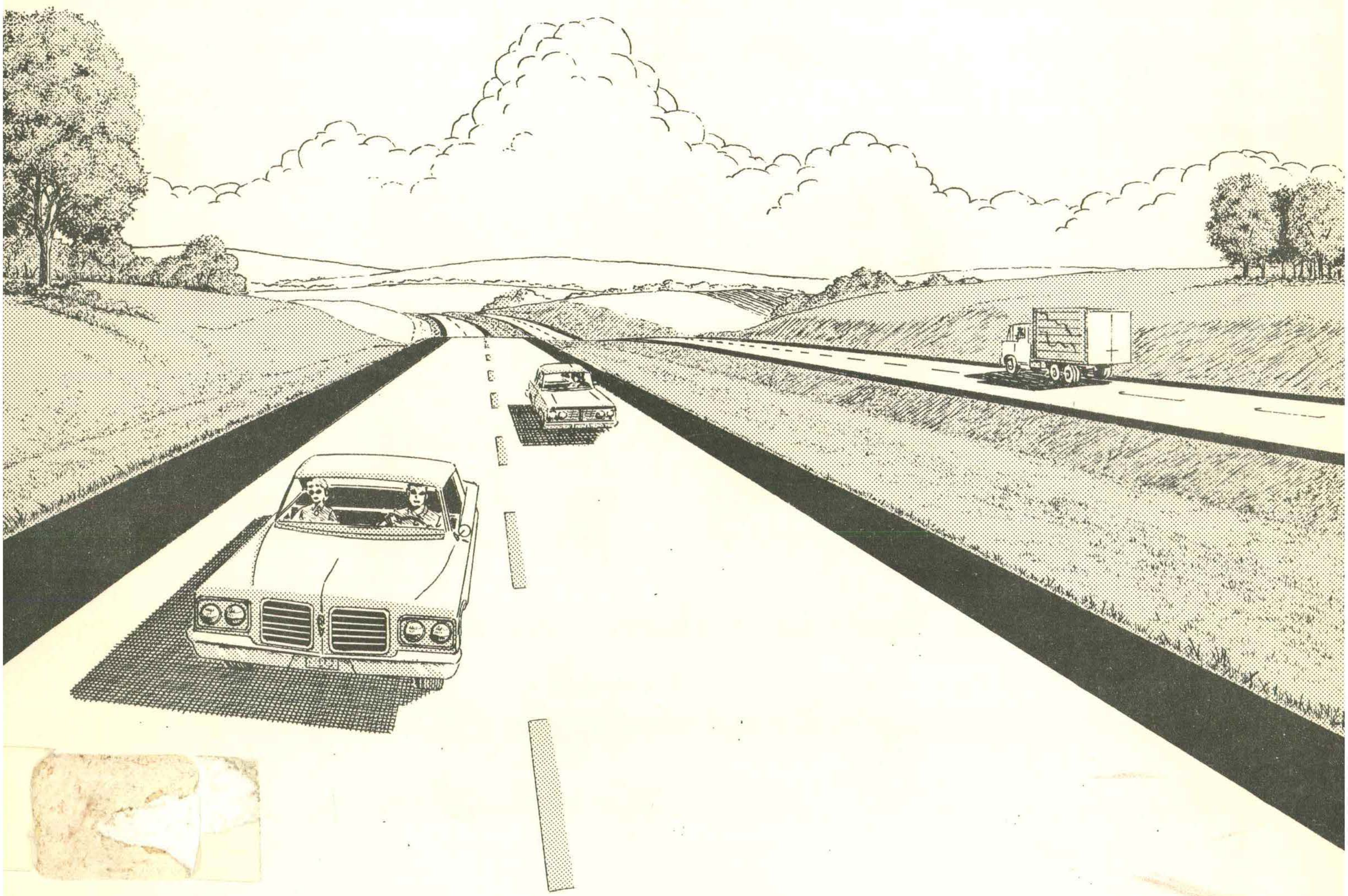
THE HIGHWAY MODE:

PRINCIPAL ROUTES

AS PROPOSED

JANUARY 1975



Prepared By

SYSTEMS PLANNING DEPARTMENT
IOWA STATE HIGHWAY COMMISSION

In Cooperation With The

UNITED STATES DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

JANUARY 1975

PREFACE

This report on *The Highway Mode* is intended for the veteran transportation planner as well as the uninitiated but concerned citizen.

A broad range of relevant issues will be covered; the reader will be introduced to transportation planning and the factors that must be evaluated in the continuing effort to provide for today's highway needs as well as tomorrow's demands.

Iowa's future multilane highway system will be examined in detail. Discussion will include its needs, expected traffic demands, the priorities involved, and the timing of its construction.

The report is arranged in three main sections:

Section I - The first section reviews the historical events leading to today's system, how highway needs have been documented, and the public hearing role of integrating these needs with the transportation planning process.

Section II - The second section addresses the factors involved in sound transportation planning; e.g., population dispersion and trends, economic effects of the system, analysis of road user benefits and environmental impacts, availability of petroleum resources, and finally, analysis of anticipated accident savings through the development of a decidedly safer multilane highway system. The section also demonstrates the modal interface of air, water, railroad and highway transportation.

Section III - The third section presents the proposed Interstate-Freeway-Expressway System for Iowa. Substantial traffic already exists in most corridors of the proposed system. These volumes are expected to increase in the future. Some of the freeway corridors are presently being served by antiquated 18 foot pavement.

Colored maps will illustrate the continuity that Iowa's proposed system of multilane facilities will have with the long-range highway plans of surrounding states. The construction of these continuous systems, of course, depends upon the availability of adequate funding.

A synopsis of the report's major points is rendered on the green sheets, and pink sheets are included with each section for the purpose of providing a brief summary of that section's content and high points.

Several appendices are provided for those who desire additional detail concerning: (1) The long-range freeway-expressway plans of states surrounding Iowa, (2) Traffic forecasting for the Interstate-Freeway-Expressway System, (3) Accident cost data, and (4) The Trip Data Survey at Grain Terminals Located in McGregor and Clayton, Iowa.

Readers who are interested in related research, or desire further elucidation of any matter covered in the report, will find a complete list of references on the final pages.

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Executive Summary

Transportation is basic and vital to survival. Iowa's population dispersion dictates a transportation mode that will provide individual mobility and efficient goods movement. A system of multilane highways to supplement the Interstate System is therefore indispensable for economic growth and the well being of Iowa's people.

Increasing highway transportation demands are well established, having been identified in Highway Needs Studies nearly thirty years ago. Highway needs are a function of traffic; traffic volume and characteristics determine highway design. Substantial traffic volumes are present in most Interstate-Freeway-Expressway corridors and are forecasted to increase in the next 20 years. These forecasted volumes will be affected by the future availability of fuel. Forecasted trend lines will require monitoring as the energy situation and its impact on travel is more clearly defined.

The proposed Freeway-Expressway System is based upon the transportation needs created by people. Population trends and projections indicate a modest growth for Iowa, which is consistent with the recommendations made at the Governor's Conference on Iowa in the year 2000.

The economic development that occurs within multilane highway corridors is important to Iowa and its cities and towns.

An economic analysis is required to determine the need for the System. The analysis makes it possible to integrate the highway with the study area, maximizing the social and economic benefits of the transportation facility while minimizing any adverse impacts upon the environment.

Divided highways with full access control provide a consistently safer route to travel than other primary highways or local road and street systems. Substantial savings in lives and dollars can be provided through the proposed Freeway System. The proposed Freeway System would save 67 lives annually by 1995, reduce bodily injuries by 2,086, and provide an annual accident savings of 15.8 million dollars.

The proposed Interstate-Freeway-Expressway System interfaces with and provides support for the air, water and rail modes. The first and last movements of goods and people are accomplished by the highway mode. Additional movement information concerning non-highway modes is required before a detailed analysis to maximize mutual support can be accomplished.

The availability of fuel directly affects travel. A review of recent literature suggests that, at worst, world crude oil production will satisfy demand over the medium term. Estimates of the total resource base vary greatly. In the future, increasing reliance on sources of energy other than petroleum can be expected to relieve a substantial amount of the pressure on crude oil reserves.

The proposed Freeway-Expressway System has been reduced from the system adopted in 1968. Three sections of expressway have been deleted from the system due to low traffic growth (U.S. 71 from I-80 north to 520; U.S. 63 from 518 north to Minnesota; Iowa 150 from 520 north to 518). The 549 Freeway has been deleted and a section of 518 Freeway between I-380 and 520 has been replaced with the 150 Expressway. The 518 Freeway in this area will follow I-380. The proposed Expressway System now totals 1,009 miles.

The proposed Freeway system totals 734 miles. Significant changes in this system since 1968 are: the two segments of Freeway (518 from I-80 to Waterloo and 520 Missouri River Crossing) which have been incorporated into the Interstate System; extension of 561 north of 520 into Dubuque; and the replacement of the previously mentioned section of 518 by the 150 Expressway.

The proposed Interstate-Freeway-Expressway System provides good continuity with states surrounding Iowa. These states have prepared long-range plans for their highway systems. Continued planning coordination with these states will be invaluable as transportation needs are jointly determined.

Interstate-Freeway-Expressway construction scheduling is dependent on facility needs and adequate financing. Most of the Interstate is now open to traffic; completion of the remaining sections is estimated for 1975 thru the early 1980's. Freeway-Expressway right-of-way and construction during the next five years is programmed for Benton, Black Hawk, Buchanan, Cerro Gordo, Clinton, Des Moines, Dubuque, Hamilton, Jasper, Johnson, Linn, Mahaska, Marion, Marshall, Scott, Warren, Washington, and Woodbury Counties.

Development of a System of Principal Highways

Claim: Iowa is almost totally dependent upon roads and streets for the economic growth and well being of its' people.

Facts: Historically, Iowa has experienced a parallel relationship between Gross State Product, vehicle registration and vehicle miles of travel; this relationship is projected to continue in the future.

Growing highway transportation demands have been documented in Highway Needs and Toll Road Studies and by Highway Study and Investigation Committees. Need for multilane highways has been identified by these committees and documented in published studies.

Planning and development of Iowa's proposed system is sensitive to community needs. Public hearings integrate these needs with the transportation planning process.

Land use and multilane highways are interrelated. Present land use patterns can be traced to prior national decisions. The percentage of land area in use for land transportation should decrease from the current amount.

Basis: Travel in Iowa is monitored by permanent automatic traffic recorders and supplemented with manual counters. Traffic forecasting is accomplished by projecting historical trends, analyzing origin-destination studies and by the Iowa Statewide Traffic Model. Trip length and purpose are established by origin-destination studies.

Highway needs studies correlate current road and street inventories for physical condition and geometric characteristics against the traffic volumes the facility is expected to carry. The 1942 study analyzed deficiencies on the Strategic Network of Highways, which was the forerunner of the Interstate System. The 1960 Highway Needs Study recommended a 1,217 mile Freeway System to supplement the Interstate System. The 1967 Needs Study recommended a 1,590 mile Freeway System (including the Interstate System) and a 1,144 mile Expressway System.

Since 1968 a total of 55 public hearings, attended by more than 10,000 citizens, have been held to guide the decision making process in establishing this Interstate-Freeway-Expressway System. These hearings have provided information to establish location and, in one case, were responsible for the deletion of a Freeway (549) from the system.

BACKGROUND

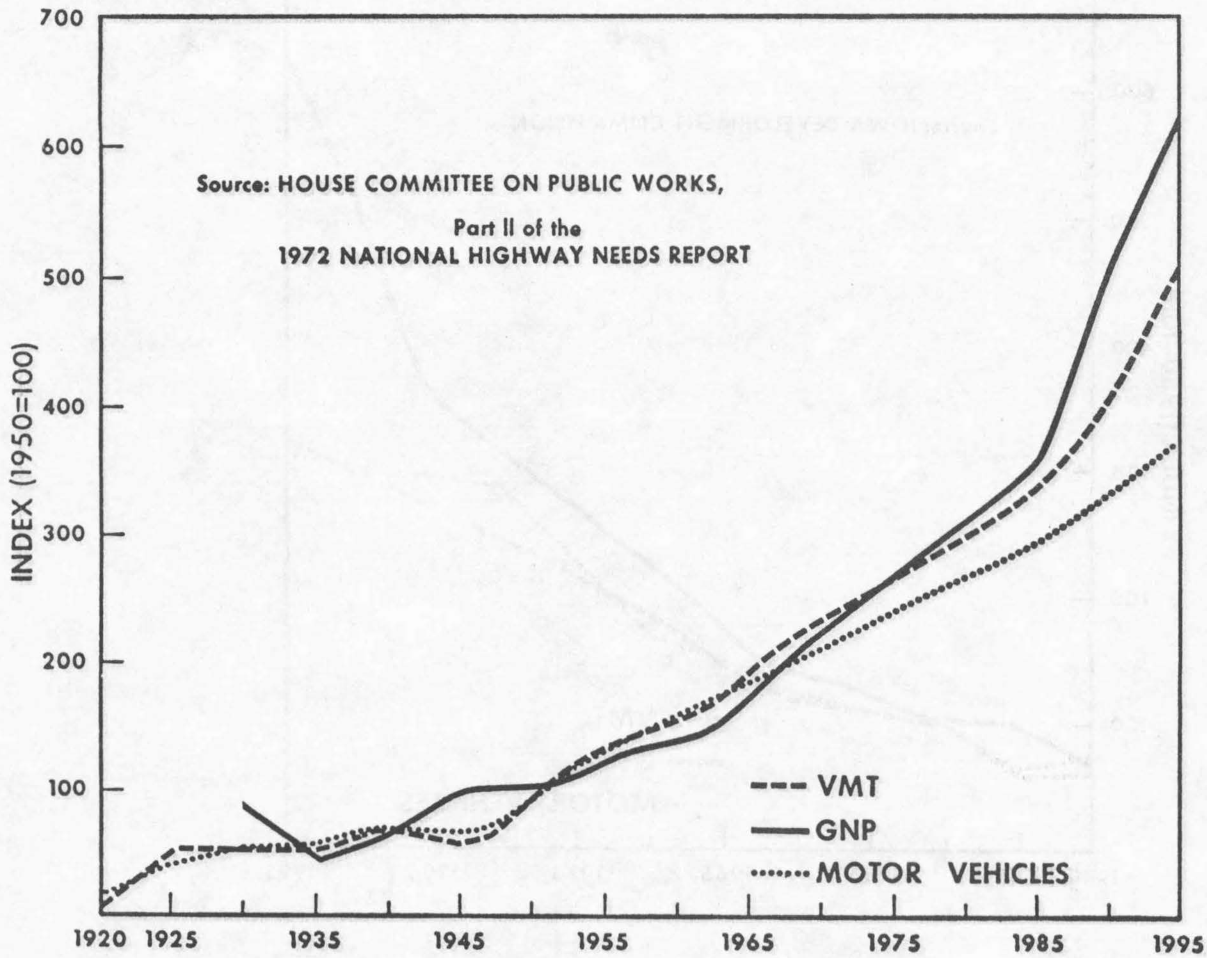
The Highway Commission, since its establishment in 1913, has been concerned with providing the users of Iowa's roads and streets with an adequate system of highways to meet their desired needs. From the early pressures to "Get Iowa out of the mud", through the strategic role highways demonstrated during World War II, then finally to the present dilemma caused by the energy situation coupled with inflation and recession sweeping hand in hand across the country, Iowa's road and street progress once again is at a crossroad.

To provide background for these crossroad decisions, it is necessary to examine prior planning efforts which have been important in the historical development of Iowa's highway heritage. To provide guidance for these crossroad decisions, forecasts of future highway transportation demands must be formulated.

The initial thrust in developing transcontinental travel was directed to providing a minimal system of all weather roads. As roads were developed and automobiles became more plentiful, a slow but steady growth in vehicle miles of travel and motor vehicle registration was experienced. As illustrated in Figure 1, this growth was only interrupted by

FIGURE 1

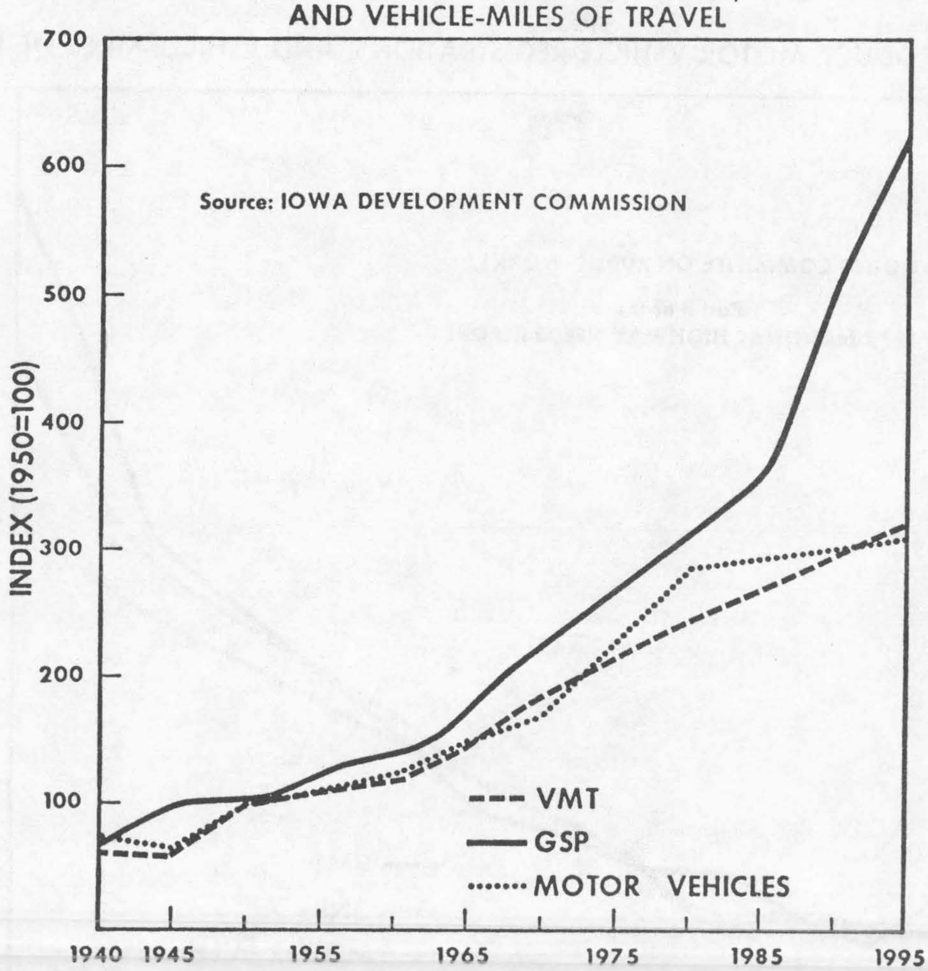
GROSS NATIONAL PRODUCT, MOTOR VEHICLE REGISTRATIONS, AND VEHICLE-MILES OF TRAVEL



the depression and war years. This figure also points up a relationship that is well known in the highway transportation field, that is, parallel rates of growth in highway travel and the Gross National Product (GNP). A slowdown in the growth of economic activity is generally followed by a slackening in the rate of travel growth, and conversely a quickening of the economic pace brings on a like response in highway travel. Using 1950 as the index year, projections have been made to 1995. Travel on U.S. highways has increased tremendously since the post-war years and is estimated to increase during the next 20 years by approximately 50 percent (Ref. 38).

Iowa's almost total dependence upon roads and streets for the economic growth and well-being of its people follows a pattern similar to that experienced in the United States. The relationships of vehicle miles of travel, vehicle registrations and Gross State Product for the State of Iowa are illustrated in Figure 2. Using 1950 as an index year, projections have

FIGURE 2
GROSS STATE PRODUCT, MOTOR VEHICLE REGISTRATIONS, AND VEHICLE-MILES OF TRAVEL



been made to 1995. Use of Iowa's roads has increased rapidly during the period from 1940 to 1973 despite only 11 percent more people (2,540,000 in 1940 and 2,825,000 in 1970) and only seven percent more primary road mileage (9,612 miles in 1940 and 10,271 miles in 1973). Registered vehicles during this same period have almost tripled from 800,000 in 1940 to nearly two million in 1972. Even more pronounced is the increase in travel that has taken place during the same time frame. The five and three quarters billion vehicle miles of travel in 1940 on Iowa's roads and streets has more than tripled, to over nineteen billion vehicle miles in 1973.

DEVELOPMENT OF THE INTERSTATE SYSTEM

To meet these increasing highway transportation needs, planning efforts during the last thirty years have been intensified. One of the first major nationwide considerations came in 1942 when a study was initiated by the Federal Government to analyze the deficiencies that existed on the Strategic Network of Highways. This system was the forerunner of the Interstate System and included U.S. 6 and U.S. 18 (east-west across Iowa) and U.S. 275-75, U.S. 69 and U.S. 218-63 (north-south across the State).

One of the first formalized needs studies ever conducted for Iowa's roads and streets was completed in November 1944 (Ref. 16). This report indicated that the needs for the Primary Road System during the following 10 years would be $188,000,000. The report stated, "Iowa traffic does not require super-highways. Except for a very limited mileage in and adjacent to the larger cities, two-lane highways will satisfactorily serve the traffic. Real and actual needs of the various street and highway systems are too great to permit of any extravagances."

Subsequent to these reports, the National System of Interstate and Defense Highways was approved by the Federal Works Administrator in August 1947, in compliance with the Federal Highway Act of 1944. This plan provided for a highway network not to exceed 40,000 miles and established certain standards for selection of routes. These standards, based on location of principal cities, requirements for National defense, and access to major agricultural areas, were established to delineate the Nation's highway needs. According to the authorization, this Interstate System included only the mileage necessary to satisfy the established standards and to serve the principal inter-regional traffic movement.

When approved in 1947, the Interstate System totaled 37,681 miles of principal highways, with 2,319 miles allocated for urban circumferential routes to be built as needed. The System served 42 state capitals and 182 of the 199 cities having populations of 50,000 or more. The existing traveled way routing of the Interstate System comprised only 1.1 percent of all rural roads, but carried 20 percent of all rural traffic.

By 1956, construction on the Interstate System was launched on a full-scale basis. In 1956, the Federal Highway Act created the Highway Trust Fund and increased the Interstate mileage limit to 41,000 miles; Iowa was allotted 710 of these miles. In 1968, another Federal Highway Act (Section 14 of Public Law 90-495) increased the Interstate mileage limit to 42,500 and Iowa was authorized an additional 71 miles of Interstate highway. Then in 1974, Iowa was authorized an additional 8 miles of Interstate, bringing the State total to 789 miles.

It is interesting to consider some of the conservative philosophy used by planners and lawmakers less than 30 years ago as they provided direction for this National System of Interstate and Defense Highways. In 1948, the report of the Highway Investigation Committee stated, "It will be noted that no provision is made in these contemplated standards of construction for the building of any so-called 'super highways' or multiple lane highways. There are only a few short sections of roads in rural Iowa that the present or predictable future traffic will require anything more than a good two-lane highway, and the problem of providing the relatively small mileage of multiple lane highways that will be needed in the next 15 or 20 year period can be considered as an initial part of the program herein outlined." (Ref. 14)

It is difficult to fully appreciate this conservative philosophy today when one drives Interstate 80 across Iowa, encountering an average daily traffic ranging from 10,000 to 20,000, of which 20 to 25 percent are trucks. Even more staggering would be the problems associated with trying to accommodate the estimated 1995 traffic ranging from 20,000 to 30,000 vehicles per day, of which 20 to 25 percent are trucks, if the design had not been expanded from the early philosophy and adequate right-of-way acquired during initial construction to protect the highway investment.

Fortunately, Iowa gave serious thought to other multi-lane divided highways in the early 1950's. One of the initial considerations of these multi-lane divided highway facilities in Iowa came with the creation of the Toll Road Study Committee in 1951. Here, for the first time, consideration was given to a fully controlled access highway. However, before the Iowa Legislature could react to the Toll Road Study, Federal legislation provided for the funding of the Interstate System. In 1953 and 1954, interviews were conducted at a series of interview stations on the east-west and the north-south routes throughout the State of Iowa in order to determine the origins and destinations of trip movements within the State. This aided planners in the early determination of major through routes to be constructed within the State. It should be noted that the location of Interstate 80 is coincidental with or in the same traffic corridor as the planned location of the Iowa Toll Road.

DEVELOPMENT OF THE FREEWAY-EXPRESSWAY SYSTEM

In 1959, the 58th General Assembly of Iowa created the Iowa Highway Study Committee with passage of House Joint Resolution 12. The Committee was required to "...make recommendations to the 59th General Assembly on matters of management, financing, safety, construction and maintenance of our highway system. These recommendations shall include, but not be limited to, the following:

1. A recommendation for sound legislative policies and management practices to be followed in primary highway

construction and maintenance in view of the increase in Federal funds for Interstate highways;

2. A recommendation for an equitable basis for distribution of state highway revenues so that this money will be spent where it is most needed;

3. A recommendation for techniques to be used to get closer coordination between the state and local units in planning and constructing our highways, roads and streets."

The Highway Study Committee entered into two agreements for technical services in carrying out provisions of the Resolution. One agreement was with the Automotive Safety Foundation of Washington, D.C., to direct the necessary engineering studies required to determine highway needs. The second agreement was with the Public Administration Service of Chicago, Illinois, to direct the necessary fiscal studies.

The final report, titled *Iowa Highway Needs 1960-1980, A Plan to Pace Highway Development with Economic Growth,* was submitted to the Highway Study Committee in November 1960. The report was compiled by the Automotive Safety Foundation in cooperation with the 99 County Engineer offices, the 51 municipalities of 5,000 and greater population, and the Iowa State Highway Commission.

A significant recommendation of the report was the 1,217-mile Freeway System to supplement the authorized 711-mile Interstate System (Figure 3).

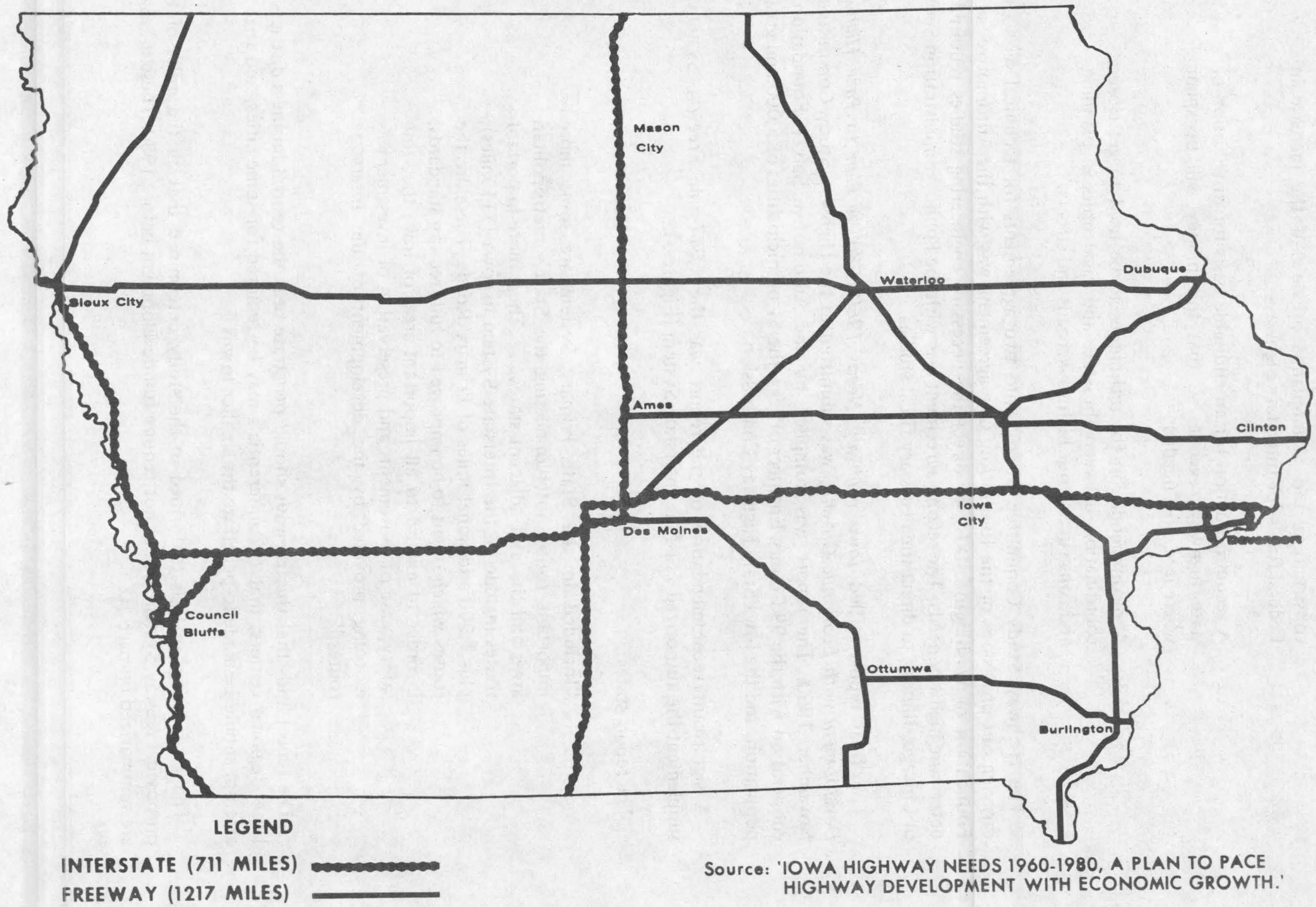
The report states:

> "Included in the State Primary System are some more important routes interconnecting the State's metropolitan areas and those of adjacent states . . . .These more important routes include all the Interstate System in Iowa (711 miles), plus 1,200 additional miles of Primary Roads. These are the routes which ought to be improved to full freeway standards, in order to extend to all important areas of Iowa the same safety, ease of movement, and preservation of investment as is being provided by the development of the Interstate routes."

The report adds that the freeways should penetrate near the central business districts of larger regional centers, that circumferentials may be required for some cities, and that no attempt should be made to penetrate the smaller towns.

The engineering analysis performed in the study determined that all the miles of the proposed Freeway System would not require full development before 1980. These mileages are summarized on page 10.

FIGURE 3
RECOMMENDED INTERSTATE-FREEWAY SYSTEM AS PROPOSED NOVEMBER 1960



Source: 'IOWA HIGHWAY NEEDS 1960-1980, A PLAN TO PACE HIGHWAY DEVELOPMENT WITH ECONOMIC GROWTH.'

Proposed Interstate-Freeway Development Prior to 1980

Interstate System	Completed	711 miles
Freeway System	Completed	710 miles
	Partial	197 miles
	No major work	310 miles
		1,928 miles

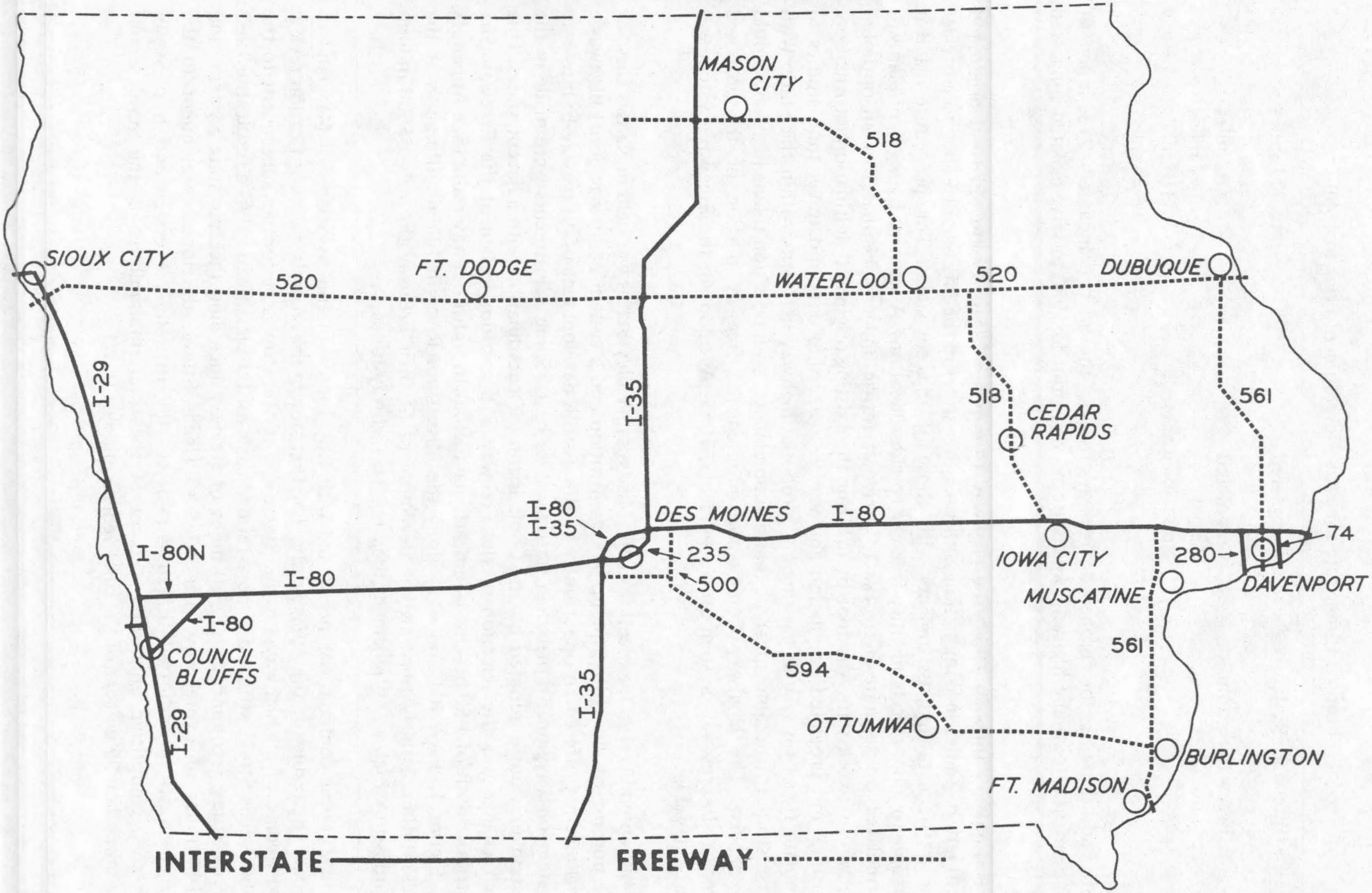
In addition to the proposed freeway routes, the report included 213 miles of supplemental four-lane highway which are needed prior to 1980 to serve isolated congested areas.

