Initially

Final Report No. 4

ANALYSIS OF ALTERNATIVE RAIL PASSENGER ROUTINGS IN THE DETROIT-CHICAGO CORRIDOR

Prepared for:

INTERAGENCY TRANSPORTATION COUNCIL
STATE OF MICHIGAN

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ANALYSIS OF ALTERNATIVE RAIL PASSENGER ROUTINGS IN THE DETROIT-CHICAGO CORRIDOR

By: JOHN W. BILLHEIMER

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CONTRACT 1-1970

SRI Project MSH-8476

PREFACE

This report, the third in a series of transportation planning reports prepared by SRI for the Michigan Interagency Transportation Council (ITC), describes an analysis of alternative rail passenger routings in the Detroit-Chicago Corridor. The objective of this research was to assist Michigan in guiding the National Railroad Passenger Corporation's (Amtrak's) choice of a corridor route and in assessing the feasibility of supplementing Amtrak service with state-subsidized service.

The work described in this report was conducted jointly by SRI personnel under the supervision of Dan G. Haney and the ITC staff supervised by Dr. William C. Taylor. The principal investigator at SRI was Dr. John W. Billheimer. William Kasip of ITC provided most of the input data required for the analysis and estimated the costs associated with alternative levels of rail service.

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I INTRODUCTION

Amtrak Background

Since the close of World War II, the image, stature, and profitability of rail passenger service in the United States have declined steeply. The number of intercity passengers carried by rail has dropped from 595 million in 1945 to 87.8 million in 1969.[1*] The number of passenger cars in use has declined from about 45,000 at the close of the War to an estimated 11,000 today, and the extent of services provided on these cars has been severely diminished. For the most part, the remaining cars have deteriorated in cleanliness and level of maintenance as well as in age. Deficits for all intercity rail services have grown to a level ranging annually from $250 million to $470 million (depending on the cost basis used) on revenues of $580 million.

In an effort to relieve the nation's railroads of the unwanted burden of rail passenger service, Congress in 1970 enacted the National Railroad Passenger Act (Public Law 91-518) creating the National Railroad Passenger Corporation. The corporation, familiarly known as Amtrak, is to operate independently of the federal government and is charged with the responsibility to:

(1) Provide modern, efficient intercity rail passenger service within the basic rail system of the nation.

(2) Use innovative operating and marketing concepts to develop fully the potential of modern rail service in meeting the intercity transportation needs.

(3) Operate on a "for profit" basis.

In accordance with the timetable specified in the National Railroad Passenger Act, Secretary of Transportation John Volpe submitted a preliminary system network on November 30, 1970. Details of this basic network, along with additional background regarding the creation and goals of Amtrak, may be found in Reference 2. The Interstate Commerce Commission, State Public Utility Commission, the railroads, and the labor unions

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* References are listed at the end of this report.

were given one month to respond to this submission with their comments and recommendations for changes. After a review of these comments and recommendations, the Secretary, on January 28, 1971, issued his final report on the basic system.[3] This report included a listing of points between which intercity passenger trains shall be operated, a listing of all routes over which service may be provided, and definitions of basic service characteristics.

Michigan Background

The basic plan proposed by the Secretary of Transportation limited rail service in the State of Michigan to the Detroit-Chicago corridor. No provision was made for connecting Detroit directly with points east of Michigan. To guide the state of Michigan during the one-month period allowed for response to this basic plan, Stanford Research Institute, in conjunction with Michigan's Interagency Transportation Council, undertook an evaluation of alternative routings within the Detroit-Chicago corridor. The report describes the techniques developed for evaluating alternative routings and the results of the evaluation process.

Task Description

The task of evaluating alternative routings began with identifying potentially attractive alternatives. For each alternative identified, such route variables as fares, line-haul travel times, access times and costs, and frequencies of service were specified. The number of passengers attracted to each specified service-routing combination was estimated through the use of a demand model developed to predict travel by mode within and outside the state of Michigan.[4] Capital and operating costs were developed for each specified combination of service level and routing alternative. These costs were compared with the passenger revenues predicted by the demand model to provide a measure of the profit or loss associated with rail passenger traffic in the Detroit-Chicago corridor.

This evaluation procedure was followed for three basic routing alternatives identified by Amtrak. Once Amtrak had formally announced its choice of a route, the procedure was repeated to assess the attractiveness of supplementing the announced service with alternative routings subsidized by the state of Michigan.

II BASIC CORRIDOR ALTERNATIVES

Identification of Alternatives

Routings

Three alternative Detroit-Chicago routings were identified for consideration in the Secretary of Transportation's initial statement of the national rail passenger system. These alternatives are listed below and mapped in Figure 1.

Alternative Route	Routing	Rail Miles
1	Detroit-Durand-Lansing-Battle Creek Kalamazoo-Chicago	308
2	Detroit-Lansing-Battle Creek-Kalamazoo-Chicago	295
3	Detroit-Ann Arbor-Jackson-Battle Creek-Kalamazoo-Chicago	283

Alternative Route 1 would follow Grand Trunk Western right-of-way from Detroit to Durand (near Flint) and on to Lansing and Battle Creek, where it would follow Penn-Central right-of-way through Kalamazoo to Chicago. Alternative Route 2 would follow C&O right-of-way to Lansing, Grand Trunk Western right-of-way from Lansing to Battle Creek, and Penn-Central right-of-way from Battle Creek to Chicago. Alternative Route 3 would follow Penn-Central right-of-way from Detroit to Chicago.

