suspected. In this way we may be in a position to better understand the factors which influence the movement of traffic over the different routes which are available. In this way we may be able to determine more successfully than we have in the past where highway improvement will, in fact, relieve rather than aggravate traffic congestion. As we begin to think in terms of total traffic flows, we may be able to perceive how changes in one part of the transportation system affect other parts and how changes in rates affect traffic flows over the different branches of the transportation plant. With knowledge of this type we would be in a better position than we are today to devise effective and equitable policies both for building and paying for the transportation facilities that the country needs.

Highway Research in Iowa

MARK MORRIS, *Director of Highway Research*
Iowa State Highway Commission

●IN 1949 research attained official and legal status in Iowa as an essential function of highway administration. As a consequence, a new approach to highway research has been developed and employed there during the past 4 years. The purpose of this paper is to describe the procedure now in effect in Iowa for the discharge of the highway research function and to explain the various operations of that procedure.

The current situation with respect to highway research in Iowa is the direct result of an emphatic conclusion of the Highway Investigation Committee of 1947 with respect to highway research in a report to the governor in 1948. This committee was created in 1947 by a joint resolution of the 52nd General Assembly, to investigate the primary and secondary problems of Iowa, to recommend a program of improvement, and maintenance of both primary and secondary roads and means of financing such program, to prepare drafts of bills for legislation where required to inaugurate and implement the proposed program of improvements and to report through the governor to the 53rd General Assembly. This committee was occupied intensely over a period of about 18 months in the task assigned to it. During that period, the committee examined carefully and thoroughly every feature of the highway problems of Iowa in evidence at the time of the study and for some years prior to the study.

The work of the Highway Investigation Committee was completed late in 1948 with the preparation of a report bearing that date. This report was handed to the governor on November 15, 1948, and transmitted to the elected members of the 53rd General Assembly on December 15, 1948, about a month prior to the opening of the session in 1949. One of the 11 principal conclusions of the committee dealt emphatically with the need for research in highway administration. In the reference to research, the committee stated that if sound progress is to be made by the public in providing modern highway facilities for the use of modern motor vehicles, such progress must be preceded by a sound and comprehensive research program covering all of the phases of the highway transportation business for which the public has accepted responsibility. The committee further stated that, among other things, information on traffic volumes and traffic needs must be kept current if costly errors are to be avoided, that the possibilities of using new materials and new processes in construction and maintenance of highways must be explored, that better ways of utilizing and conserving known materials must be sought, and that these must be done by the technical forces in Iowa charged with the responsibility of engineering for the Iowa highway program.

In further emphasis of highway research and to eliminate possible handicap to research through narrow construction of certain existing laws, the highway investigation committee devoted one of the 16 bills drafted for legislative consideration that were included in the

report to provisions for research for secondary roads. This bill insured, if accepted by the legislature, provision for research for all roads as the committee in the course of the study of highway laws had determined that the state highway commission had authority under existing laws to conduct research for primary roads.

In 1949, the 53rd General Assembly enacted into law with few dissenting votes all but 5 of the 16 bills proposed by the highway investigation committee. It failed to act favorably only on bills dealing with motor-vehicle inspection, motor-vehicle speeds, enlargement of highway patrol, clarification and simplification of certain laws pertaining to highway administration, and the revision of laws relating to classification and control of secondary highways and expenditures for construction and maintenance of these highways. Subsequent assemblies have adopted two of this group. Three are under consideration. Lack of legislative action on the bills has interfered little, if any, with the program of highway improvements contemplated by the highway investigation committee during the development of the report on the highway needs of Iowa. Some highway administrative features would be greatly simplified and expenditures from some funds more efficient if these bills were adopted.

Conspicuous among the bills adopted by the 53rd General Assembly was the act dealing solely with provisions for research for secondary roads. In adopting this act, the assembly recognized research as an essential function of highway administration and gave it legal status as such. By implication, it also concurred in the highway-investigation committee's conclusion that progress in providing highways must be preceded by a comprehensive research program and that Iowa engineers and research workers must conduct that program. The members of the assembly were fully aware that in the passage of this act they were eliminating an obstacle to research for secondary roads and, in so doing, were providing for a comprehensive research program for all roads in the state through removal of that obstacle.