From 1959 through 1962, the Highway Commission again conducted rural origin and destination studies in conjunction with the other states in the Mississippi Valley to correlate our traffic data and assignments with those of adjacent states. This procedure made it possible to more closely identify freeway corridor locations. A segment by segment plan was formulated on separate networks to arrive at traffic and cost estimates of an optimum freeway network. This was done by utilizing the existing origin and destination information, existing and projected population and vehicle ownership data and travel time studies to simulate travel on various existing and proposed highway networks within the State. With these studies it became apparent that a supplemental system of multi-lane highways would be needed. The Highway Commission adopted the freeway portion of the proposed Freeway-Expressway System on November 3, 1965. As adopted, the Freeway System was 760 miles (Figure 4).

In September 1967, a meeting of the Mississippi Valley States was held in Kansas City for the purpose of discussing functional classification and a system of inter-regional highways. This meeting offered an opportunity to discuss the development of a Freeway-Expressway System on a regional rather than state by state basis. Some adjustments were made in the system previously adopted by the Commission for coordination with adjacent states. One such change was the selection of the Freeway 518 corridor in lieu of the Freeway 561 corridor south of I-80 because of a nearly parallel north-south freeway route (See Appendix A, Figure 1, FAP 404 and 413) along the Mississippi River in Illinois. Illinois is at the present time actively pursuing the development of their Freeway through a $600 million bond issue which will supplement their regular highway funds.

In 1966, a contract was negotiated with Roy Jorgensen and Associates of Maryland to update the results of the 1960 Study. The first step in the analysis was classification review and update of all highways in the State. The traffic studies performed subsequent to the 1960 Needs Study afforded a more refined basis for the classification. As a result, the 1967 Needs Study recommended 1,590 miles of freeway including the Interstate System, and 1,144 miles of expressway. The 1968-88 Needs Study, developed subsequent to the Jorgensen study, indicated that if completed, the Interstate, Freeway and Expressway Systems, comprising only three percent of the total rural mileage in the State, would accommodate 52 percent of the rural vehicle miles of travel.

FIGURE 4
RECOMMENDED FREEWAY SYSTEM
ADOPTED NOVEMBER 3, 1965



Following completion of these studies, the Highway Commission again performed a series of traffic assignment studies on the Freeway-Expressway System to determine corridor locations. The final corridor locations as determined in the 1967 studies were incorporated into a revised version of the original Freeway System. Five additional separate traffic assignment systems were studied to arrive at the optimum traffic service network. It was determined that an Expressway System would be required to supplement the Freeway System and consequently a segment by segment estimate of traffic and cost was included for the Expressway System. The resultant Freeway-Expressway System, based upon continuity and traffic volumes, was formally adopted by the Commission in February 1968. The system, as shown in Figure 5, contained 839 miles of freeway in addition to the Interstate and 1,139 miles of expressway.

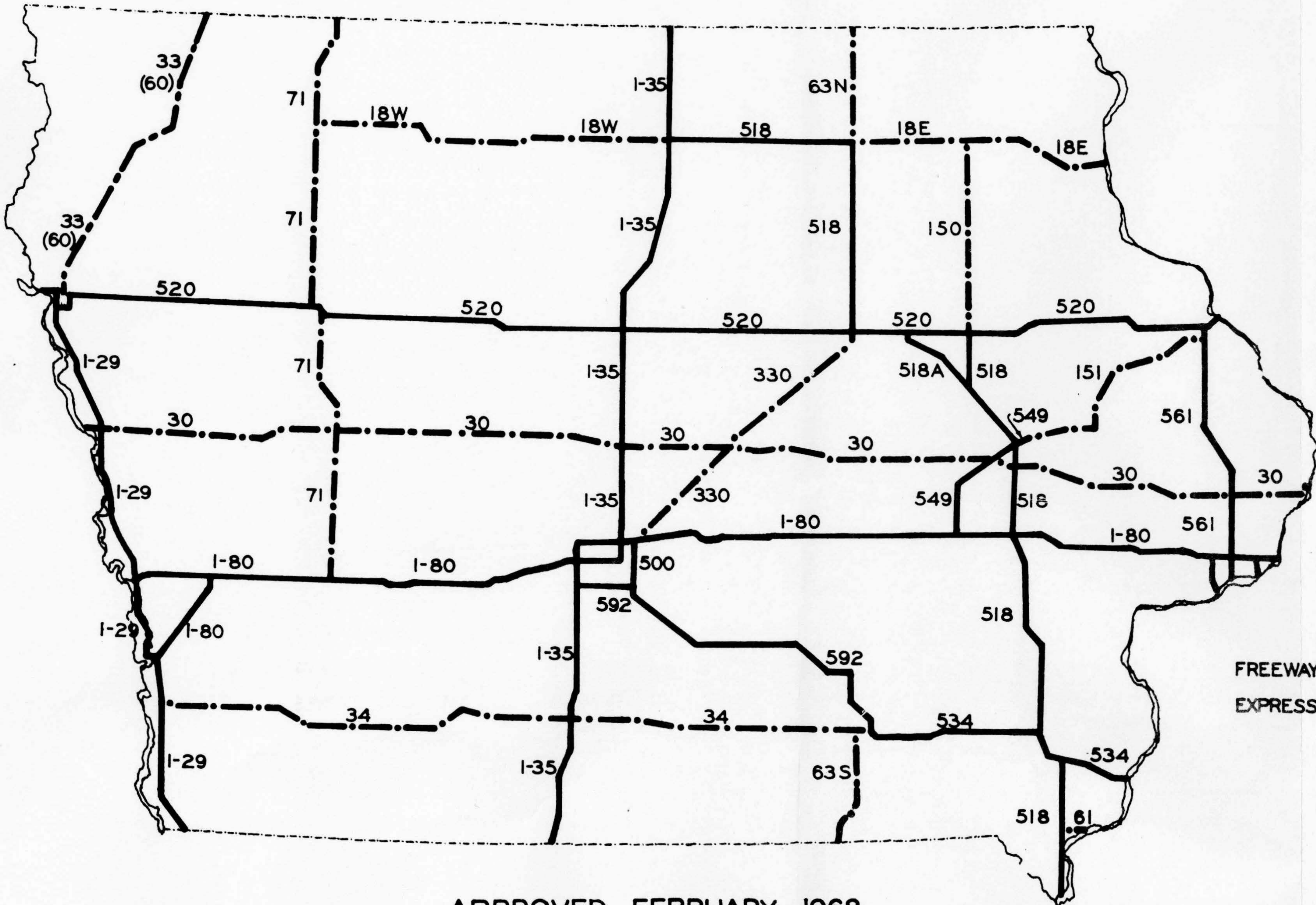
Since adoption of the Freeway-Expressway System in 1968, two segments of freeway have been incorporated into the Interstate System. These two segments are Freeway 518 from I-80 near Iowa City north through Cedar Rapids to Waterloo which is now I-380, and Freeway 520 Missouri River crossing at Sioux City which is now I-129. Both routes are currently under construction.

The Freeway-Expressway System Report published in 1968, has served as the basic planning document during the past seven years. A total of 55 public hearings, attended by more than 10,000 citizens, have been held to guide the decision making process in establishing the system. Much of the information received at these public hearings has strengthened the need for a Freeway-Expressway System. Hearings tend to foster additional public involvement in the planning process and bring forth the total feelings of people relevant to their transportation needs and how these needs should be fulfilled.

An example of this can be seen in the development of the 549 Freeway as shown in Figure 5, beginning at I-80 and extending north to U.S. 30. The original corridor public hearing for this project was held in Amana, Iowa, in 1968. At that time the Freeway was well supported as " . . .a very necessary part of our Interstate road system providing a link for Cedar Rapids to I-80 west . . . .These proposed facilities are not only a necessary economic factor but a required road from I-80 to the Amana Colonies establishing a direct all weather route to serve the constantly increasing travel market that is developing into a year around industry." Two years later at the design public hearing again held in Amana, the people had reassessed their travel needs and felt that " . . .a modern, state constructed and maintained two-lane highway would serve the immediate purpose." The Highway Commission studied these new proposals and deleted the section of Freeway 549 from I-80 north to Cedar Rapids from the Freeway-Expressway System.

Deletion of a section of freeway does not make the need for the facility disappear. As shown in Figure 20 later in this report a substantial traffic desire exists in this corridor. The estimated 1995 average daily traffic (ADT) in the 549 Freeway corridor ranges from 5,100 vehicles per day (VPD) between I-80 and U.S. 6, to 7,300 VPD near Amana to 8,000 VPD near U.S. 30. At the present time a two lane facility is being programmed for construction in fiscal year 1980. This proposed construction will follow the original 549 Freeway corridor between I-80 and U.S. 6. This two lane facility may not meet the needs of 1995 traffic, but the intervening years will allow both the Highway Commission and area residents to monitor the developing community and travel needs.

IOWA'S PROPOSED NETWORK OF FREEWAYS AND EXPRESSWAYS



APPROVED FEBRUARY 1968

FIGURE 5

LAND USE

Land use and multilane highways are interrelated. Concentration of high traffic volumes in some highway corridors enhances the opportunity for a high intensity of land use in adjaceng areas. To correlate policies and plans for transportation and land use an understanding of the current commitment of land for transportation purposes and some history leading to the present situation is necessary. This is essential to the process of establishing realistic long-range goals and intermediate range objectives. The most critical need is to examine the factual data about current land use status and the probable effect transportation system change can have on total land use. The questions needing response are:

Question 1 - How much of our land area is now in use for the public road systems?

As indicated by Figure 6, the land area of Iowa is slightly more than 36 million acres. The current land area dedicated to the public way is 1,105,000 acres or 3.07 percent of the total. These roads and streets are 113,000 miles in length including rural roads and city streets.

Question 2 - What is the historical background leading to the present transportation land use pattern?

The establishment of the Iowa road network, generally in a one-mile grid pattern, can be traced to a prior national decision which in a way reflected transportation technology, as well as other needs, at the time of decision. This concept stems from an Act of the Continental Congress in 1785. In an action entitled, *An Ordinance for Ascertaining the Mode of Disposing of Lands in the Western Territory*, the Continental Congress established a basic pattern for land organization. The motivation at the time was to obtain revenue from the sale of the newly acquired lands in the northwest territories and also to encourage settlement and thereby assure continued control. It was decided to survey the land into " townships" six miles square and further to subdivide the townships into "lots" of one-mile square or 640 acres yielding 36 such lots per township.

The land organization pattern established in 1785 continued westward and thus Iowa land was surveyed and organized according to these principles. An interesting footnote to the choice of the six-mile square township concept, is that it related to the speed of a man walking. It was conceived that there would be a community within each township, probably at its center, and therefore a man walking at three miles per hour could walk from the side of the township to its center and back in two hours. Figure 7, a map of a typical Iowa county, illustrates how this governmental action of nearly two centuries ago has affected our land organization and use pattern of today.

In 1860, the General Assembly created the County Board of Supervisors with the power to tax and to build and repair bridges, and to "lay-out, establish or discontinue any roads in the county". Following this legislation, the road pattern of today was developed as roads were generally opened along section lines to provide for an inter-connected public way with minimum interference with agriculture. The decision was made to establish the widths of these public ways at four rods or 66 feet with 33 feet taken from each side of the section line. **Thus, 33 feet taken from each of the four sides of a square mile represents 2.5 percent of land area dedicated to the public way.** A review of Figure 7 showing the extensive one-mile grid coverage indicates that approximately 2.5 percent of the state's land area was thus directed to public way usage through a combination of land organization and travel requirements which needed to be resolved by government in the formative stages of the country and the state.

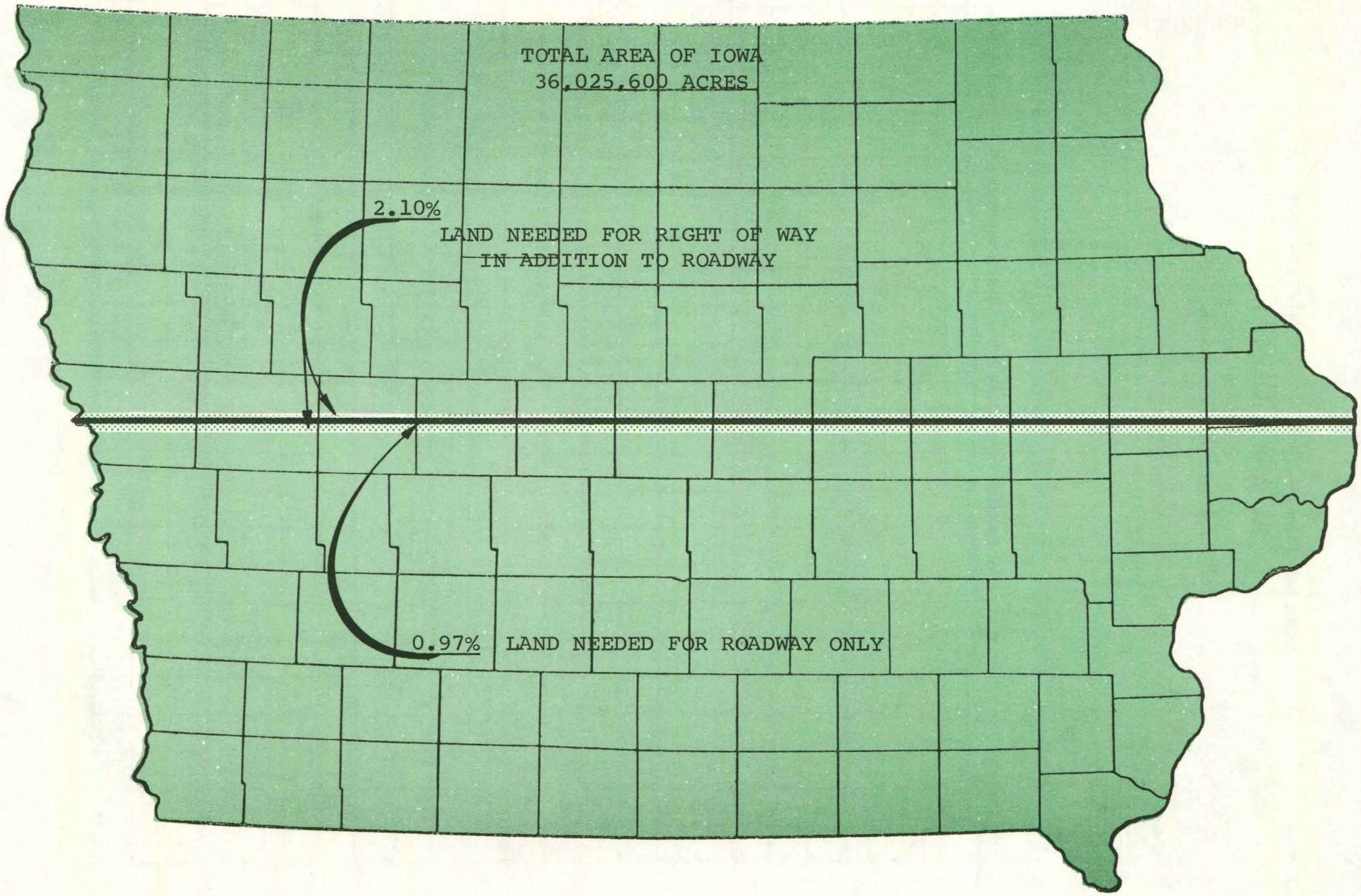
At the turn of this century, with the appearance of the first automobile, Iowa had more than 100,000 miles of public way established which was created to meet requirements totally unrelated to this type of transportation. More reliable roads were required to utilize the versatility of this technology. The administrative systems were changed through legislation. A State system was created, federal assistance was introduced, and user fees were initiated. Because of system growth to the present 113,000 miles and expansion of right-of-way width for Primary and higher usage Secondary roads, the land usage rose to 3.07 percent. A significant part of the increase represents municipal streets reflecting the growth of the urban population. There has been no major reduction of rural mileage to reflect the reduced number of farmsteads, particularly over the past four decades.

Question 3 - With present technology and anticipated intermediate range development, what are reasonable quantitative long-range transportation land use goals and intermediate objectives?

Certainly the total percentage of land area in use for land transportation should decrease from the current amount. It seems reasonable that an objective could be three percent by the year 2000 with an ultimate reduction to 2.9 percent, or less, as a possibility. Perhaps this is too conservative. In any event, it will be achieved mainly through development of greater transportation efficiency in the higher-usage portions of the system whether it be highway or rail. Figure 8, illustrating the current high degree of usage on a relatively small portion of the highway system **(9% of the mileage carries 77% of the rural travel)** indicates a policy direction that should yield the desired results. Attraction of travel to the higher functional systems will allow greater usage on less mileage. The land use potentially transferable from road purposes to other purposes must come from the 58 percent of the total system that presently serves only eight percent of the total travel.

The public road system over the years has been a multi-use facility. Much of the distribution system of the utility companies is contained within this network. Important drainage functions are provided within the system. In addition, in many areas of the state, the public road right-of-way is the only land area not subject to annual cultivation or other agricultural pursuit. As such, it furnishes the only consistently available wildlife habitat. Further, the pattern of public road ownership tends to provide a buffer against the possibility of extremely large areas of cultivation. This buffer has a significant influence on the prevention of erosion and aids in the attainment of other air and water quality and land stewardship objectives. Therefore, any state level policy for conversion of significant quantities of rights-of-way from transportation should adequately consider the highest and best future land use, which may not in each case be agriculture.

FIGURE 6 TOTAL AREA OF IOWA COMPARED TO LAND PRESENTLY UTILIZED FOR ALL EXISTING HIGHWAYS, ROADS AND STREETS



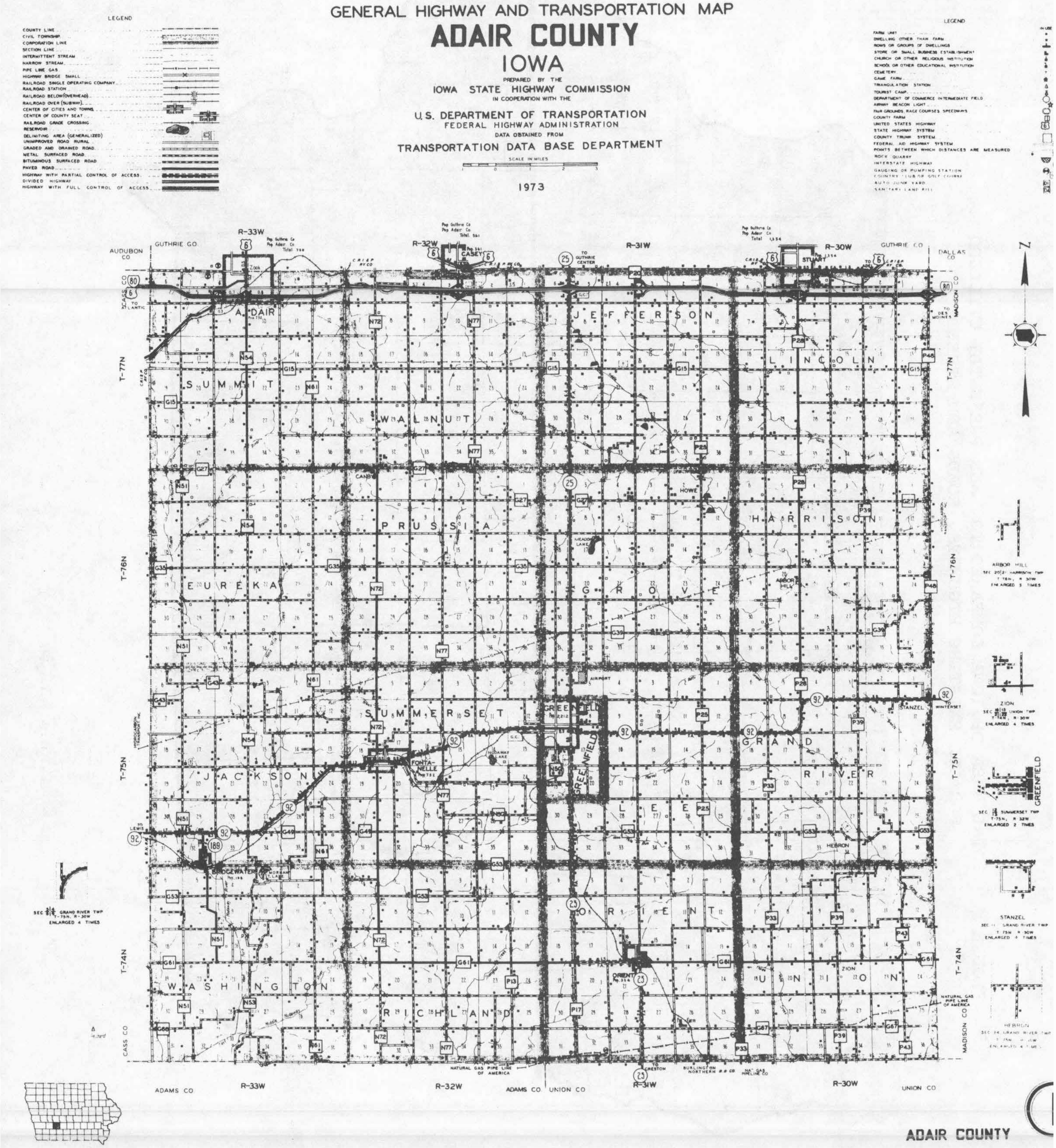
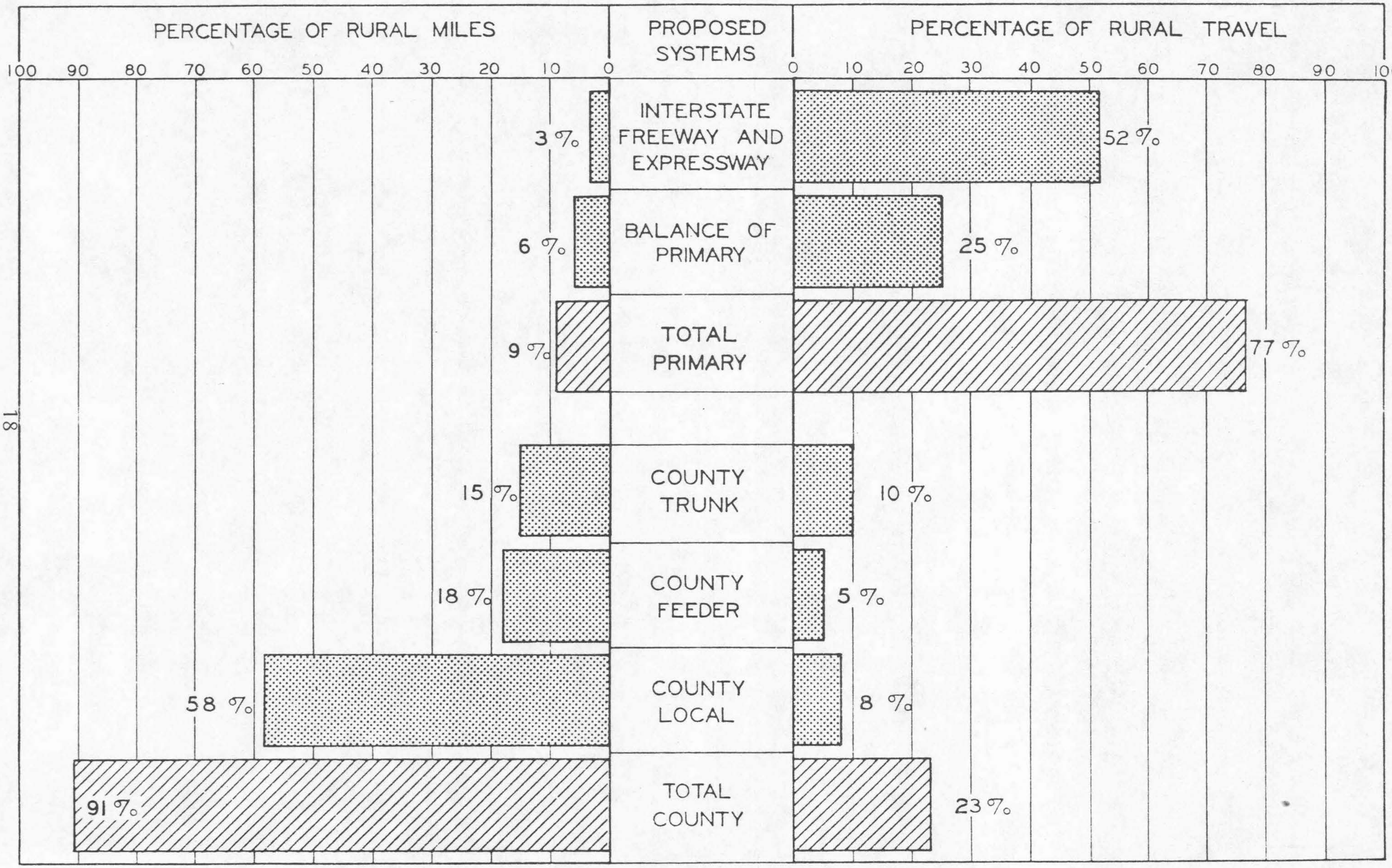

GENERAL HIGHWAY AND TRANSPORTATION MAP
ADAIR COUNTY
IOWA
PREPARED BY THE
IOWA STATE HIGHWAY COMMISSION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
DATA OBTAINED FROM
TRANSPORTATION DATA BASE DEPARTMENT
1973
LEGEND
ADAIR
JEFFERSON
LINCOLN
SUMMIT
WALNUT
PRUSSIA
HARRISON
EUREKA
GROVE
SUMMERSET
GREENFIELD
GRAND RIVER
JACKSON
LEE
ORIENT
WASHINGTON
RICHLAND
UNION
CASEY
STUART
FONTANELLE
BRIDGEWATER
ORIENT
HOWE
CANBY
STANZEL
HEBRON
ZION
ARBOR HILL
R-33W
R-32W
R-31W
R-30W
T-77N
T-76N
T-75N
T-74N
AUDUBON CO
GUTHRIE CO
DALLAS CO
CASS CO
MADISON CO
ADAMS CO
UNION CO
TO GUTHRIE CENTER
TO DES MOINES
TO ATLANTIC
TO CRESTON
TO WINTERSET
ADAIR COUNTY

FIGURE 7

Figure 8

RURAL MILES AND TRAVEL – 1988



Source: *Iowa Highway Needs & Finances 1968-1988*
Iowa State Highway Commission, Ames, Iowa, 1968, p. 53.

The Population Factor in Transportation Planning

Claim: Transportation needs are created by people. Future demands are influenced by the size and characteristics of forecasted population.

Fact: Population trends and projections are dependent upon future fertility rates, death rates and net migration.

The Governor's Conference on Iowa in the year 2000 recommended a modest population growth for Iowa, sufficient to maintain its relative position (25th) among the 50 states. There was majority support at this conference for creating incentives to encourage population redistribution, specifically from larger cities to smaller towns and rural areas.

U.S. Department of Commerce Projection, Series I-E, places the 1990 population of Iowa at over three million.

Basis: Population forecasts were prepared by U.S. Department of Commerce and H. C. Chang, Associate Professor of Sociology, Iowa State University. Statistics on fertility rates in 1973 were obtained from the Iowa Department of Public Health. *Iowa: 2000 Final Report* provided guidance relative to desired population growth and economic development.

THE POPULATION FACTOR IN TRANSPORTATION PLANNING

The background section of this Freeway-Expressway Report illustrated the correlations between vehicle registration, vehicle miles of travel, gross national product and gross state product. Fundamental to all three of these trends are the needs created by people. Statistically, people are population. An understanding of population trends and specific goals relative to its growth and distribution is essential in transportation planning.

H. C. Chang of Iowa State University, in his introductory remarks of the book titled *Population Projections by Age and Sex for State and Counties of Iowa* (Ref. 19) says, "The knowledge about the size, composition, and distribution of a population in the future is essential to planning for economic and social development. It is only when the future demands for goods, services, and facilities are known that these demands can be met and dealt with in an orderly and adequate manner. Future demands of a population depends upon the sizes and characteristics of that population--the number of total population, the number of young, old, and working people and the number of males and females. Whether planning for schools, churches, medical service, transportation, utility, welfare, or business, population projections will provide a rough guide for estimating future needs."

To understand population trends and projections it is essential to begin with the three basic factors that influence growth; fertility rate, death rate, and net migration. The fertility rate is the average number of children per woman at the end of child bearing period.

Death rate is the expected number of people per thousand to die in a given period. Net migration is defined as the difference between the number of people who move into and out of an area.

Population forecasts prepared by the U.S. Department of Commerce utilize four fertility assumptions and three migration trends.

Fertility assumptions include (Ref. 37):

Series B - 3.1 fertility rate which was the approximate fertility rate in 1964 and 1965.

Series C - 2.78 fertility rate which was the approximate fertility rate in 1966.

Series D - 2.45 fertility rate which was the approximate fertility rate in 1968.

Series E - 2.11 fertility rate which is below the lowest fertility rate experienced in any calendar year in the United States through 1970. This represents "replacement level" fertility; i.e., that level of reproduction required to maintain a stable (zero growth) population in the absence of immigration.

Net migration assumptions include (Ref.37):

Series I - continuation of 1960 to 1970 gross migration to 1990.

Series III - no net internal migration among States for the forecast period.

Series II - yields results between Series I and III.

The analysis of three series of net migration combined with four series of fertility rates is complex. To simplify the analysis for this report, Series B and C were eliminated from fertility considerations and Series II was omitted from net migration. The reasons underlying these deletions are: (1) most fertility rates fall below 3.1, and (2) since Series D lies between Series C and Series E, its elimination would remove only a middle range of fertility considerations. Similarly, by eliminating Series II, only the midrange of net migration is removed. Combinations of Series I and III with Series C and E will provide a span of population forecasts ranging from the higher growths resulting from Series C (fertility rate of 2.78) and Series III (no net migration) down to the lower growths indicated by Series E (fertility rate of 2.11) and Series I (continued net migration).

Table 1 reflects the U.S. Department of Commerce forecasted population for Iowa based on the two fertility and net migration rates.

Table 1

Iowa's Projected Population (000's)

	1975	1980	1985	1990
I-C	2,884	2,985	3,111	3,230
III-C	2,977	3,175	3,404	3,629
I-E	2,861	2,908	2,962	3,009
III-E	2,954	3,091	3,239	3,376

These differences are even more pronounced when graphically illustrated in Figure 9.

Differences in fertility rates account for 0.22 to 0.25 million people in 1990 while differences in net migration account for 0.37 to 0.40 million. This would indicate that net migration will be the most influential factor in Iowa's population growth.

H. C. Chang (Ref. 19) studied the changes in Iowa's population, the results of which are summarized in Table 2.

Table 2

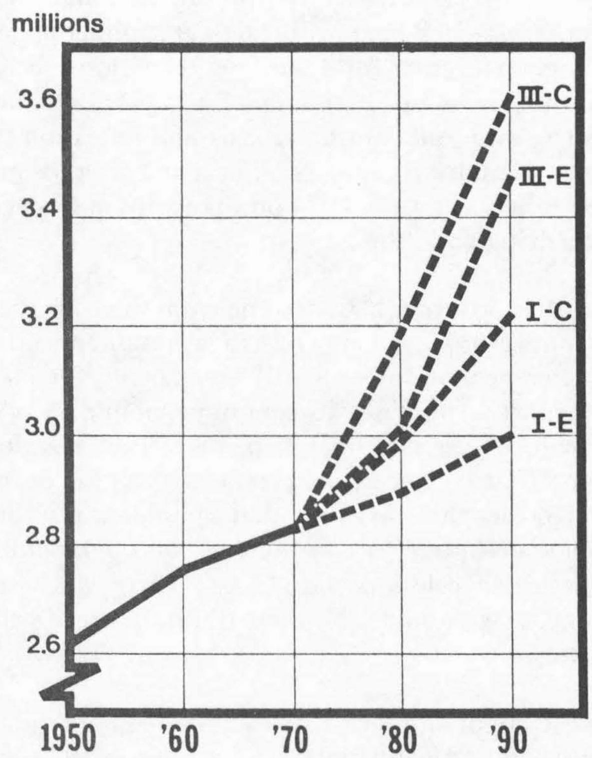
Change in Population Components in Iowa
1940-1950, 1950-1960, and 1960-1970

Decade	Net Increase	Net Migration	Net Change
1940-1950	265,317	-182,512	73,805
1950-1960	372,779	-236,315	136,464
1960-1970	247,544	-180,705	66,839

Chang's studies show that net migration has accounted for a loss of approximately 200,000 people each decade during the thirty year period. If the net migration continues at the same rate as experienced in 1960-1970, it will result in a loss of 361,000 people by 1990. This is comparable with the difference between Series I-E and III-E as projected by the U.S. Department of Commerce.

Equipped with some of the fundamentals of population forecasting, it is now possible to examine goals set forth for the State of Iowa and the objectives that need to be

Iowa's Projected Population



Source: U.S. Department of Commerce (Ref. 13)

Figure 9

accomplished to reach these goals. Ideally, these goals and objectives should be contained in a State Comprehensive Plan. Eventually such a plan will probably be forthcoming, but during the interim and for the purposes of the present Freeway-Expressway Report, Iowa: 2000, a statewide comprehensive conference on Iowa's future will be used.

