PHOTO / FILE SURVEYS

SPECIAL REPORT

PREPARED BY

TRAFFIC AND HIGHWAY PLANNING DEPARTMENT

DIVISION OF PLANNING

IOWA STATE HIGHWAY COMMISSION

IN COOPERATION WITH THE

UNITED STATES BUREAU OF PUBLIC ROADS

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INTRODUCTION

On October 5, 1961, the Iowa State Highway Commission in cooperation with the United States Bureau of Public Roads entered into a contract with Photo/File Surveys Incorporated, a subsidiary of the Aero Service Corporation of Philadelphia, Pennsylvania. Under the terms of this contract, Photo/File Surveys were to supply the specialized equipment and trained personnel necessary to photograph 200 miles of the Iowa primary road system. Approximately 100 miles of municipal and 100 miles of rural highways were designated to be photographed.

This report describes the equipment and techniques used in the Photo/File Survey and presents an evaluation of this system with regard to its application and use by the Iowa State Highway Commission.

EQUIPMENT AND TECHNIQUES

The Photo/File system employs two specially modified, truck mounted 16 mm cameras to provide a series of photographs taken at 52.8 foot intervals showing the highway and its appurtenances. Each of the cameras are mounted at a height of 48 inches above the highway, approximating the eye level of persons seated in a passenger car. One camera is mounted in the right front of the vehicle to photograph the right hand lane while the other camera is located in the left rear of the vehicle to photograph the left hand lane, thereby permitting both sides of the highway to be photographed simultaneously. On highways having three or more lanes, two passes are made using only the front camera. Both cameras are actuated by a special odometer attached to the right front wheel of the vehicle. The Photo/File vehicle can survey at speeds ranging from 5 to 60 miles per hour depending on road conditions and traffic.

The Photo/File cameras are modified to permit the inclusion of a data board which is shown at the bottom center of each frame. The date, time, route number, direction of travel and odometer reading may be shown on the data board which appears in each frame of film.

Each 100 foot spool of 16 mm film contains a photographic record of thirty-five miles of highway. The film required to photograph 10,000 miles of highway can be stored in about ten cubic feet of storage space. The film can be indexed for quick reference to any specific section of highway.

The exposed film (either color or black and white) may be viewed, projected, or reproduced in a number of ways. A 16 mm time and motion study projector which is capable of varying projection

speeds may be used to project a single frame or a continous series of frames suitable for viewing by a number of people. A desk top viewer is available which may be coupled to a projector for close-up viewing. The Thermo-Fax "Filmac 100" Reader-Printer may be used either for viewing or printing copies of individual frames. (Prints made with this method are negative prints, however, since Photo/File film is positive, but this is of minor significance.) Photographically enlarged prints may also be made from Photo/File film.

MEASUREMENTS

A perspective grid has recently been developed by Photo/File Surveys for use in determining measurements from their films. (A reduced facsimile of this grid is included in this report, and will be found in the appendix.) The grid is rectangular in shape and is drawn in proportion to a single frame of 16 mm film. The grid measures 28 1/2 by 21 3/4 inches and is designed to be used as a projection screen. The projector is positioned in such a manner that the projected frame corresponds in size with the perspective grid. A series of lateral lines are used to indicate measurement in ten foot intervals in front of the camera station. Another series of lines converge at infinity and intersect the lateral lines at two foot intervals for measurement of widths.

The perspective grid has been checked against known road widths and bridge lengths. Measurements of widths are accurate to six inches or less if measurements are made no further than thirty to forty feet from the camera station. Distances down the road are accurate to about one or two feet up to about fifty feet from the camera station. Beyond this distance, the accuracy of the grid is not consistent. An estimation of distance down the road from the camera station may be determined from odometer readings on the data board for distances too great to measure with the grid.

The grid is for use only on flat or nearly flat surfaces and will not function properly on vertical curves. The present grid was designed specifically for use with photographs taken by the front camera although a similar grid could perhaps be developed for use with the rear camera.

APPLICATION AND EVALUATION

Some of the various possible uses of Photo/File data are listed in the following outline.

I. Sufficiency Rating and Adequacy Studies

A. Pavement Type

The Photo/File system makes it possible to determine pavement types such as Portland cement concrete, asphaltic concrete, or gravel. The system could be used on all roads to verify existing data for a specific section of roadway.