Line-Haul Speeds

For each alternative routing, line-haul speeds of 45 miles per hour, 80 miles per hour, and 150 miles per hour were considered. A speed of 45 miles per hour corresponds roughly to that for existing passenger trains in the Detroit-Chicago corridor, while an 80 mile per hour speed is the average operating range of the Metroliner currently in use in the Northeast Corridor, and a 150 mile per hour speed is within the capability

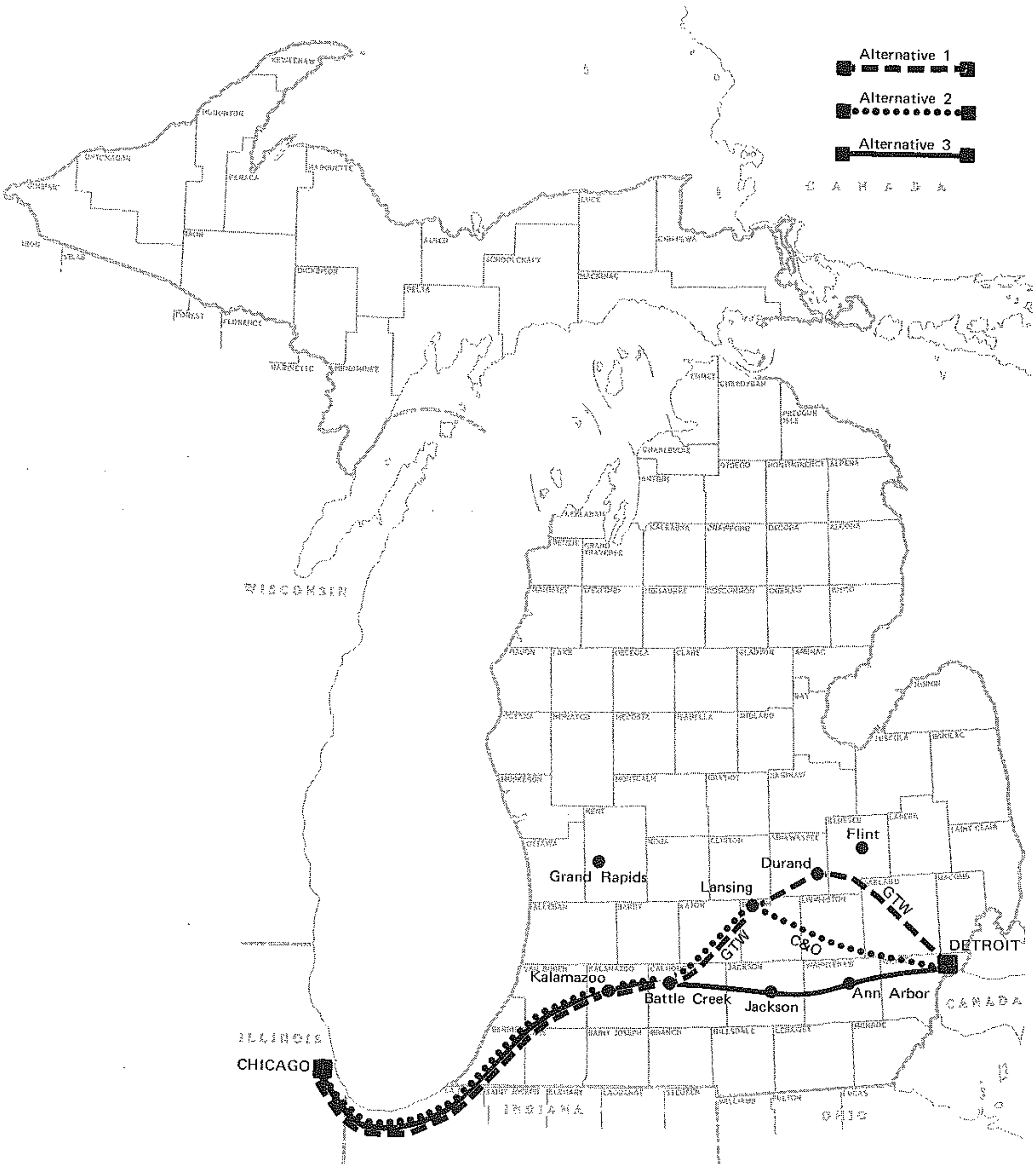

FIGURE 1 BASIC ROUTING ALTERNATIVES

of Japan's Tokaido Line. In the case of Alternative Route 3, the most direct route between Detroit and Chicago, a speed of 250 miles per hour was also considered. Such a speed might be achieved by a tracked air cushion vehicle or a gravity-vacuum train. Six-minute stops were assumed at all intermediate stations.

Fares

Existing fares were used to provide a basic fare structure for use with all routing-speed combinations. In addition to existing fares, higher fares were chosen to accompany higher-speed alternatives. Existing fares were increased by 10 and 20 percent in considering speeds of 80 miles per hour and by 30 and 50 percent in considering speeds of 150 miles per hour and above.

Service Frequencies

For Alternative Routes 1 and 2, service frequencies of 1, 2, 3, 5, and 8 trains per day were considered for each speed-cost combination. Frequencies of 3, 5, and 8 trains per day were studied in connection with Alternative Route 3.

Competing Modes

Any rail link between Detroit and Chicago must compete for passengers with two other common carrier modes in the form of air and bus travel and with the most popular form of intercity travel in the corridor, the automobile. To provide a basis for comparing rail alternatives with competing common carrier modes, current air and bus schedules were studied, and the time, cost, and frequency of line-haul service between corridor cities were recorded for each competing mode.

In calculating automobile costs and times, operating costs of $.04 per mile and speeds of 65 miles per hour were assumed. These figures reflect average experience with freeway operation in the corridor and do not include the additional time and expense of operation on local roads in gaining freeway access. An average automobile occupancy of 1.7 persons per vehicle was assumed.