This conference was officially established in 1972 by the General Assembly's approval of Senate Concurrent Resolution 130 which asked the Governor to "proceed forthwith to determine a proper time and place for a statewide comprehensive conference on Iowa's future". Governor Ray named an 11 member committee to plan the conference and select topics on which the meeting would focus. One of the committee's first actions was to set three conference goals (Ref. 15):

> "To create statewide awareness of the factors and trends affecting the future.
>
> To identify the major problems that Iowan's will face in the near and long-term future.
>
> To suggest goals for Iowa and strategies for achieving these goals."

Although conference planning extended through 1973, for most Iowans, the term Iowa: 2000 became known with the appearance of the "Iowa Quiz" in the January 13, 1974 Sunday papers. The quiz was designed with facts and opinions about the State and its future. On that same Sunday evening, an hour-long television special, hosted by television personality Harry Reasoner, examined reactions of a random sample of Iowans surveyed in the *Des Moines Register's Iowa Poll.* From the quiz and television special beginning, Iowa: 2000 reached throughout the state via a series of local and regional meetings and culminated with a state conference June 13 and 14, 1974 on the Simpson College campus in Indianola-- nearly 50,000 people participated in the process.

The final report of the Governor's Conference on Iowa in the Year 2000 (Ref. 15) summarizes each task force group's recommendations presented to the full conference on its final day. These recommendations provide guidance for several areas of this Freeway-Expressway Report. The task force on economic development "... favored modest population growth sufficient to maintain the relative position (25th) among the 50 states. At the same time 'much concern was expressed about outmigration, especially of younger, better educated people.' Arguing that 'population follows opportunity,' the delegates supported 'some definite effort to increase job opportunities, at least to develop enough nonfarm jobs to balance loss of farm jobs.' There was also majority support for creating incentives to encourage population redistribution, specifically from larger cities to small towns and rural areas."

To maintain a "modest population growth," factors of population need to be examined. The Iowa Department of Public Health statistics for Iowa in 1973 indicate the fertility rate was 1.8. This was significantly below Series E the "replacement level". If this fertility rate continues in the future, net migration will be the most influential factor in Iowa maintaining its relative position of 25th.

Economic Effects of the Interstate-Freeway-Expressway System

Claim: The economic development that occurs within multilane highway corridors is important to Iowa and to its cities and towns.

Fact: A significant portion of the industrial development in the State of Iowa occurs within the Interstate-Freeway-Expressway corridors.

During the past 11 years, approximately 18 percent of the new industry, 14 percent of the branch plants and 15 percent of the expansions in the State located or occurred within a five-mile radius of I-80.

Studies indicate that relocation of a multilane highway around a town generally results in an improved economic outlook.

Basis: Industrial development statistics from the Iowa Development Commission, and Economic Impact Studies prepared by the Iowa Highway Commission were used for assessing the importance of the highway to the bypassed community.

ECONOMIC EFFECTS OF THE INTERSTATE-FREEWAY-EXPRESSWAY SYSTEM

In the previous section of this report the aspects of population in transportation planning were examined. This section of the report will illustrate the development that has occurred in new highway corridors, how this development interrelates with population goals and supports the philosophies set forth in the "Economic Development" section of the *Iowa: 2000 Final Report.* (Ref. 15).

The only section of the Interstate-Freeway-Expressway System fully completed is I-80 east-west across the State. A compilation of industrial developments occurring within five miles of I-80 during 1963-1973 was made, using records from the Development Division of the Iowa Development Commission.

The 1963-1973 time period was chosen for this study since it reflects developments that took place during and after completion of Interstate 80 across Iowa. The route was completed from I-29 to the Mississippi River in December 1966. It is assumed that some firms for whom I-80 was an important locational factor began plant construction in the early 1960's in anticipation of the route's completion.

Table 3 illustrates temporally the amount of development occurring in the I-80 corridor:

Table 3

Industrial Development Within a Five-Mile Radius of Interstate 80

Year	New Industry	Branch Plants	Expansions	Total
1963	4	5	20	29
1964	11	8	22	41
1965	4	13	15	32
1966	2	12	26	40
1967	2	9	29	40
1968	9	5	25	39
1969	4	10	29	43
1970	5	10	19	34
1971	5	2	18	25
1972	12	*	31	43
1973	22	*	46	68
Totals	80	74	280	434

SOURCE: Iowa Development Commission

*Records for 1972-1973 combine branch plants into new industry totals.

Table 4 illustrates temporally the total amount of industrial development occurring within the State of Iowa:

Table 4

Total Industrial Development in the State of Iowa

Year	New Industry	Branch Plants	Expansions	Totals
1963	28	33	124	185
1964	49	71	158	278
1965	36	89	163	288
1966	30	101	181	312
1967	20	70	151	241
1968	34	67	174	275
1969	23	37	185	245
1970	32	36	155	223
1971	21	29	119	169
1972	75	*	181	256
1973	98	*	277	375
Totals	446	533	1,868	2,847

SOURCE: Iowa Development Commission

*Records for 1972-73 combine branch plants into new industry totals.

Comparison of Tables 3 and 4 indicates that approximately 18 percent of the new industry, 14 percent of the branch plants and 15 percent of the expansions in the State located within a five-mile radius of Interstate 80. These industrial facilities range in size from small agricultural chemical plants employing up to five persons and representing an investment of up to $100,000, to multi-million dollar industries employing as many as 1,000 persons. While many of the manufacturing facilities are oriented to agricultural demands, other types of firms engaged in food and kindred products, rubber, plastics, fabricated metal products, machinery, and miscellaneous manufacturing are also located within this five-mile corridor.

Statistics on individual industries are confidential; however state totals are shown in Table 5. It is difficult to accurately assess the net dollar influence I-80 has contributed toward the economic growth of the immediate area and the State of Iowa, but comparison of the relatively small area encompassed by this corridor in relation to the State as a whole would indicate the I-80 contribution is substantial. The 525 million dollar capital investment in new industry and expansions in 1973 alone is greater than the total cost of I-80, which is the vital transportation link that supports these industries.

Table 5

New Industry and Expansions Occurring
Within the State of Iowa
1963-1973

TOTAL EMPLOYMENT

Year	New Industry	Expansions	Totals
1963	3,139	2,954	6,093
1964	3,317	3,559	6,876
1965	4,558	6,969	11,527
1966	5,768	9,698	15,466
1967	2,459	6,848	9,307
1968	2,246	4,763	7,009
1969	5,033	6,206	11,239
1970	4,034	3,508	7,542
1971	3,501	2,812	6,313
1972	5,708	7,457	13,165
1973	10,696	14,892	25,588
Totals	50,459	69,666	120,125

CAPITAL INVESTMENTS*

Year	New Industry	Expansions	Totals
1963	$ 33,137,296	$ 37,675,764	$ 70,813,060
1964	68,967,000	65,400,753	134,367,753
1965	98,271,000	111,224,900	209,495,900
1966	105,050,000	132,160,000	237,210,000
1967	57,430,000	213,575,600	271,005,600
1968	34,144,000	176,920,125	211,064,125
1969	80,477,000	128,879,000	209,356,000
1970	122,018,000	96,930,200	218,948,200
1971	56,097,000	56,394,200	108,491,200
1972	71,346,000	122,732,900	194,078,900
1973	202,801,000	322,476,950	525,277,950
Totals	$929,738,296	$1,460,370,392	$2,390,108,688

*Does not include electrical generating facilities.

SOURCE: Iowa Development Commission

The decision to locate a new industrial facility is based on a great number of factors, one of which pertains to the proximity of efficient highways. Other important factors include: land prices, available supply of skilled and reliable labor, local tax structure, proximity of rail, water and air transport facilities, and attractive site location. Interstates, Freeways and Expressways carry large volumes of traffic and hence have a substantial advertising effect for plants located on adjacent sites. Also, these high type highways are important since they help determine the accessibility of markets and sources of raw materials. This importance is demonstrated in Figure 10. The light yellow area indicates same working day service by truck is available to surrounding urban centers such as Chicago, St. Louis, Kansas City, Omaha and Minneapolis. Further, the darker yellow, 1st, indicates the area where truck delivery times from central Iowa are usually reached within 24 hours, red within 48 hours, orange within 72 hours and blue within 96 hours.

The industrial development that has occurred along I-80 is also being experienced along other Freeway-Expressway corridors. Examples of industrial growth that have occurred in lower traffic volume expressway corridors are pictorially illustrated on the following pages. This growth has been very important to these two small Iowa towns (Jefferson with a 1970 population of 4,735 and Red Oak with 6,210). Both of these communities originally were located with U.S. highways passing through the center of town (Jefferson on U.S. 30, Red Oak on U.S. 34).

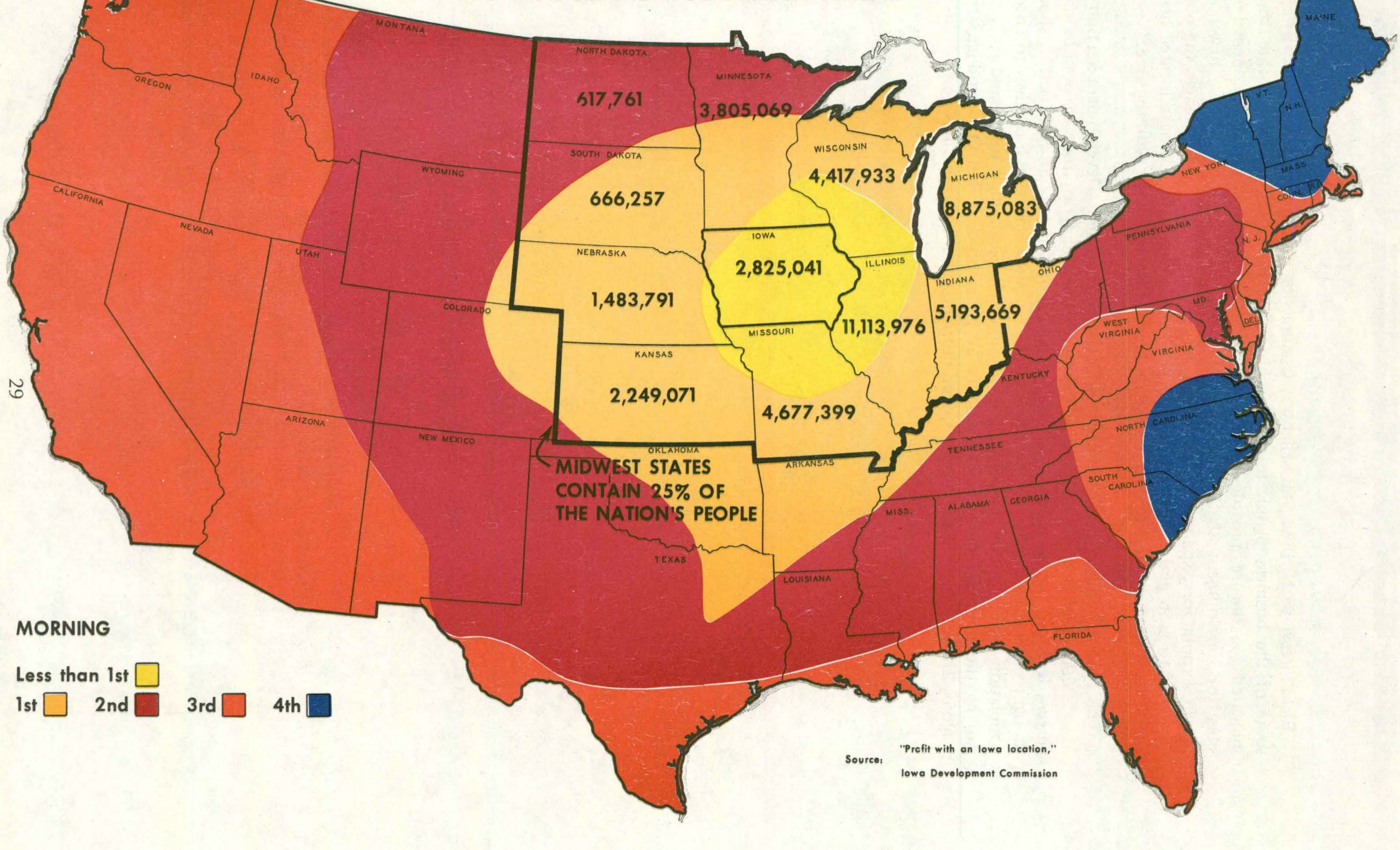
When these highway relocations were first proposed some citizens and business people were very apprehensive about the effects of bypassing their community and removing the traffic and potential customers from the central business district. The Iowa State Highway Commission, in recognizing this concern and the need to provide data giving insight into the social and economic changes created by a major relocation of a highway, proposed in 1959 studies of eleven communities where major relocations were to occur. The eleven communities are:

1. Albia
2. Boone
3. Chariton
4. Decorah
5. Grinnell
6. Jefferson
7. Newton
8. Osceola
9. Red Oak
10. Stuart
11. Webster City

Since then the communities of Anamosa, Corning and DeWitt were added to the list of towns to be studied. The population of these communities range from 1,480, (Stuart) to 15,380, (Newton).

The study of these communities examined such areas as retail sales, land use, traffic, highway safety, zoning, industry and employment, and area improvements. These areas are indices of a community's social and economic pulse. To date, eight reports have been completed and published. Not all of the indices reflect a positive position toward bypassing a community, but when considered as a total, the reports conclude "the community economic outlook was improved".

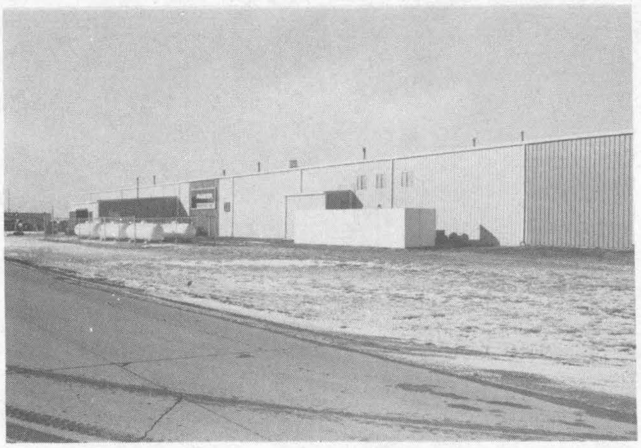
TRUCK DELIVERY TIMES FROM CENTRAL IOWA TO MAJOR METROPOLITAN AREAS



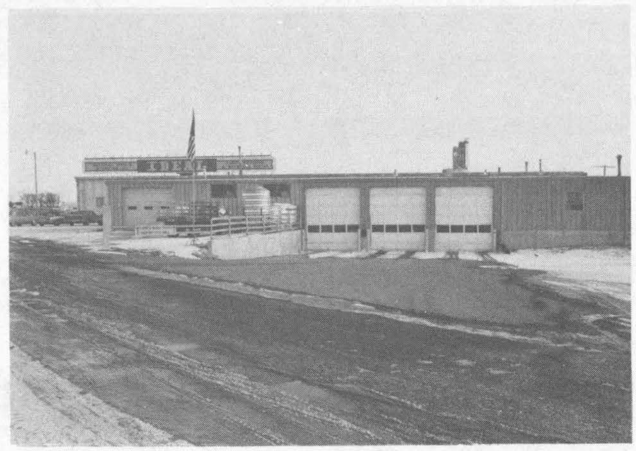
Field interviews by Iowa State Highway Commission personnel in December, 1974 with some of the business people in these industrial parks located on the relocated highway indicated " . . .the area provides quality employees . . .the relocated highway opened up new sites for development that otherwise would not have been available . . .new location provides room for expansion . . .traffic on the relocated highway encourages the potential customer to stop and look at our product . . . probably would not have located here if it hadn't been for the new highway . . .easy to direct those unfamiliar with the area."

This type of industrial development supports the Economic Development Section of the *Iowa: 2000 Final Report* " . . .economic growth is necessary to attain, or even to maintain current levels of the good life. Economic growth should not be an end itself; it should be thought of as a tool to serve the needs of the people . . .creating incentives to encourage population redistribution specifically from larger cities to small towns and rural areas." Among the products these new industries at Jefferson and Red Oak produce are farm wagons, livestock feeders and waterers, feed nutrients, and farm buildings.

New Industry Located
in the
Industrial Development
on
Relocated US 30
at
Jefferson, Iowa



Manufacturer of Farm Wagons



Manufacturer of Livestock
Feeders & Waterers

Manufacturer of Sporting Equipment

Farm & Industry Building
Contractor

Examples of
Other Retail Establishments
in the
Industrial Development
on
Relocated US 30
at
Jefferson, Iowa

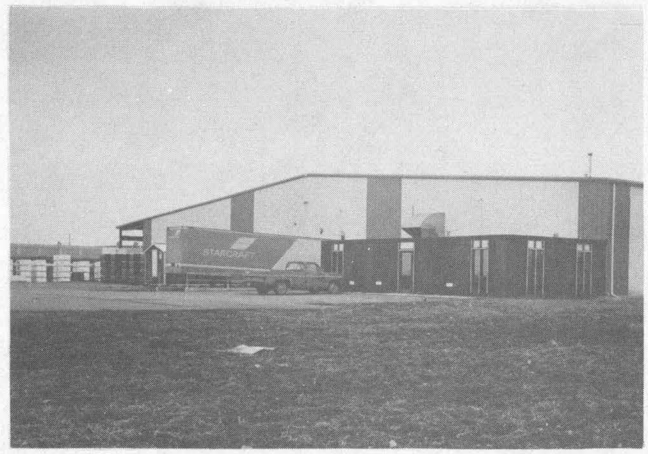
Auto Truck Sales

Lumber Mart

Restaurant

New Industry Located
in the
Industrial Park
on
Relocated US 34
at
Red Oak, Iowa

Producer of Plant Food

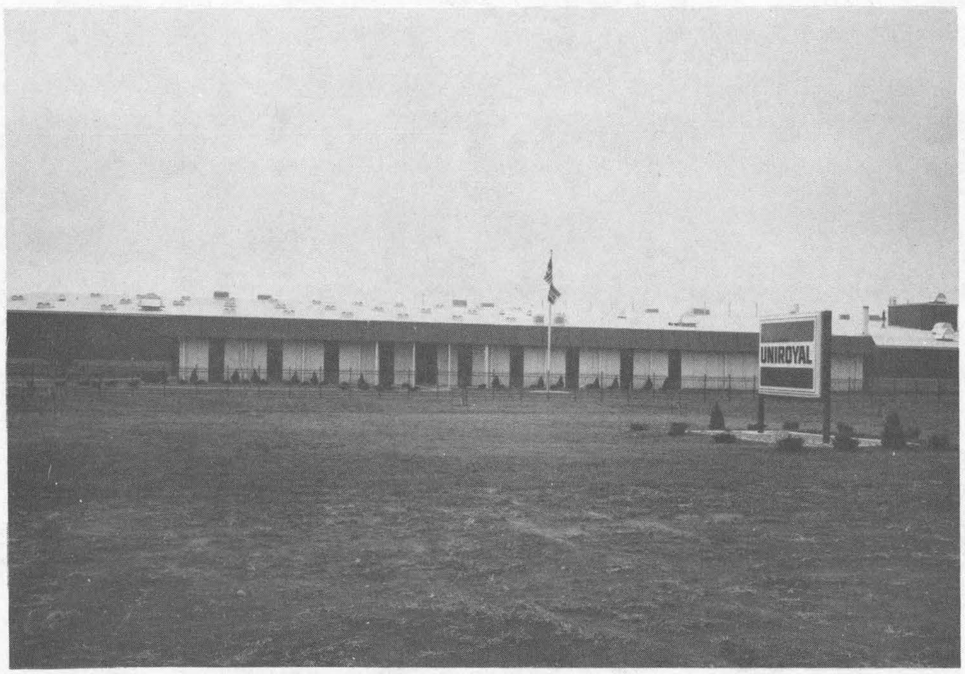


Manufacturer of Livestock Feeders & Waterers

Concrete Products

Manufacturer of Automotive Parts

New Industry Located
Approximately ½ Mile North
of
Industrial Park
on
US 34
at
Red Oak, Iowa



Manufacturer of Hydraulic Hoses

Economic Analysis

Claim: An economic analysis is needed to aid in the process of determining the need for a Freeway-Expressway System.

Fact: An economic analysis provides the relationship between costs and benefits.

Alternatives to be considered in an economic analysis:

1. Do nothing
2. Improve existing facility
3. Provide new facility

There are seven methods available for use in an analysis of economy; the equivalent uniform annual cost method and the benefit/cost ratio are currently being used by the Iowa Highway Commission.

The economic analysis makes it possible to fully integrate the highway with the study area, maximizing the social and economic benefits of the transportation facility while minimizing any adverse impacts upon the environment.

Basis: Methodology for economic analysis and analysis of economy were derived from Robley Winfrey's books titled *Economic Analysis for Highways* and *Economic Analysis for Transportation - A Guide for Decision Makers*, and Robert Daiute's book titled *Economic Highway Planning.* Both authors are considered authorities in the field of economic analysis.

ECONOMIC ANALYSIS

Introduction

An economic analysis is needed to aid in the process of determining the need for a Freeway-Expressway System in general and improvements for specific projects. The purpose of this section is to provide a foundation for the economic analyses of future projects on the Freeway-Expressway System; a complete analysis is beyond the scope of this interim report. A thorough economic analysis will be conducted as needed on a project by project basis.

The need for an improvement of a section of road is determined by a sufficiency rating. A sufficiency rating is a point rating method for determining the adequacy of an existing highway. It allows highway administrators to measure a particular road section or structure in its proper perspective with all other road sections or structures in the state against a selected level of service. A sufficiency rating study is published each year (as required by law) for the Iowa Primary Road System. But the sufficiency rating by itself does not identify the full range of alternative types of improvements, the most economical alternative to adopt, or the timing of an improvement.

The importance of an economic analysis lies in its two basic applications in decision-making. First, it provides for an analysis of costs in relation to returns (benefits), and second, it aids in deciding what specific design, in the long run, will produce the most economical structure, process, or procedure. Two distinguished authors, considered authorities in the field of economic analysis, will be used as references in this section. They are Robley Winfrey(1) and Robert J. Daiute.(2)

Economic analysis considers two major topics: economics and economy (Ref. 46). Economics is a broad-meaning word that relates to the production, distribution, and consumption of commodities and resources. The improvement of highways usually has a direct bearing upon the economics of the community. This economic influence affects business volume, business location, employment, land use, and recreation; in fact almost every aspect of living in the present motor vehicle age. Both the location of a highway route and its vehicular capacity affect the economic development resulting from the highway. These developments are not within the control of highway officials, but highway decisions greatly affect the social and economic life of a community.

On the other hand, economy of highway transportation is a subject largely within the control of highway officials because it is determined, to a large extent, by elements of highway design. Economy means prudent expenditure; the husbanding of the dollar; spending not more than the minimum necessary to achieve an objective. The cost of

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(1) Robley Winfrey, former Professor of Civil Engineering at Iowa State University, Ames, Iowa, guest professor at Stanford University and presently in private consulting practice.

(2) Robert J. Daiute, assistant professor in the School of Business Administration at Rider College, Trenton, New Jersey, and chairman of the research and publication committee of the Eastern Academy of Management.

highway construction and the cost of operating motor vehicles over the highway are both affected by the highway design. The objective is to so design the highway that in the long run the sum of the highway cost plus the motor vehicle running cost is at a minimum.

Various alternatives are to be considered in an economic analysis:

1. The "do nothing" alternative
2. Additions to, and betterments of, existing facilities
3. Providing completely new facilities.

The different methods that can be used to compare these alternatives will be discussedon the ensuing pages.

Different factors that can be used in an economic analysis are shown in figure 11.

Analysis of Economy

An analysis of economy can be performed using the factors outlined in figure 11. One of the main factors in the analysis is the motor vehicle running costs on the road (Ref. 6). Considerable research has been conducted on the subject. Five basic steps can be identified in the prediction of these costs (Ref. 26). The five steps are:

1. Definition of representative vehicles,
2. Prediction of driver behavior for each vehicle and segment of roadway,
3. Prediction of vehicle performance capabilities,
4. Determination of actual travel possibilities for each traffic volume, and
5. Prediction of the consequences of vehicle operation for each vehicle, each road segment, and each traffic volume level.

Other factors to be considered in the analysis are accident costs (described in another section of this report), travel time, and highway costs that directly affect the vehicle running expense. Some of these highway cost factors are distance, vertical grades, horizontal curvature, roadway surface, travel speed and speed changes.

Before an analysis of economy can be performed,length of the analysis period must be defined. The normal analysis period is 20 years because the accuracy of forecasting traffic beyond that point decreases. Also, annual road user costs and highway maintenance costs must be determined to complete a meaningful analysis.

The factors listed in Figure 11, Group 1 can be assigned monetary value after substantial research, while those in Groups 2 and 3 are intangible and therefore not subject to price. Factors in Group 2 relate to driver preferences, and those in Group 3 relate to social, economic, and environmental matters.

FACTORS OF ANALYSIS LEADING TO DECISION AIDS

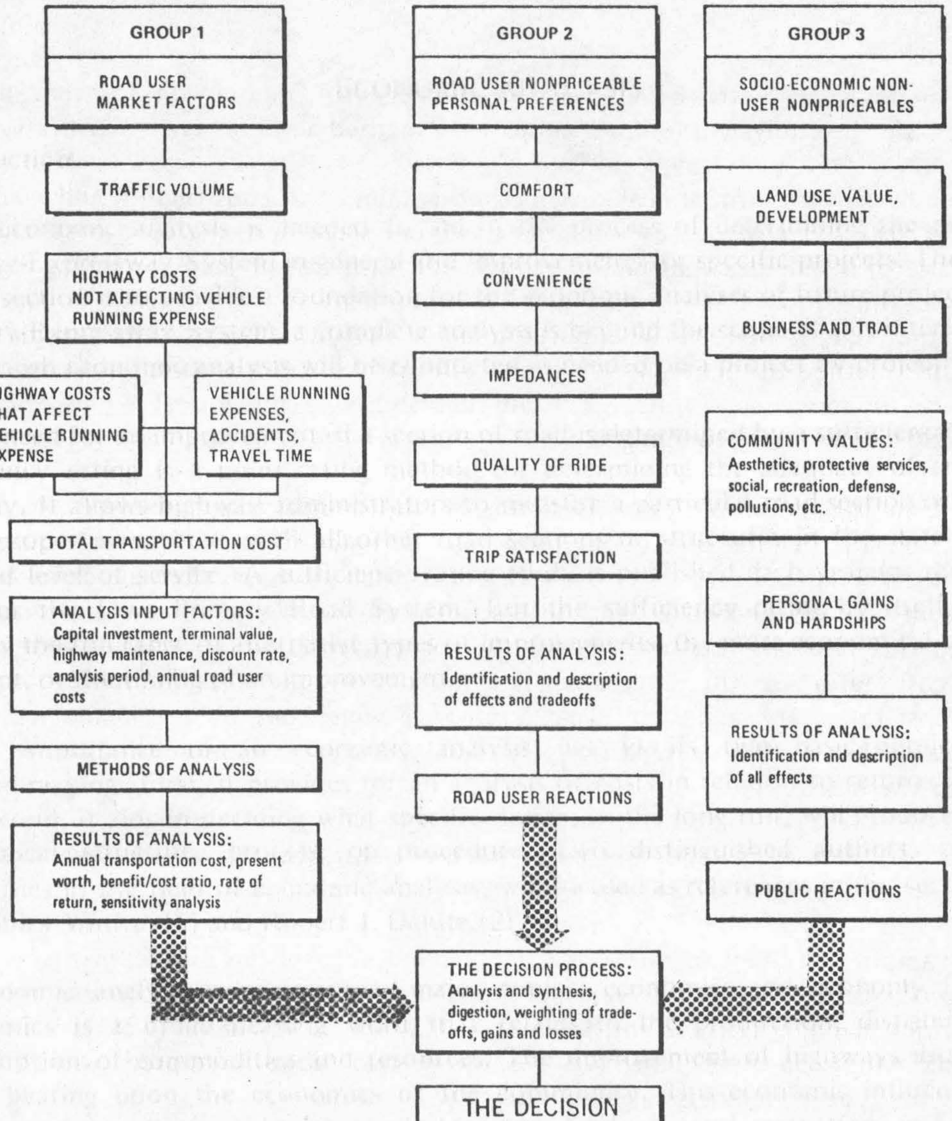


Figure 11 (Ref. 47)

The method of analysis must be determined once all the pertinent information has been gathered. There are seven different methods available as follows:

1. Equivalent uniform annual cost (EUAC)
2. Present worth of costs (PWOC)
3. Equivalent uniform annual net return (EUANR)
4. Net present value (NPV)
5. Benefit/cost ratio (B/C ratio)
6. Rate of return (ROR)
7. Cost-effectiveness

The methods currently being used by the Highway Commission for the analysis of economy are the equivalent uniform annual cost method and the benefit/cost ratio method.

The equivalent uniform annual cost method combines all construction and maintenance costs and road user costs for each alternate into one single annual project cost. This is done by the use of a time-discount factor, reducing all cash expenditures occurring at different times over the chosen analysis period, to an equivalent uniform amount of cost for each year of the analysis period. An important factor that must be carefully considered when using this method is mutually exclusive alternatives be compared only under equal conditions of service performed. The alternative having the lowest equivalent uniform annual costs is the most economical.

The benefit/cost ratio method compares the annual cost involved in operation, construction and maintenance of the proposed alternates versus the present route, present conditions. The annual road user cost savings that each proposed alternate experiences over the present route is divided by the difference in annual highway costs and maintenance expense, the resulting quotient being the benefit/cost ratio. After determining the benefit/cost ratio of the alternate as compared to the present route, incremental benefit/cost ratios are computed. That alternative which has an incremental benefit/cost ratio greater than 1.00, in comparison with the second most economical alternative, is the preferred alternative.

The annual savings in road user costs are in the form of decreased travel time, lower operating costs, comfort and convenience.

An example of these two methods can be found in the *Final Environmental Statement and Location Study Report on Freeway 520, Delaware and Dubuque Counties* prepared by the Corridor Planning Department, Iowa State Highway Commission (Ref. 18). The project is approximately 35 miles long. The following two tables excerpted from this report illustrate the type of numbers calculated in a freeway analysis.

Table 6

Road User Analysis

Alternate	Annual Road User Costs	Annual Const. and Maint. Costs	Benefit/Cost Ratio
Present Route Present Conditions	$32,388,900	$ 194,000	--
Present Alignment	$29,053,900	$2,880,500	1.24
Dyersville Bypass	$28,883,300	$3,026,000	1.24
Dyersville-Farley Reloc. (North Alt.)	$28,991,400	$3,052,600	1.19
Dyersville-Farley Reloc. (South Alt.)	$29,239,800	$3,124,100	1.07

Table 7

Equivalent Uniform Annual Project Costs

Alternate	Equivalent Uniform Annual Project Costs
Present Route Present Conditions	$32,582,900
Present Alignment	$31,934,400
Dyersville Bypass	$31,909,300
Dyersville-Farley Reloc. (North Alt.)	$32,044,000
Dyersville-Farley Reloc. (South Alt.)	$32,363,900

As can be seen from Table 6, Road User Analysis, all of the alternates were economically feasible from a road user-benefit/cost analysis stand point, since they all had a benefit/cost ratio greater than one. In Table 7, Equivalent Uniform Annual Project Costs, the costs were all relatively close with the Dyersville Bypass having the lowest costs which makes it the most economical.

Economic Analysis

The benefit/cost analysis and the equivalent uniform annual cost analysis only indicate the ultimate development that is economically feasible for a project. But a modern highway is planned not only in terms of vehicular travel within its right-of-way, but also in the context of its social, economic, and natural environment. This makes it possible to fully integrate the highway with the study area, maximizing the social and economic benefits of a new transportation facility while minimizing any adverse impacts upon the natural environment. Such comprehensive planning potentially yields a multi-purpose rather than a single-purpose facility (Ref. 18).

Referring to Figure 11, Group 3 factors are factors that can be used in an economic analysis of the nonpriceables -- factors that effect the social, economic, and natural environment (Ref. 47). In using these factors, a cost-effectiveness type of analysis is appropriate. Such an analysis will compare the results of an analysis of economy with the favorable and unfavorable socio-economic consequences. Those comparisons are in terms of quantifiable factors where possible and in terms of qualitative descriptions for other factors. The consequences can be described to the extent that the decision maker may visualize the differences in major factors such as relocation of families and businesses, probable changes in wholesale and retail trade volumes and patterns, changes in environmental factors, and changes in community aesthetics.

Currently, the factors being considered by the Highway Commission in an economic analysis are:

1. Regional and Community Growth
2. Conservation and Preservation
3. Public Facilities and Services
4. Community Cohesion
5. Displacement of People, Businesses, and Farms
6. Air, Noise, and Water Pollution
7. Aesthetics and Other Values

After these factors are defined in the analysis, certain adverse effects which cannot be avoided are determined and steps outlined to minimize the harm. Examples of steps to minimize the harm are (Ref. 18):

1. Dislocation and Relocation Assistance
2. Erosion Control Measures
3. Conservation of Top Soil
4. Controlled Burning of Solid Wastes and Fugitive Dust
5. Landscaping and Planting to Improve Aesthetics
6. Mowing Practices
7. Spraying Practices
8. Management of Right-of-Way for Wildlife Habitat
9. Salting Practices and Effects on Plants and Water
10. Preservation of Archaeological Values and Historic Sites
11. Regulation of Outdoor Advertising
12. Recreational and Scenic Areas Protection

A study of the relationship between short-term uses of man's environment and long-term productivity and an analysis of the commitments of resources is also conducted. Public hearings are also held whereby public reaction to the proposed project can be weighed and used in the final decision-making process.