This act, as it appears in Sections 310.34 to 310.36, Code of Iowa, 1950, provides that, if needed, 1½ percent of the funds allotted from the state road-use-tax fund for use on the farm-to-market subsystem of the secondary road system may be used for secondary road research. The act also directs the highway commission to use the funds so provided solely for the purpose of financing research projects having for their objectives the more-efficient use of funds and materials available for the construction and maintenance of secondary roads. The law further provides that these research projects be conducted by the highway commission in coöperation with county engineers and requires that reports on the projects be made to the governor, the general assembly and the county engineers, to the first and the last annually and to the second of these biennially.

Attention is here directed to the use of the words "construction" and "maintenance" in the act. Legal practice in Iowa defines these words in the primary sense. The definition has been construed to be so narrow in the laws relating to secondary roads as to preclude use of any funds provided for construction or maintenance on these roads for any other purpose such as research. Consequently, the act establishes research as a specific function of the administration of secondary roads in the same manner as construction and maintenance have long been established in secondary-road law. Adoption of the act is, therefore, particularly revealing as to the attitude of the legislature toward the importance of research as a function of all highway administration.

Enactment of the secondary road research law placed the highway commission under obligation to conduct such research in behalf of secondary roads as could be shown to be advisable. Provisions of the act implied the organization and conduct of this research in a methodical and continual operation. Such a procedure had never been developed for the research conducted by the Iowa State Highway Commission for many years in behalf of the primary roads but had been considered and discussed at intervals over a long period of time. The opportunity was therefore at hand to again consider the installation of a new procedure for primary-road research. Furthermore, it was deemed advisable to place the responsibility for research for all roads in single agency and to direct the research activities authorized by law on behalf of secondary roads and those conducted by the highway

commission in behalf of primary roads under existing authority through that agency.

Several months were occupied in the study of plans for the accomplishment of that objective. Procedures used by other state highway departments for discharging the research function were examined, and aid was sought and obtained from the Highway Research Board of the National Research Council. Conferences were held with representatives of the Iowa Association of County Engineers, with representatives of the State University of Iowa (Iowa City) and Iowa State College (Ames) and with staff members of the highway commission. Finally, a plan of procedure acceptable to all persons and organizations to be involved in the proposed operation was completed. Early in December of 1949, this plan in the form of an official memorandum of instructions was submitted to the highway commission. Approval of the plan by the commision was granted on December 20, 1949. With this approval, the administration and direction of research financed from the funds provided from the state road-use fund for secondary roads and from funds provided for primary roads were placed under the jurisdiction of single agency of the highway commission.

The agency created for that purpose by the memorandum of instructions is the Iowa Highway Research Board. This board consists of eleven members, six of whom are county engineers, three are engineers from the staff of the highway commission, one is a representative of the University of Iowa, and one is a representative of Iowa State College.

The county-engineer members are appointed by the Iowa Association of County Engineers. The members from the highway commission are appointed by the commission. The representatives from the state university and the state college are appointed as these institutions may determine. The present representatives of these institutions are the dean of the College of Engineering and the dean of the Engineering Division, respectively. All appointments are certified to the chief engineer of the highway commission who, in turn, notifies the chairman of the Iowa Highway Research Board of that action. The length of term for each member is 3 years and the members serve without compensation but receive actual expenses while engaged in travel away from home or headquarters on business connected with service on the board.

The board elects its own chairman and vice chairman and establishes its own rules of procedure, including fixing of numbers and dates of all regular and special meetings and the places where special meetings are to be held. All regular meetings are required by the memorandum of instructions creating the board to be held in Ames.

That memorandum of instructions also prescribes the duties of the board to: (1) receive and consider all suggestions for highway research projects pertaining to either primary or secondary roads; (2) develop an orderly, efficient, and coördinated highway research program; (3) recommend highway research projects to the state highway commission that the board deems meritorious and most urgently needed; (4) recommend to the state highway commission an agency that the board deems appropriate for the conduct and prosecution of each research project recommended; (5) keep in touch with progress being made on each active research project and bring the work on each such project to a conclusion as promptly as may be practicable; (6) receive, consider, and act on all reports on highway research projects; (7) disseminate information relating to highway research; and (8) report annually to the state highway commission on June 30.

The memorandum further requires that the highway commission designate one of its engineers as director of highway research and that the director serve as secretary to the board, without either membership on the board or a vote in its meetings.