Access and Egress Times and Costs

Line-haul times and costs between common carrier stations do not reflect the total time and cost entailed in intercity travel. The common carrier passenger experiences additional delays and expenses in getting from his point of origin to the carrier terminal, in waiting for the carrier to arrive and depart, and in proceeding from the destination terminal to his final destination. The automobile user experiences similar delays in gaining access to freeways for over-the-road travel and in proceeding to his final destination over arterials and local streets. To reflect these additional delays and expenses, the times and costs of access and egress were computed for each mode of intercity travel.

Previous work in estimating the demand for intercity passenger travel entailed the computation of terminal access and egress times for cities in and around Michigan.[4,5] From this work, three separate sets of access and egress times were computed for cities in the Detroit-Chicago corridor. One set of access and egress times and costs was computed for travel between the two large terminal cities of Detroit and Chicago. A second set of times and costs was computed for travel between either of these end points and any of the smaller intermediate cities within the corridor. Finally, a third set of access and egress times and costs was computed for travel between the smaller intermediate cities. Table 1 depicts the combined access and egress times by mode for each case.

The air access times depicted in Table 1 include an allowance of one-half hour to account for waiting time before departure. Waiting times of one-fourth hour were included in the case of rail and bus travel. When the Flint metropolitan area was considered to be an intermediate point, one-fourth hour and 60 cents were added to the times and costs of rail access and egress shown in Table 1 to account for the comparatively great distance of the Durand railroad station from Flint's population center.

The Intercity Passenger Demand Model

Model Formulation

The effect of alternative rail systems on passenger travel in the Detroit-Chicago corridor was estimated by using a demand model developed to predict traffic by mode between cities in and around Michigan. This model is an extension of the Northeast Corridor Model developed by McLynn and modified by the National Bureau of Standards.[6,7,8]

Table 1

COMBINED ACCESS AND EGRESS TIMES AND COSTS

City Pair	Air		Rail		Bus		Auto	
	Time (hours)	Cost	Time (hours)	Cost	Time (hours)	Cost	Time (hours)	Cost
End to end	3.00	$3.00	1.25	$1.00	1.25	$1.00	1.00	$1.00
End to intermediate	2.40	2.65	1.00	0.75	1.00	0.75	0.75	0.75
Intermediate to intermediate	1.80	2.30	0.75	0.50	0.75	0.50	0.50	0.50

Model selection and calibration were described in detail in Report No. 2 of this series.[4] The variables considered by the model in determining the traffic by mode m between an origin-destination pair (i, j) are defined as follows:

t_m = total $(i \rightarrow j)$ travel time

c_m = total $(i \rightarrow j)$ out-of-pocket per capita cost (dollars)

f_m = frequency of $(i \rightarrow j)$ service (trips per day)

F = number of families with annual incomes exceeding \$10,000 in the SMSA or county of the origin or destination city.

With these variables, the demand model may be defined by the following relationships:

$$w_m = \begin{cases} a_m t_m^{\alpha(1)} c_m^{\alpha(2)} \left[1 - \exp\left(-Kf_m\right)\right]^{\alpha(3)} & (m \neq \text{auto}) \\ t_m^{\alpha(4)} \left(c_m/1.7\right)^{\alpha(5)} & (m = \text{auto}) \end{cases} \tag{1}$$

$$W = \sum_k w_k \tag{2}$$

$$D = \begin{cases} \beta(0)\left(F_i F_j\right)^{\beta(1)} W^{\beta(2)} & ; \quad F_i F_j > G \\ \beta'(0)\left(F_i F_j\right)^{\beta'(1)} W^{\beta(2)} & ; \quad F_i F_j \leq G \end{cases} \tag{3}$$

$$D_m = D w_m / W \tag{4}$$

The terms w_m and W may be regarded as modal conductance and total $(i \rightarrow j)$ conductance, respectively. D_m and D are daily one-directional modal $(i \rightarrow j)$ demand and total $(i \rightarrow j)$ demand, respectively (measured in persons).

Because of the wide range of city sizes of interest in Michigan transportation studies, it was necessary to segment the demand model as indicated in Equation (3). Thus the demand for travel between origin-destination pairs whose population product $F_i F_j$ was below a specified value, G, received different treatment than city pairs having larger population products.

Calibration of the above model for 1967 travel data between 20 city pairs resulted in the identification of the following demand model parameter values.

$$a_m = \begin{cases} 1.5, & m = \text{air} \\ .75, & m = \text{bus, rail} \end{cases}$$

$$\alpha(1) = \alpha(2) = -1.5$$

$$\alpha(3) = .3247, \ K - .12$$

$$\alpha(4) = \alpha(5) = -1.8$$

$$\beta(0) = 25{,}000, \ \beta'(0) = 2{,}500$$

$$\beta(1) = 1.0, \ \beta'(1) = 0.1$$

$$\beta(2) = .9, \ G = 750 \times 10^6$$

Model Adaptation

The above calibration parameters were developed by comparing model predictions for 20 city pairs in and around Michigan with existing origin-destination data describing travel by mode between those city pairs. Regretably, origin-destination data for rail passenger travel were lacking in many instances and had to be estimated from terminal flow statistics. Such data as were available indicated that the calibrated model severely overestimated the demand for rail travel between closely spaced cities (cities separated by less than 50 miles) when no rail commuter service existed between those cities.

Because relatively recent rail origin-destination data were available for the cities in the Detroit-Chicago corridor, it was possible to compensate for the model's tendency to overstate rail traffic between closely spaced cities. This was done by forcing the model output to agree with recorded rail travel in the base year 1967. For each alternative routing, the time, cost, and frequency of rail service during the base year were used as model inputs. The unadjusted model output was then compared with base year experience and multiplied by a corrective factor that forced the output to agree with this experience. A sample of the adjusted model output for Alternative Route 3 appears in Table 2. This table shows daily one-way intercity travel for each mode serving the Detroit-Chicago corridor. In addition, the output format contains a detailed rail summary listing intercity rail fares, line-haul revenue by city pairs, and an annual profit-loss statement.