Conclusion

As can be seen from the foregoing information, a thorough economic analysis makes it possible for the Iowa Highway Commission to consider the many factors, suggestions, and alternatives brought out in public hearings and by special groups and interested individuals. Establishing a rational procedure of economic analysis adds considerable probability that all feasible alternatives will be considered.

The analysis of economy and the economics analysis described in the foregoing information and illustrated by figures extracted from a Freeway 520 report will be conducted on a project by project basis. The same methods will be formulated and used in a study of the Freeway-Expressway system as a whole, but that is beyond the scope of this interim report. As noted in the introduction, the purpose of this section was to produce a foundation for future economic analyses.

Anticipated Savings in Accidents

Claim: Divided highways with full access control provide a consistently safer route to travel than other primary highways or local road and street systems. Substantial savings in lives and dollars can be provided through the proposed Freeway System.

Fact: The proposed Freeway System would save 67 lives annually by 1995, reduce bodily injuries by 2,086, and provide an annual accident savings of 15.8 million dollars.

The 1973 fatality rate on rural primary highways was 5.78 deaths per 100 million vehicle miles traveled (HMVM), other non primary rural roads 7.43 deaths per HMVM, while the rural Interstate System rate was only 2.27 deaths per HMVM.

Traffic would be diverted from the primary and non-primary roads to the safer Freeway System.

Basis: Accident Statistics were developed from Iowa Department of Public Safety records. Accident cost analysis methodology was obtained from books written by distinguished authors in the field of economic analysis. Accident cost studies from eight private and public agencies were used as basis for accident costs.

ANTICIPATED SAVINGS IN ACCIDENTS

Introduction

Unquestionably, divided highways with fully controlled access and constructed to current design standards provide a substantially and consistently safer route to travel than other primary highways or local road and street systems. This safety feature of the Freeway System is intuitive, but more importantly, it is substantiated by officially recorded statistics on fatalities, injuries, and property damage accidents on freeways and the other systems. This section of the report will show that **by 1995, the Freeway System would annually save 67 lives, reduce bodily injuries by 2,086 and provide an annual accident savings of 15.8 million dollars.**

Accident Savings Analysis

Accident rates in Iowa for 1973 are listed in Table 8. These rates are presented by accident type, both rural and municipal for Interstate, other primary highways, and non-primary roads and streets. As an illustration of savings in accident costs realized through the construction of the Interstate System, suppose the 2.1 billion vehicle miles of rural Interstate travel in Iowa during the year 1973 had occurred on conventional primary highways. From Table 8 it can be seen that these drivers would have been expected to

Table 8

Accident Rates in Iowa by System for 1973

(Accidents per 100 Million Vehicle Miles)

System	Fatal Accidents	Fatalities	Injury Accidents	Property Damage
Rural				
Interstate	1.94	2.27	29.9	3.12
Other Primary Highways	4.59	5.78	68.3	121.70
Non-Primary Roads and Streets	6.26	7.43	117.8	215.76
Municipal				
Interstate	1.31	1.48	69.8	171.64
Other Primary Highways	3.17	3.51	231.1	648.62
Non-Primary Roads and Streets	1.48	1.58	197.0	757.13
Total				
Interstate	1.80	2.09	38.8	84.82
Other Primary Highways	4.19	5.14	114.0	269.54
Non-Primary Roads and Streets	3.32	3.83	166.5	548.77

experience a fatality rate of 5.78 deaths per 100 million vehicle miles traveled on conventional primary highways rather than the 2.27 deaths per 100 million vehicle miles traveled that was actually experienced on the rural Interstate System during that year. In solid numbers this means that instead of the 48 recorded deaths on the rural Interstate System in 1973, Iowa would probably have witnessed the loss of 122 lives from within this same group of drivers. That amounts to 74 additional deaths, or 254 percent more than was experienced by having the rural Interstate System open to travel.

It can be further shown that there is a corresponding significant reduction in bodily injuries and property damage accidents brought about through the existence of this fully controlled access facility.

This section of the report is intended to analyze the safety benefits that could be realized through construction of the proposed Freeway System (excluding the Interstate) in Iowa. The Freeway System is projected to be completed and open to traffic by 1995. It is assumed that the accident rates experienced on all systems in Iowa during 1973 will be maintained at that level per 100 million vehicle miles of travel during the period of study. This assumes no additional rate decrease due to improved vehicles, driver skill or reduced posted speed limit. If improvement of vehicles, driver skill and attitude cause the fatality rate to continue its historic decline, or if the lower speed limit permanently lowers the fatality rate, the number of deaths will probably be even further reduced. The main potential for saving lives through system reconstruction relates to diverting traffic from the primary highways, local roads and streets to the Freeway System which, as indicated in Table 8, has a significantly better safety potential.

When considering that portions of the Interstate were built as long as sixteen years ago and that today's freeway design standards have greatly improved over earlier freeway designs, it is apparent that any facility designed and built to current standards will be inherently safer than its predecessors. This would encompass such improved design standards as increased minimum sight distance; wider structures, shoulders, and medians; flatter foreslopes; greater offsets to obstacles or signs; and improved guardrail.

In light of these improved features it will be assumed that a new freeway facility constructed between now and 1995 will experience accident rates 20 percent lower than the corresponding average accident rate being experienced on the existing Interstate-Freeway System. The California Division of Highways has been using this reduction factor (Ref. 31) in analyzing anticipated accident experience on proposed facilities during recent years to account for improved design standards.

The first step in analyzing accident savings was to forecast travel that would be expected on the completed Freeway System. It has been predicted that by its completion in 1995 the Freeway System (excluding the Interstate) would be carrying 2.04 billion vehicle miles of travel annually. Traffic on a new facility such as this is composed of traffic diverted from other existing roads and streets, and additional traffic generated because of the existence of the higher type facility. It was estimated that 80 percent of the freeway traffic would be traffic diverted from other parallel Primary highways, ten percent would be traffic diverted from local roads and streets not on the primary system, and the other ten percent would be newly generated traffic that would not exist if the freeway facility were not available.

Based on the previously stated assumptions, and forecasted vehicle miles of travel, it is estimated that in the year 1995 the Freeway System would save 57 lives annually on the rural portion, and an additional ten lives on the municipal portion, for a total savings of 67 lives. It is estimated that the completion of the Freeway System by 1995 would in that year yield a reduction in bodily injuries of 953 on the rural portions, and 1,133 on the municipal portions, for a total of 2,086 less injuries than if this travel were forced to remain on the existing Primary and local road and street systems.

Viewing the anticipated accident savings over the 20 year period between now and 1995, and **assuming the Freeway System would be built and opened to traffic at a uniform rate over the 20 year period, it would be expected that 670 lives would be saved and an additional 20,860 bodily injuries prevented.** In addition to the reduction in number of deaths and injuries there is also a very significant reduction in property-damage-only accidents.

Accident Cost Studies

It is extremely difficult to attach a dollar value to a human life or to the loss experienced by someone who is permanently paralyzed or disabled. There is a great diversity of opinion as to which items should be included in determining accident costs as well as the value placed on such items. The cost elements within the total cost of traffic accidents are many and involved. There are direct and indirect costs, on-site and off-site costs, immediate and future costs, costs to those involved in the accident and costs to others, and intangible costs. Because of the diversity of elements included there is a corresponding disparity in accident cost estimates, depending on the source of figures. This range of figures is further widened as a result of the element of time involved in costs incurred. In the case of fatalities and some injury accidents, estimation of net present worth of probable future income is an involved computation affected by the procedure used and by the subjective assumptions made. For example, the present worth of future incomes will vary depending on whether future income is predicted by using an average income or predicted yearly income for the remaining working years. This task involves estimating work - life spans and living costs plus assigning values to housewife services, for example. The discount rate or time - value of money used will also greatly affect the present value of future income or related injury costs.

An extensive list of elements constituting costs and benefits associated with highway traffic accidents is presented on pages 368-371 of Reference 46. Studies differ in which elements should be considered. The important thing to know, however, is which cost elements are included in any report of traffic accident costs, since only then do the stated traffic accident costs have real meaning.

Table C-10of Appendix C has been compiled to illustrate accident costs developed in various studies for the three categories: fatalities, bodily injury, and property-damage-only. A short description of the parameters used in deriving these statistics is also found in the appendix.

In addition to the sources listed in Appendix C, statistical data have been compiled and categorized to indicate the average jury verdict award for a wide variety of injury and fatality accidents (Ref. 21). Courts and juries are frequently forced to place a value on life, but the basis is generally not stated. This basis may be the value of support to dependents, present worth of future income, sentimental value, or any combination of the three. The value of human life as life, however, is not a cost in the sense that expense is incurred, as is the case in support to dependents or present worth of future income. For this reason it is commonly felt that economy studies of highway improvements should not include the value of life as a sentimental factor, but only as an economic factor.

There is no strict consensus of opinion on the costs of accidents or even on what elements should be considered. The wide variation in cost figures would diminish considerably if all costs were expressed in terms of a common year. As was stated earlier, however, the important things to know are which cost elements are included and the discount rate used to assign a time value to costs. Review of Table C-6,Appendix C,indicates that the National Safety Council (NSC) cost figures are the most current and represent a mid-range of the studies.

The accident cost analysis in this section will therefore be based on these 1973 cost figures; $90,000 per fatality, $3,700 per injury and $500 per property-damage-only accident.

Applying the NSC accident cost figures to the anticipated reductions in fatalities, injuries and property damage on the proposed Freeway System, yields an anticipated annual dollar savings of 15.8 million dollars in 1995. It should be emphasized that this 15.8 million dollars would be an annual savings. Assuming that the Freeway System would be constructed and opened to traffic at a uniform rate between now and 1995, the accumulated savings during this period alone would amount to 158 million dollars. It should be further emphasized that the sizable cost savings relating to safer facilities such as the Freeway System would continue to accumulate for as long as the facility remains in use.

Other Transportation Modes

Claim: Transportation by air, water, railroad and highway must interface and be mutually supportive.

Fact: First and last movements of goods and people are necessarily accomplished by the highway mode; therefore, it is essential that good streets and highways interface with terminals to provide efficient transportation.

Substantial movement of goods and people is provided by non-highway modes. Additional movement information concerning these other modes is required before a detailed analysis of each mode can be accomplished.

Basis: Sources of information for the other modes include the *State Airport System Plan,* U.S. Army Corps of Engineers, Iowa Development Commission, Iowa State Commerce Commission and *Railway Age Magazine.*

AIR TRANSPORTATION

Air transportation has become an integral part of our total transportation system since its beginning in the early 1900's. At the present time, Iowa has nearly 9000 registered pilots, and over 2600 registered aircraft based at 355 Iowa airports.

The air transportation system in 1972 included the following number and type of airport facilities (Ref. 20):

12 -	publicly owned airports with scheduled commercial service
101 -	publicly owned airports with no commercial service
120 -	privately owned airports open for public use
45 -	privately owned airports not open for public use
10 -	special purpose airports (heliports, STOL and water landings)
67 -	other airports, information incomplete
355 -	Total Airports

Figure 12 shows the location and type of the municipal airports in Iowa, thirteen of which provided scheduled commercial air service in 1974. The *Iowa State Airport System Plan* (Ref. 20), published in 1972, recommends a system of 117 airports in order to satisfy Iowa's need for air transportation in 1992. These recommendations are based on projections which assume the use of private and commercial air transportation will increase at a rate consistent with the national growth rate.

The estimated number of airline passengers utilizing the Des Moines Municipal Airport in 1974 is 1,011,132. This estimate is 8 percent over the corresponding 1973 figure of 940,226 (Ref. 22). Current planning for the Des Moines Airport includes increasing their present parking by 200 cars in 1975 and an additional 200 cars in 1977. This growth rate is not representative of all airports in Iowa. In spite of the fuel shortage, Ozark Airlines, which is the only airline providing service to seven Iowa cities, estimates the total number of passengers enplaned in 1974 to be 20 percent above the 1973 figure (Ref. 22).

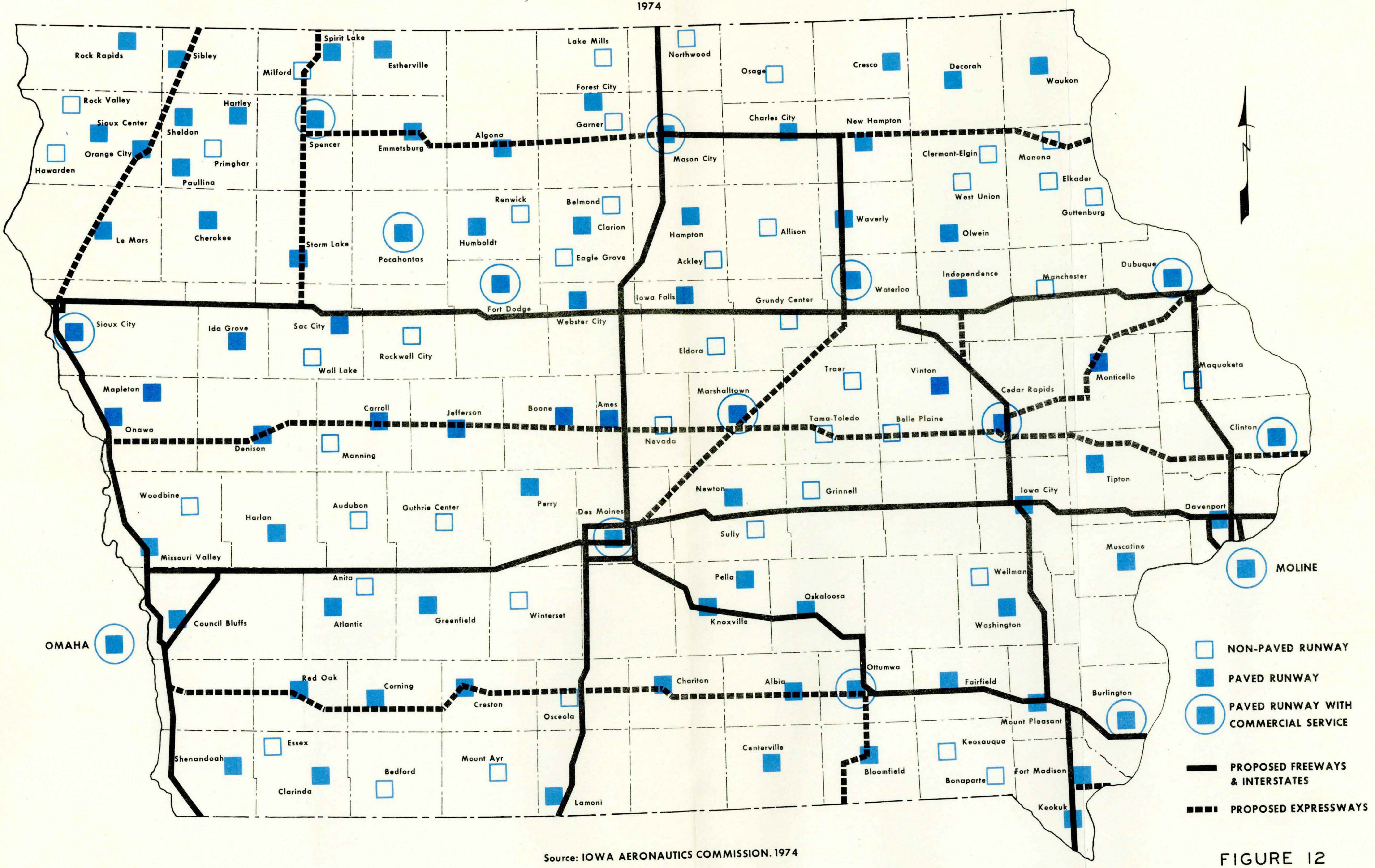
Time is the most significant factor associated with air transportation. Most cargo shipped by air is done so because of the substantial time savings. Likewise, people travel by air because of convenience and speed, especially for moderate to long distance trips.

Industry has become particularly dependent on air travel. The ability of any city or area to attract and retain industry or business is directly related to its ease of access to air transportation facilities. Airport accessibility is also extremely important when considering air cargo shipped by a scheduled commercial air service.

The accessibility of a particular airport is solely dependent on the ground transportation. Further, the interaction of high speed air transportation with efficient ground transit such as busses, limousine service, and taxis is vital to future airport growth. A lasting negative impression of a city is created when one has to spend more time on the ground battling congested streets than was spent in the air covering hundreds of miles. It is therefore not consistent with the philosophy of air transportation to provide a major municipal airport with inadequate ground transportation. The January 1975 proposed Interstate-Freeway-Expressway System is designed to complement the present and proposed Iowa Airport Systems as can be seen in Figure 12.

In addition to supplying quick and convenient transportation to and from major rural airports, the Interstate, Freeway, and Expressway will reduce ground travel costs. An estimate of these savings cannot be determined at this time because adequate air travel data is not available from existing state or federal sources. It is anticipated that as additional information becomes available, a more definitive determination of the interface between ground and air travel will be developed.

MUNICIPAL AIRPORTS IN IOWA
1974



Source: IOWA AERONAUTICS COMMISSION. 1974

FIGURE 12

RIVER TRANSPORTATION

Iowa is fortunate to be bordered on two sides by a navigable waterway-- the Mississippi River on the east, and the Missouri River on the west. A minimum channel nine feet deep and 300 feet wide is maintained by the U.S. Corps of Engineers from Minneapolis, Minnesota to Cairo, Illinois on the Mississippi, and when the Missouri River project is completed, a similar navigation channel will be maintained on the Missouri River from Sioux City, Iowa to its confluence with the Mississippi River near St. Louis, Missouri. This navigation channel is maintained by the Corps of Engineers with 27 locks and dams from Minneapolis to St. Louis on the Mississippi River, and with six large dams on the Missouri River, the farthest downstream one being Gavin's Point Dam above Sioux City, Iowa. Dredging, levees, wing dams, and revetments are also used to control the channel. From Cairo, Illinois south to the Gulf of Mexico, the Corps of Engineers maintains a minimum navigation channel depth varying from nine feet to 40 feet, and widths from 300 feet to 500 feet. Ocean going vessels are able to reach New Orleans.

The navigation season on the two rivers along the Iowa borders is from April 1 to December 1, however, high water in the spring can delay the start to June. Lock and Dam 19 on the Mississippi River near Keokuk, Iowa is the northernmost point on the River that is open all year.

Commercial docks are scattered along the shores of both rivers, however, the main concentrations of activity are near the cities of Burlington, Muscatine, Davenport, and Dubuque on the Mississippi River, and Sioux City, Council Bluffs, and near Nebraska City, Nebraska on the Missouri River. These commercial docks are shown in Figure 13. The number of docks are shown in parenthesis and the location of the dock as to left or right bank (L or R) when facing downstream.

In order to take advantage of relatively inexpensive water transportation, the shipper must transport his freight to the waterfront to be loaded onto barges, and conversely, must pick up his freight at the waterfront and transport it to the final destination. This first and last movement must be accomplished by rail, motor truck, or pipeline. Only a limited amount of data is available as to the origin or destination of the freight handled by river barge lines, or how it is transported to and from the waterfront. A report prepared by the Iowa Highway Commission in 1973 titled *Trip Data Survey at Grain Terminals Located in McGregor and Clayton, Iowa* examines the origin and destination of grain truck trips for these two terminals. A copy of this report is found in appendix D.

Most of the inbound or outbound material handled by water transportation is delivered to storage facilities at or near the river terminals. Therefore, it is essential, in the case of motor truck transportation, that all weather modern access roads be available between these river terminals and major statewide highways to provide efficient, economical freight movement. The important river terminal cities are located on or close to proposed freeway or expressway routes, however, access roads to the river terminals in some areas leave much to be desired.

Considerable freight is moved on both of these rivers. Freight shipments through the Omaha District of the Missouri River set a record in 1972, and the Rock Island District estimates higher tonnages for 1974 than in 1973 moved through their district on the Mississippi River, even though the navigation season was curtailed ten weeks because of high water. There are many who believe river transportation could be expanded--and should if maximum benefits from our unique geographical position are to be realized. The Wisconsin Department of Transportation describes the Mississippi River as "...one of the greatest under utilized natural resources." (Ref. 48).

The volume of river transportation on the two rivers as it relates to Iowa is shown in the accompanying tables. In 1973 total tonnage passing through the Rock Island District on the Mississippi River was over 23 million tons, with grain accounting for over 52% of this tonnage. Volume between Sioux City, Iowa and Nebraska City, Nebraska on the Missouri River was slightly over one million tons, with almost 32% of this tonnage being grain. This grain can be barged to New Orleans, loaded on ocean liners, and shipped to overseas markets.

With the emphasis given foreign trade today, and its importance in the future, Iowa is in a truly enviable position for grain shipments to world markets.

Table 9

Tonnages of Commodities Shipped on the Mississippi River Through District 2 Rock Island, Illinois

	Total 1973	Jan.-June 1974
Petroleum	1,945,900 Tons	880,574 Tons
Grain	12,284,720 Tons	4,959,350 Tons
Coal	4,414,260 Tons	1,796,900 Tons
Other	4,666,062 Tons	1,806,056 Tons

Total: Jan.-June 1973 = 6,970,835 Tons
Jan.-June 1974 = 9,442,880 Tons

Source: U.S. Corps of Engineers, Rock Island District, Rock Island, Illinois

Table 10

Total Tonnages of Commodities at Missouri River Ports, 1972 Between Sioux City, Iowa & Nebraska City, Nebraska

Code	Description	Total Tonnage
01	Farm Products[1]	441,875
14	Non-Metalic Minerals[2]	148,504
20	Food & Kindred Products[3]	316,045
26	Pulp, Paper, & Newsprint	13,955
28	Chemicals & Related Products[4]	277,702
29	Petroleum Products	9,528
32	Stone, Clay, Cement, Lime	160,953
33	Primary Metal Products	27,851
35	Machinery	464
37	Transportation Equipment	514
Total		1,397,391

1 Grains

2 Phosphate Rock, Salt, Etc.

3 Tallow, Flower, Molasses, Soybean Oil, Animal Feeds

4 Largely Fertilizer

Source: U.S. Army Corps of Engineers, Missouri River Division: Omaha, Nebraska

RAILROAD TRANSPORTATION

The state of Iowa has over 11,600 total miles of trackage operated in the state. There are eight class I and six class II railroads which actively employ over 9,400 Iowa citizens. Iowa ranks 5th nationally in miles of class I railroad track (Ref. 13). A class I railroad is defined as a railroad whose operating revenues are over $5,000,000 annually.

In 1972, a total of 88,488,853 tons of revenue freight were carried on Iowa's eight class I railroads,of which 22,956,982 tons originated in Iowa while 20,636,065 tons terminated in Iowa. The major export items transported by rail were 8,771,611 tons of farm products and 6,339,957 tons of food and kindred products. The major import items were 4,701,338 tons of farm products and 4,175,285 tons of coal (Ref. 13).

These statistics show that railroads are an important part of Iowa's total transportation system. The cost/ton-mile to transport most goods by rail is significantly lower than truck transportation. However, one fact remains obvious, a significant portion of commodities shipped by rail require transportation either to or from the railroad terminal by a different mode of transportation. As a result of this situation, railroads have developed an increasing amount of combination service where a trailer is loaded at its origin and is physically transported by the rail carrier on a flatcar to its terminal destination. A truck tractor is then connected and the trailer is pulled to its final destination and unloaded. Many types of trailer-on-flatcar (TOFC) service, more commonly known as "piggyback", have developed. These types range from the complete ownership of the trailer and the flatcar by the railroad to complete ownership of the trailer and flatcar by the shipper (Ref. 29).

There has been considerable growth in TOFC service since its beginning. Most of the class I railroads participate in some type of "piggyback" service. 1970 data indicates TOFC carloadings account for approximately 4 percent of total rail carloadings (Ref. 17). The locations of the ramp terminals for TOFC service in Iowa are shown below:

Table 11
TOFC Service in Iowa

City	Railroad
Boone	CNW
Burlington	BN-CRIP
Cedar Rapids	CNW-CRIP-MILW
Cherokee	ICG
Clinton	BN-CNW-CRIP
Council Bluffs	BN-CNW-CRIP-ICG MILW-N&W
Creston	BN
Davenport	MILW
Denison	CNW-ICG
Des Moines	BN-CNW-CRIP-MILW-N&W

Table 11(continued)

Dubuque	BN-ICG-MILW
Estherville	CRIP
Fairfield	CRIP
Fort Dodge	CNW-ICG
Fort Madison	ATSF-BN
Glenwood	BN
Iowa City	CRIP
Iowa Falls	ICG
Keokuk	BN
LeMars	ICG
Marion	MILW
Marshalltown	CNW
Mason City	CNW-CRIP-MILW
Muscatine	CRIP
Nahant	MILW
Newton	CRIP
Oakland	CRIP
Ottumwa	CRIP
Pacific Junction	BN
Postville	MILW
Sioux City	BN-CNW-ICG-MILW
Spencer	MILW
Storm Lake	ICG
Waterloo	CNW-CRIP-ICG

Inspection of the list of TOFC terminals will show all but four of the terminals are located in cities or towns on the proposed Interstate-Freeway-Expressway system. This close location to fast and efficient ground transportation will provide an important interface between highway and rail transit. The actual dollar benefits to be derived from this interaction cannot be determined until more specific railroad data has been compiled.

Despite the substantially lower cost per ton mile of railroad transportation, use of this mode has decreased from 1969 to 1972 while the tonnage transported by motor freight has increased (Ref. 13). In the October 1974 issue of *Railway Age* (Ref. 27) some of the reasons for the decrease in rail usage were cited by Mr. Howard P. Gabriel, general traffic manager, Hershey Foods Corporation, Hershey, Pennsylvania: "We believe shipper/carrier relations have broken down completely in the last three years. The financial condition of the carriers makes it almost impossible for them to make selective rate adjustments and with service on the poor side they have little opportunity to 'sell'. For these reasons, carriers have stayed away from contacting shippers." Gabriel listed five contributing factors for reduced rail shipments:

"(1) The advancing cost of transportation and the differential between modes.

(2) The shocking increase in rail damage and the inconvenience of not having stock available.

(3) Unit loading, by slip sheets or pallets, and the resultant labor savings.

(4) Increased cost of car leasing, without adjustment in mileage allowance.

(5) Difference in transit time and the related cost of inventory investment."

Not all information about railroads is pessimistic. One major grain company in Iowa is installing rail lines into 2 of the 3 major barge terminals on the Mississippi River. The shipment of grain by rail will allow this particular company to nearly double its corn shipments by 1976, an increase of approximately 12,000,000 bushels.

Another grain company in Iowa is shipping grain by unit train. This concept utilizes 20-car trains of 100-ton covered hopper cars to move grain from country elevators in Iowa and Minnesota to barge-loading facilities on the Mississippi River. A three month trial was conducted. Each trip ranged approximately 300 miles in each direction between cooperating country elevators and the barge loading facility. Since the test, two separate unit trains have been scheduled, each makes 3 round trips per week and carries a total of 70,000 bu. of grain per trip (Ref. 23).

The 1974 Iowa Legislature approved a $3 million railroad subsidy. This subsidy, to be administered by the newly formed Energy Policy Council (EPC), was the nation's first direct subsidy of private railroads with state money in modern times. The $3 million subsidy will be used for the improvement of six branch lines chosen by the EPC. As a result of this subsidy, which demonstrated Iowa's interest in the improvement of rail transit, Iowa was chosen as the location for a $281,974 federally financed study. This study of Iowa's total railroad system is to be incorporated in the Iowa Department of Transportation (DOT) over-all state transportation plan when it is completed in early 1976. It is anticipated that the results of this study and the compilation of significant railroad data will allow the DOT to analyze Iowa's total transportation system and determine the important interactions between railroads and all other modes of transportation in Iowa.

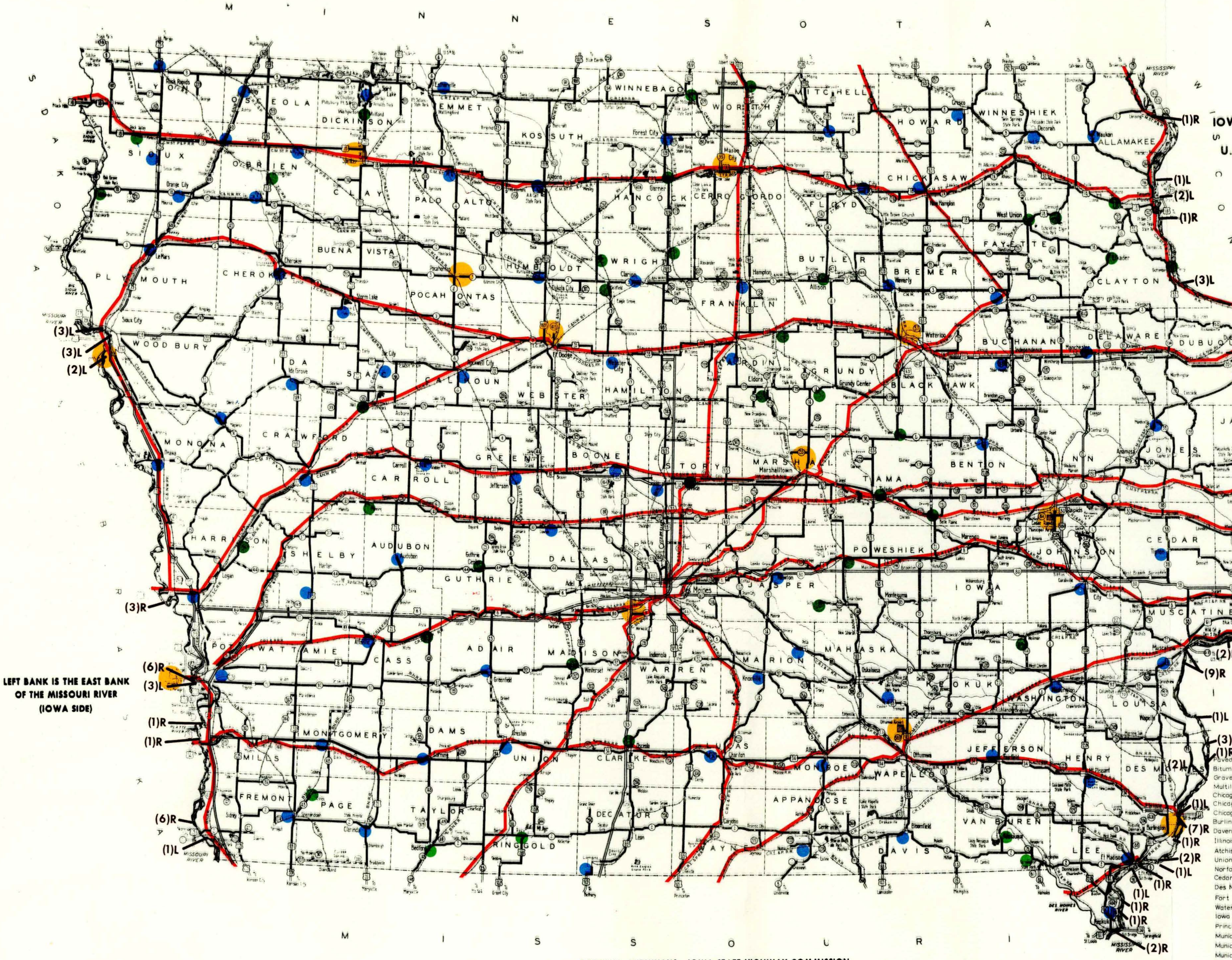
CURRENT INVENTORY AND TRANSPORTATION MAP OF

IOWA

IOWA DEPARTMENT OF TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

PREPARED BY
TRANSPORTATION DATA BASE DEPARTMENT
AMES, IOWA
PHONE (515) 296-1328

SCALE IN MILES
0 2 4 6 8 16 24
1974



LEFT BANK IS THE EAST BANK OF THE MISSOURI RIVER (IOWA SIDE)

RIGHT BANK IS THE WEST BANK OF THE MISSISSIPPI RIVER (IOWA SIDE)

LEGEND

Paved Road	
Bituminous Surfaced Road	
Graveled Road	
Multilane Road	
Chicago Rock Island & Pacific Railroad Co.	C.R.I. & P. R.R.
Chicago Milwaukee St Paul & Pacific Railroad	C.M. ST. P. & P. R.R.
Chicago & North Western Railway Co.	C.& N.W. RY.
Burlington Northern Inc.	B.N. R.R.
Davenport Rock Island & Northwestern Railway Co.	D.R.I. & N.W. RY.
Illinois Central Railroad Co	I.C. R.R.
Atchison Topeka & Santa Fe Railway Co.	A.T. & S.F. RY.
Union Pacific Railroad Co.	U.P. RY.
Norfolk & Western Railroad Co	N.W. RY.
Cedar Rapids & Iowa City Railway Co.	C.R. & I.C. RY.
Des Moines Central Iowa Railway Co	D.M.C.I. RY.
Fort Dodge Des Moines & Southern Railway	F.D.D.M. & S. RY.
Waterloo Railroad Co.	W.R.R.
Iowa Terminal Railroad Co.	I.T. R.R.
Principal Rail Lines In Iowa	
Municipal Airports (Commercial Service)	
Municipal Airports (Paved Runways)	
Municipal Airports (Non-paved Runways)	
Commercial Docks (R=Right Bank; L=Left Bank)	(No. of Docks)

* SOURCE: HIGHWAYS - IOWA STATE HIGHWAY COMMISSION
RAILROADS - IOWA STATE COMMERCE COMMISSION
AIRPORTS - IOWA STATE AERONAUTICS COMMISSION
BARGE TERMINALS - UNITED STATES ARMY CORPS OF ENGINEERS

FIGURE 13

ROAD CONDITION JANUARY 1, 1975

Petroleum Resources

Claim: World reserves of crude oil will be sufficient to meet demand at least over the design life of the Interstate-Freeway-Expressway System.