The duties of the director are to: (1) keep the minutes and other records of the board; (2) actively supervise and prosecute the highway research work as recommended by the board and approved and authorized by the commission; (3) report to the chief engineer of the state highway commission all recommendations of the board as to highway research projects to be undertaken, estimate of probable cost thereof, the agency recommended to execute such project and other matters relating thereto; (4) formulate and negotiate proposed agreements with research agencies, the Bureau of Public Roads, and other involved agencies, for approval by the commission, for the execution of all highway

TABLE 1
STATUS OF RESEARCH PROJECT SUGGESTIONS, DECEMBER 31, 1953

Research Project Suggestion Number	Title of Project	Source of Suggestion and Date Received	Estimated Cost	Project Period in Years	Action upon Suggestion		Highway Commission Research Project Number	Agency to Conduct Project
					By Board and Date Taken	By Commission and Date Taken		
1	Accelerated Testing of Highway Pavements	L. H. Csanyi 5/25/50	$7,000	1	Adopted 7/28/50	Approved 8/16/50	7	Iowa Engineering Exp. Sta., Iowa State College (Completed)
2	Investigation of the Loess and Glacial Till Materials of Iowa	D. T. Davidson 5/25/50	$45,000	3	Adopted 6/13/50	Approved 7/ 7/50	1	Iowa Engineering Exp. Sta., Iowa State College
3	The Supporting Strength of Concrete Pipes	M. G. Spangler 5/25/50	$12,700	1	Postponed 1/26/51	—	—	—
4	Motor Vehicle Operating Costs	Robley Winfrey 5/25/50	$19,400	2	Postponed 9/29/50	—	—	—
5	Origin and Destination Traffic Surveys	Robley Winfrey 5/25/50	$5,700	1	Adopted 7/28/50	Approved 8/16/50	8	Iowa Engineering Exp. Sta., Iowa State College
6	Elimination of Long Bridges on Streams with Small Drainage Areas	Paul Mahoney 5/26/50	$8,000	1	Adopted 6/13/50	Approved 7/ 7/50	5	Iowa Institute of Hydraulic Research, State Univ. of Iowa
7	Flood Frequency and Flood Magnitude Analysis	V. R. Bennion 5/27/50	$10,000	2	Adopted 6/ 9/50	Approved 7/ 7/50	2	U. S. Geological Survey District Off., Iowa City (Completed)
8	Determination of Flood Discharge Characteristics of Small Drainage Areas	V. R. Bennion 5/27/50	$50,000	10	Adopted 6/ 9/50	Approved 7/ 7/50	3	U. S. Geological Survey District Office, Iowa City
9	Strengthening of Existing Light Pony Trusses	L. J. Schiltz 5/28/50	—	—	Postponed 8/25/50	—	—	—
10	Treatment of Wood Floors For Wearing Surfaces	L. J. Schiltz 5/28/50	—	—	Postponed 8/25/50	—	—	—
11	Precast Concrete Bridge Floor Construction	L. J. Schiltz 5/28/50	—	—	Postponed 8/25/50	—	—	—
12	Thickness of Stabilized Aggregate Bases for Use With Bituminous Surfaces	L. J. Schiltz 5/28/50	$25,000	1	Adopted 6/ 9/50	Approved 7/ 7/50	4	Dubuque County and Iowa State Highway Commission
13	Accounting Practices in County Engineer Offices	L. J. Schiltz 5/28/50	—	—	Postponed 9/29/50	—	—	—
14	Hydraulic Design of Highway Culverts	Hunter Rouse 6/ 1/50	$39,000	3	Adopted 7/25/52	Approved 7/29/52	23	Iowa Institute of Hydraulic Research State Univ. of Iowa
15	Hydraulic Design of Highway Valley Crossings	Hunter Rouse 6/ 1/50	$34,000	2	Postponed 10/28/50	—	—	—
16	A Study of Limestones of Iowa for Low Cost Road Construction	W. H. Behrens 6/ 1/50	—	—	—	—	—	Data sought now available in Commission Files
17	Construction of Earth Fills to Resist Erosion When Flooded	F. M. Dawson 6/ 2/50	$10,000	1	Adopted 6/13/50	Approved 7/ 7/50	6	Iowa Institute of Hydraulic Research, State Univ. of Iowa
18	Thickness of Concrete Pavements for Light Traffic Roads	C. A. Elliott 7/24/50	$25,000	1	Adopted 12/ 5/50	Approved 12/20/50	9	Greene County and Iowa State Highway Commission
19	Durability of Portland Cement Concrete	Bert Myers 7/27/50	$5,000	P	Adopted 12/ 5/50	Approved 12/20/50	10	Iowa State Highway Commission
20	Sources of Highway Material in Southwestern Iowa	H. G. Hershey 9/29/50	$24,000	3	Adopted 12/ 5/50	Approved 12/20/50	11	Iowa Geological Survey
21	Elastic Behavior of Steel Truss Members	J. F. Downie Smith 9/29/50	$19,700	1	Postponed 1/26/51	—	—	—
22	Live Load Distribution in Four Beam I-Beam Bridges	E. W. Blumenschein 12/ 2/50	$23,800	1	Adopted 2/23/51	Approved 3/20/51	12	Iowa State Highway Commission
23	Extent and Nature of Rural Road Usage	Mark Morris 2/23/51	$10,000	1	Adopted 3/30/51	Approved 4/17/51	13	Iowa State Highway Commission