In the base year, three trains per day traveled over Alternative Route 3 between Detroit and Chicago at about 45 miles per hour. The matrix of intercity fares is shown in Table 2. In evaluating speed, frequency, and fare alternatives over Alternative Route 3, all demand predictions were multiplied by the correction factors developed for the base year population and service levels. Thus the relative impact of changes in population or service levels remained undistorted by the adjustment process.

The choice of a recent year for calibrating and adjusting the demand model can be expected to handicap the rail mode slightly. The demand model does not take into account elements such as cleanliness, attractiveness, reliability, and efficiency of personnel. In recent years, all these elements have been noticeably lacking in rail passenger service. Yet a part of Amtrak's mandate is to restore these amenities. If Amtrak succeeds in accomplishing this, the demand model predictions, based as they are on a pre-Amtrak calibration, can be expected to understate Amtrak patronage somewhat. Nonetheless, the model predictions establish a useful lower bound on probable Amtrak patronage.

Capital and Operating Expenses

The demand model discussed earlier can be used to predict rail passenger travel and, hence, anticipated revenue for each specified combination of routing, speed, frequency, and fare alternative. However, revenue estimates are but half the total cost picture. These estimates must be balanced against the capital and operating costs of providing a specified level of service over a particular route.

Estimates of capital and operating costs were developed for each of the four alternative system speeds, and these estimates were extended to each routing and frequency alternative.

Table 2

SAMPLE COMPUTER OUTPUT

RAIL SPEED 45   RAIL FREQUENCY 3   RAIL CØST FACTØR 1

AIR

	ANN ARBØR	JACKSØN	BATTLE CRK	KALAMAZØØ	CHICAGØ
DETRØIT	0.	12.	6.	17.	720.
ANN ARBØR	-----	0.	0.	0.	0.
JACKSØN	-----	-----	0.	6.	9.
BATTLE CRK	-----	-----	-----	5.	5.
KALAMAZØØ	-----	-----	-----	-----	23.

TØTAL PASSENGERS 801.504
TØTAL PASSENGER MILES 198130.
TØTAL LINE HALL REVENUE 16365.9

RAIL

	ANN ARBØR	JACKSØN	BATTLE CRK	KALAMAZØØ	CHICAGØ
DETRØIT	9.	2.	5.	9.	61.
ANN ARBØR	-----	2.	1.	4.	18.
JACKSØN	-----	-----	1.	1.	11.
BATTLE CRK	-----	-----	-----	1.	9.
KALAMAZØØ	-----	-----	-----	-----	26.

TØTAL PASSENGERS 160.528
TØTAL PASSENGER MILES 32268.1
TØTAL LINE HALL REVENUE 1702.04

BUS

	ANN ARBØR	JACKSØN	BATTLE CRK	KALAMAZØØ	CHICAGØ
DETRØIT	401.	49.	18.	30.	103.
ANN ARBØR	-----	117.	34.	20.	19.
JACKSØN	-----	-----	142.	55.	3.
BATTLE CRK	-----	-----	-----	151.	5.
KALAMAZØØ	-----	-----	-----	-----	14.

TØTAL PASSENGERS 1161.06
TØTAL PASSENGER MILES 81211.4
TØTAL LINE HALL REVENUE 4265.26

Table 2 (Concluded)

AUTØ

	ANN ARBØR	JACKSØN	BATTLE CRK	KALAMAZØØ	CHICAGØ
DETRØIT	2343.	284.	57.	86.	662.
ANN ARBØR	-----	1083.	160.	95.	199.
JACKSØN	-----	-----	604.	253.	194.
BATTLE CRK	-----	-----	-----	1814.	33.
KALAMAZØØ	-----	-----	-----	-----	414.

TØTAL PASSENGERS 8281.01
TØTAL PASSENGER MILES 587629.
TØTAL LINE HALL REVENUE 21961

TØTAL

	ANN ARBØR	JACKSØN	BATTLE CRK	KALAMAZØØ	CHICAGØ
DETRØIT	3233.	398.	91.	151.	1666.
ANN ARBØR	-----	1342.	215.	129.	230.
JACKSØN	-----	-----	821.	347.	215.
BATTLE CRK	-----	-----	-----	2288.	48.
KALAMAZØØ	-----	-----	-----	-----	487.

TØTAL PASSENGERS 10404.1
TØTAL PASSENGER MILES 899239.
TØTAL LINE HALL REVENUE 44294.2

DETAILED RAIL SUMMARY

RAIL REVENUE MATRIX

	ANN ARBØR	JACKSØN	BATTLE CRK	KALAMAZØØ	CHICAGØ
DETRØIT	18.	8.	31.	65.	903.
ANN ARBØR	-----	4.	5.	22.	243.
JACKSØN	-----	-----	3.	2.	112.
BATTLE CRK	-----	-----	-----	2.	90.
KALAMAZØØ	-----	-----	-----	-----	195.