Fact: A review of recent literature suggests that, at worst, world crude oil production will satisfy demand over the medium term (2000 A.D.).

Estimates of the magnitude of the total resource base (& hence expected supply life) vary greatly, with some exceeding others by a factor of 2.

One expert contends that, with a decrease in the positive acceleration of the production curve, a substantial amount of petroleum can be available well into the 22nd century-- and there are authorities who place remaining recoverable crude at a level nearly double his.

In the future, increasing reliance on sources of energy other than petroleum can be expected to relieve a substantial amount of pressure on this obviously finite resource.

Basis: Data and expert opinions were taken from such authoritative sources as: *The Oil and Gas Journal*, *National Geographic*, *Fortune*, and American Petroleum Institute Publications.

BACKGROUND

As late as the early spring of 1973 Americans took petroleum for granted; gasoline was cheap and plentiful, oil was mistakenly assumed to be a product one pumped from vast underground pools (oil is not found in pools), and Arab sheiks were merely romantic figures seen in an occasional movie.

Data presented in *The Oil and Gas Journal* indicates, that for the month of March, 1973, total petroleum product demand was about 17.5 million barrels per day, while domestic wells were producing only about 9.3 million barrels of crude oil per day! The gap, of course, was (and is) being filled by imported crude oil and petroleum products.

The origin and utilization of these staggering quantities of liquid hydrocarbons is illustrated in Figure 14.

Our casual attitude toward energy was soon to be changed by soaring prices, the Arab oil embargo, long lines at service stations, and talk of gasoline rationing. Yamani, Faisal, and "oil shortage" became household words.

What few Americans realized was that the seeds for the current crisis were planted more than 20 years ago. According to M. King Hubbert, petroleum geologist for the U.S. Geological Survey (USGS) "In 1947 our domestic production slipped below our consumption, and we became a net importer of oil."

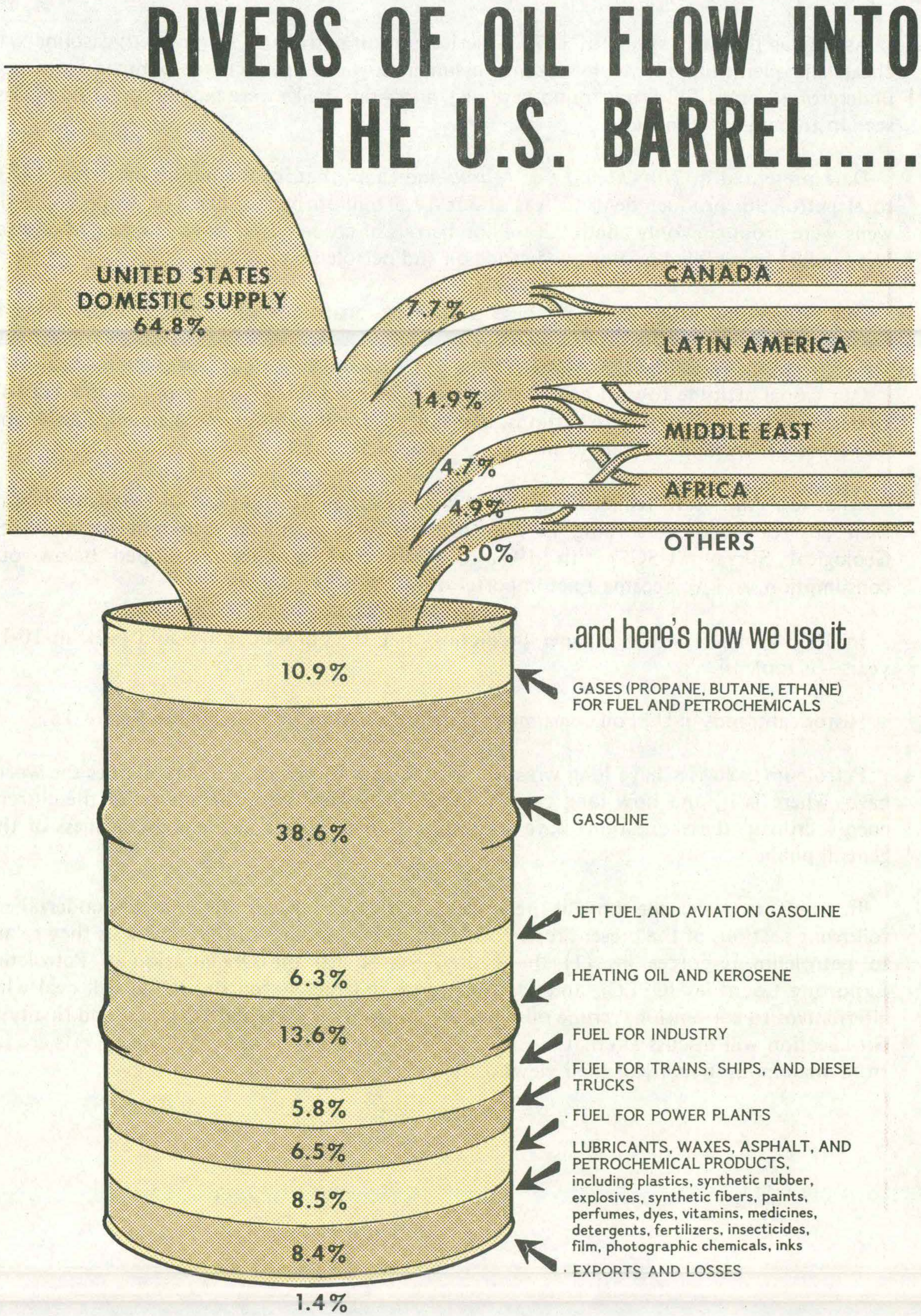
In 1956 Hubbert wrote a paper predicting that U.S. production would peak in 10-15 years -- it took 14.

Historical trends in U.S. oil consumption and production are indicated in Figure 15.

Petroleum geologists have long wrestled with the questions: How much oil does the world have, where is it, and how long can we expect it to last? With the advent of the current energy crunch, these questions have abruptly assumed a place in the consciousness of the general public.

In an effort to provide some of the answers, a review of recent literature was undertaken; following sections of the present report will outline the findings of that review as they relate to petroleum resources in: (1) the United States, (2) the Organization of Petroleum Exporting Countries (OPEC), and (3) the world at large. A fourth section will deal with alternatives to conventional crude oil -- petroleum from oil shale and tar sands; and finally, a fifth section will discuss alternate sources of energy. It will be seen that the experts are far from unanimous in many of their views.

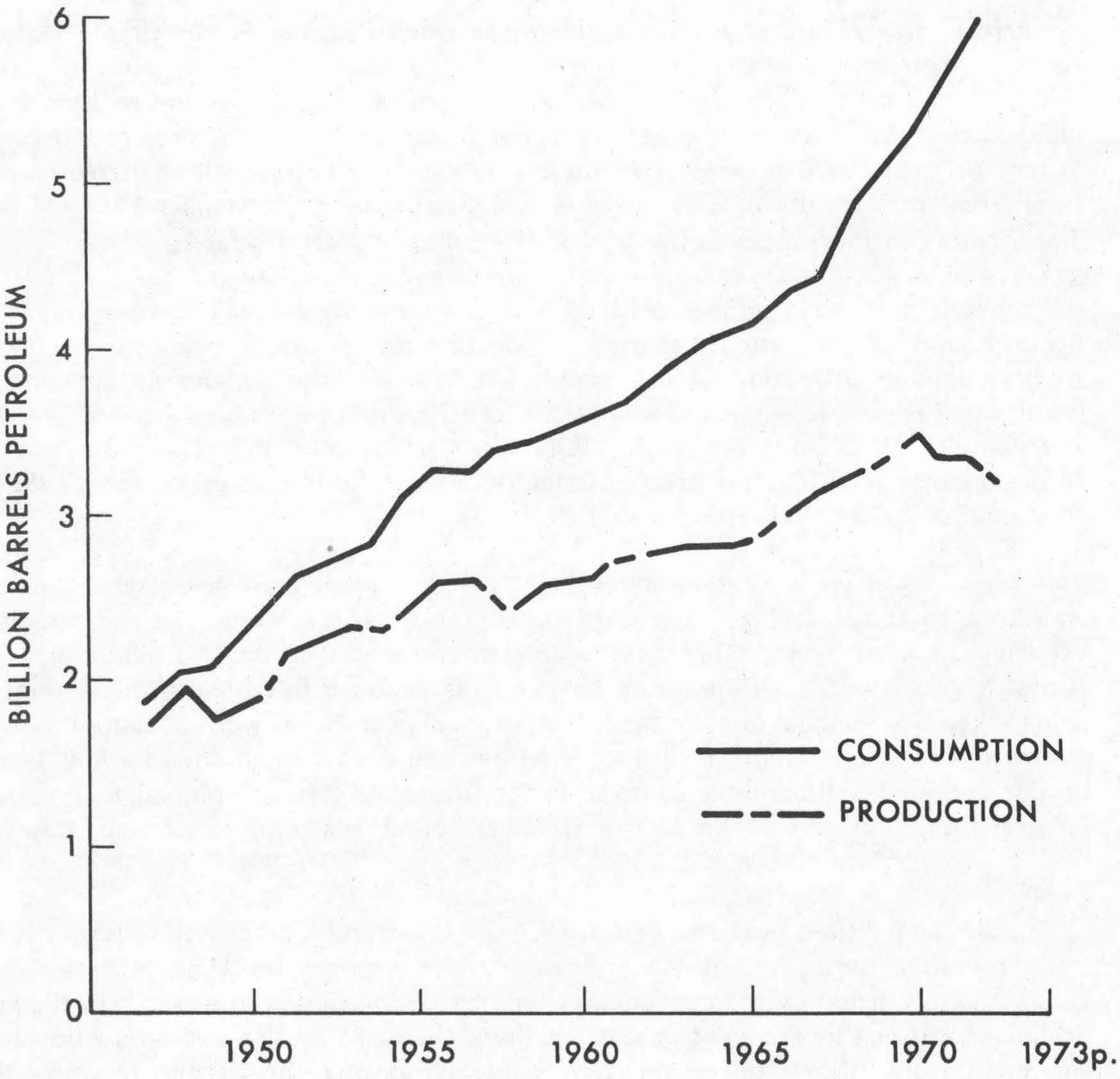
Figure 14



Source: "NATIONAL GEOGRAPHIC" June 1974 — Vol.145, No. 6, p 813

Figure 15

U.S. ENERGY PRODUCTION AND CONSUMPTION 1947-1973



SOURCE: "EXECUTIVE SUMMARY" FROM PROJECT INDEPENDENCE REPORT, (FEA).

PETROLEUM RESOURCES IN THE UNITED STATES

Proved Reserves

Since "proved reserves" is the measure of petroleum resources in least dispute, it is probably the best point of departure for probing the knotty world of oil statistics. According to the definition given by the American Petroleum Institute, proved reserves "are the estimated quantities of all liquids statistically reported as crude oil, which geological and engineering data demonstrate with reasonable certainty to be recoverable in the future from known reservoirs under existing economic and operating conditions."

There is general agreement on the amount of proved reserves in the United States: The American Petroleum Institute places them at 36.339 billions of barrels (Ref. 36); the "oil industry", according to an April, 1974 issue of *Fortune* magazine, claims we have about 37 billion barrels (Ref. 28); and the "Executive Summary" from the Project Independence Report pegs total U.S. reserves at an apparently conservative 35.3 billion barrels (Ref. 39). Data from the Institute of Gas Technology appearing in the November 11, 1974 issue of *The Oil and Gas Journal* places the total at 38.1 billion barrels (Ref. 34).

How long can we expect that much oil to last? Taking the proved reserve figures of 35-38 billion barrels, and our annual domestic production rate of over 3 billion barrels, it appears we have only about a 10 or 11 year supply left. Although the mathematics are correct, the result can be misleading; reserves that are continually being added are not considered. According to *The Oil and Gas Journal,* American Petroleum Institute data indicates that the U.S. has added 36.4 billion barrels of crude oil reserves during the period from 1958-1971, an average of 2.6 billion barrels per year (Ref. 35).

A June, 1974 issue of *Fortune* states that: "in recent years, gross new reserves found have amounted to about 2 billion barrels of oil a year . . .If discoveries rise comparably with expected accleration in drilling, new reserves found might be up to 3 billion or 4 billion barrels a year by 1980. That would be more than enough to replenish the amounts now being taken out of the ground in the U.S. each year".(Ref. 5) A word of caution is in order at this point: The amount of oil discovered per well drilled has followed a long historical decline and may well continue to do so in the future. As Kenneth Montague, president of General Crude Oil says: "The easy oil has been found. It's going to be tough now" (Ref. 5).

Reserves added have been less than total production, and total proved reserves have been on the decline during recent years, however, higher prices for U.S. crude will almost certainly result in an upturn in production and new discoveries, or at worst, slow the present decline. According to *The Oil and Gas Journal:* "Increased drilling and production activity stemming from higher prices for U.S. crude is slowing the decline in domestic oil production . . ."(Ref. 43).

The consensus of oil companies surveyed by the Journal is that domestic crude oil production is now 100,000 - 200,000 barrels per day higher than it would have been with the old oil prices. The American Petroleum Institute's latest well count, as noted in the same article, shows 14,323 wells have been drilled in all domestic areas the first six months of 1974 -- that is an increase of 17.2% from the same period in 1973 (Ref. 43).

Higher prices for crude and refined products, in addition to sparking new drilling for the "tough oil", make secondary and even tertiary recovery methods an attractive proposition for the companies operating in currently known fields. The methods will, as petroleum geologists believe, at least slow the decline in proved reserves by making it possible to recover more of the oil in known reservoirs. As *Fortune* puts it: "Right now, primary recovery is gathering in only about 20 to 30% of the total oil in the ground. Secondary recovery can double that proportion, and tertiary methods can boost total recovery to 75%" (Ref. 28).

Vincent E. McKelvey, director of the U.S. Geological Survey, declared in testimony before Senator Henry M. Jackson's Interior Committee last March: "If prices remain high, it's almost certain that secondary and tertiary recovery of oil will increase. This, along with production from previously uneconomic sources, will add to our recoverable resources" (Ref. 44).

Furthermore, even some of our currently known resources are not doing us much good; Alaska's proved reserves of about 10 billion barrels (nearly all of it in the North Slope's Prudhoe bay area) will not materially effect domestic supply until the transcontinental pipeline is complete. The Alaska pipeline, as noted by *National Geographic*, could carry 2 million barrels of oil a day by 1980 -- about 10% of estimated U.S. needs (Ref. 11).

Petroleum Resource Potential

Once outside the relatively straight-forward area of proved reserves, one steps into the arena of petroleum resource potential. Contradictory opinions abound, and, particularly in the area of what are known as undiscovered recoverable resources, differences in the estimates of magnitude can be substantial. One thing, however, seems clear: proved reserves cannot, by any stretch of the imagination, be equated with "what's left".

A discussion in *Fortune* addresses the issue: " . . .proved reserves seriously understate the amount of oil that is potentially available."

"If one turns from the American Petroleum Institute's 'proved reserve' concept to a simple 'how much is out there?' concept, the totals change dramatically. Over the years, U.S. oil producers have discovered about 430 billion barrels of oil in the U.S. Approximately 100 billion barrels have been extracted thus far, leaving 330 billion barrels still in the ground.

"Some of this oil is in abandoned fields; some of it -- including all the proved reserves -- is in currently active fields. The new higher prices for oil make it profitable to attempt recovery of perhaps half that remaining 330 billion barrels. In other words, potentially recoverable reserves now represent over 50 years supply at present rates of production.

"This calculation, furthermore, includes only oil that has already been discovered -- and we are bound to discover more. The U.S. Geological Service estimates that the lower 48 states contain somewhere between 575 billion and 2.4 trillion barrels of oil, some of it on shore and a good deal more on the continental shelf -- for example, in the Gulf of Mexico and off the Atlantic coast (Ref. 28)".

In addition to lower 48 onshore and offshore potential, Alaska's as yet unproved oil reserves may considerably extend our total resource base. Whether or not this "extension" is likely to materialize, however, may very well depend upon the exploitation of the Naval Petroleum Reserve Number 4 (NPR-4) on Alaska's north slope -- and that, more than anything else, is a political matter.

As *The Oil and Gas Journal* views north slope potential: " . . .so far the discoveries on the north slope beyond Prudhoe Bay have been few in number and nowhere near the Prudhoe scale.

"The best hunting grounds may well be located in NPR-4, where the USGS has conservatively estimated the presence of 10 billion barrels of oil -- about the size of Prudhoe's present estimate of reserves (Ref. 45)."

Full exploitation, were it possible, of the Elk Hills Naval Reserve in California (NPR-1) is not likely to have a significant impact on domestic supplies of crude. The Report by Special Sub-Committee on Department of Defense Energy Resources and Requirements of the House Committee on Armed Services, 93rd Congress, 2nd Session (HASC93-48, June 1, 1974) places Elk Hills potentially recoverable resources at 1.7 billion barrels. According to an American Petroleum Institute publication entitled *Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Productive Capacity as of December 31, 1973,* the Elk Hills Production potential is an incremental daily average of 158,000 barrels; when taken in the context of a domestic petroleum product appetite requiring almost 18 million barrels per day for satisfaction, that is, as it were, a drop in the proverbial bucket.

The Buena Vista Reserve in California and the Tea Pot Dome Reserve in Wyoming, Naval Petroleum Reserve Numbers 2 and 3 respectively, again according to the House Committee Report, are depleted and not considered in reserve figures.

The Undiscovered Recoverable Resource Debate

The National Petroleum Council, according to an April 30, 1973 issue of *U.S. News & World Report,* estimates that 385.2 billion barrels of oil remain to be discovered in the U.S., "or more than 60 year's supply at present rate of use (Ref. 40)".

The Institute of Gas Technology estimates that 335 billion barrels of recoverable oil remain in the U.S. (Ref. 34). At present production rates, that's enough to last over 100 years.

The U.S. Geological Survey's estimates of undiscovered recoverable resources are viewed as over-optimistic by a number of researchers, perhaps the most outspoken of which is M. King Hubbert. According to *The Oil and Gas Journal,* dissenters contend that USGS estimates of U.S. undiscovered recoverable resources, listed as 200-400 billion barrels of crude oil and natural gas liquids, are more than 10 times too high in some areas (Ref. 44).

USGS resource estimates are based on what is known as the Volumetric Method -- and it is this method that draws fire from Hubbert, particularly the underlying assumption that favorable but unexplored geologic formations contain in the range of 0.5 to 1.0 times as much oil as similar volumes of explored geologic formations (Ref. 44).

"Hubbert declares his calculations show that land and offshore areas of the lower 48 are literally running out of discoverable oil. He figures that less than 30 billion barrels of crude remain to be discovered.

"Based on mathematical curves tied to historic discovery rates, he places all-time recoverable crude in the lower 48 at 150-200 billion barrels, with 170 billion the most likely volume. Production and proved reserves had accounted for 143 billion barrels of this volume by the end of 1972, according to Hubbert's calculations, leaving only 29 billion for future discoveries, of this, 20 billion lies offshore.

"USGS errs in assuming that future discovery rates will remotely resemble those of the past, Hubbert maintains. He says this viewpoint ignores the diminishing returns in the form of new reserves established per foot of explatory hole drilled by a maturing oil industry whose normal practice is to drill its best prospects first." (Ref. 44).

Other undiscovered resource estimates, such as the Mobile Oil Corporation's, tend to support Hubbert's pessimistic prognosis. Estimates by the National Petroleum Council and the Potential Gas Committee fall somewhere between the extremes delimited by Hubbert - Mobile and the USGS (Ref. 44). Table 12 provides a comparison of the aforementioned estimates. These estimates are for the lower 48 onshore only and do not include natural gas liquids, hence some numbers may not seem to agree with those presented in the above narrative.

Table 12

Opposing Views of Lower 48 Onshore Potential

	Undiscovered recoverable oil (billion bbl)
U.S. Geological Survey	110-214
National Petroleum Council	53-70
Mobile Oil Corp.	11
M. King Hubbert	9

Source: *The Oil and Gas Journal,* Sept. 16, 1974, P. 25

Which estimate is least in error? In the last analysis, only time will tell.

Iowa's Oil Potential

A recent flurry of activity near the town of Grant in Montgomery County has led many Iowans to speculate that perhaps some of that "undiscovered recoverable" oil may lie beneath our state -- some of it may, but any vision of a booming oil economy is likely to remain, unfortunately, only a vision.

An investigation of the situation revealed that two test wells were drilled to about 3000' by the Blazer Corporation, a Coralville, Iowa firm. Having shown no indications of the existence of recoverable oil, the wells were abandoned and cemented shut.

Iowa's oil history, according to the Iowa Geological Survey's *Resume of Oil Exploration and Potential in Iowa,* has seen only one producing well -- the W. F. Flynn P-1. Announcement of the Washington County discovery was made March 8, 1963. The well pumped 15 barrels of oil per day until it was capped in November, 1963; total production was 400 barrels (Ref. 25).

In 1971, Colorado's 1,785 producing wells pumped an average of 41 barrels each per day; for the same year, Wyoming's 8,952 wells pumped a daily average of 45 barrels per well. Contrast these production figures with the typical Saudi Arabian well's 11,830 (Ref. 11) barrels per day.

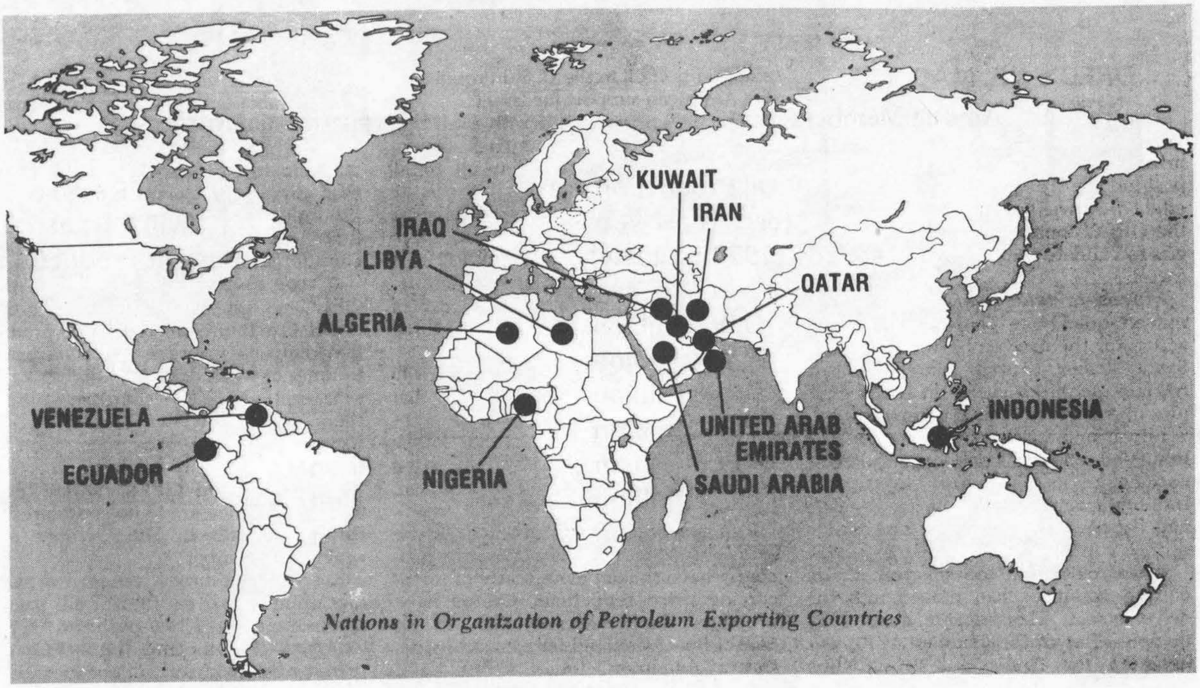
The Iowa Geological Survey endorses the view that, although some potential for crude oil production in Iowa is indicated, our state's geological characteristics are such that the probability of attaining a nationally significant petroleum and natural gas reserve is minimal.

RESERVES OF THE ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES

The Organization of Petroleum Exporting Countries (OPEC) was founded in 1960 by Saudi Arabia, Kuwait, Iraq, Iran, and Venezuela. During 1961 and 1962, Qater, Indonesia and Libya joined. In 1967, Abu Dhabi (later to become part of the United Arab Emirates) joined, Algeria became a member in 1969, Nigeria in 1971 and Ecuador in 1974 (Ref. 42). Member nations are graphically displayed in Figure 16 on the following page.

According to *U.S. News & World Report:* "For years, international companies controlled the world's flow of oil. They set prices and determined how much oil would be produced, and where.

"A study for a special committee of the U.S. House Banking and Currency Committee reports that two price cuts by these big companies in 1959 and 1960 triggered the formation of OPEC. The members announced purpose: to defend and stabilize the oil price structure that then existed" (Ref. 42).



Source: U.S. News & World Report, Oct. 28, 1974, P. 37

Figure 16

Late in 1973 OPEC hiked the price of a barrel of crude oil by 70% and then doubled that – what could be bought for less than $4.00 a few months earlier now cost $11.65. The cartel had embarked on a course of commodity price blackmail that was to have the severest of world economic consequences.

U.S. News & World Report notes that: "They now hold 38.3 billion dollars of the free world's financial reserves. By the end of 1976, at the present rate of accumulation, OPEC holdings could amount to as much as 200 billion -- the present total of all free world reserves" (Ref. 41).

How have they managed all that? Among other things, they produce 54% of all the oil in the world and hold 64% of the world's currently proven reserves -- for some countries at least, OPEC has the only store in town.

Production and reserve data for OPEC countries are presented in Table 13.

Whether or not the Cartel's iron grip on crude oil prices can be maintained over the long term is questionable; for the time being, however, it appears doubtful that any sharp cut in the price they charge the world for oil should be expected.

Table 13

The Oil Wealth of OPEC

Among Members of Organization of Petroleum Exporting Countries --

	Oil Production (barrels per year) (1974 estimate)	Oil Reserves (barrels, proven)	Years Reserve Will Last at Current Production
Saudi Arabia	3,066 million	132 billion	43
Iran	2,234 million	60 billion	27
Venezuela	1,128 million	14 billion	12
Kuwait	1,007 million	64 billion	64
Nigeria	832 million	20 billion	24
Libya	672 million	25.5 billion	38
Iraq	650 million	31.5 billion	48
United Arab Emirates	635 million	25.5 billion	40
Indonesia	540 million	10.5 billion	19
Algeria	380 million	7.6 billion	20
Qatar	190 million	6.5 billion	34
Ecuador	84 million	5.7 billion	68

Source: U.S. News & World Report, Oct. 28, 1974, P. 38

WORLD PETROLEUM RESOURCES

Proved Reserves

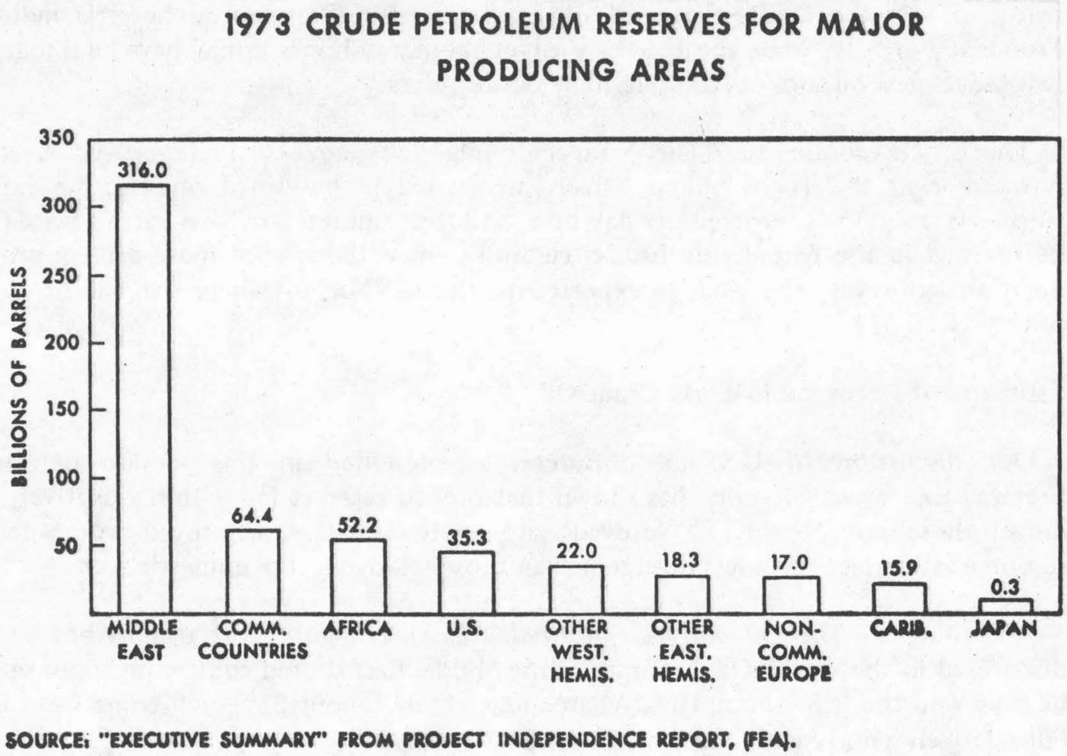
Figures concerning world proved crude oil reserves tend to run about the same order of magnitude.

Figure 17, appearing in the "Executive Summary" from the Project Independence Report, indicates world proved reserves amount to 541.4 billion barrels (Ref. 39).

Other sources of data suggest that this figure is comparatively conservative; for example, Ygnacia Bonillas, a retired Standard Oil Company of California executive, places world proved reserves at about 700 billion barrels (Ref. 33). M. King Hubbert estimates the world has about 628 billion barrels of proved crude reserves, (Ref. 11) and H. R. Linden and J. D. Parent of the Institute of Gas Technology place the figure at 633 billion barrels (Ref. 34).

NOTE: Some of the differences in these reserve estimates are attributable to the fact that they were made at different points in time.

Figure 17



The Mexican Oil Find

Recent publicity has suggested that world proved reserves might be materially increased because of oil discovered in Mexico by Petroleos Mexicanos (Pemex).

Indications are, however, that estimates of the size of the Mexican find appearing in the news media may have been exaggerated.

According to *The Oil and Gas Journal:* "The new hydrocarbon source is an oil province discovered in 1972 by state-owned Petroleos Mexicanos in the swamps and floodlands of Northern Chiopas and South-Central Tabasco (OGJ, April 29, P. 24).

"Pemex officials interviewed last week were most cautious in releasing information about the new developments -- and declined to disclose reserves estimates.

"But a major U.S. oil company says it has information that Reforma's proved reserves could amount to 10-20 billion barrels if the five fields discovered so far prove to be one giant field. However, those making this estimate admit it is based on incomplete data"(Ref. 10).

A week later, the Journal published another article saying, in part: "Mexico may not be ready to join the OPEC Cartel of oil exporters. But President Echeverria indicated to President Ford last week the U.S. can forget about any hopes it may have held that Mexico will use its new oil supplies to undermine OPEC prices."

The article continues: "The Ford entourage was advised that: proved reserves are nowhere near the 10-20 billion barrels mentioned in published reports; the exportable surplus is only 35,000 barrels per day now, and the rumored 2 million barrels per day won't be reached in the foreseeable future, certainly not without a lot more drilling proving up additional reserves; and what is exported to the U.S. or anywhere else will be at market prices" (Ref. 32).

Estimates of Recoverable World Crude Oil

Our discussion of U.S. oil resources, as presented in this section of the Iowa Freeway-Expressway Report, has shown that proved reserves fall within a relatively narrow range; those not considered "proved" are another matter. Unproved world petroleum resource estimates are no less divergent than those relative to the domestic scene.

According to *The Oil and Gas Journal:* "Bonillas figures 1.0 trillion bbl yet to be discovered in the world. Of that amount the Middle East should contribute about one-third, he says, and the U.S. about 10%. A large new chunk, about 25%, will come from the vast but relatively poorly explored Sino-Soviet area" (Ref. 33).

M. King Hubbert's assessment of world oil resources indicates that 1.072 trillion more barrels of oil will be discovered and pumped from the world's oil wells (excluding now-proven reserves) (Ref. 11).

Hubbert and Bonillas place undiscovered recoverable resources at about the same level. Other researchers, such as H. R. Linden and J. D. Parent of the Institute of Gas Technology, offer different estimates. According to them, remaining recoverable crude oil amounts to 2.685 trillion barrels (Ref. 34). This figure, of course, includes the world's proved crude oil reserves -- but even after they are deducted from the 2.685 trillion barrels, the gap is substantial.

The World Petroleum Cycle

To some extent, Hubbert and Bonillas agree on the world's petroleum cycle.

As noted in *The Oil and Gas Journal,* "Bonnillas figures that with a continuation of the rapidly increasing production rates of today, world production will peak at something over 100 million barrels per day in the year 2000.

"After that there will be a sharp decline.

'We have discovered to date enough oil, about 1 trillion barrels, to get up to the peak,' he said. 'We need to find the other trillion to get back down.

'This trend, however, can be varied sharply if the producing companies retard expansion of the producing rate. In that case, a substantial amount of the world's crude would still be available into the 22nd century.

'But if we wait for 10 years before flattening the curve (of upward production), then very little can be done to substantially alter the exhaustion of the total resource base well before the end of the next century'" (Ref. 33).

Hubbert, on the other hand, is less optomistic about the decline in the production curve; he sees petroleum resources declining rapidly after 1995 until they are substantially exhausted early in the next century. His view of the world's petroleum cycle is displayed in Figure 18.