24	Determination of New Formula For Bearing Value of Piles	C. A. Elliott 2/23/51	—	—	Postponed	—	—	—
25	Preparation of Engineering Soils and Drainage Maps	D. T. Davidson 3/17/51	$15,000	P	Postponed 4/27/51	—	—	—
26	Lateral Pressures on Retaining Walls	M. G. Spangler 3/20/51	$30,000	2	Adopted 4/27/51	Approved 5/15/51	14	Iowa Engineering Experiment Station, Iowa State College
27	Limestones for Concrete Aggregates	C. J. Roy 5/21/51	$11,420	2	Adopted 5/25/51	Approved 5/29/51	15	Industrial Science Research Institute, Iowa State College
28	Sediment Transportation in Conduits	Carl Izzard 7/13/51	$5,000	1	Adopted 8/31/51	Approved 9/19/51	16	Iowa Institute of Hydraulic Research, State Univ. of Ia.
29	Low Cost Surfacing for Secondary Roads	J. R. Dougherty 7/27/51	$40,000	1	Adopted 8/31/51	Approved 9/19/51	17	Muscatine County and Iowa State Highway Commission
30	Treating Loess, Fine Sand and Limestone Dust with Liquid Binders	L. H. Csanyi 9/24/51	$48,900	2	Adopted 12/ 4/51	Approved 12/28/51	20	Iowa Engineering Exp. Station, Iowa State College
31	Low Cost Asphalt Surface Construction	Edward Winkel 9/24/51	$21,575	1	Adopted 11/ 3/51	Approved 11/13/51	18	Osceola County and State Highway Commission
32	Use of Sand as a Highway Material	Bert Myers 9/28/51	$18,000	1	Adopted 11/ 3/51	Approved 11/13/51	19	Iowa Engineering Exp. Sta., Iowa State College and Iowa State Highway Commission
33	Sodium Acrylate and Furfural Resins for Stabilizing Soils	F. M. Dawson 11/ 3/51	$10,700	1	Postponed 2/25/52	—	—	—
34	Use of Shales as Highway Materials	Chas. O. Frush 12/20/51	$6,000	1	Adopted 5/23/52	Approved 6/10/52	21	Iowa Engineering Exp. Station, Iowa State College
35	Fertilizer Response on Highway Cuts and Fills	D. B. Chittenden 5/22/52	$15,000	5	Adopted 6/27/52	Approved 7/ 2/52	22	Iowa Agricultural Exp. Station, Iowa State College
36	Field Observations on Scour Around Bridge Piers and Abutments	Mark Morris 8/29/52	$7,500	5	Adopted 12/16/52	Approved 12/31/52	24	Iowa Institute of Hydraulic Research State University of Iowa
37	Study of the Deep Loess of Eastern Iowa	George R. Town 9/19/52	$13,750	1	Adopted 9/26/52	Approved 11/19/52	Combined with 1	Iowa Engineering Exp. Station, Iowa State College
38	Prestressed Concrete Highway Bridges	James Michalos 10/29/52	$3,088	1	Adopted 5/29/53	Approved 6/17/53	25	Iowa Engineering Exp. Station, Iowa State College
39	Stabilization of Subgrade Soils by Air Drying	C. J. Posey 12/ 1/52	$12,000	2	Adopted 5/29/53	Approved 6/17/53	26	Engineering College State University of Iowa
40	Control of Moisture in Highway Subgrades	M. G. Spangler 1/26/53	$17,780	1	Adopted 5/29/53	Approved 6/17/53	27	Iowa Engineering Exp. Station, Iowa State College
41	Size of Aggregate for Traffic Bound Roadway Surfaces.	Cletus M. Striegel 3/10/53	To be Determined	3	Adopted 8/25/53	Approved	28	Iowa State Highway Commission
42	Compilation of Drainage Areas	V. R. Bennion 8/ 3/53	$20,000	3	Adopted 10/ 3/53	Approved 10/20/53	29	U. S. Geological Survey Iowa City
43	Scour in Stream Beds at Highway River Crossings	J. S. McNown 8/ 5/53	$20,000	2	Adopted	Approved	30	Iowa Institute of Hydraulic Research State University of Iowa

