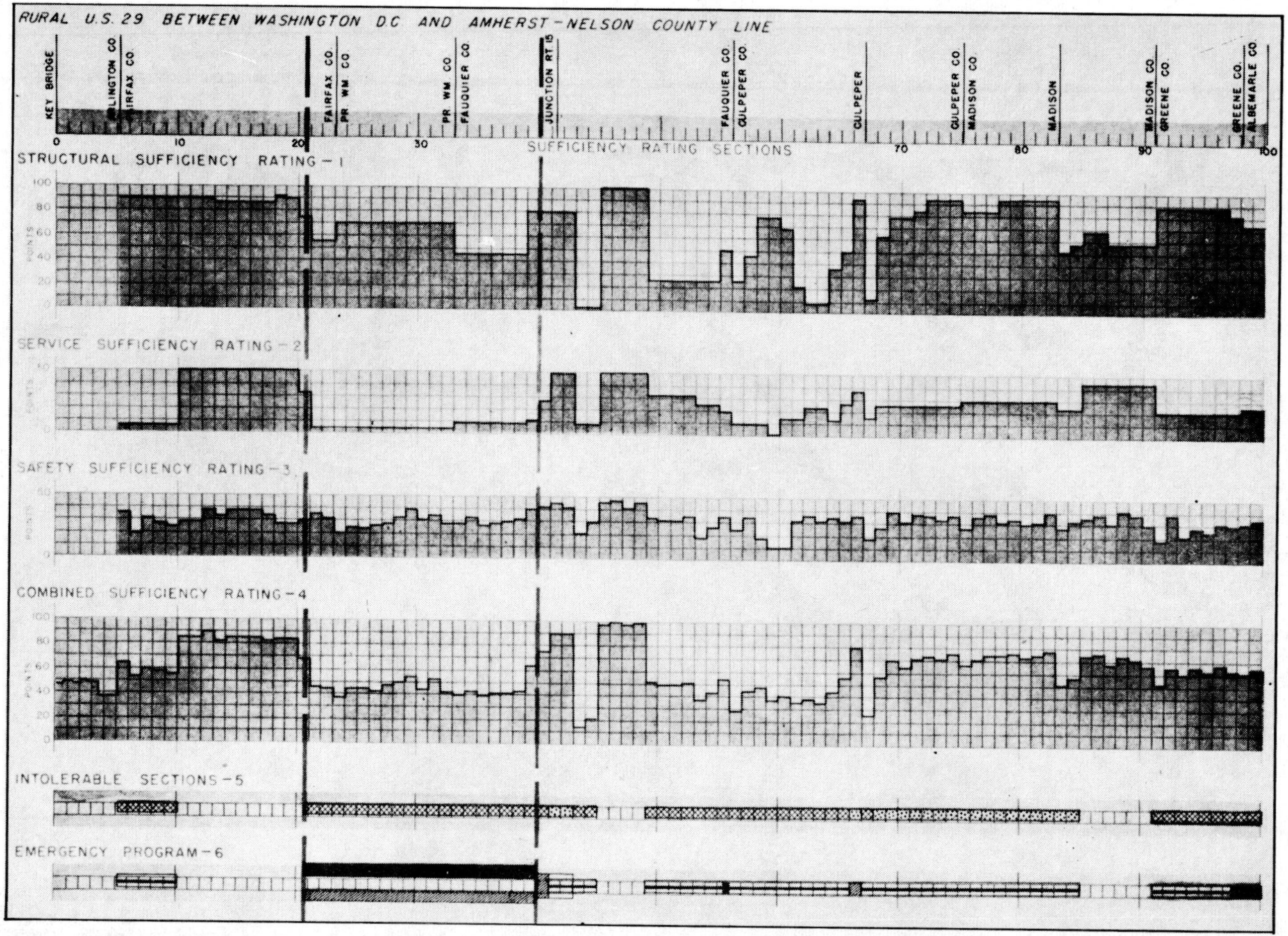



Figure 8.