ANNUAL SUMMARY

ANNUAL REVENUE...$ 1242488
ANNUAL CØST......$ 5558120
ANNUAL PRØFIT....$-4315632
PRØFIT/PASS......$-36.8273

RAIL FARE MATRIX

	ANN ARBØR	JACKSØN	BATTLE CRK	KALAMAZØØ	CHICAGØ
DETRØIT	2.00	4.00	6.25	7.50	14.75
ANN ARBØR	-----	2.00	4.50	5.50	13.25
JACKSØN	-----	-----	2.53	3.75	10.25
BATTLE CRK	-----	-----	-----	1.20	9.70
KALAMAZØØ	-----	-----	-----	-----	7.50

For the basic 45 mph system, existing facilities and equipment would be used over each routing alternative. The fully allocated cost of Grand Trunk Western's 1969 operations in the states of Michigan, Indiana, and Illinois was estimated on the Interstate Commerce Commission's Form A to be $8.95 per train-mile. For the purposes of this analysis, it was assumed that $6.00 per train-mile represented direct operating expenses, while the remainder represented fixed investment in plant, right-of-way, and equipment.

In the case of the three high-speed systems (80 mph, 150 mph, and 250 mph), capital and operating cost estimates were developed from cost analyses performed for the Northeast Corridor Transportation Project.[9] Capital cost estimates were modified to reflect the differences in terrain and land costs between the Northeast Corridor region and lower Michigan. The following assumptions, made in the NECTP study, were used in calculating annual costs for each high-speed alternative.

(1) The economic life of assets was established at 35 years for all fixed facilities, 14 years for rolling stock, and an infinite period for land.

(2) The return on capital was set at 10 percent as recommended by the Bureau of the Budget. The returns on land acquisition costs were set at 8 percent.

Table 3 shows the cost breakdown by route for the existing system and for each of the higher-speed systems under an assumed frequency of three trains per day. Operating costs for the higher-speed systems were estimated as follows:

System Speed	Operating Cost per Train-Mile
80 mph	$ 6.30
150 mph	8.60
250 mph	10.20

These costs include allowances for power, crew wages, burden, car and guideway maintenance, as well as indirect operating costs, and are consistent with the estimates developed in the Northeast Corridor Transportation Project.[9] As can be seen, the capital costs for the higher-speed systems so overwhelm the operating costs that the total annual system cost will not vary appreciably with frequency of service for these system alternatives. Thus a more detailed analysis of the operating costs

Table 3

ANNUAL CAPITAL AND OPERATING COST ESTIMATES
(Millions of Dollars)

Route	System Speed											
	Capital Cost				Operating Cost (3 trains per day)				Total Cost (3 trains per day)			
	45 mph	80 mph	250 mph	250 mph	45 mph	80 mph	150 mph	250 mph	45 mph	80 mph	150 mph	250 mph
Alternative 1	$2.0	$94	$164	$203	$4.0	$4.3	$5.8	$6.9	$6.0	$98.3	$171.8	$209.9
Alternative 2	1.9	90	157	195	3.9	4.1	5.6	6.6	5.8	94.1	162.6	200.8
Alternative 3	1.8	86	151	186	3.7	3.9	5.3	6.3	5.5	89.9	156.3	191.5

of high speed rail systems would have little effect on total annual costs and, consequently, on policy decisions resulting from a revenue-cost comparison.

Results

The results of applying the intercity demand model to predict passenger levels along the three basic Detroit-Chicago routing alternatives are detailed in the Appendix. For Alternative Routes 1, 2, and 3, Tables A-1, A-2, and A-3 of the Appendix show passenger levels, passenger miles, annual revenues and costs, and the subsidies required for each identified combination of rail speed, fare, and frequency of service.

Impact of Speed, Fare, and Frequency of Service

Figure 2 depicts the typical impact of each of the three service parameters varied in the analysis on annual revenues. Of the three parameters, speed has the greatest effect on revenue. Figure 2 shows that doubling the average operating speed nearly doubled revenue on each of the three routes. Unfortunately, the profit and loss statistics of the Appendix show clearly that the investment required to achieve significant increases in speed overwhelms the revenue received from additional patrons attracted to the faster service.

Figure 2 also shows that fare increases in the Detroit-Chicago corridor can be expected to lower rather than raise annual revenue. Losses in ridership counteract the effect of increased fares, causing slight net decrease in the revenue realized each year.

The final parameter, frequency of service, has a marked effect on revenue over the low frequency range but tends to have little impact when frequency levels of five to eight trains per day are approached. Figure 2 shows that the addition of a single train to the daily schedule will significantly increase revenue if it is the second or third train in the schedule but will produce little additional revenue in a seven or eight train schedule. The Appendix further shows that additional trains in the Detroit-Chicago corridor fail to return enough additional revenue to justify their marginal operating cost at any level of service.