TABLE 2

ESTIMATED ANNUAL AND TOTAL COSTS TO THE COMMISSION OF RESEARCH PROJECTS RECOMMENDED BY THE IOWA HIGHWAY RESEARCH BOARD TO THE IOWA STATE HIGHWAY COMMISSION AND APPROVED BY THE COMMISSION TO DATE OF DECEMBER 31, 1953

Research Project Number	Agreement Terminal Date	Estimated Expenditures for the Fiscal Year										Total
		1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	
HR-1 Investigation of the Loess and Glacial Till Materials of Iowa.	8/11/53	$17,000	$14,000	$38,775	—	—	—	—	—	—	—	$111,125
HR-2 Flood Frequency and Flood Magnitude Analysis.	9/30/53	5,000	5,000	5,000		—	—	—	—	—	—	15,000
HR-3 Determination of Flood Discharge Characteristics of Small Drainage Areas	9/30/53	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	50,000
HR-4 Thickness of Stabilized Aggregate Bases for use with Bituminous Surfaces	5/31/52	25,000	—	—	—	—	—	—	—	—	—	25,000
HR-5 Elimination of Long Bridges on Streams With Small Drainage Areas.	8/31/53	8,000	—	—	—	—	—	—	—	—	—	8,000
HR-6 Construction of Earth Fills to Resist Erosion When Flooded.	8/31/53	10,000	—	—	—	—	—	—	—	—	—	10,000
HR-7 Accelerated Testing of Highway Pavements.	9/31/51	7,000	—	—	—	—	—	—	—	—	—	7,000
HR-8 Origin and Destination Traffic Surveys.	8/31/51	5,700	—	—	—	—	—	—	—	—	—	5,700
HR-9 Thickness of Concrete Pavements for Light Traffic Roads.	9/31/52	25,000	—	—	—	—	—	—	—	—	—	25,000
HR-10 Durability of Portland Cement Concrete.	—	5,000	—	—	—	—	—	—	—	—	—	5,000
HR-11 Sources of Highway Materials in Southwestern Iowa.	6/30/54	8,000	8,000	8,000	—	—	—	—	—	—	—	24,000
HR-12 Live Load Distribution in Four Beam I-Beam Bridges.	—	—	—	10,000	—	—	—	—	—	—	—	10,000
HR-13 Extent and Nature of Rural Road Usage.	—	—	—	10,000	—	—	—	—	—	—	—	10,000
HR-14 Laterial Pressure on Retaining Walls.	5/31/54	—	20,000	10,000	—	—	—	—	—	—	—	30,000
HR-15 Limestones For Concrete Aggregates.	5/31/54	4,000	7,240	—	3,613	—	—	—	—	—	—	14,853
HR-16 Sediment Transportation in Conduits.	7/31/53	—	5,000	—	3,000	—	—	—	—	—	—	8,000
HR-17 Low Cost Surfacing For Secondary Roads.	5/31/54	—	—	40,000	—	—	—	—	—	—	—	40,000
HR-18 Low Cost Asphalt Surface Construction.	5/31/53	—	—	21,575	—	—	—	—	—	—	—	21,575
HR-19 Use of Sand as a Highway Material	11/30/52	—	5,000	13,000	—	—	—	—	—	—	—	18,000
HR-20 Treating Loess, Fine Sands and Limestone Dust with Liquid Binders.	12/31/53	—	18,000	15,900	15,000	—	—	—	—	—	—	48,900
HR-21 Use of Shales as Highway Materials.	5/31/54	—	—	6,000	12,689	—	—	—	—	—	—	18,689
HR-22 Fertilizer Response on Highway Cuts and Fills	8/31/57	—	—	3,000	3,000	3,000	3,000	3,000	—	—	—	15,000