B. Pavement Width

Measurements of width accurate to 6 inches or less are possible with the perspective grid at distances up to 50 feet from the camera station. The grid will measure widths up to a maximum of 24 feet. On roads having greater widths than 24 feet, individual lane widths may be added together, if lane markings are visible, to obtain total road width. The grid may be used for verification of road width in instances where substantial differences are noted in existing information and will provide supplemental data pertaining to road width.

C. Shoulder Type and Width

The perspective grid used in conjunction with Photo/File data will not replace present methods used in determining width of shoulders. Due to the fixed position of the camera, and occasionally excessive vegetation along the roadway, it is not always possible to see enough of the shoulder to accurately measure it with the grid. The grid can frequently be used to

obtain an indication of shoulder width, but cannot be used in all instances.

The Highway Planning Section does not at present differentiate shoulder type in its sufficiency ratings.

D. Signs, Type, Location, and Condition

Restrictive parking signs and speed advisory signs are the only signs which are noted in connection with sufficiency ratings. Speed advisory signs are usually legible and can be seen clearly on Photo/File film. Restrictive parking signs are occasionally posted so far out of camera range as to be illegible or may be obscured by vehicles at the point of film exposure.

Street name signs, while they are not a part of sufficiency rating, would be valuable in orientation if they could be seen and read, but are usually too small and too far out of camera range to be legible. In some cases, there is a possibility that the film would record signs missed by field personnel and could be used to verify existing data.

Sufficiency rating surveys are not concerned with the condition of speed advisory signs or restrictive parking signs as such, as long as the sign is legible. The Photo/File system will provide supplemental information pertaining to speed advisory signs and parking regulations and can be used in conjunction with field reports.

E. Signals, Type, Location, Condition

Sufficiency rating surveys are concerned with the frequency and type of traffic control signals and school signals for a given road section. The condition

of such signals is not taken into account. Photo/File data can be used to satisfactorily determine type and location of signals for sufficiency ratings.

F. Parking Conditions

The type of parking which is permitted along a given section of primary extension in a municipal area is used in developing sufficiency ratings. This information is obtained from posted parking regulations and can be satisfactorily determined from film.

G. Access

The frequency of private and business drives per mile of primary extension in a municipal area is used in developing the sufficiency rating for that particular section. Photo/File data can satisfactorily determine the frequency of such access for sufficiency rating purposes and would perhaps equal or exceed present methods used in determining the frequency of access points.

H. Passing Sight Distance

Passing sight distance is determined on the basis of design speeds. Distances involved in determining passing sight distance are too great to be determined from the perspective grid but can be satisfactorily established from odometer readings. Information obtained from Photo/File data can be used to good advantage in answering inquiries regarding passing or stopping sight distance since these inquiries frequently involve field examinations which could largely be eliminated if such data were available.

I. Stopping Sight Distance

Stopping sight distance is used as the basis for establishing the location and length of no passing zones. Photo/File data obtained from odometer readings on the data board can be used to determine stopping sight distance with accuracy similar to that obtained in the field.

J. General Pavement Condition

This information is used in developing sufficiency ratings, but is presently furnished by District Maintenance Engineers. There has been no need to verify this information in the past. A physical examination of the pavement is necessary to obtain this information and must be done periodically in order to maintain accurate records.

K. Drainage

Photo/File data cannot be used to evaluate all drainage features for sufficiency rating purposes since these features are usually located out of camera range. Data of this type will disclose ponds, ditch erosion and ditch filling under certain conditions, but it cannot show the structural condition of culverts, silted culverts, or the hydraulic capacity of culverts and therefore is of limited use in respect to drainage.

L. Hazards, Narrow Bridges, Sharp Curves, Etc.

The number of sight restrictions per mile and the number of hazards such as narrow bridges, sharp curves, etc., are assigned point values and used in computing the overall sufficiency rating for each road section.

This information can be obtained from Photo/File data.

M. Needs Studies

Photo/File data can be used to a limited extent in verification of information obtained from needs studies. Surface condition, rideability, continuity of design, traffic control features and street lighting structures can be satisfactorily observed and verified. Surface type and drainage adequacy require physical examination and cannot be fully determined from film for needs studies.

Photo/File data will not replace present methods of gathering data for sufficiency rating purposes but can be used in many cases to verify or clarify existing information and thereby eliminate the need for additional field inspection. It can be used to verify pavement type, location and type of traffic control signals, frequency of access per given mile, passing sight distance, stopping sight distance, and hazards such as narrow bridges and sharp curves.