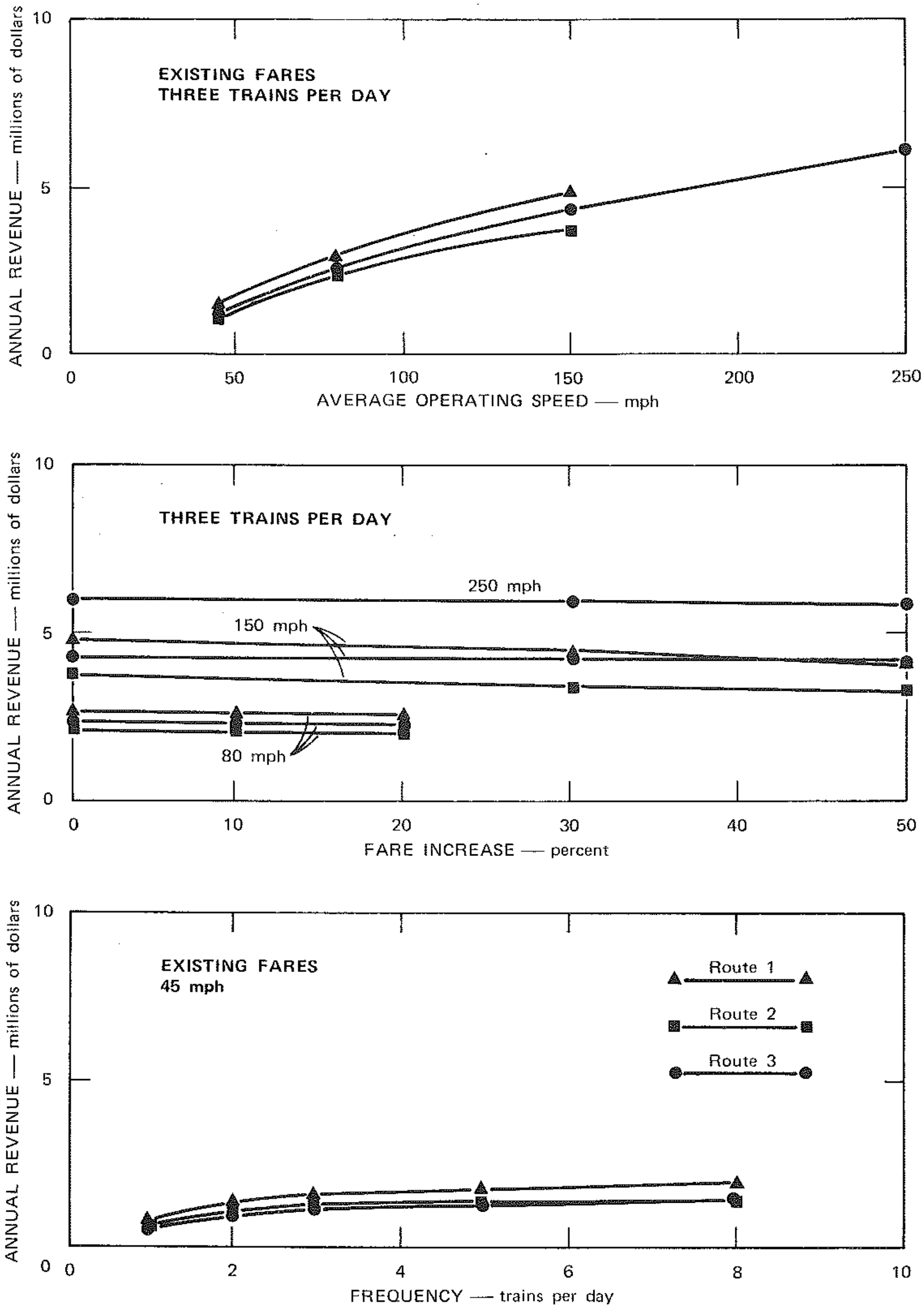

FIGURE 2 EFFECT OF SPEED, FARE, AND FREQUENCY ON ANNUAL REVENUE

Route Economics

Table 4 presents a comparison by operating speed of the annual subsidies required to operate three trains per day over each of the three alternative routes at existing fare levels. At existing 45 mph speeds, the operating losses incurred by the direct route from Detroit through Jackson and Kalamazoo to Chicago (Alternative Route 3) are nearly equivalent to the losses incurred by the more roundabout route through Durand and Lansing (Alternative Route 1). However, Table 4 also shows that the roundabout route would serve more Michigan passengers.

Table 4

ANNUAL PASSENGER LEVELS AND LOSSES BY ROUTE
(Existing Fare Structure,
Three Trains per Day)

Speed (miles per hour)	Routing Alternative: Passenger Levels (thousands of passengers) Route 1	Route 2	Route 3	Losses (millions of dollars) Route 1	Route 2	Route 3
45	164	117	118	$ 4.4	$ 4.6	$ 4.3
80	291	213	212	95.5	91.9	88.1
150	494	362	375	165.1	158.9	152.0
250	--	--	527	--	--	187.1

As operating speeds increase, the more direct routing of Alternative Route 3 can be seen to incur less annual losses than Alternative Routes 1 and 2. For any alternative, however, the annual cost of increasing operating speeds is prohibitive. Even allowing for the conservative bent of the calibrated demand model and the impact of future population increases, it would appear impossible that any high-speed rail alternative requiring significant capital investment in right-of-way, track improvements, or equipment could ever be self-supporting in the Detroit-Chicago corridor. Moreover, the subsidy levels generated by such an investment are so overwhelming as to appear unjustified by the potential volume of rail traffic available in the corridor.

Amtrak Decision

On January 28, 1971, after reviewing the comments and recommendations of the states, railroads, and labor unions, the Secretary of Transportation issued his final report on the basic Amtrak system.[3] This report provided for two trains per day between Detroit and Chicago over the direct Penn Central route via Ann Arbor, Jackson, Battle Creek, and Kalamazoo (Alternative Route 3). The primary reason given for the choice of route was that the Penn Central line was the shortest and fastest route and offered the greatest potential for high-speed rail service. A background study of the basic system[2] also noted that the Detroit-Lansing route (Alternative Route 2) suffered from a slow track, the lack of a track connection at Lansing, and low ridership on existing trains.

III SHUTTLE ALTERNATIVES

The Shuttle Concept

Although Amtrak's decision to use the direct route between Detroit and Chicago was logical, it left several major Michigan cities, notably Flint, Lansing, and Grand Rapids, with no rail passenger service whatsoever. However, the state of Michigan could elect to subsidize rail service to these cities. Ideally, a state-subsidized service might take the form of a rail shuttle paralleling and complementing the mainline Amtrak service. To provide guidance for the state of Michigan in assessing the attractiveness of supplying rail service to cities not included in the Amtrak network, the intercity demand model was used to forecast the ridership, cost, and revenues associated with three alternative intrastate rail shuttles. The three alternative shuttle services identified for analysis are listed below and mapped in Figure 3.