TABLE 2—*Continued*

Research Project Number	Agreement Terminal Date	Estimated Expenditures for the Fiscal Year										
		1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	Total
HR-23 Hydraulic Design of Highway Culverts	8/31/55	—	—	$10,000	$10,000	$10,000	—	—	—	—	—	$30,000
HR-24 Field Observations of Scour Around Bridge Piers.	12/31/53	—	—	3,000	4,500	—	—	—	—	—	—	7,500
HR-25 Prestressed Concrete Highway Bridges.	6/30/54	—	—	—	3,088	—	—	—	—	—	—	3,088
HR-26 Stabilization of Subgrade Soils by Air Drying.	8/31/55	—	—	—	6,000	6,000	—	—	—	—	—	12,000
HR-27 Control of Moisture in Highway Subgrades.	6/30/54	—	—	—	17,780	—	—	—	—	—	—	17,780
HR-28 Size of Aggregate for Traffic Bound Roadway Surfaces	—	—	—	—	—	—	—	—	—	—	—	To be determined
HR-29 Compilation of Drainage Areas.	9/30/56	—	—	—	5,000	7,500	7,500	—	—	—	—	20,000
HR-30 Scour in Stream Beds at Highway River Crossings.	8/31/55	—	—	—	10,000	10,000	—	—	—	—	—	20,000
Total	—	$120,700	$104,000	$189,065	$137,445	$41,500	$15,500	$8,000	$5,000	$5,000	$5,000	$631,210
Actual Expenditure Total	—	$28,764	$100,763	$154,771								$284,298
Amount Obligated	—	—	—	—	—	—	—	—	—	—	—	$346,912

research projects approved by the commission; and (5) perform such other duties relating to highway research as the board or the commission may direct.

For the support of the research program to be developed in accord with the procedure just described, the memorandum of instructions establishing that procedure pledges that the highway commission will annually adopt a highway research budget for both primary and secondary roads to finance research projects in behalf of each kind of roads recommended by the board to the highway commission and approved and authorized by the commission.

The Iowa Highway Research Board began operations in an organizational meeting held in Ames on May 18, 1950. Several suggestions for research projects were received in this first meeting. These were referred to the director for recommendation for disposition in a subsequent meeting. To date, the board has had an average of one regular meeting per month and two to three special meetings each year. All meetings are well attended. Absences are rare. This is due in part to a provision for attendance by an alternate when a regular member finds it impossible to attend a meeting. Regular meeting date is the last Friday in each month, except when such date falls on a holiday. In that event, special action is taken to fix another date for the meeting which conflicts with the holiday.

In the operating procedure of the board, all suggestions for research projects are filed with the director of highway research. He examines these suggestions for clarity only, at this stage, and prepares a sufficient number of copies of each suggestion to provide one for each member and alternate member of the board. In this form, the suggestions are placed before the board at the next meeting following their receipt by the director. In that meeting the board, in formal action, refers the suggestions to the director for recommendation as to disposition. If possible such a recommendation is made to the board at the next meeting following that in which the suggestion was received by the board. In some instances, a suggestion for a major project may require more time for study by the director before preparation of a recommendation. Upon receipt of the recommendation of the director, the board may act either to accept or reject that recommendation. To date all recommendations of the director have been accepted.

The recommendations of the director may be either to the effect that the suggestion for

a research project be adopted or be rejected for recommendation by the board to the highway commission as the subject for a research project. In some instances, the recommendation may be for postponement of action by the board for inability to develop an outline for the research proposed, for lack of a suitable agency to conduct the work or to avoid overloading an available agency which is engaged upon previous assignments.

When the recommendation of the director is to the effect that the suggestion for a research project be adopted for recommendation by the board to the highway commission as the subject for a research project and action by the board is for adoption, the director reports the action of the board to the commission and on behalf of the board recommends to the commission that the project be approved and funds authorized for its performance. In the event of approval of the project by the commission, the director proceeds with the remainder of his duties as set forth in the memorandum of instructions establishing the procedure for discharging the research functions of the Commission. To date, the commission has approved all research projects recommended to it by the board.

To date 43 suggestions have been received and studied by the board. Thirty of these suggestions have been recommended by the board to the highway commission as the subjects for research projects. Action on twelve suggestions has been postponed for some one of the reasons given heretofore in this paper. One suggestion has been satisfied with data available from other sources. The board has but one suggestion before it for consideration at this time. Table 1 shows the status of all suggestions for research projects received by the board as of December 31, 1953.

Two of the thirty research projects recommended by the board and approved by the commission have been completed and two others are nearly completed.

The projects proposed include a variety of subjects. Examination of the titles of the suggestions as given in Table 1 will suffice to give a good idea of the variety of the work proposed, and examination of the titles of the projects listed in Table 2 will give a good idea of the variety of the work included in the program as it has developed to date under the new procedure for discharging the research function of highway administration in Iowa.