II. Public Hearings

A. Research and Study Prior to a Hearing

Photo/File data can be used by the Hearings Engineer and his staff for research and study of a particular area prior to personal inspection of the area. This information would reduce the amount of time required in planning and developing a hearing by permitting a tentative program to be developed in the office prior to field inspection. Photo/File data would also reduce the number of field trips required by making it possible

to integrate the collection of field data through advance planning.

B. Familiarization of Public with the Need for Reconstruction or Relocation of Routes

Photo/File film may be shown at hearings to point out the need for reconstruction or relocation of routes through specific illustrations. Film may be edited or shown in its entirety to illustrate surface conditions along the present route such as cracking and rutting; side friction created at points of access and egress; signs and signals; congested traffic conditions, etc. Photo/File data would help substantiate sufficiency ratings which have indicated the need for reconstruction or relocation. In some cases, it might be possible to show a comparison to similar areas which have undergone construction and the subsequent alleviation or elimination of specific problems.

At present, 35 mm slides are used at public hearings to illustrate the need for proposed construction. Photo/File data can be used to illustrate much of the information presently shown on slides. However, Photo/File data will not replace the use of slides to show a particular problem from various aspects.

III. Sign Inventory

A. Sign Type

Sign type relative to legend and function can be satisfactorily determined from Photo/File data provided that light conditions and camera angle are appropriate.

B. Sign Location

Location of signs can be determined from odometer readings which appear on the data board in each frame of film. Proper placement of signs relative to function and proximity to roadway can also be determined. Photo/File data can also be used in the surveillance of advertising signs placed along Interstate highways.

C. Visibility of Signs

Signs which are partially obscured by trees, vegetation, other signs, etc., as seen on Photo/File film are viewed from the perspective of the driver. Advertising signs placed in the right-of-way in conflict with official highway signs can be readily observed and decisions regarding their removal can be made on the basis of Photo/File data.

D. Sign Material

Determination of sign material such as wood or metal frequently cannot be made on the basis of photographic data. The reflectorized coating used on many signs does not show up on Photo/File film.

E. Sign Condition

Structural damage to signs is readily apparent from Photo/File data. Dust or dirt on signs, however, makes it difficult to accurately evaluate the surface condition.

F. Signals, Location, Type, and Condition

The location, type and condition of electric traffic control signals may be determined in the same manner as signs.

IV. Engineering

A. Preliminary Studies of Terrain Along Proposed Routes Prior to Reconstruction

Preliminary studies based on Photo/File data can be made by design engineers to familiarize themselves with the terrain along proposed reconstruction routes prior to initial field examination and planning. Photo/File data can also be used for verification of notes following a field examination and for review of plans and data with key personnel.

Information pertaining to surface type; approximate height of curbs; location, type and grade of driveways; elevation and slope of property adjoining the right-of-way; retaining walls; location of utility poles; etc., can likewise be observed and evaluated. Data of this nature can also be used to familiarize personnel who frequently are unable to make a field examination, but are required to design the physical features of a highway section. Photographic data provides the engineer and draftsman with a comprehensive three dimensional view of an area unlike that which is obtained from plans and specifications.

B. Comparison of Design for Future Application

Design characteristics can be quickly compared and evaluated with regard to possible application in proposed construction by using Photo/File data.

C. Evaluation of Design and Construction

Photo/File data can be used by design engineers to

visually evaluate design features from the perspective of the driver. Visual inspection of medians, islands, channelization, etc., may disclose surface usage or tire scuff marks indicating operational difficulties thereby providing a basis for re-evaluating the design or geometrics.

Photo/File data can provide a quick means of checking resurfacing construction for signs of deterioration as an indication of the adequacy of materials and construction. The quantity of sand and debris in gutters can be used as an indication of design adequacy in regard to cross slope and grade lines as evidenced from Photo/File data. The design and placement of intakes and other drainage structures can be similarly evaluated.

V. Legal Application

A. Evidence

Photo/File data may be submitted as evidence in legal disputes if properly substantiated. This may, in some instances, involve verification of data by the camera operator.

B. Removal of Access

In cases involving the removal of access rights, especially when such access constitutes a hazard because of insufficient sight distance, Photo/File data can be used to help verify the need for such removal.

C. Extension of Right-of-Way

In cases involving the removal of bill boards, fences, etc., due to the extension of right-of-way, Photo/File

data can help to establish the location, general condition, and approximate value of structures.

D. Damage or Destruction of State Property

Since the Photo/File system provides a permanent record of highways and their appurtenances, this data can be used in the assessment of damage to state property by showing the condition of the structure prior to such damage.

In addition to the uses outlined above, Photo/File data can be used in Highway Commission meetings to familiarize commissioners with specific sections of highway. This type of data can also be used to establish proper locations for interview stations in origin-destination surveys.