Shuttle	Stops	Rail Miles
1	Detroit-Durand-Lansing-Battle Creek	142
2	Detroit-Lansing-Battle Creek	129
3	Detroit-Lansing-Grand Rapids-Benton Harbor-Chicago	314

The proposed Amtrak route follows the Penn Central's line from Detroit through Ann Arbor, Jackson, Battle Creek, and Kalamazoo to Chicago. Shuttles 1 and 2 would connect with this mainline service in Battle Creek. Shuttle 3 would follow existing C&O lines without intersecting the Amtrak route.

Service Characteristics

In view of the unattractiveness of the high speed and high frequency alternatives evaluated in the basic Detroit-Chicago corridor analysis, shuttle service characteristics were limited to low speed, low frequency options. Passenger and cost projections were prepared for shuttle frequencies of one and two trains per day and for speeds of 45 and 80 miles

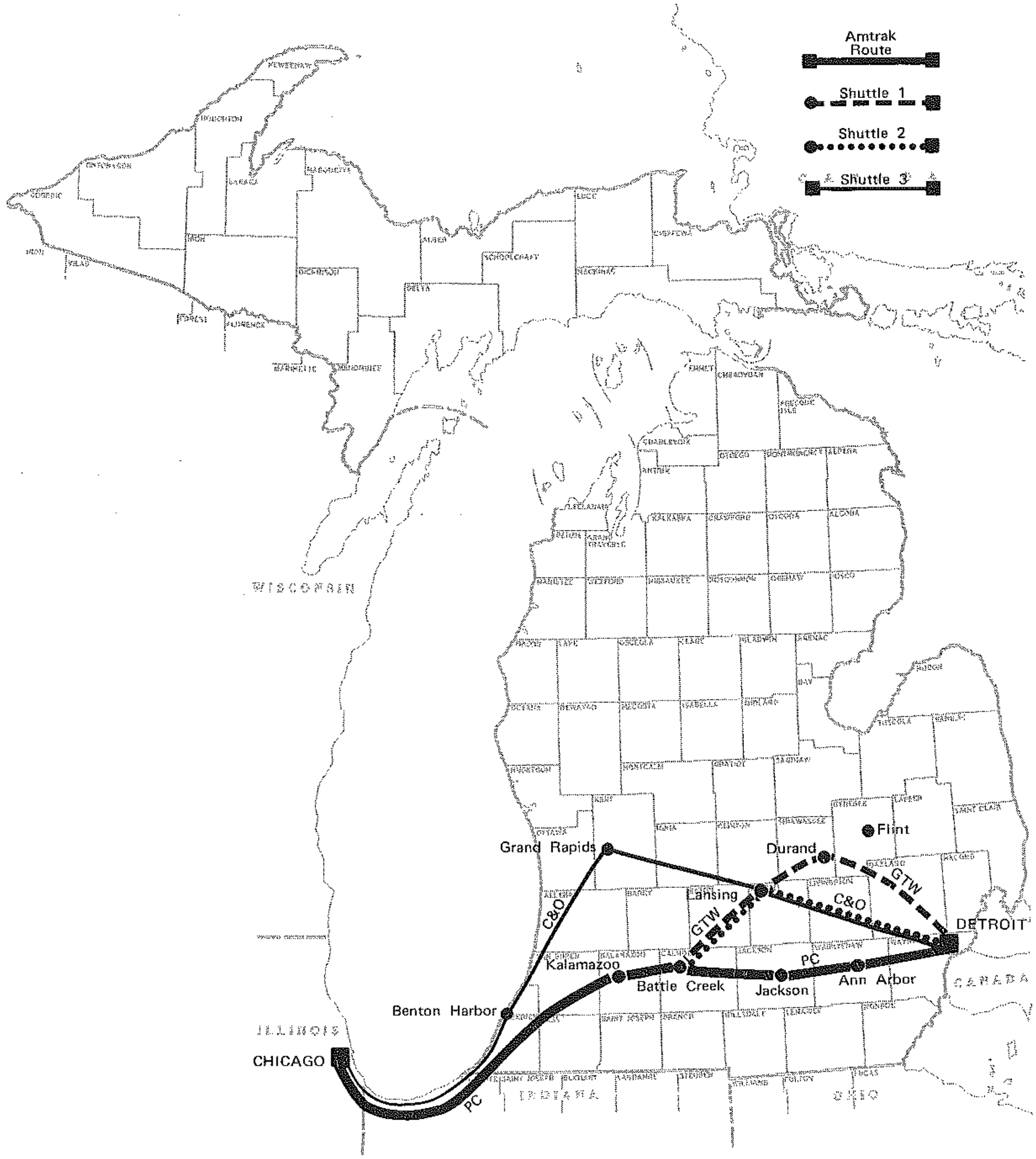

FIGURE 3 SHUTTLE ROUTING ALTERNATIVES

per hour. It was assumed that the speed of through service along the Penn Central line would match the speed of the shuttle service and that through service would be offered twice a day.

Current intercity fare structures were used to estimate travel costs and line-haul revenues. Because the basic corridor analysis showed fare increases to be self-defeating, these current fare structures were not varied.

Preliminary Assumptions

Through Passengers

In projecting the number of passengers attracted to the alternative shuttle services, it was assumed that through passengers from Detroit to Battle Creek, Kalamazoo, and Chicago would never elect to use shuttle service. Direct service along the main Amtrak route would always be quicker than the shuttle service and, in the case of Shuttles 1 and 2, would have the same arrival time at points west of Battle Creek.

Access and Egress Times and Costs

The access and egress times and costs shown in Table 1 were assumed to apply to the proposed shuttle alternatives, as well as to the basic Amtrak alternatives.

Capital and Operating Expenses

The capital and operating expense estimates developed in the analysis of the three basic corridor alternatives were assumed to apply to the three shuttle alternatives. Extension of these estimates in the case of the identified service levels resulted in the annual cost breakdown shown in Table 5.