Fortune has this to say about Hubbert: "While many dispute both Hubbert's forecasting methods and his conclusions, they no longer reject his ideas out of hand; . . .To Hubbert the history of world petroleum production, like that of other fossil fuels, follows a bell shaped curve, . . .Extraction speeds up, levels off, and then follows a roughly symmetrical downward curve until supplies are exhausted."

The article continues: "While Hubbert is classed as a pessimist, even some of the optomists concede that petroleum cannot last for very many generations. Bruce Netschert, Vice President of National Economic Research Associates, Inc., and an authority on natural resources, pooh-poohs talk of any imminent worldwide shortage of oil. But he concedes 'the petroleum age is limited'" (Ref. 8).

ALTERNATIVES TO CONVENTIONAL CRUDE OIL

We have known about oil shale and tar sands for years; until recently however, extracting oil from these sources has not been a feasible alternative to conventional crude. The costs involved, in dollars, and perhaps environmental damage, were much too high when plenty of conventional oil could be imported for less than $3.00 a barrel as late as 1972.

That situation has changed now, and it appears that at least some of the world's vast deposits of oil shale and tar sands are commercially exploitable.

According to *National Geographic,* oil shale deposits in Colorado, Utah, and Wyoming (Figure 19) are estimated to be capable of yielding about 80 billion barrels of oil under present technology. Potentially recoverable reserves amount to 600 billion barrels (Ref. 11).

TWO CENTURIES OF OIL

"The end of the oil age is in sight," says U.S. petroleum geologist M. King Hubbert. He bases his bell-shaped curve on estimated ultimate production of 2,000 billion barrels from the world's oil wells, including 300 billion barrels already used up by 1974 and 628 billion of now proven reserves. If present trends continue, Dr. Hubbert estimates production will peak in 1995--the deadline for alternative forms of energy that must replace petroleum in the sharp drop off that follows.

Source: "NATIONAL GEOGRAPHIC" June 1974

Vol.145, No. 6, pp 820-821

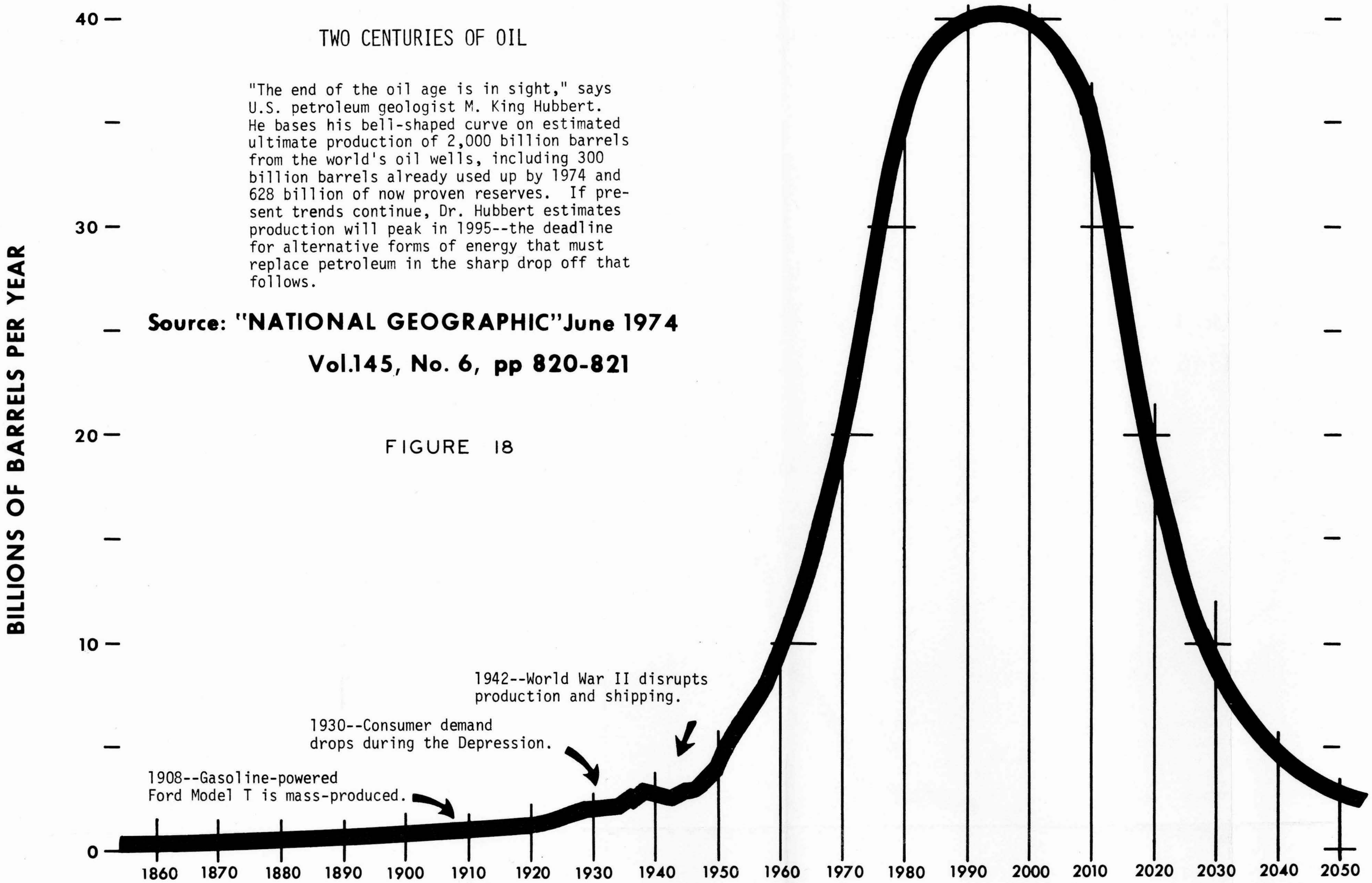
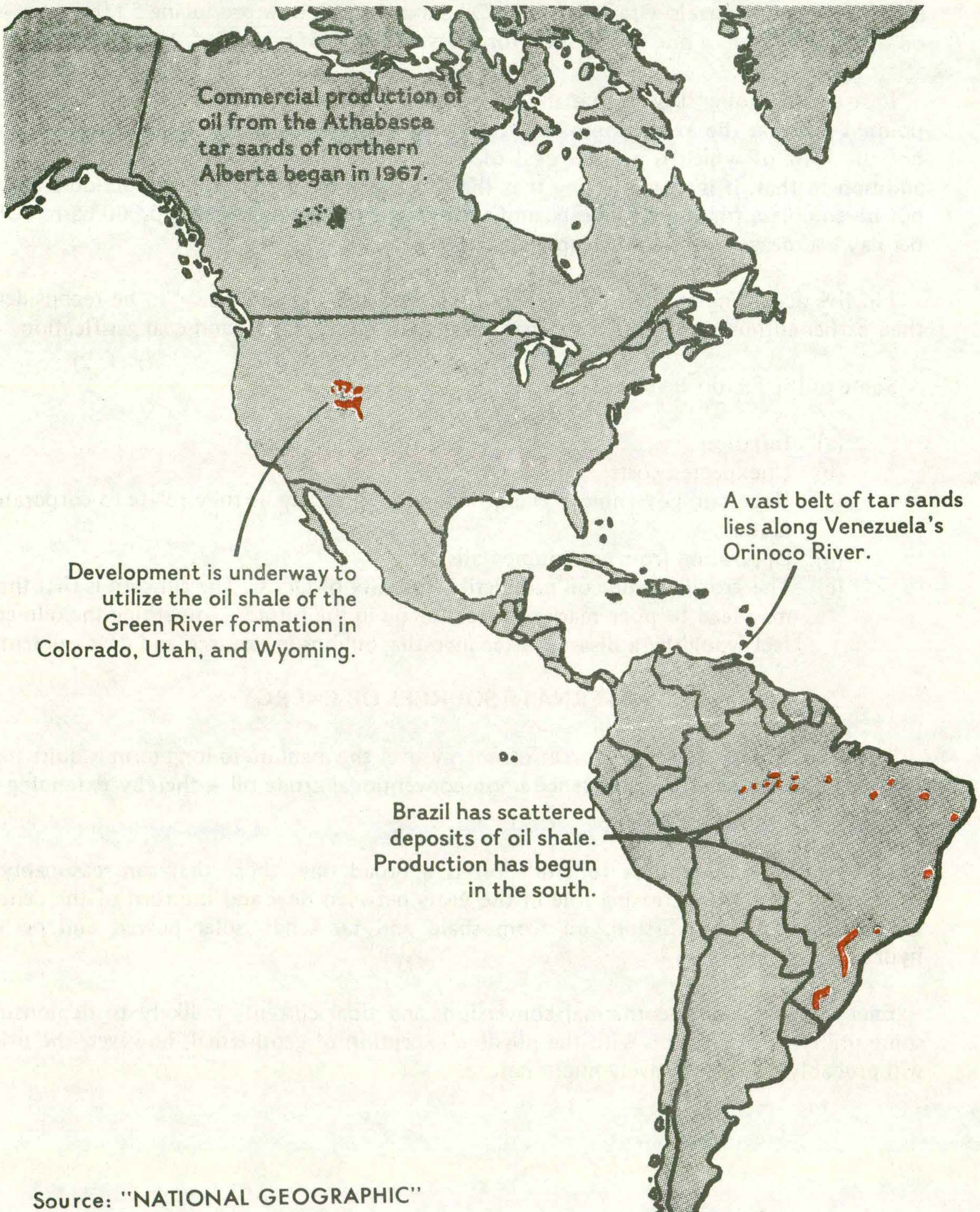


FIGURE 18

FIGURE 19
DESCRIBES THE LOCATIONS OF KNOWN EXPLOITABLE DEPOSITS OF OIL SHALE AND TAR SANDS.



Source: "NATIONAL GEOGRAPHIC"
June, 1974, Vol. 145, No. 6

As *Fortune* sees it: "The far more extensive oil shales of the Rocky Mountain states, which have stirred imaginations for half a century, are said to contain the equivalent of more than a trillion barrels of oil. But the best relatively accessible shales, containing 30 gallons per ton, may amount to only about 80 billion barrels" (Ref. 8).

Reserves of oil in the tar sands of northern Alberta, Canada (Figure 19) are estimated at about 600 billion barrels. Great Canadian Oil Sands Ltd., is now producing 52,000 barrels of oil daily at the rate of one barrel of oil for every two tons of sand (Ref. 11).

Lest the foregoing suggest that the panacea for our energy woes is at hand, it should be pointed out that the extraction of oil from shale and tar sands is fraught with difficulties, not the least of which is a good deal of opposition from some environmental groups. In addition to that, it is worth noting that the first commercial shale oil production plant will not be complete for at least 3 years, and even then it will produce only 50,000 barrels of oil per day -- a meager four minute supply for the U.S.

Finally, according to *The Wall Street Journal,* many oilmen appear to be reconsidering their earlier enthusiasm for such alternatives as shale oil, tar sands, and coal gasification. (Ref. 2)

Some of the factors involved:

(a) Inflation
(b) Unexpected costs
(c) Uncertain government energy policies, especially as they relate to corporate taxes.
(d) Opposition from environmentalists.
(e) The growing crude oil production capacity of OPEC. The concern is that this may lead to poor market prices for oil in the future -- something the oilmen feel would be a disaster after investing billions in research and development.

ALTERNATE SOURCES OF ENERGY

The adoption of alternate sources of energy over the medium to long term is quite likely to materially reduce our dependence upon conventional crude oil -- thereby extending the life of recoverable resources.

The range of alternatives to crude oil is a broad one; those that can reasonably be expected to play an increasing role in the years between now and the turn of the century include coal, nuclear fission, oil from shale and tar sands, solar power, and perhaps hydrogen.

Energy from wind, geothermal conversion, and tidal currents is likely to demonstrate some utility in the future. With the possible exception of geothermal, however, the utility will probably be of a relatively minor nature.

Nuclear fusion, once harnessed, promises to be the ultimate source of power. Fusion is relatively free of pollution problems, and, perhaps more importantly, requires a fuel -- heavy hydrogen compounds found in water -- that is virtually inexhaustible.

Unfortunately, harnessing the fusion reaction poses such enormous engineering difficulties that most scientists hold little hope for significant fusion power use before the end of the century.

All of this may have a "science fiction" flavor, but it's not as futuristic as it sounds; a great deal of research and development is taking place in these and many other energy producting technologies. They are the subjects of countless publications, conferences and meetings -- the Iowa Energy Conference (Jan. 22-24), in which all of the aforementioned alternates were discussed, is an example.

A number of authorities with extensive public and private backgrounds in energy matters presented data on a wide range of energy resources and technologies; views were aired concerning alternate energy development and environmental factors.

Since these energy concerns directly relate to transportation, members of the Iowa Department of Transportation (DOT) attend conferences of this nature.

As issues are defined and energy decisions made, the DOT's relationship with the Iowa Energy Policy Council will provide the factual material essential to arriving at a valid assessment of the extent to which transportation demands will be affected.

Hydrogen and Electric Power

The Hydrogen Economy Miami Energy Conference, held in Miami Beach, Florida on March 18-20, 1974, brought out a number of important points when considering the potential of hydrogen-energy. The following points of view were obtained from the collection of papers presented at this Conference.

Hydrogen is not a new energy; it is an energy-carrier analogous to electricity and it offers principally a long-range or strategic benefit in the sphere of energy demand and supply. Also, it is unlikely to displace all other approaches for moving energy to the consumer in wholesale fashion.

The facilities which can be readily converted to hydrogen are those presently using natural gas, which represents almost half of industrial fuel energy sources. The complete changeover may be accomplished in about five years, since the distribution system exists and only minor burner changes are required.

The residential and commercial energy sources together are comprised of 46% gas, 33% oil, 3% coal and 18% electricity. The substitution of hydrogen for natural gas can be readily accomplished by 1980. The conversion of oil and coal to hydrogen fuel could be accomplished in 20 years. Of the electric energy, 35% could be converted to hydrogen fuel by 1985.

Transportation consumes 24% of the total energy and passenger car travel consumes 55% of this amount (1970 estimates). The importance of a highly developed fuel distribution system for transportation cannot be overemphasized. Without large quantities of fuel readily available throughout the country, the present transportation system would collapse. Even if the energy necessary to operate the transportation system is available, unless the form of the fuel is compatible with the distribution and storage facilities, the energy is virtually useless.

The use of hydrogen is most advantageous to forms of transportation which have mass limitations but lesser volume limits. Aircraft, rail vehicles and watercraft are best able to utilize hydrogen fuels as they are not greatly limited by volume. Aircraft are very sensitive to loads so hydrogen gains further advantages. Road vehicles have important volume limitations so that conversion to hydrogen would be more difficult. It is estimated that 50% of the 1985 aircraft energy demand and 10% of the 1995 demand of all other transportation uses can possibly be converted to hydrogen fuel.

The technical options of the personal road vehicle of the future include: hydrogen (gaseous storage, liquid storage, metal hydride storage, chemical carriers), methane (gaseous storage, liquid storage, binary liquid solutions), methanol, ethanol, electric technology (battery, fuel cell, fly wheel), and engine technology (turbine, external combustion). It is significant that initial implementation of all the alternatives listed except hydrogen could employ either the existing gasoline distribution system, a relatively gradual modification of that system (methanol, ethanol), or the existing and pervasive electrical and natural gas networks. A battery-operated automobile, suitably equipped with an on-board rectifier, could operate and refuel virtually everywhere in the country because an extensive electrical distribution network already exists. The fuel distribution network would have to be started from scratch for the hydrogen-based alternatives. Because a hydrogen based, private vehicle ground transportation system is so different, physically, from the existing system, the need for investments contains implementation to a long period of transition.

If a compact, lightweight, and inexpensive method of storing hydrogen could be developed, the direct changeover of transportation to hydrogen fuel would be practical. Cryogenic (very low temperature) hydrogen storage may have its greatest impact on aviation, mass transit, and fleet vehicle operation where centralized refueling by trained personnel is feasible. In the case of aircraft, the extremely light weight of liquid hydrogen could prove it to be an ideal fuel.

Hydrogen can be stored as a metal hydride and released for use by the application of waste heat from the engine. Hydrides are produced by combining elements, alloys, or other compounds with hydrogen through a chemical process of varying complexity. Magnesium hydride formed from the metal and containing a small percentage of nickel as a catalyst has been found to be a lightweight material with a potential for substituting for gasoline comparable in purpose to electric vehicles under development. Refueling times of 15 to 30 minutes are anticipated.

The development and introduction of hydrides for vehicular use is best done in terms of fleet vehicle systems. A taxi or bus fleet with a central garage operation would provide the proper degree of control over fuel storage and charging operations. The vehicle would perform reasonably like a standard auto and would have a range of about 70 miles with a 1000 lb. storage unit. The vehicle would be an ideal urban car, and cooling air ducts would be attached to the vehicle and refueling would commence, with the service station receiving its hydrogen gas through a pipeline from some central source. The use of metal hydrides would thus avoid much of the expense of liquid hydrogen systems because the service station would merely tap the pipe grid which serves other domestic and industrial purposes in the proposed hydrogen economy.

A gaseous hydrogen tank for an automobile could take up the passenger space and trunk to deliver energy comparable to that of a typical gas tank. Liquid and hydride containers, by contrast, are much closer to the conventional gasoline tank in their size requirements. All of the hydrogen storage systems presently developed are somewhat bulkier and heavier than a gasoline tank.

The feasibility of converting to hydrogen in the United States appears favorable from a systems approach. By 1980, approximately 51% of the country's energy use could be converted to the use of hydrogen and by 1990, 65% could be converted. Electric power generation and industrial-fuel consumption appear to have excellent conversion possibilities. The technical capability of changeover with the residential and commercial sector exists but economic and fuel availability factors will affect the rate of conversion.

The safety considerations will be different for hydrogen, but will probably be no more stringent than present hydrocarbon fuel precautions. Overall air quality should improve as the combustion of hydrogen replaces that of fossil fuel.

Electric power generating energy is obtained from various sources as follows: coal (46.5%), natural gas (23.5%), hydropower (15%), liquid hydrocarbons (13%), nuclear and other (2%).

The demand for electrical energy has grown rapidly in the past due to the convenience and active promotion of this form of energy. Of the present residential energy, 16% is supplied by electricity and this is expected to increase to 30% by 1985 and to 35% by 2020, due to the increasing use of electrical devices. The commercial usage of electricity is anticipated to grow at the commercial growth rate of 3.5% per year. The consumption of electrical energy in the processing of materials (industrial-fuel usage) is to continue to grow at 3% per year.

Several uses of pipelined gaseous hydrogen to generate electricity are available-- conversion of existing boilers, gas turbines and Rankine cycle boiler systems designed for hydrogen. Technology for conversion of electric power generation equipment is either present or projected to be available in the near future. It is estimated that all gas-fired generation equipment can be converted by 1980, and oil fired by 1985. However, it is expected that as old equipment is phased out, replacements will operate on a fuel source other than fossil or hydrogen. Nuclear energy and solar energy are possible fuel sources. It is estimated that by 1980, 7.5% of electric power generation will be readily convertible and an additional 2.5% could possibly be converted.

The foregoing discussion illustrates the broad range of possible alternatives to petroleum. It further demonstrates that those alternatives largely apply to high volume users with stationary operations. As these possibilities continue to be explored and are eventually tapped, the energy situation will continue to take on new dimensions in transportation planning.

The Proposed 1975 Interstate-Freeway-Expressway System

Claim: Highway transportation demands indicate the need for a 2,532 mile system of Interstate-Freeway-Expressway highways (789 miles of Interstate, 734 miles of Freeway, and 1,009 miles of Expressway).

Fact: Volume and nature of traffic determine the extent of highway facility needed.

Substantial traffic already exists in most corridors of the proposed system. These traffic volumes are expected to increase in the next 20 year forecast period.

Traffic growth is not being experienced in three Expressway corridors and is not expected to significantly increase within the 20 year forecast period; these sections will therefore be deleted from the system (U.S. 71 from I-80 north to 520; U.S. 63 from 518 north to Minnesota; Iowa 150 from 520 north to 18E).

Inasmuch as traffic growth is affected by the availability of fuel, current traffic forecasts reflect the lower traffic volumes recorded in 1974. Trend lines are relatively insensitive to minor anti-trend fluctuations, therefore, historical data remains the most powerful factor in the trend projection. Trend lines will require monitoring as the energy situation and its impact on travel is more clearly defined.

States surrounding Iowa have long range plans for Freeway-Expressway systems that connect with Iowa's proposed system.

Construction scheduling for the Interstate-Freeway-Expressway System is dependent on facility needs and adequate financing. Programmed right-of-way and construction is listed on page 82.

Basis: A modern two lane highway is sufficient to serve traffic needs if the design year traffic is less than 4,000 ADT. The deleted sections of expressway are not required to provide continuity with surrounding states.

THE PROPOSED 1975 INTERSTATE-FREEWAY-EXPRESSWAY SYSTEM

Planning for an Interstate-Freeway-Expressway System begins with determining the specific needs of the highway users. Much of the information used in determining needs is obtained from origin and destination traffic surveys, traffic counts, and historical traffic related data. As indicated in the previous section of this report, major surveys were conducted in 1953 and 1954 on the east-west and the north-south routes throughout the State and again in 1959 through 1962 in conjunction with other Mississippi Valley States to provide a trip data base. This data base provided the trip information necessary to forecast future traffic demands and closely identify freeway corridor locations. This base is further broadened by using over one hundred available origin-destination studies that have been conducted at cities and towns throughout Iowa.

Traffic assigned to this Interstate-Freeway-Expressway network reflects trip desire lines from origin and destination traffic surveys and includes traffic diverted from lower type primary and secondary facilities to the higher type highway. Details of the statewide traffic forecasting procedures used for this network are found in Appendix B. Traffic growth to year 1995 is based on an interrelationship of several parameters and indicators. The relationship of highway travel, motor vehicle registration, and Gross National Product was illustrated earlier in this report. The method of "least squares" equations was used for projecting future traffic volumes, motor vehicle registrations, and vehicle miles of travel. This method in part reflects the lower traffic volumes experienced in 1974 but in determining the best fit for the equations, historical data still heavily influences the projected trend line. It will therefore be important to carefully monitor these trends as the energy situation and its impact on travel is more clearly defined.

Section volumes were then grouped into six volume ranges and illustrated on Figure 20. The volume groupings provide an easy reference for identifying the high, medium and low volume corridors.

Volume and nature of traffic indicate the extent of highway facility needed. Generally, if the design year traffic is less than 4,000 ADT a two lane modern design highway will be sufficient to serve the traffic needs. Traffic on the proposed U.S. 71 Expressway between I-80 and the 520 Freeway is well below this 4,000 ADT volume. Therefore this section of the Freeway-Expressway System is being deleted. The U.S. 63N Expressway from 518 Freeway north to the Minnesota border is also below the 4,000 ADT volume. In referring to Figure 22 and Appendix A, Figure A-2this proposed Expressway does not connect with any proposed Freeway or Expressway in Minnesota. Therefore, since the traffic needs in this corridor can adequately be met by providing a two lane modern highway and the Expressway is not needed to provide continuity with Minnesota's System it is being deleted from the Expressway System. Likewise, traffic in the 150 Expressway corridor can be served by providing a modern two lane highway and therefore is being deleted from the proposed 1975 Expressway System.

The proposed System of Interstates, Freeways and Expressways is illustrated in Figure 21. The 2,532 mile system represents 789 miles of Interstate, 734 miles of Freeway and 1,009 miles of Expressway. The reduced system provides good continuity in the State and with surrounding states as reflected in Figure 22.

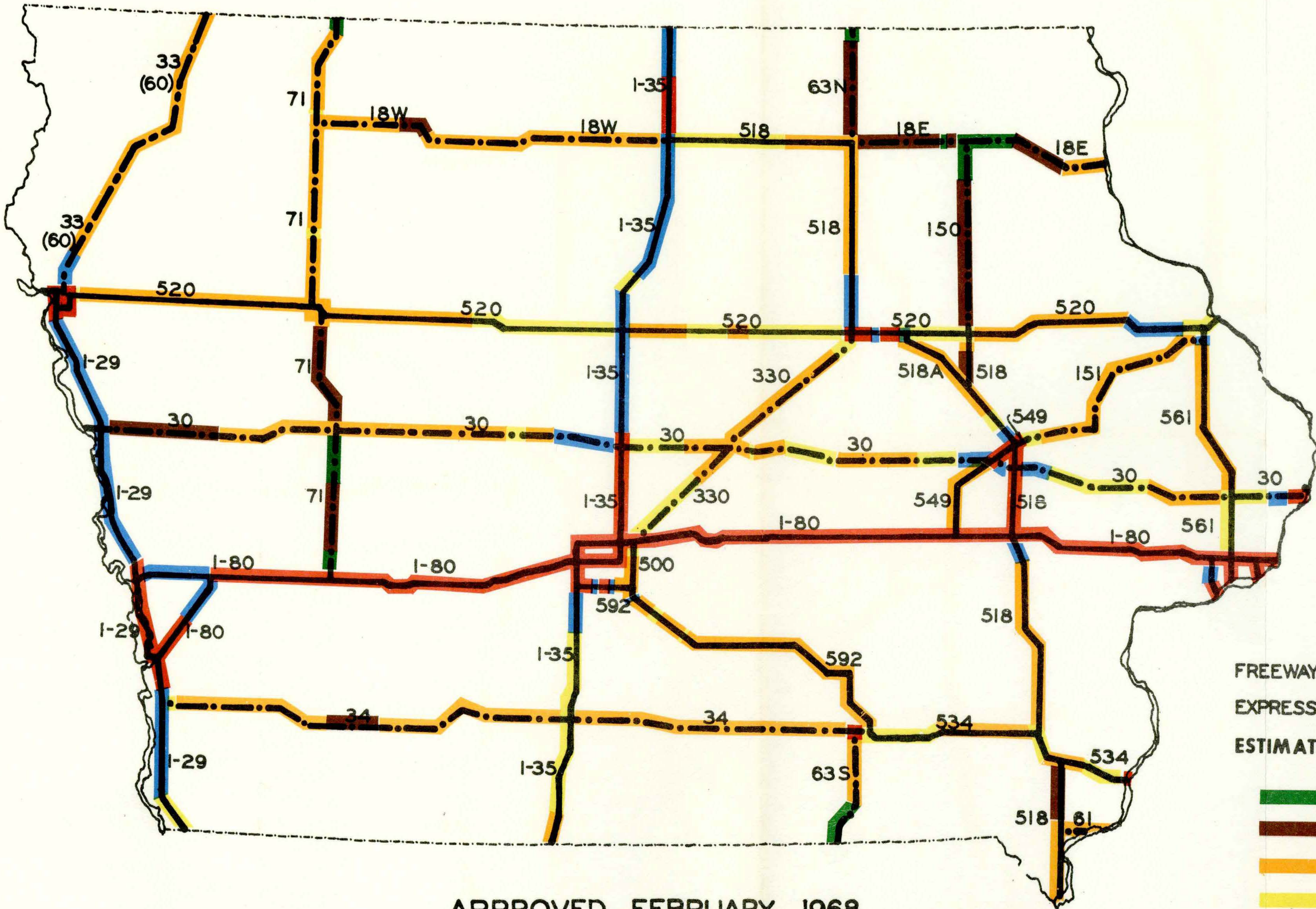
States surrounding Iowa also have prepared long range plans for their highway systems. Corridors reflecting these long range plans are illustrated in Appendix A, Figures A-1 through A-5. These systems are in various stages of planning and construction. Like Iowa, these states are also struggling with the issues that affect planning for tomorrow's transportation. Continued planning coordination with these surrounding states will be invaluable as transportation needs are jointly determined.

Construction scheduling for the Interstate-Freeway-Expressway System is dependent on facility needs and adequate financing. The Interstate System with the exception of I-680 in Pottawattamie County and I-380 from Cedar Rapids to Waterloo will be open to traffic or fully under contract in 1975, I-129 in Woodbury County by 1976, and completion of the remaining sections of interstate will be in the early 1980's.

Traffic in some Freeway corridors is presently being served by 18 foot highways that were paved 40 years ago. The critical needs of these areas will have priority in construction programming. The *1975 Primary Road Accomplishment Program and Estimated Five Year Obligations 1976 Through 1980* published by the Iowa State Highway Commission lists the following freeway-expressway construction for 1975 through 1980:

Freeway 518	- Black Hawk County, in Cedar Falls, Freeway 520 north to U.S. 20 - Cerro Gordo County, I-35 east to U.S. 65 - Washington & Johnson Counties, Iowa 92 north to I-80
Freeway 520	- Buchanan & Black Hawk Counties, U.S. 63 in Waterloo east to Iowa 187 - Dubuque County, U.S. 20 west of Dubuque east to U.S. 61 - Hamilton County, Iowa 17 east to U.S. 69 - Woodbury County, Sioux City Bypass, I-29 northeast to U.S. 20
Freeway 534	- Des Moines County, in West Burlington
Freeway 561	- Clinton County, west of DeWitt, relocated U.S. 61 north to present U.S. 61 - Dubuque County, in Dubuque, N-S Freeway - Scott County, I-80 north 3.9 miles
Freeway 591	- Marion & Mahaska Counties, west of Knoxville east 21 miles - Warren County, I-35 east to Iowa 5
30 Expressway	- Benton & Linn Counties, Iowa 82 east to Iowa 13 - Clinton County, DeWitt to Malone - Marshall County, Iowa 330 east to Tama County
330 Expressway	- Jasper, Marshall & Polk Counties, I-80 northeast to U.S. 30

IOWA'S PROPOSED NETWORK OF FREEWAYS AND EXPRESSWAYS



APPROVED FEBRUARY 1968

FREEWAYS (INTERSTATE INCLUDED)

EXPRESSWAYS ....