Photo/File data is of limited value in connection with the acquisition of right-of-way and access control since it is felt that the film does not show sufficient side development for such purposes. It has been suggested that an additional camera mounted at an angle of 45 to 90 degrees to the roadway might provide data which could be used in the acquisition of right-of-way and in access control. The use of Photo/File data in connection with maintenance work is economically impractical due to the expenses involved in maintaining up-to-date film for each road section.

The Photo/File system is basically a photographic tool and as such is subject to the technical problems and limitations inherent in photography. Unfavorable light conditions due to insufficient light or improper light angle will adversely affect the quality of the film unless appropriate steps are taken to avoid or compensate for such conditions.

Accurate measurement, an inherent requirement in many phases of Highway Commission work, cannot be obtained from Photo/File data in all instances due to the limitations of the perspective grid which were discussed earlier in this report. The grid can be used in estimating distances whenever absolute accuracy is not essential.

ECONOMIC CONSIDERATIONS

The total cost of the initial 200 mile test program in Iowa came to $6000.00. Rental of Photo/File equipment, salaries, and supplies came to $3500.00. The remaining $2500.00 covered costs of services, subsistence, and travel expenses of Aero Service personnel engaged in the project before and after the actual photography.

Under the terms of a proposal made by Photo/File Surveys Inc., the Iowa State Highway Commission could lease a Photo/File vehicle for a two year period for $15,000.00 plus an additional amount determined on the basis of $1.50 per mile of photography and $00.10 per mile when not engaged in photography. A minimum of 6000 miles would be photographed during this period. Commission personnel trained by Photo/File Surveys Inc. would maintain and operate the camera vehicle during the lease period.

CONCLUSIONS

On the basis of the initial 200 mile Photo/File survey in Iowa, the following conclusions have been drawn:

1. The quality of photographic data obtained by this method is acceptable provided that a reasonable amount of caution is exercised in the photography to avoid unfavorable light conditions.
2. The perspective grid designed to aid in the determination of measurements is of limited value since it will not function properly on vertical curves and does not give accurate measurements throughout the range of its scale.
3. Photographic data of this nature can be highly useful to administrators and other key personnel in that it would frequently eliminate the need for extensive field trips to verify existing data or to familiarize themselves with a particular area.
4. Information listed on the data board in each frame of film is sufficient to accurately establish the time and exact location of photography.

SUMMARY

The recent development of the Photo/File recording system is a significant addition to the list of modern equipment and techniques available to the progressive highway department. It is a tool which can be used in many phases of highway development to provide readily accessible photographic data pertaining to highways and their appurtenances.

Among the areas in which the use of Photo/File data has extensive application are: sufficiency rating and adequacy studies, public hearings, sign inventory, design engineering and various legal applications. It may also be used as a focal point in Highway Commission meetings to familiarize commissioners with specific problems. The location of interview stations for origin-destination surveys can also be established from this data.

In its present form, Photo/File data is of limited value in the acquisition of right-of-way and access control since the film frequently does not show sufficient side development for such purposes. Although the film shows the need for highway maintenance in particular areas, the cost and effort required to maintain up-to-date information for maintenance use is not justified.

A perspective grid designed to aid in determining measurements from Photo/File data may be used when absolutely accurate measurements are not essential. The grid will not function accurately on vertical curves and is not accurate throughout the range of its scale. If used on level or nearly level sections of roadway, it will provide reasonably accurate measurements of length and width up to about forty to fifty feet from the camera station.