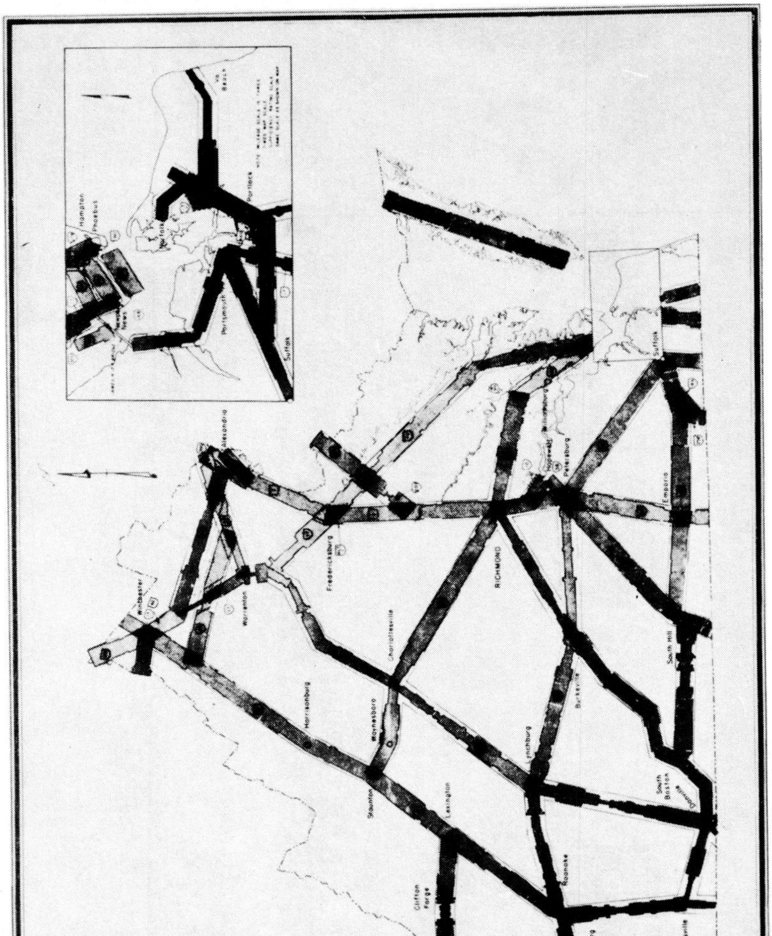

SUFFICIENCY RATINGS
OF
STUDY ROUTES
Prepared by
Automotive Safety Foundation
in cooperation with
Virginia Department of Highways
and
Bureau of Public Roads, U.S. Department of Commerce
LEGEND
Sufficiency Rating Scale
Winchester
Alexandria
Warrenton
Fredericksburg
Harrisonburg
Charlottesville
Waynesboro
Staunton
Lexington
Clifton Forge
RICHMOND
Petersburg
Emporia
South Hill
Suffolk
Burkeville
Lynchburg
South Boston
Roanoke
Christiansburg
Martinsville
Pearisburg
Dublin
Pulaski
Richlands
Abingdon
Bristol
Hampton
Phoebus
Portsmouth

Figure 9.

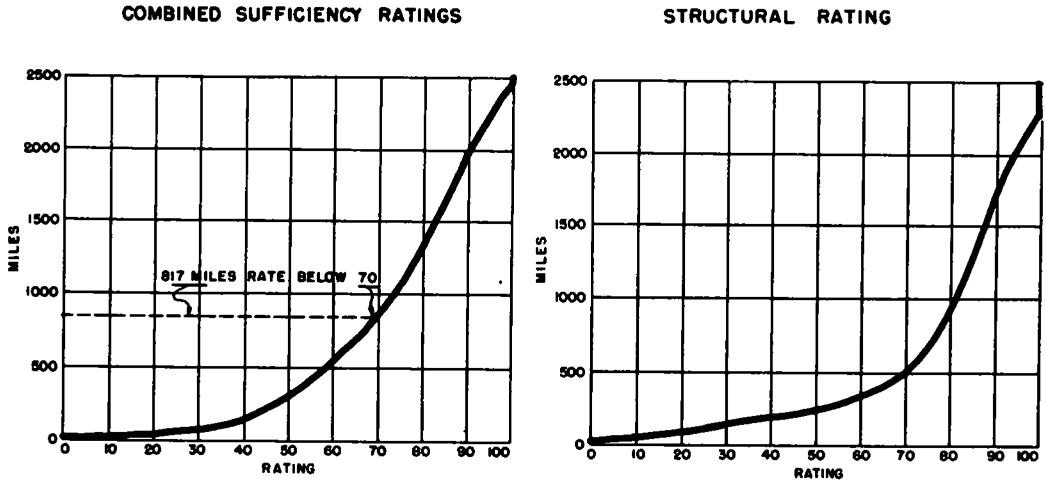



Figure 10.

come the defects of the chart just described, it was necessary to prepare also a relatively large-scale map showing combined sufficiency ratings on all routes studied. It is obviously similar to the Arizona product, with most of the same advantages and disadvantages.

Emphasis is given to the combined ratings alone, with much map detail omitted, leaving only the minimum needed for identification. Difficulty is encountered at road junctions - scale reading only partly aided by use of overlapped shading which gives the shadow effect.

To improve understanding of what the map shows and to avoid misinterpretation of it as the sole indicator of needs or priority, considerable text was included. This fact alone points to the difficulties encountered in developing good graphic presentation.

Figure 9: Virginia Rural Summary Charts. These summary charts of sufficiency ratings for 2,500 mi. of Virginia's principal rural highways show one means of clearly portraying the 1951 status of the system as a whole.

Such charts were published for each major element, one of which is shown, and for the combined rating. While a simple picture, accumulative mileage curves may not be entirely clear to a layman, and so the device of brief example printed on one of the graphs was used.

Such charts can be replotted at intervals to show graphically the gain or loss of ratings over the period, and breakpoints in curves can be observed.

It was not desirable to use bar charts for this purpose because of scale difficulties encountered with the distribution of values.

Figure 10: Virginia Urban Summary Charts. These bar charts summarizing ratings on urban sections of the Virginia study system are feasible with the distribution of values as shown here. Their use is more familiar to the average person and they tell the story. They are not quite as accurate as the previous charts since all values between the points indicated are accumulated in a single bar. However, for quick information about distribution of ratings, this method is helpful.

## CONCLUSION

From this quick review of available material on how sufficiency ratings have been graphically presented, it would appear that data should more often be interpreted graphically, that engineering uses have predominated the techniques so far developed, and that good "imagineering" and careful study are needed to make the most effective use of graphic presentation.