ESTIMATED 1995 ADT

2499 or less

2500 to 3999

4000 to 7499

7500 to 9999

10,000 to 14,999

15,000 & over

FIGURE 20

IOWA'S PROPOSED NETWORK OF INTERSTATES, FREEWAYS AND EXPRESSWAYS

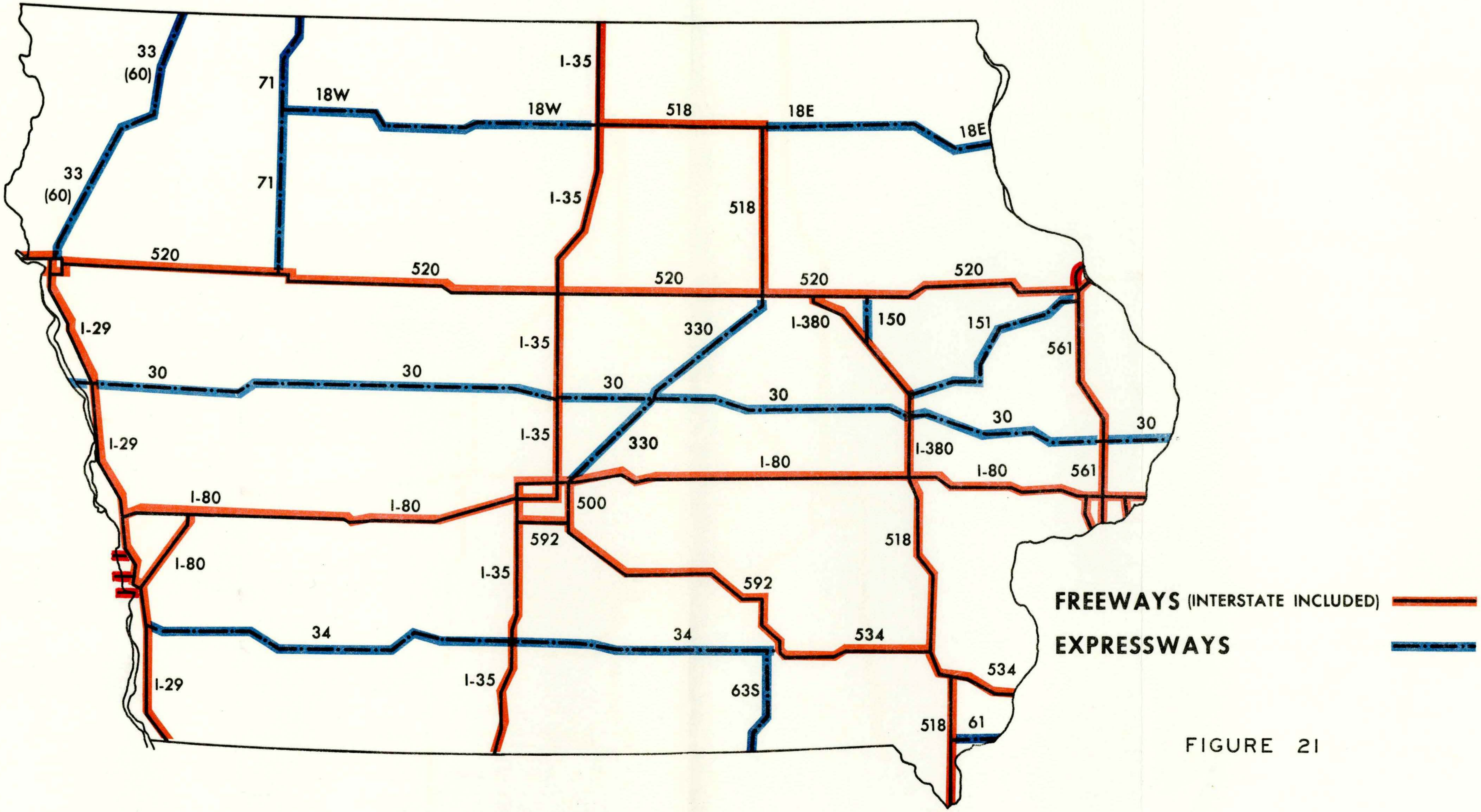


FIGURE 21

JANUARY 1975

HOW IOWA'S NETWORK CONNECTS WITH SURROUNDING STATES

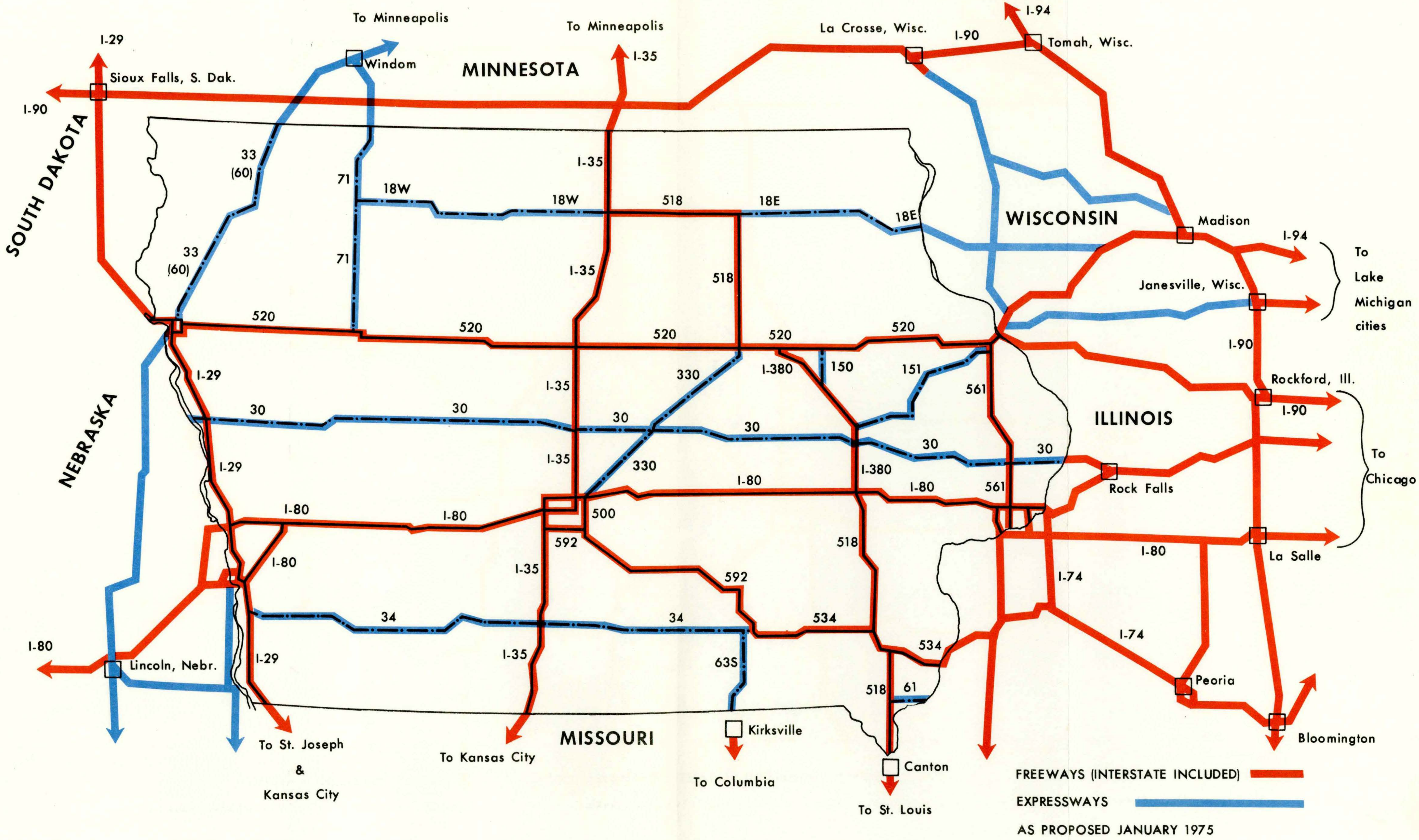
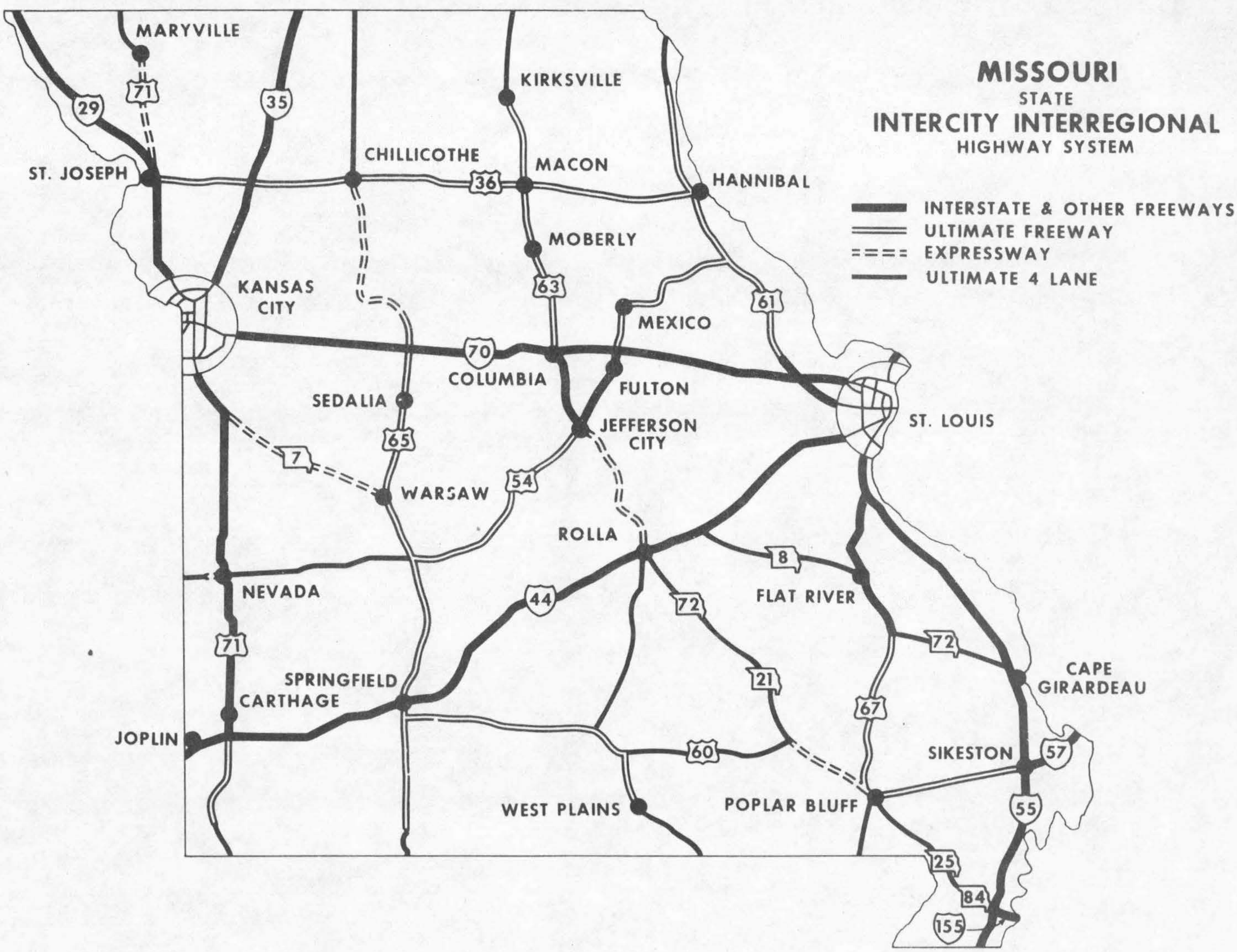


FIGURE 22

FIGURE A-3


MISSOURI
STATE
INTERCITY INTERREGIONAL
HIGHWAY SYSTEM
INTERSTATE & OTHER FREEWAYS
ULTIMATE FREEWAY
EXPRESSWAY
ULTIMATE 4 LANE
MARYVILLE
KIRKSVILLE
ST. JOSEPH
CHILLICOTHE
MACON
HANNIBAL
MOBERLY
KANSAS CITY
MEXICO
COLUMBIA
FULTON
SEDALIA
JEFFERSON CITY
ST. LOUIS
WARSAW
ROLLA
NEVADA
FLAT RIVER
SPRINGFIELD
CARTHAGE
CAPE GIRARDEAU
JOPLIN
SIKESTON
WEST PLAINS
POPLAR BLUFF
29
71
35
36
63
61
70
65
7
54
8
44
72
21
67
60
57
55
25
84
155

APPENDIX A

FREEWAY-EXPRESSWAY MAPS

FOR

ILLINOIS
MINNESOTA
MISSOURI
NEBRASKA
WISCONSIN

FIGURE A-I

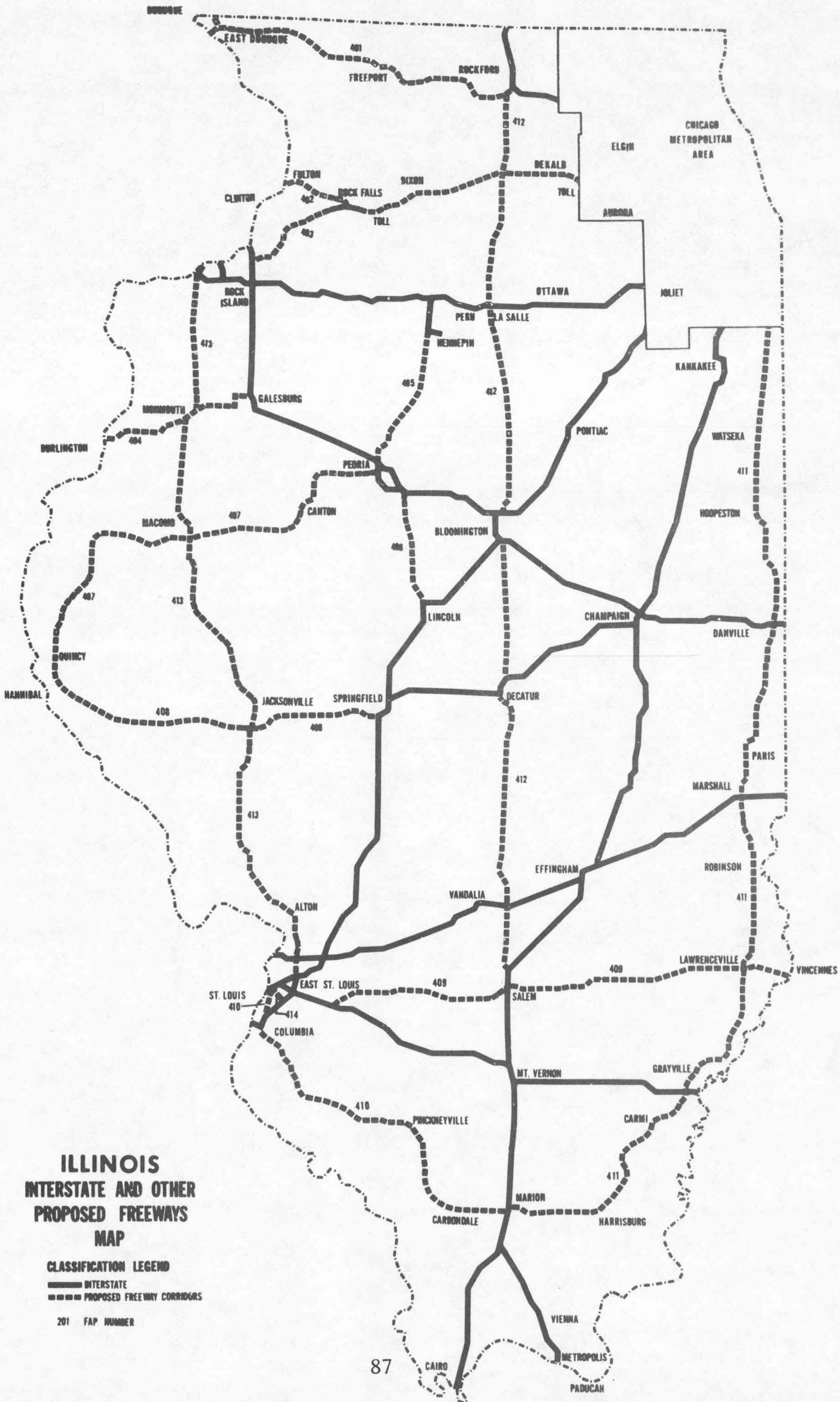

DUBUQUE
EAST DUBUQUE
401
FREEPORT
ROCKFORD
412
ELGIN
CHICAGO
METROPOLITAN
AREA
FULTON
DIXON
DEKALB
TOLL
CLINTON
ROCK FALLS
402
TOLL
AURORA
403
ROCK
ISLAND
OTTAWA
JOLIET
PERU
LA SALLE
HENNEPIN
473
KANKAKEE
405
412
GALESBURG
MONMOUTH
PONTIAC
BURLINGTON
404
WATSEKA
PEORIA
411
407
CANTON
HOOPESTON
MACOMB
BLOOMINGTON
406
407
413
LINCOLN
CHAMPAIGN
DANVILLE
QUINCY
HANNIBAL
JACKSONVILLE
SPRINGFIELD
DECATUR
408
408
PARIS
412
MARSHALL
413
ROBINSON
EFFINGHAM
VANDALIA
411
ALTON
LAWRENCEVILLE
409
VINCENNES
EAST ST. LOUIS
409
ST. LOUIS
410
SALEM
414
COLUMBIA
MT. VERNON
GRAYVILLE
410
PINCKNEYVILLE
CARMI
411
MARION
CARBONDALE
HARRISBURG
VIENNA
METROPOLIS
CAIRO
PADUCAH
ILLINOIS
INTERSTATE AND OTHER
PROPOSED FREEWAYS
MAP
CLASSIFICATION LEGEND
INTERSTATE
PROPOSED FREEWAY CORRIDORS
201 FAP NUMBER

FIGURE A-2

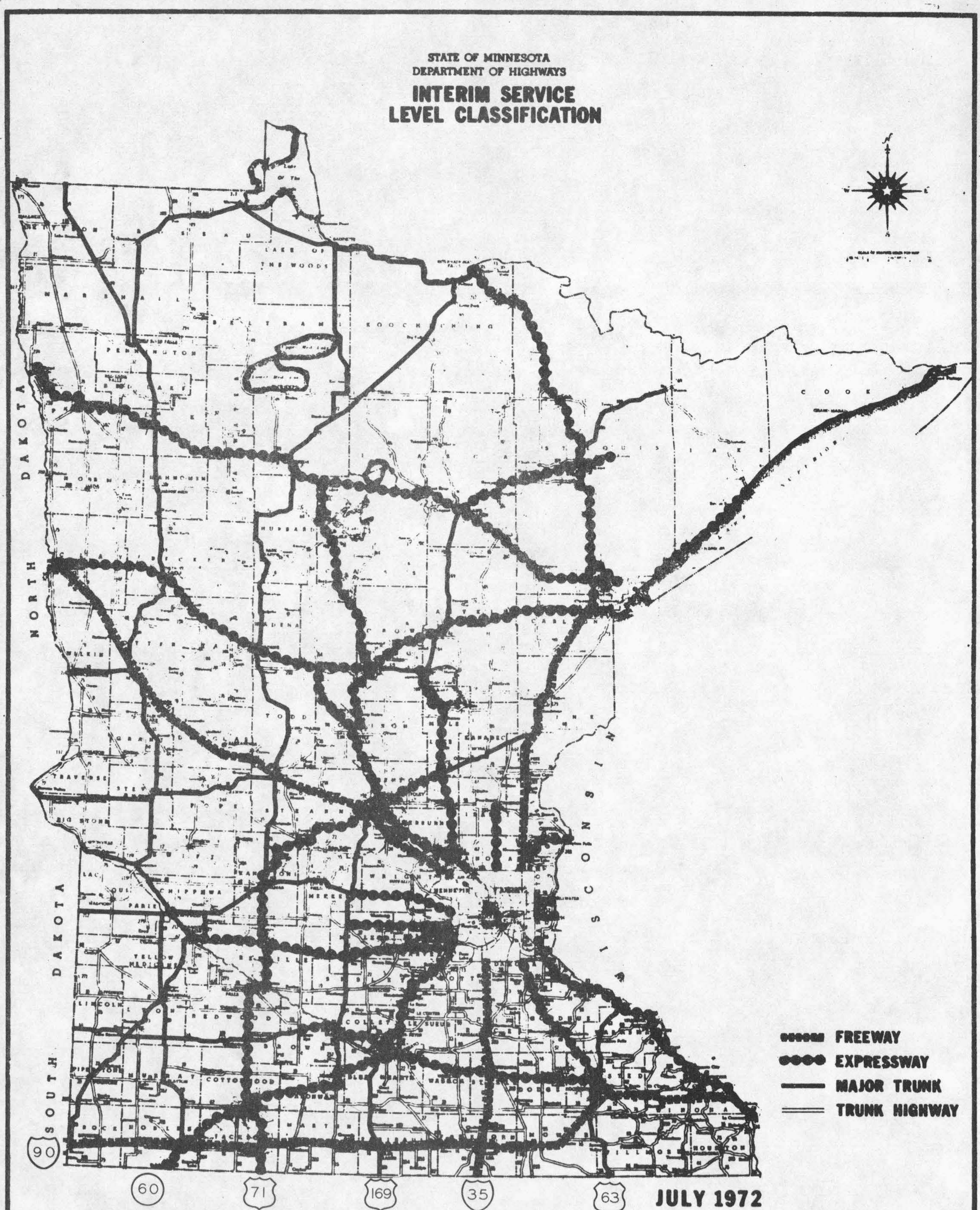

STATE OF MINNESOTA
DEPARTMENT OF HIGHWAYS
INTERIM SERVICE
LEVEL CLASSIFICATION
NORTH DAKOTA
SOUTH DAKOTA
WISCONSIN
LAKE OF THE WOODS
KOOCHICHING
COOK
FREEWAY
EXPRESSWAY
MAJOR TRUNK
TRUNK HIGHWAY
90
60
71
169
35
63
JULY 1972

FIGURE A-4

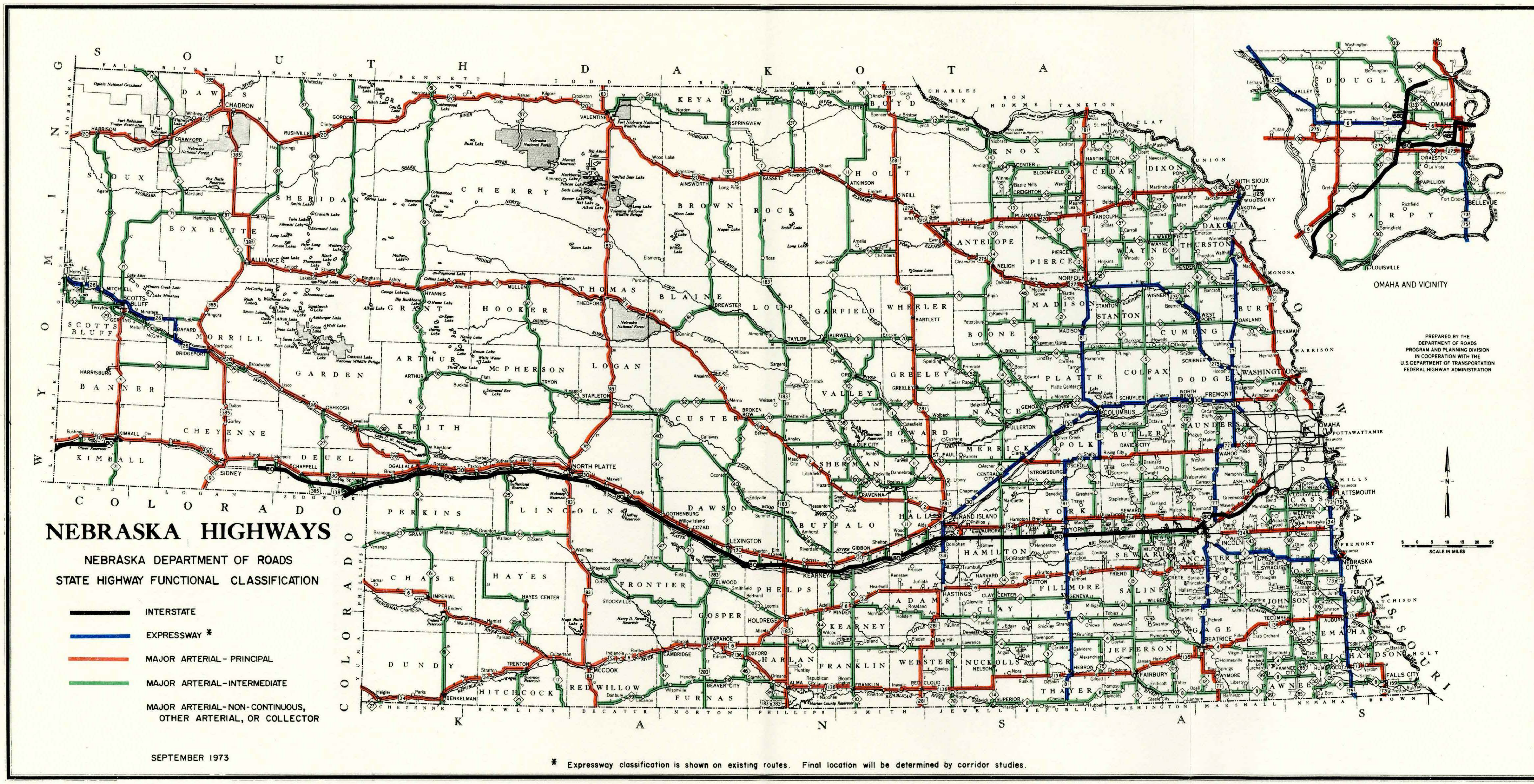
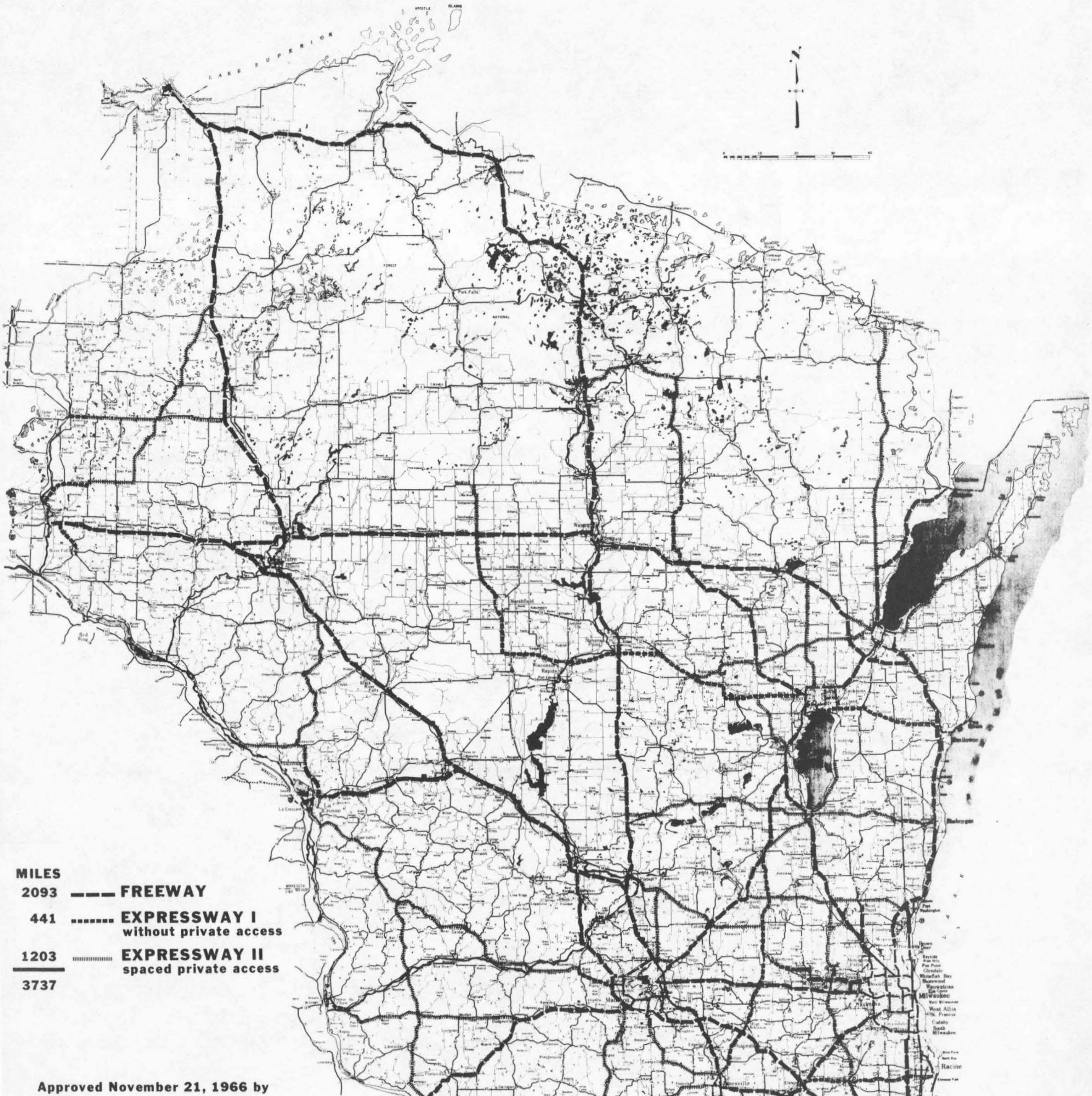

NEBRASKA HIGHWAYS
NEBRASKA DEPARTMENT OF ROADS
STATE HIGHWAY FUNCTIONAL CLASSIFICATION
INTERSTATE
EXPRESSWAY *
MAJOR ARTERIAL - PRINCIPAL
MAJOR ARTERIAL - INTERMEDIATE
MAJOR ARTERIAL - NON-CONTINUOUS, OTHER ARTERIAL, OR COLLECTOR
SEPTEMBER 1973
* Expressway classification is shown on existing routes. Final location will be determined by corridor studies.
OMAHA AND VICINITY
PREPARED BY THE
DEPARTMENT OF ROADS
PROGRAM AND PLANNING DIVISION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE IN MILES
SOUTH DAKOTA
KANSAS
COLORADO
WYOMING
MISSOURI
IOWA

FIGURE A-5

1990 FREEWAY - EXPRESSWAY PLAN



Approved November 21, 1966 by
State Highway Commission of Wisconsin

Revised - February 18, 1969
May 18, 1970
December 8, 1970
March 30, 1972

APPENDIX B

TRAFFIC FORECASTING

TRAFFIC FORECASTING FOR THE INTERSTATE-FREEWAY-EXPRESSWAY SYSTEM

The traffic estimates in this report were prepared by the Corridor Planning Department utilizing the data available in statewide traffic assignments, Interstate Cost Estimates, and project planning reports. The statewide traffic assignments were completed and published in 1964 (Ref.). Origin-destination data for this assignment were obtained from 132 interview stations of the Mississippi Valley Multiple Screenline O & D Survey conducted in 1959 and 1960. This data was supplemented by 292 internal interview stations. Zones were developed on the basis of townships of more than 150 population. This resulted in 855 internal zones plus 72 external stations at the state line, for a total of 927 zones.

The zonal population was forecasted to 1980, and a forecast of travel was made by the Fratar Method. The forecast of trips between zones was based on population growth modified by an overall state factor for increased auto ownership and increased travel in 1980. The statewide assignment was used in later Interstate Cost Estimates, and in Iowa's 1965 proposed Freeway-Expressway Network; in addition, it was used to test Alternate I-35 locations in North Central Iowa.

Assignments from the program were published by the Iowa State Highway Commission in the 1965 report *Iowa Freeway-Expressway System.* These traffic assignments were forecasted for the year 1990 and still correlate well in rural areas where little or no growth has occurred. In areas of population and economic growth, these 1990 volumes are rapidly being approached or surpassed by existing volumes on the primary highways.

The traffic estimates for each section of the Interstate System were prepared by means of a comparison program. This program compared the volumes for each route on a section by section basis from the 1965, 1968, 1970 and 1972 Interstate Cost Estimates. The basic data for this analysis was the turning movement information for each interchange developed from the Interstate Cost Estimates. From this comparison, an estimated 1972, 1980, 1990 and 2000 ADT turning movement for each interchange on the Interstate System was developed. For those sections already open to traffic, the estimated 1972 ADT was compared to the most current traffic count data available.

After these comparisons were made, any necessary adjustments were made to the average estimated volumes to produce a final volume for each section. This method of preparing traffic estimates makes it possible to utilize data from previous estimates thus providing a broader base for this estimate. In comparing the estimated 1972 ADT to actual 1972 counts observed on the opened Interstate System, most cases compared very well, thus indicating previous estimates were still valid. The 1995 forecasted volumes for the Interstate System were derived by averaging the 1990 and 2000 volumes.

Forecasted volumes for the Freeway-Expressway System also utilized a comparison analysis. The Freeway-Expressway Report developed in 1968 contained 1990 forecast volumes on a section by section basis. Since that time traffic estimates have been prepared for various Freeway-Expressway projects, some are in the design stages while others are constructed and open to traffic. These estimates and the latest traffic counts were utilized in the comparison analysis.

Traffic estimation for an Interstate-Freeway-Expressway System is one of the most complex tasks facing the highway engineer today. Unlike many other engineering decisions, forecasting traffic involves many subjective parameters that must be considered and quantified with the best judgement available. Engineering materials, for example, can be tested and expected to perform to certain standards. The accuracy of a traffic forecast can only be finally judged when the forecast interval has elapsed. The accuracy of the forecast rests basically with the accuracy of the assumptions and their application. It is difficult to reflect the impact of energy shortages, reduced economic activity, major depression or world war when projecting historical trends. The forecasted volumes contained in this report are satisfactory for a systems approach but will need to be periodically updated and evaluated in the project planning development stage.

APPENDIX C

ACCIDENT COST DATA

ACCIDENT COST DATA

Numerous state highway agencies, the Federal Highway Administration, the National Safety Council, and private insurance organizations have conducted studies to determine the costs of traffic accidents. Traffic accident cost may be expressed as direct cost and indirect cost.

Direct cost (Ref. 3) is defined as the monetary value of property damage, ambulance fees, medical services, work time lost, loss of use of vehicle, legal and court fees, damage awards and settlements, and other miscellaneous cost items. Direct cost, in other words, is the monetary value of damage and losses to persons and property which results directly from accidents and which might have been saved the motor vehicle owner had the accident not occurred.

Indirect cost (Ref. 9) is the monetary value of damages and losses to persons and property which results indirectly from the accident, plus those expenditures related to accident prevention. This includes loss items such as the future earnings of persons killed or permanently injured in accidents.

It should be noted that, although funeral costs are "out-of-pocket" expenses which occur directly after a fatality, they are not considered as an element of direct cost since it is reasoned that death is inevitable and that the accident merely fixes the time of death (Ref. 30). Thus funeral costs are considered indirect costs in an accident. In many of the accident cost studies (Refs. 4, 12, and 30), damage awards or settlements made as the result of a fatality or serious injury have been considered a direct cost item. However, in some accident cases, the value of such damage settlements could exceed the indirect costs associated with the loss of future earnings or societal costs. An example of this would be those damages awarded for permanent disfigurement.

Another item which can make a significant difference in the indirect accident cost is the discount rate used to determine the present worth of expected future earnings and related injury costs (Ref. 1). A review of the literature indicates that the minimum discount rate should be four percent. Accident cost studies are presented in this appendix to determine the parameters used, the variation in costs associated with traffic accidents, and how these costs can be used effectively in the evaluation of highway safety improvement projects. The majority of these studies consider accident costs in the following three categories: fatality, injury, and property damage only. A brief discussion of each study follows and a summary of results is found in Table C-10.

Illinois Study

In Illinois, a study was conducted in 1959 using accident data for the calendar year 1958 (Ref. 12). This study sampled both the State's file of accident reports and the State's file of registered motor vehicle owners. Thus, through matching results, it was possible to obtain cost values for both reported accidents and unreported accidents. Table C-1 shows the costs per accident involvement by vehicle type for urban locations and for intersections:

Table C-1

Accident Costs per Vehicle Involvement - Illinois, 1958

Severity	All Accidents Pass. Cars	All Accidents Trucks	Urban Accidents	Intersection Accidents Urban	Intersection Accidents Rural
Fatality	$5,061	$5,242	$5,426	$7,272	$9,330
Injury	821	695	860	1,663	1,490
P.D.O.	100	86	114	165	255

It can be noted by comparing the two sets of accident costs that the cost per accident at an intersection is much higher than the costs associated with accidents on other portions of the roadway. It should also be noted that the Illinois accident costs do not include indirect cost, such as the loss of future earnings. This indirect cost can be the most important component in total costs involving fatal accidents.

Washington, D. C. Study

In 1964, a study was conducted in Washington, D. C., on the costs involved in vehicle accidents (Ref. 7). This study involved the systematic selection of samples from official police records for the study of reported involvements and from motor vehicle registration data for the study of unreported involvements. In addition, home interviews were conducted in connection with the sample of reported involvements and questionnaires were mailed to sampled vehicle owners. A 100 percent sample was selected for all involvements in accidents where:

1. A fatal injury occurred;
2. Injuries occurred to three or more persons;
3. Property damage was estimated as $5,000 or more.

Out of a total of 107,618 recorded involvements, 13,881 were sampled.

The Washington Area Motor Vehicle Accident Cost Study was the first study of its type of include costs for the present value of loss of future earnings for persons fatally injured or permanently impaired. Table C-2 shows the accident cost per vehicle involvement for the three different categories of traffic accidents from this study.

As can be seen by comparing the data in Table C-2 to the costs associated with accidents in the Illinois study, the inclusion of indirect costs makes a significant difference in the cost of fatal accidents.