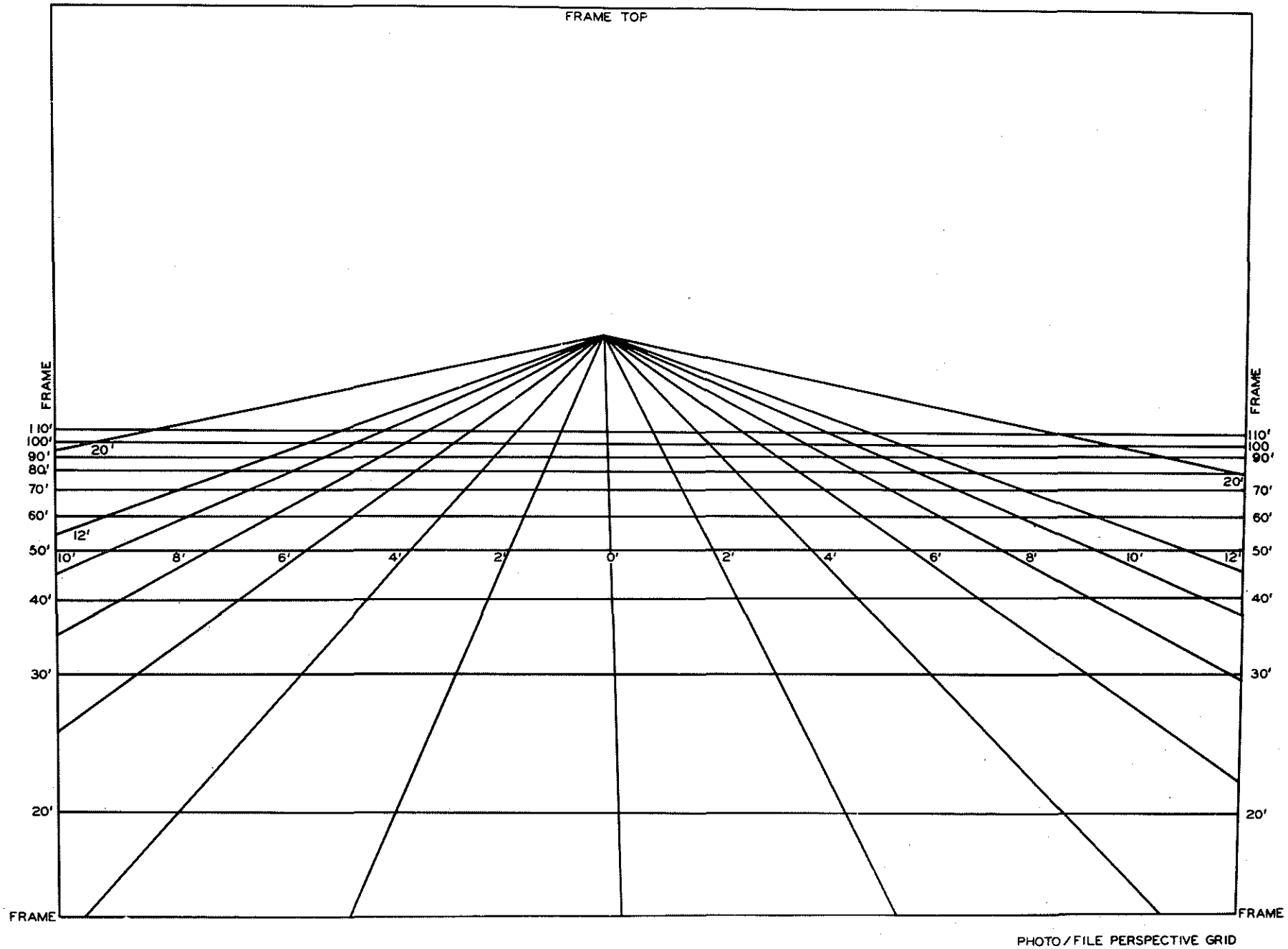
Since the Photo/File system is basically a photographic tool, the photographic quality of data obtained with this method is largely dependent on proper light conditions at the time of photography. Improper lighting conditions due to insufficient light or improper light angle will adversely affect the quality of the photographic data obtained unless steps are taken to avoid or compensate for such conditions. The photographic quality of the data obtained in the initial 200 mile survey in Iowa is acceptable for its intended usage.

The actual amount of time and money which would be saved as a result of using the Photo/File method cannot be accurately assessed since the data is of a permanent nature and could be used by a number of departments for a variety of purposes. It will, in many cases, eliminate the need for extensive field examinations. It can be used to verify or substantiate existing information and will provide a permanent, comprehensive record of each highway as seen from the drivers' point of view.

A P P E N D I X

PHOTOGRAPHIC ILLUSTRATIONS

The following illustrations on pages 25 through 35 are enlarged photographs made from Photo/File film. Due to the size of the enlargement and the numerous steps involved in preparing these photographs for publication, the clarity of the pictures has been greatly reduced. The inclusion of these photographs is intended to illustrate the use and scope of this type of data rather than the quality of the photography.