The estimated cost of the work in the thirty projects which have been approved to date of December 31, 1953 is $631,210. The distribution of costs among these thirty projects is shown in Table 2, which also shows the financial program of the projects approved to date. In a number of instances the cost shown for a given project in Table 2 is greater than that shown for the project in Table 1. The difference is due to the extension of the original project to include additional work. Suggestions for such extensions are handled in the same manner as the suggestions for the original projects.

Funds in any amount likely to be required can be made available for the research program conducted under the procedure now in effect in Iowa. The provisions of the secondary road research act permit the use of up to 1½ percent of the funds allocated from the state road-use-tax fund to the farm-to-market-road fund. The same percentage of the federal-aid allocations to Iowa for highways is available for economic and engineering investigations and highway research under provisions of the Federal Highway Act of 1944. These allocations may be matched with a like amount of state funds. In addition, funds for primary roads may be used for research without legal restriction. The combination of the maximum amount which could be made available through allocation of 1½ percent of the farm-to-market-road fund, 1½ percent of the federal-aid allocation, and a like amount of state funds would provide annually approximately $550,000 for economic and engineering investigations and highway research at the present rate of income from these sources. Normally about $400,000 would be available for highway research. It is unlikely that such an amount will be required. But even if it were all used for highway research, it would constitute only 0.4 percent of the total amount currently available annually for highway purposes in Iowa. This would be judged by an industry with a comparable gross income as a small outlay for research. The current attitude in Iowa appears to be to use as much of the amount available for research as may be required for greatly needed and highly meritorious research projects.

In the procedure now in effect for carrying on highway research in Iowa, the major por-

tion of the work is performed by research agencies for the state highway commission under agreements between the commission and the agencies for that purpose. These agreements provide for the payment of predetermined amount for work performed in a stated period of time. These agreements also provide for annual progress reports, a final report, presentation of papers in technical society meetings and for extensions of time and increases in amount of payment for additional work that may be found to be necessary or desirable during the performance of the work specified in the original outline for the project. Research agencies employed on the projects listed in Table 2 include the Iowa Institute of Hydraulic Research of the State University of Iowa, the Iowa Engineering Experiment Station of Iowa State College, the Iowa Agricultural Experiment Station at Iowa State College, the Industrial Science Research Institute at Iowa State College, the Iowa Geological Survey, the U. S. Geological Survey and the Ames Laboratory of the Iowa State Highway Commission. Several projects are being conducted cooperatively by counties and the highway commission. Greene, Dubuque, Osceola, Muscatine, Cass, Lucas, and Scott counties are coöperating with the commission in experimental road projects in which the county furnishes part of the funds, usually half, sometimes more, and the commission furnishes the remainder from secondary road research funds. In these projects the county undertakes the construction of an experimental road under controlled conditions and the commission furnishes the personnel required for the research aspects of the project.

Examination of the list of projects shown in Table 2 reveals that a considerable number deal with the properties of soils, the uses of materials, the construction of roadway bases and surfaces, and the characteristics of materials. This is natural and logical for Iowa, particularly for research for secondary roads in which the quest for some means of using any material readily available is of major importance in the attainment of the prime objectives, low cost of construction and maintenance for a great mileage of light traffic roads. The financial advantages of a successful solution are great. The need is urgent in the face of diminishing supplies of conventional materials in areas where they were once plentiful and imperative in areas where materials suitable for the types of construction now required even for light traffic roads were never available locally.

To date, the projects undertaken have been largely those involving physical research. Suggestions are, however, in the offing for projects in highway economics and other nonphysical features of highway transportation. So far, in spite of the need for work in these fields, suggestions for projects in them have been slow in making an appearance and when offered have been difficult to develop as subjects suitable for research attack.

After 4 years of operation, the new procedure for highway research in Iowa appears well on its way toward becoming a successful venture. The Iowa Highway Research Board is an active, alert, and vigorous body, seeking through every means at its command to provide knowledge needed for the solutions of the highway problems encountered in Iowa. The several research agencies engaged in the actual research are sincere, energetic, thoroughly competent and wholly coöperative in their efforts to produce results of value and benefit in the prosecution of the improvement programs for the highways of the state. The highway commission and the county highway officials regard the research program as a highly essential feature of highway administration and await patiently the day when that program begins to produce the various items of knowledge which constitute the objectives of the venture and which are urgently needed for aid in the solution of the horde of highway problems which confront these officials.