Table C-2

Accident Costs per Vehicle Involvement
Washington Area Motor Vehicle Accident Cost Study

Severity	Accident Costs Direct and Indirect
Fatality	$47,481
Injury	863
Property Damage Only	193

Texas Study

The Texas Transportation Institute in 1970 utilized cost data developed in Illinois, Massachusetts and New Mexico to develop a method for estimating Texas accident costs (Ref. 4). The cost estimates include direct and indirect accident costs and are based upon a vehicle involvement. The Washington, D. C. Study and the Illinois Study also used involvements as the basic study unit. A distinction should be made between the concept of an accident and an involvement. A traffic accident is any incident involving one or more vehicles in motion, which occurs on a traffic way and results in death, injury and/or property damage. An involvement is that portion of an accident relating to a single vehicle and the death, injury and/or property damage associated with that vehicle.

Frequency data for the vehicular involvements in accidents were obtained from Texas accidents reported in 1969 and were used to develop weighted averages to apply to the cost data. Fatal accident costs included direct costs as well as indirect costs. The Texas Accident Cost Study was one of the first studies to determine accident involvement costs by highway type, highway system, road characteristics, types of vehicles involved, the type of accident, (e.g. rear end or sideswipe), and accident severity. Table C-3 illustrates some of the costs associated with accidents from the Texas Study.

Table C-3

Direct Cost per Accident Involving Multi-Vehicles, by Accident Type, Texas 1969

Accident Type	Severity of Accident Fatal	Injury	P.D.O.	All
Head-On	$16,516	$3,341	$595	$3,500
Rear End	12,093	1,932	310	700
Angle	13,413	1,873	405	900
Sideswipe	12,799	1,302	246	400
Turning	10,242	1,875	321	700
Parking	---	923	133	200
Other	6,392	1,722	152	400
All	13,781	1,955	318	800

It is interesting to note, when comparing the ranking of all accidents by type, that head-on accidents are most costly followed by angle accidents. Rear end and turning accidents are next, with sideswipes and parking accidents being the least costly among these categories.

California Study

In 1964, California developed accident costs based upon accident data from the State of Illinois, utilizing the Consumer Price Index to reflect the general increase in accident costs from 1958 to 1964. Since the Illinois costs reflect the average number of persons killed and injured per vehicle or involvement, California utilized data from their own accident files to determine the number of vehicles involved in each accident to arrive at accident costs. Table C-4shows the various costs of the fatal, injury and property damage accidents for reported and unreported accidents in both rural and urban areas of California.

Table C-4

Accident Costs in California, 1964

	Reported Accidents			Unreported Accidents		
Severity	Rural	Urban	Total	Rural	Urban	Total
Fatal	$9,660	$7,740	$8,950	---	---	---
Injury	2,500	2,030	2,200	$940	$1,030	$980
P.D.O.	490	310	360	230	170	180
All	1,610	990	1,190	270	180	200

It should be noted that accident costs for California are similar to those determined in the Illinois study, since they consider only the direct accident costs. They reason that the utilization of indirect costs involves the rather difficult and philosophical question of whether or not anticipated future earnings are in fact a loss to society in general. They feel direct costs provide a more reasonable and conservative estimate of the expenses of highway users in traffic accidents.

Ohio Study

Using accident and vehicle registration data for the year 1961, the Transportation Engineering Center of Ohio State University prepared for the Ohio Department of Highways an analysis of motor vehicle accident costs in the State of Ohio. This study involved the statistical sampling of the reported accident files as well as the registration files. By using this method, they were able to obtain reported accidents as well as unreported accidents. A total of 208,931 passenger car accidents were analyzed, which included 134,214 property damage only, 73,623 nonfatal injury, and 1,094 fatal injury accidents. In addition to passenger cars, accident data and registration information were sampled for lightweight trucks, other single-unit trucks and truck combinations. Accident costs were developed, not only for the rural and urban highway situation, but also for the various types of collision, such as head-on, rear end and sideswipe, and also for the vehicle types previously mentioned.

Table C-5 shows some of the accident costs that were developed in the Ohio study:

Table C-5

Rural Accident Costs in Ohio
1961, Two or More Vehicles

Type of Accident	Passenger Cars Fatal	Passenger Cars Injury	Passenger Cars P.D.O.	Trucks Fatal	Trucks Injury	Trucks P.D.O.
Head-on and Sideswipe (Oppsite Direction)	$7,495	$1,171	$312	$5,517	$1,545	$203
Rear End and Sideswipe (Same Direction)	5,792	892	115	5,263	1,183	163
Angle and Turning Movement	5,489	1,408	178	7,226	1,049	98
Parking, Backing or Collison with Parked Vehicle	2,604	583	104	474	796	59

In the Ohio study, only direct costs occasioned as a result of the accidents were used. The Ohio study follows the same concept as those conducted in Illinois and in California.

National Safety Council

The National Safety Council (Ref. 24) prepares yearly publications relating to accident costs associated with all classes of accidents. The cost data for their estimates are based upon information from the National Center for Health Statistics, State industrial commissions, state and local traffic authorities, State departments of health, insurance companies, industrial establishments and other sources. The accident costs developed by the National Safety Council include wage losses, medical expenses, insurance administration costs, and the present value of anticipated future earnings for permanent total disability or death. The accident costs in Table C-6 have been developed by the National Safety Council and are shown for three different years to illustrate the inflationary trend in accident costs.

Table C-6

Traffic Accident Costs - National Safety Council, 1964, 1971, 1973

	Year		
Severity	1964	1971	1973
Fatality	$34,400	$52,000	$90,000
Injury	1,800	3,100	3,700
P.D.O.	310	410	500

As can be seen from the data in Table C-6, there has been an increase in the costs associated with motor vehicle accidents between 1964, 1971 and 1973.

KLD Associates Study

In 1973 a study was prepared by KLD Associates (Ref. 1), to evaluate many of the previously mentioned accident cost studies and develop relative accident cost figures that could be applied to any given situation. This study attempted to weight and update the accident cost data developed by other studies. An objective was to develop a quantative figure of merit or index of accident costs that can be used in the evaluation of accidents as it affects the decision making process related to safety projects. Table C-7 displays the summary of accident costs developed in this study.

Table C-7

Summary of Accident Cost Data

Accident Type	Fatality	Injury	P.D.O.	All
Head-on	$58,116	$3,341	$595	$3,500
Rear End	53,693	1,932	310	700
Angle	55,013	1,873	405	900
Sideswipe	54,399	1,302	246	400
Turning	51,842	1,875	321	700
Pedestrian	46,879	1,433	---	5,100
Average	$50,000	$2,500	$500	---

Based on the data in Table C-7, it was recommended that the average costs of $50,000 per fatality, $2,500 per injury and $500 per property-damage-only (P.D.O) are suitable for use in accident analysis studies. It should be noted that these costs consider indirect costs which include the loss of total earnings.

Other Sources

The previous studies are not the only sources of accident cost data; insurance organizations, such as the Insurance Information Institute (Ref. 1), also develop accident costs. These accident costs are based upon a sampling of State traffic accident reports and include all injuries and accidents whether on public roads, private property, or on public streets and highways. Accident costs included in the Insurance Information Institute's figures include wage loss, medical expense, property damage values and insurance-related administrative costs. The Insurance Information Institute, which is a public relations and educational organization sponsored by the insurance industry, publishes a yearbook of insurance facts. The Institute also compiles accident rates and provides statistical services to insurers and other organizations based on information filed by participating companies. Table C-8 shows costs for accidents in 1971 as estimated by the Insurance Information Institute.

Table C-8

Traffic Accident Cost Data, 1971,
Insurance Information Institute

Severity	1971 Accident Costs
Fatality	$48,115
Injury	2,850
P.D.O.	570

Another area that was reviewed was explored in a recent study (Ref. 1) which attempted to define and estimate in economic terms the losses in societal welfare or level of social well-being. Categories included in this analysis are medical costs, productivity costs, property damage, losses to other individuals, insurance administration, funeral costs, employer losses, community service losses, pain and suffering, and miscellaneous accident costs. Based upon the data from this study, the costs in Table C-9 were developed for the three different types of accidents.

Table C-9

Societal Costs of Motor Vehicle Accidents, 1972

Severity	Cost
Fatality	$234,960
Injury	11,200
P.D.O.	500

When comparing the costs shown in Table C-9 to the costs developed in previous studies, it appears that the societal and intangible costs have a tremendous impact in fatal and injury accidents.

In 1970, the Department of Transportation, Federal Highway Administration, prepared an Automobile Insurance and Compensation Study (Ref. 9), which represents the results of a probability sample survey of police reported injuries and fatalities related to automobile accidents in 48 states and the District of Columbia. The study is a very detailed and comprehensive analysis of automobile accidents occurring in the United States during the year 1967. The results indicate that the average economic loss for seriously injured persons was $4,200; Of this, 45 percent is wage loss, 38 percent is medical costs, and 12 percent is property damage. It was demonstrated that over 50 percent of the persons who died as the result of automobile accidents had a present worth of future earnings in excess of $25,000. The average economic loss for fatality cases exclusive of lost earnings, was placed at $2,300; of this amount, funeral and related costs contributed over half.

Results of the study indicated that legal costs amounted to approximately 25 percent of the total recovery in tort claims for serious injury or fatality cases. On the average, approximately 16 months elapsed between the date of accident and final settlement of tort claim. Larger economic claims were settled after long delays and small claims after shorter delays.

Accident Costs - Summary

From the data presented in this appendix it can be seen that accident costs vary considerably, depending upon the source of the accident data, the methodology used in the analysis of the accident data, and the intended purpose for which the accident costs were developed. The decision of whether indirect costs should be used still varies depending upon the state utilizing the data.

Table C-10

Accident Costs By Type Accident
From Various Studies

(in Dollars)

Accident Study	Cost Unit	Accident Category: Fatal	Injury	P.D.O.	Discount Rate	Date of Costs
Illinois	Accident	5,061	821	100	--	1958
NCHRP 130	Accident	5,242	821	100	--	1972
Washington, D.C.	Involvement	47,481	863	193	4	1964
	Involvement	20,300	740	193	10	1964
Texas	Accident	50,227	1,917	334	4	1970
	Accident	29,927	1,917	334	10	1970
California	Accident	8,950	2,200	360	--	1964
Societal	Accident	234,960	11,200	500	4	1972
NSC	Case	90,000	3,700	500	4	1973
	Case	52,000	3,100	440	4	1971
	Case	34,400	1,800	310	4	1964
I.I.I.	Case	48,115	2,850	570	4	1971

APPENDIX D

TRIP DATA SURVEY AT GRAIN TERMINALS LOCATED IN McGREGOR AND CLAYTON, IOWA

TRIP DATA SURVEY

AT GRAIN TERMINALS LOCATED

IN McGREGOR AND CLAYTON IOWA

November 1973

Prepared by

TRANSPORTATION DATA BASE DEPARTMENT

DIVISION OF PLANNING

IOWA STATE HIGHWAY COMMISSION

In Cooperation with the

UNITED STATES DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

A study was conducted November 14, 1973, at the grain terminal facilities along the Mississippi River in McGregor and Clayton, Iowa. The objective of this study was to obtain trip data on the grain trucks that utilize these two terminals.

The Farmers Grain Terminal, located in McGregor, Iowa, is in operation from March to December. Grain is shipped from the terminal by barge five days a week. The average number of trucks unloading at the terminal during the spring and summer months is approximately 80 per day. During the fall, approximately 120 trucks utilize this terminal each day. The trucks haul primarily from grain elevators within a 100 mile radius of the terminal. They then return, empty, to their point of beginning. Some of the trucks, coming from the closer locations, make two to three trips a day to the terminal.

The Patterson Grain Terminal is located just south of Clayton, Iowa. The terminal is in operation from March to December and grain is shipped from the terminal by barge five days a week. The average number of trucks utilizing the terminal ranged from approximately 160 per day during the summer months to approximately 130 during the fall months. The number of trucks utilizing the terminal during the summer months of 1973 was probably somewhat higher than average due to a difficulty in obtaining barges during the early spring months.

Two days' trip data was obtained at each terminal, one day during a peak period of operation and one day during a normal period of operation. This data was obtained from the trip records (Daily Grain Log) on file in the main office of each terminal. See attached vehicle type summaries and traffic flow diagrams for Clayton and surrounding counties.

Also adding to the number of truck movements in this area, is an industrial sand quarry located one mile south of Clayton. Approximately 70 loads of industrial sand are transported from this quarry weekly. Approximately 50 of these 70 loads are bound for the John Deere Foundry located in Waterloo. A small portion of the trucks hauling grain to the Patterson Terminal in Clayton haul sand from this quarry on their return trip.

ALL GRAIN TRUCK TRIPS TO FARMERS GRAIN TERMINAL
IN MC GREGOR, IOWA ON MAY 25, 1973

	Single Unit		Truck Tractor-Semi-Trailer		
	2 axle	3 axle	4 axle	5 axle	Total
McGregor	2	2			4
Fredericksburg	1	9		6	16
Ventura				1	1
Dunkerton				2	2
St. Olaf	2				2
Cresco				9	9
Maynard		16	1	2	19
Greene				7	7
Dougherty				1	1
Luana		1			1
Nashua				4	4
West Union	1	2			3
Lake Mills				1	1
Rockford				2	2
Thornton				1	1
Carpenter				2	2
Ionia			1		1
Rockwell				2	2
Kanawha				1	1
Total	6	30	2	41	79

The volumes shown represent only the trip from the various locations to the terminal and do not account for the return trip.

ALL GRAIN TRUCK TRIPS TO FARMERS GRAIN TERMINAL
IN MC GREGOR, IOWA ON NOVEMBER 13, 1973

	Single Unit		Truck Tractor-Semi-Trailer		
	2 axle	3 axle	4 axle	5 axle	Total
Fredericksburg		3		5	8
Elkader	15	9			24
McGregor	11			1	12
Monona	1	5			6
Readlyn				4	4
Postville		2			2
Colewell				4	4
Ventura				3	3
Thornton				2	2
Luana	1	2			3
Grafton				1	1
St. Olaf	3				3
Cresco		2		9	11
Maynard				8	8
Waukon	7	3			10
Greene				2	2
Dunkerton				4	4
Allendorf				3	3
Rockford				2	2
New Hampton				1	1
Marble Rock				1	1
Total	38	26		50	114

The volumes shown represent only the trip from the various locations to the terminal and do not account for the return trip.

ALL GRAIN TRUCK TRIPS TO FARMERS GRAIN TERMINAL
IN CLAYTON, IOWA ON JULY 11, 1973

	Single Unit		Truck Tractor-Semi-Trailer		
	2 axle	3 axle	4 axle	5 axle	Total
Fayette		1		3	4
Monona		8			8
Tripoli				10	10
Elkader	11	8			19
Masonville				3	3
Protivin		3		3	6
Farmersburg				1	1
Garnavillo	11	2		4	17
Nashua		1			1
Eitzen, Minn.				6	6
Oran	2	2		1	5
Fairbank		1		4	5
Clear Lake				1	1
St. Ansgar				1	1
Arlington	1	2		1	4
Strawberry Point				3	3
Packard		2		3	5
Carterville		1		1	2
Oelwein		1		5	6
Aurora		2		1	3
Waukon		1			1
Riceville				4	4
Chester				4	4
Rockford	1	2	1		4
Charles City		6		1	7
Marble Rock		9	3	2	14
Westgate		2		4	6
Fredericksburg		1	2	2	5

(Continued)

ALL GRAIN TRUCK TRIPS TO FARMERS GRAIN TERMINAL
IN CLAYTON, IOWA ON JULY 11, 1973 (Continued)

	Single Unit		Truck Tractor-Semi-Trailer		
	2 axle	3 axle	4 axle	5 axle	Total
Lamont		2		1	3
Hazelton				1	1
Denver				3	3
Total	26	57	6	73	162

The volumes shown represent only the trip from the various locations to the terminal and do not account for the return trip.

ALL GRAIN TRUCK TRIPS TO FARMERS GRAIN TERMINAL
IN CLAYTON, IOWA ON NOVEMBER 13, 1973

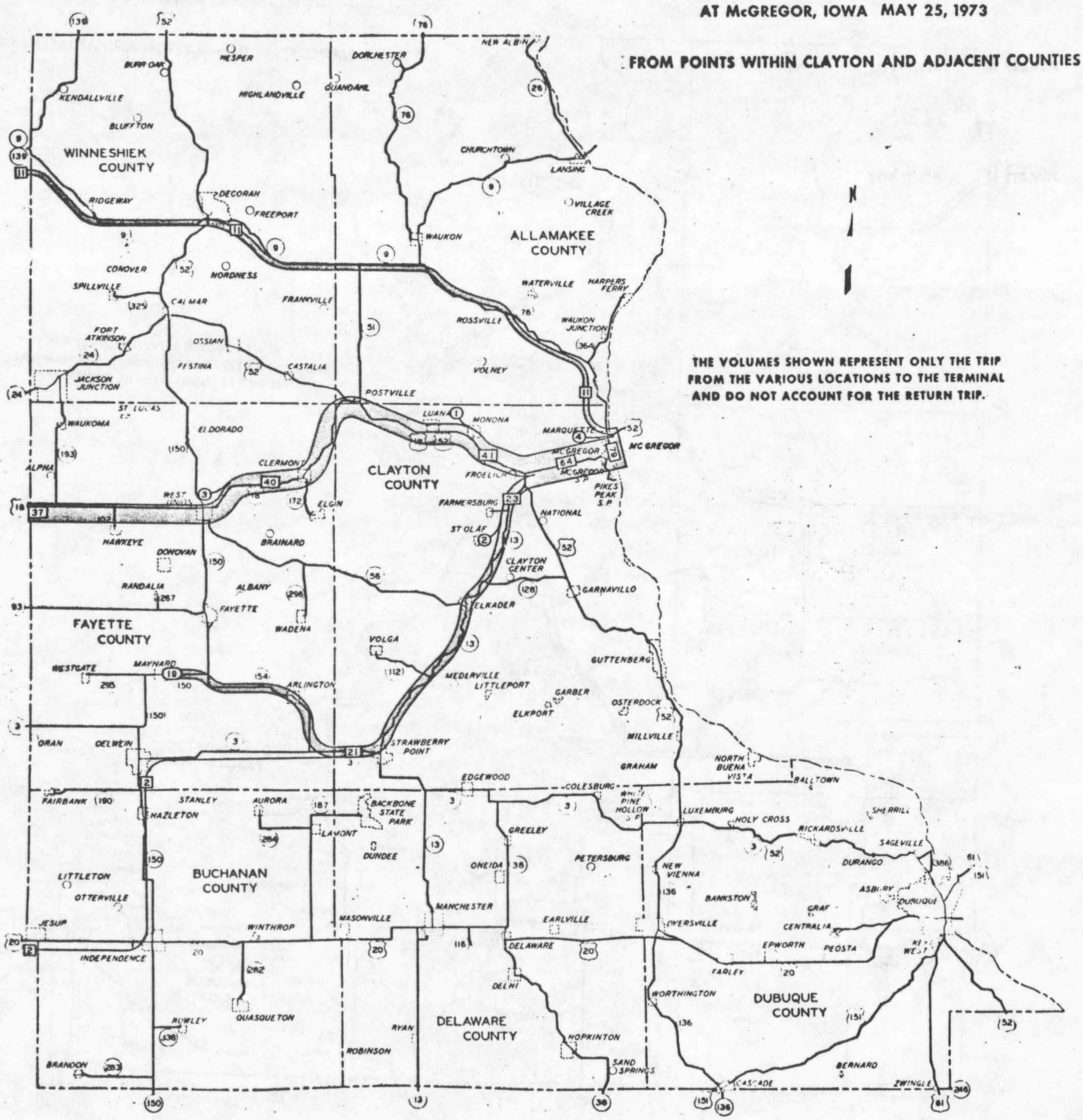
	Single Unit		Truck Tractor-Semi-Trailer		
	2 axle	3 axle	4 axle	5 axle	Total
Fayette		4		9	13
Monona		10		9	19
Tripoli				1	1
New Hampton				6	6
Elkader	1	7			8
Postville		7		4	11
Masonville				1	1
Protivin		1		17	18
Farmersburg		2		3	5
Garnavillo	3	4		9	16
Nashua		1		1	2
Edgewood		6		3	9
Guttenberg		4			4
Cresco				2	2
Eitzen, Minn.				2	2
Grove, Wisconsin		2			2
Lime Springs				1	1
Chester				2	2
Fredericksburg			2		2
Packard				2	2
North Washington		1			1
Denver				2	2
St. Olaf	1				1
Lamont				1	1
Alpha		1			1
Total	5	50	2	75	132

The volumes shown represent only the trip from the various locations to the terminal and do not account for the return trip.

DISPERSION OF GRAIN TRUCK TRIPS TO THE McGREGOR GRAIN TERMINAL

AT McGREGOR, IOWA MAY 25, 1973

FROM POINTS WITHIN CLAYTON AND ADJACENT COUNTIES

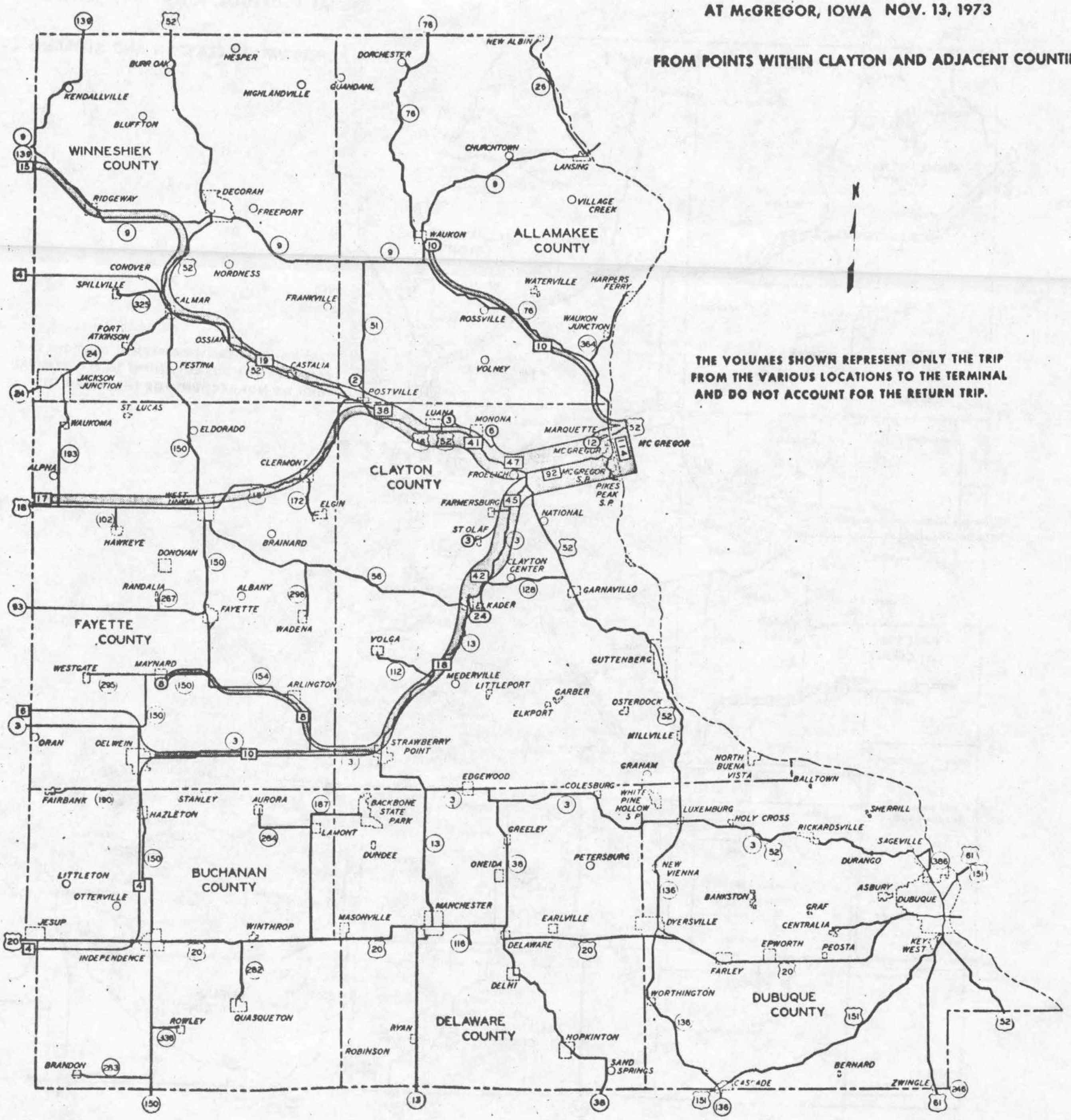


THE VOLUMES SHOWN REPRESENT ONLY THE TRIP FROM THE VARIOUS LOCATIONS TO THE TERMINAL AND DO NOT ACCOUNT FOR THE RETURN TRIP.

DISPERSION OF GRAIN TRUCK TRIPS TO THE McGREGOR GRAIN TERMINAL

AT McGREGOR, IOWA NOV. 13, 1973

FROM POINTS WITHIN CLAYTON AND ADJACENT COUNTIES

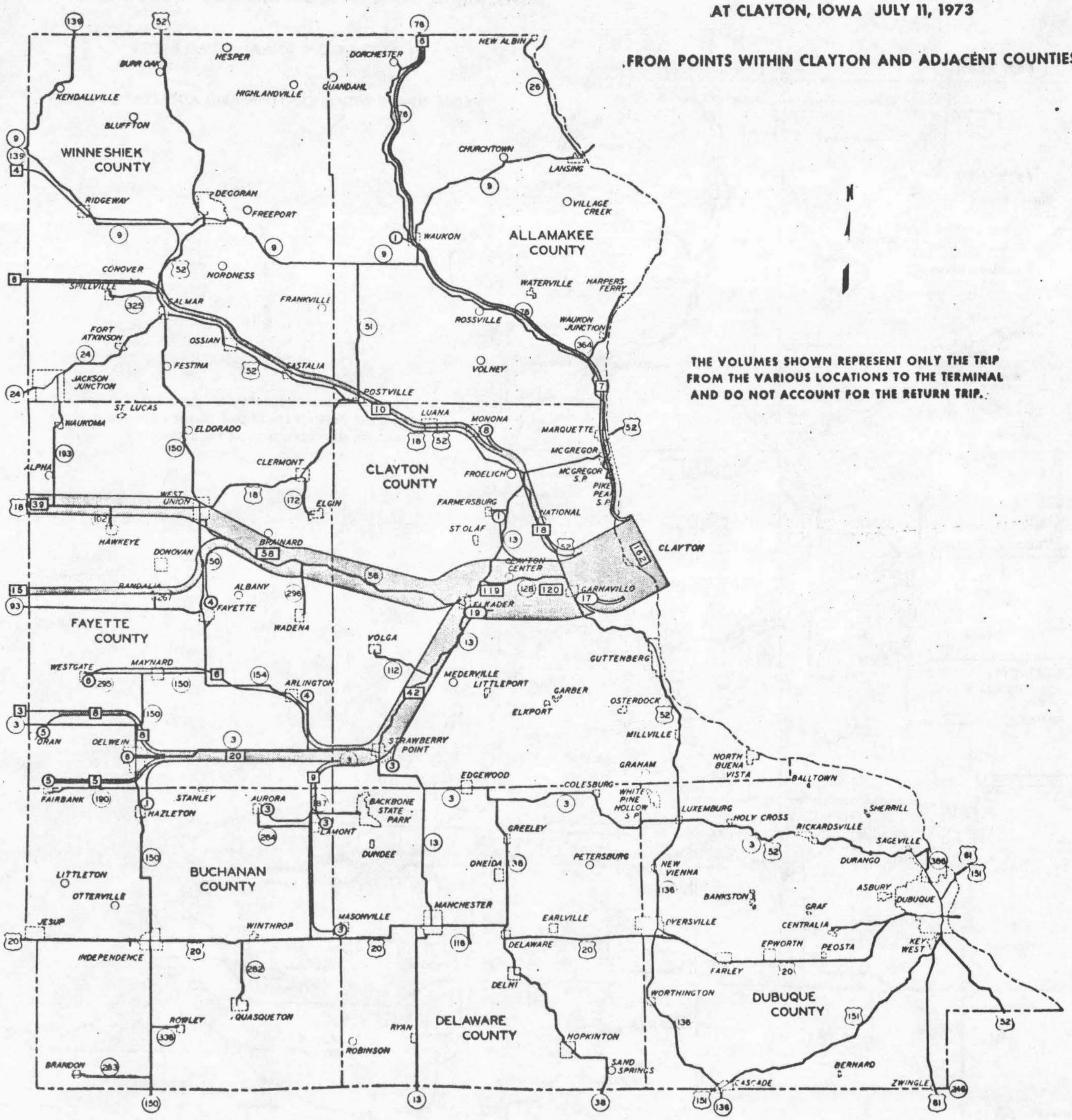


THE VOLUMES SHOWN REPRESENT ONLY THE TRIP FROM THE VARIOUS LOCATIONS TO THE TERMINAL AND DO NOT ACCOUNT FOR THE RETURN TRIP.

DISPERSION OF GRAIN TRUCK TRIPS TO THE PATTERSON GRAIN TERMINAL

AT CLAYTON, IOWA JULY 11, 1973

FROM POINTS WITHIN CLAYTON AND ADJACENT COUNTIES

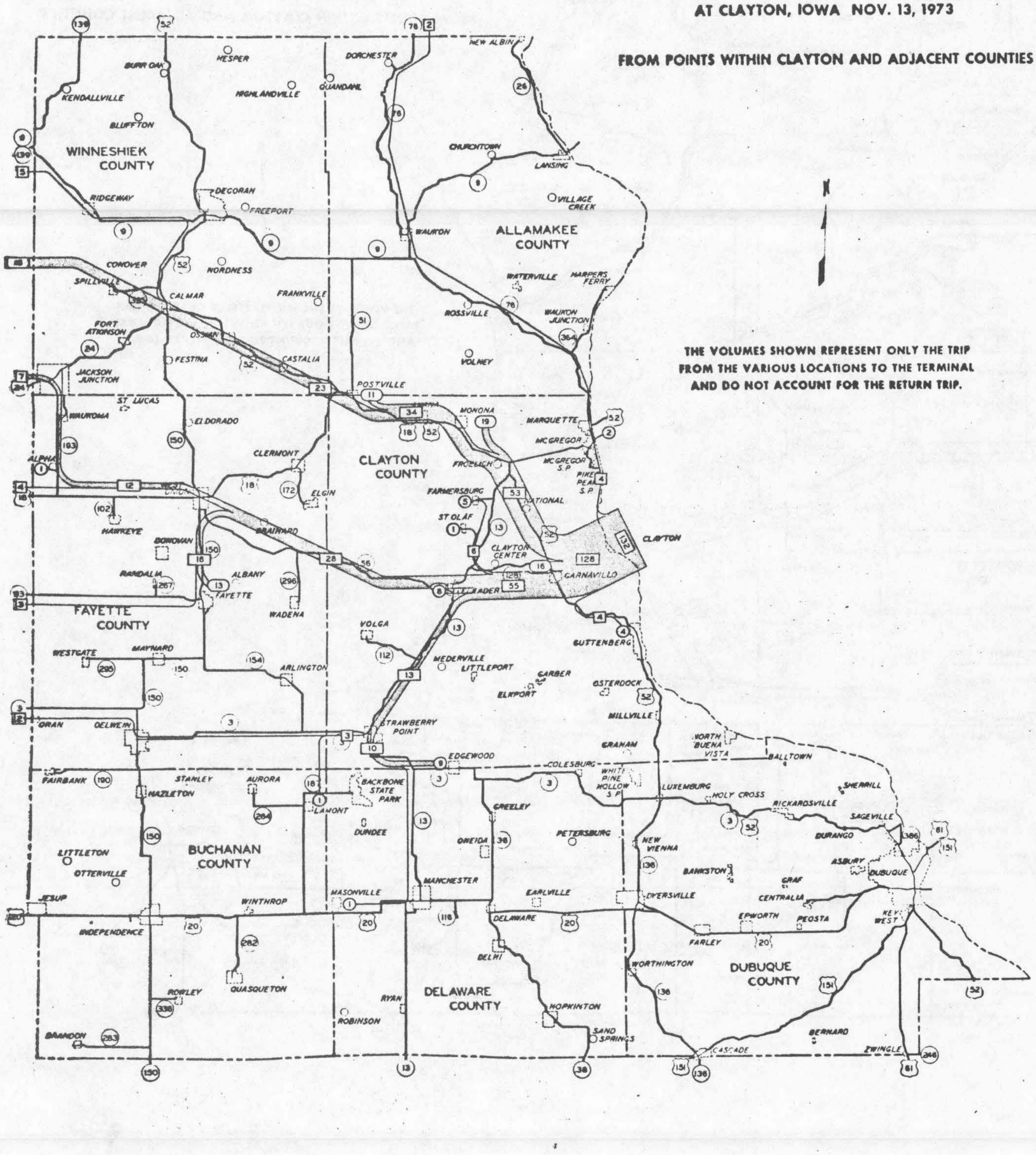


THE VOLUMES SHOWN REPRESENT ONLY THE TRIP FROM THE VARIOUS LOCATIONS TO THE TERMINAL AND DO NOT ACCOUNT FOR THE RETURN TRIP.

DISPERSION OF GRAIN TRUCK TRIPS TO THE PATTERSON GRAIN TERMINAL

AT CLAYTON, IOWA NOV. 13, 1973

FROM POINTS WITHIN CLAYTON AND ADJACENT COUNTIES



THE VOLUMES SHOWN REPRESENT ONLY THE TRIP FROM THE VARIOUS LOCATIONS TO THE TERMINAL AND DO NOT ACCOUNT FOR THE RETURN TRIP.

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