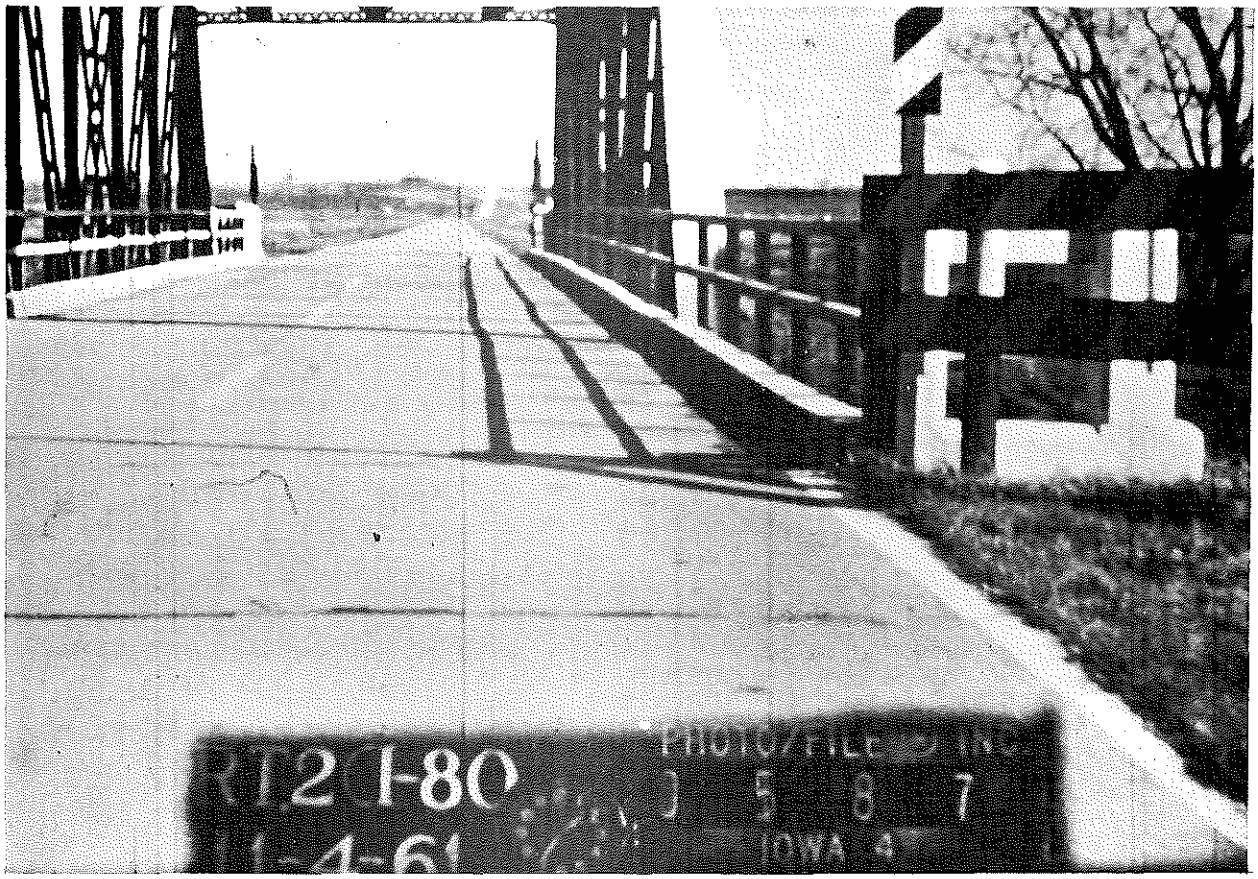


PHOTO/FILE PERSPECTIVE GRID

Concrete Bridge, Iowa 2, County 80 (Ringgold County), November 4, 1961, 2 P.M., 18.52 miles from control point.

Sign Assembly, Iowa 2, County 80 (Ringgold County), November 4, 1961, 2:03 P.M., 15.42 miles from control point.

Intersection with signals, sign assembly, lane markings and island, U.S. 67, County 82 (Scott County), November 10, 1961, 2:40 P.M., 4.48 miles from control point.



High Truss Bridge, Iowa 2. County 80 (Ringgold County), November 4, 1961, 1:35 P.M., 5.87 miles from control point.