All concerned and involved are aware that research takes time. At this stage little fruit is either available or visible, but in a short time a steady crop of useful items of knowledge should make an appearance and become parts of the day to day administration of the highway systems of the state. As a matter of fact, the harvest has even now begun with the completion of two projects and the near completion of two others.

The Iowa Highway Research Board is composed of men directly from the field of practical application of knowledge and men directly from the fields of science, education and research. The practicing engineers on the board bring to it their problems and those of others engaged in the various functions of highway

administration, they bring their needs for data and information and they bring their experience in the highway administration. The educators and the men of science bring to it the technical skills and the research facilities and personnel at their command, their theoretical knowledge, and their familiarity with research techniques. The two groups meet, become thoroughly acquainted with the problems confronting the one and with the abilities, talents and skills of the other for assisting in the solution of these problems. Each group benefits from the contact with the other. Participation by the man from the field in the administration of research broadens the base of his interest in the work and acquaints the research workers with the basic needs of the men on the firing line. This mutual participation in the work serves to focus the attention of both groups upon the actual and immediate needs for highway research. As a consequence, the suggestions for research projects, which have been for the most part from within these groups, have been of substantial and practical nature, seeking the collection of data and the provision of knowledge urgently needed in some phase of highway administration, principally, to date, in the fields of design, construction, and maintenance. The board therefore affords a means for bringing the practicing engineer, the educator, the scientist, and research worker together in a coöperative attack on the solution of highway problems.

Iowa has been active in highway research and has made many notable contributions in that field over the years from about 1913 to 1949. These have been largely due to the personal and individual efforts of such men as Anson Marston, one time dean of engineering at Iowa State College and one of the founders of the Highway Research Board of the National Research Council; T. R. Agg, late dean of engineering at Iowa State College and long active in the work of the Highway Research Board; R. W. Crum, late director of the Highway Research Board, for a time professor of civil engineering at Iowa State College and engineer of materials and tests of the Iowa State Highway Commission; Robley Winfrey, director of engineer-training program, Bureau of Public Roads and one-time professor of civil engineering at Iowa State College; R. A. Moyer, research engineer, California Institute of Traffic and Transportation, and once professor of civil engineering at Iowa State College; M. G. Spangler and W. J. Schlick, professors of civil engineering at Iowa State College; W. H. Root, deputy chief engineer, Iowa State Highway Commission and vice chairman of the Highway Research Board and active in the work of that board for the past 27 years; Bert Myers, engineer of materials and tests, Iowa State Highway Commission. The work of these men and many others has been of great value to highway technology. The results of much of their work have been incorporated in the basic standards and specifications for highway design and construction for many years. Many of these basic practices and specifications will bear the imprint of their touch permanently.

The quality and value of the work of these men in highway research constitute a challenge to all who come after them. Great were their achievements in spite of the fact that the climate for their work was greatly different than that provided in the current approach to highway research in Iowa. It remains to be determined that the more-favorable climate will produce more valuable results. The probability of an improvement in quality of product directly proportional to the improvement in the climate for research is small, but the probability of a greater quantity of product of a comparable quality is great. For this advantage alone the current approach to highway research in Iowa is justifiable.

It may be noted that all but a few of the research workers of the past were members of the faculty at Iowa State College and all but one received their engineering education under Anson Marston. In the few years since the new procedure has been in effect, members of other research agencies have begun to appear under the titles of technical papers pertaining to highway research in Iowa, and many new names have begun to appear as the authors of these papers. With the continuation and extension of that procedure, many of these names will become as familiar as those of their illustrious predecessors and their numbers will increase many fold. Hence, the procedure produces and develops, in addition to the products of research, two of the essential elements of such research itself—the research workers and the agencies for research.

From the foregoing it appears that the current approach to highway research in Iowa

now has all of the essential elements for a successful operation and for notable achievement. It is founded upon a recognition of the need for comprehensive highway research; it is inspired by a desire to engage in research; it is supported by a willingness to engage in and embark upon a research program, it is equipped with funds, personnel, and facilities appropriate to the work at hand, and it is undertaken with a willingness to assign research a place in highway administration comparable in importance to that of other long established functions. The legislature, highway commission, county engineers, county officials, University of Iowa, and Iowa State College have coöperated in supplying these basic elements and have contributed toward the procedure for research, each in accord with their respective powers, authorities, abilities and talents. There remains only the achievement of the objective of the procedure which has been developed by their collective efforts and contributions. Present indications are that it will be a successful venture.