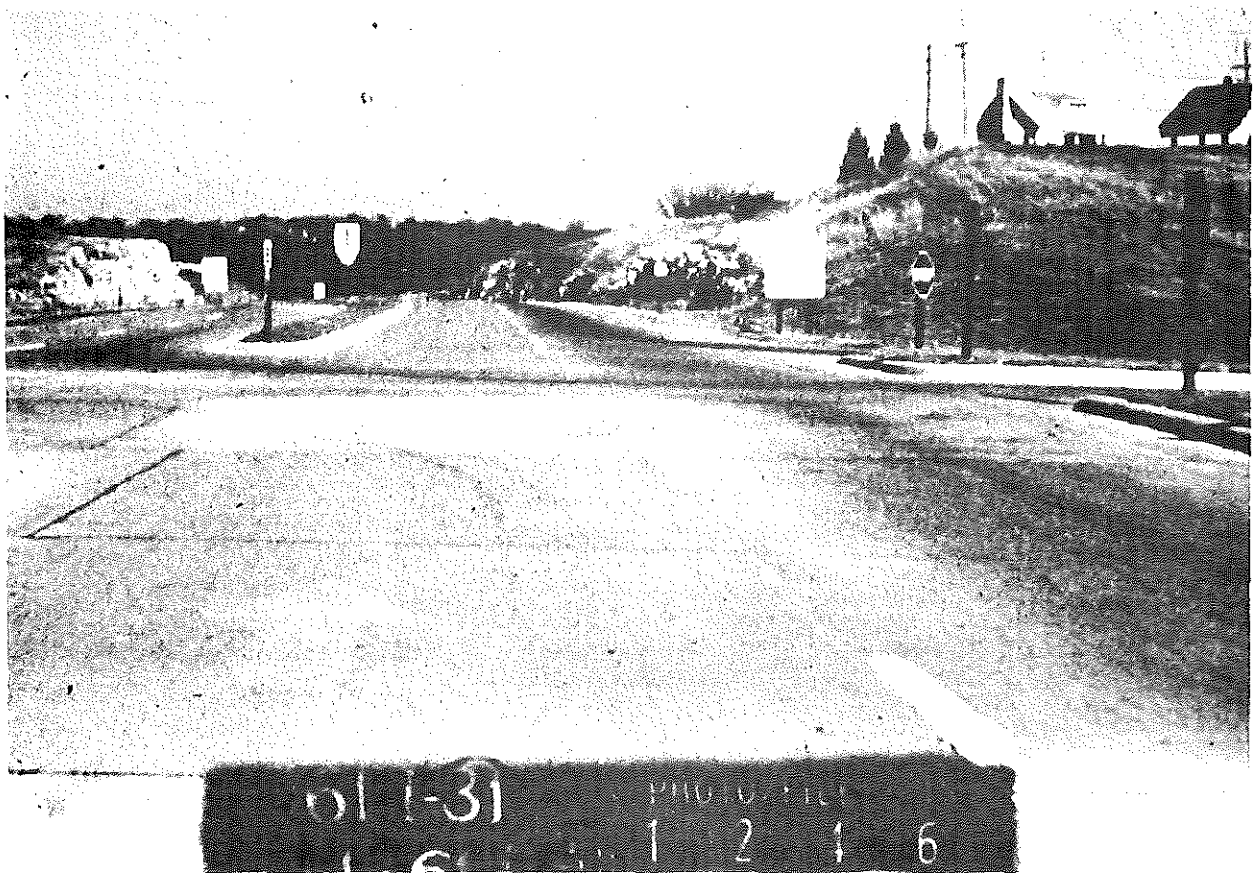
Underpasses on primary highway. Iowa 163, October 29, 1961, 9:44 A.M., 4.26 miles from control point.

Parking conditions on primary highway in Des Moines. U.S. 6, County 77 (Polk County), November 24, 1961, 3:15 P.M. 9.38 miles from control point.

Shoulder erosion on primary highway. Iowa 132, County 77 (Polk County), December 5, 1961, 10:40 A.M., 1.45 miles from control point.

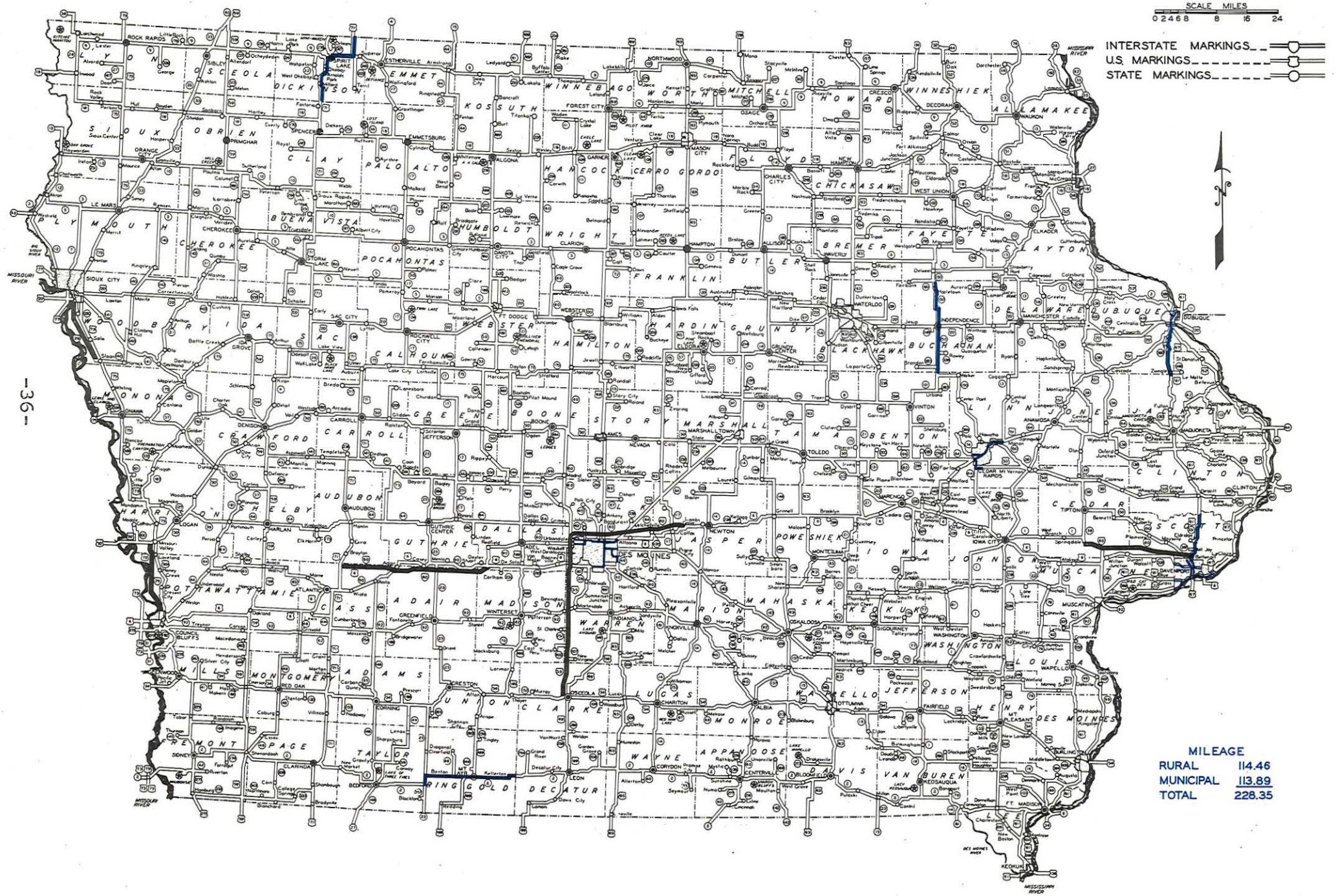
Unprotected grade crossing on primary highway. Sharp curve (15 mph advisory speed), with access on curve. Iowa 46, October 29, 1961, 10:20 A.M., 2.45 miles from control point.

Advertising signs in right-of-way. Iowa 163, October 29, 1961, 9:41 A.M., 3.12 miles from control point.



Channelized Intersection, U.S. 61, County 31 (Dubuque County), November 11, 1961, 3:15 P.M., 12.46 miles from control point.

LOCATIONS OF THE 200 MILE TEST ROAD SECTIONS
USING THE PHOTO/FILE SURVEY TECHNIQUE



Route, County, and Total Number of Miles
Photographed in the Initial Photo/File Survey in Iowa

Route	County	Total Miles
Ia. 2	Ringgold	27.10
Ia. 60 - 28	Polk	4.55
U.S. 65 - 69	Polk	7.97
Ia. 163	Polk	5.14
Ia. 46	Polk	6.73
Ia. 132	Polk	4.28
U.S. 6 - 65 and Ia. 90	Polk	14.34
U.S. 151	Linn	11.06
U.S. 30	Linn	8.00
U.S. 218	Linn	1.53
U.S. 74	Linn	3.16
Ia. 150	Linn	6.70
U.S. 61	Dubuque	18.98
U.S. 20	Dubuque	1.72
U.S. 52	Dubuque	3.09
Ia. 150	Buchanan	25.13
U.S. 71	Dickinson	24.44
U.S. 61	Scott	23.65
U.S. 61	Scott	5.20
U.S. 67	Scott	8.08
Ia. 150	Scott	6.19
U.S. 6	Scott	11.31
	Total	228.35

Rural	114.46
Municipal	113.89
Total Miles	228.35