Results

The results of supplementing the proposed Amtrak service with intra-Michigan shuttles are summarized in Table 6. This table shows the number of passengers, passenger miles, and line-haul revenues and costs forecast by the intercity demand model for both mainline and shuttle service under the stated operating assumptions.

Table 5

ANNUAL CAPITAL AND OPERATING COST ESTIMATES FOR CORRIDOR SHUTTLE ALTERNATIVES
(Millions of Dollars)

	System Speed									
			Operating Cost				Total Cost			
	Capital Cost		One Train		Two Trains		One Train		Two Trains	
Alternative	45 mph	80 mph	45 mph	80 mph	45 mph	80 mph	45 mph	80 mph	45 mph	80 mph
Shuttle 1	$0.9	$43	$0.6	$0.7	$1.2	$1.3	$1.5	$44	$2.1	$44
Shuttle 2	0.8	39	0.6	0.6	1.1	1.2	1.4	40	2.0	40
Shuttle 3	2.0	96	1.4	1.4	2.7	2.9	3.4	97	4.7	99

Table 6 shows that Shuttle 1, passing through Durand and Lansing, can be expected to attract more passengers and revenue than Shuttles 2 and 3. This shuttle would also require a smaller annual operating subsidy than the other two alternatives. In absolute economic terms, however, the Durand-Lansing shuttle can hardly be termed an attractive investment. Minimal operation of this shuttle on a once-daily basis would require an annual state subsidy in excess of $1 million or roughly 75 percent of the estimated yearly operating cost. This subsidy would amount to nearly $20.00 per passenger, more than three times the average fare.

As in the case of the basic corridor alternatives, higher speed shuttles requiring substantial capital investment in right-of-way, track improvements, and equipment would require overwhelming subsidies and could not be justified by the volume of traffic available in the Detroit-Chicago corridor.

Table 6

SHUTTLE ALTERNATIVES
ANNUAL SUMMARY

	Speed (mph)	Frequency (trains/day)	Passengers (thousands)	Passenger Miles (thousands)	Revenue (thousands of dollars)	Cost (thousands of dollars)	Profit (Loss) (thousands of dollars)	Deficit per Passenger
Amtrak Route	45	2	105	21,100	$1,111	$ 4,319	($ 3,208)	$ 30.62
Durand-Lansing Shuttle	45	1	58	8,200	377	1,500	(1,123)	19.35
Durand-Lansing Shuttle	45	2	85	11,500	545	2,100	(1,555)	18.27
Lansing Shuttle	45	1	27	3,500	175	1,400	(1,225)	45.40
Lansing Shuttle	45	2	38	4,800	240	2,000	(1,760)	46.40
Lansing-Grand Rapids Shuttle	45	1	27	6,400	324	3,400	(3,076)	113.80
Lansing-Grand Rapids Shuttle	45	2	37	8,800	445	4,700	(4,255)	115.00
Amtrak Route	80	2	190	39,000	2,059	89,060	(87,000)	459.25
Durand-Lansing Shuttle	80	1	101	13,500	640	43,700	(43,060)	425.10
Durand-Lansing Shuttle	80	2	145	18,800	900	44,300	(43,400)	298.80
Lansing Shuttle	80	1	49	6,000	296	39,600	(39,304)	802.50
Lansing Shuttle	80	2	69	8,100	404	40,200	(39,796)	575.00
Lansing-Grand Rapids Shuttle	80	1	53	11,900	602	97,400	(96,798)	1,825.00
Lansing-Grand Rapids Shuttle	80	2	75	16,300	820	98,900	(98.080)	1,305.00

IV FUTURE WORK

The intercity passenger demand model appears to represent a useful tool for evaluating rail passenger alternatives, and its continued use in such evaluations is to be encouraged. Guidelines for incorporating the model output within the framework of a rigorous benefit/cost analysis were established by Dan Haney in a paper, "Consistency in Transportation Modal Split and Evaluation Models."[10]

Detroit-New York Alternatives

One possibility for future application of the demand model is in the detailed evaluation of alternative Detroit-New York rail routes and service levels. Amtrak's basic network made no provision for service from Detroit to the East Coast. After meeting with Michigan and other Midwest states, however, the Corporation agreed to continue to provide Detroit-New York service on a provisional basis for six months and to continue the service until July 1, 1973, if the states benefiting from the service agree to assume two-thirds of the net operating cost beyond the six month provisional period. This arrangement would be reviewed in 1973, at which point the service would either be incorporated into the basic Amtrak system, thereby requiring no state subsidy, or be dropped altogether.

The analytic techniques outlined in this report could easily be used to predict the patronage attracted by different levels of Detroit-New York service and to assess the operating subsidies required to support each service level. Preliminary work with the intercity demand model in evaluating alternative routes between Detroit and New York[11] has indicated that the interests of Michigan residents would be better served by a route via Cleveland and Buffalo than by a more direct route through Canada to Buffalo.

Recalibration

As noted, the choice of 1967 as a base year for calibrating the demand model serves to handicap the rail mode. If the model is to continue to be used to predict rail passenger demand, it should be recalibrated as soon as Amtrak has had a chance to establish itself and refurbish the image of rail passenger service in the United States. Recalibration is a simple process once suitable origin-destination data have been obtained.[4]

Appendix A

OPERATING STATISTICS FOR BASIC ROUTE ALTERNATIVES

Table A-1

OPERATING STATISTICS--ALTERNATIVE ROUTE 1

Detroit-Durand-Lansing-Battle Creek-Kalamazoo-Chicago

			Daily One-Way Passenger Data						Annual Cost Data (thousands of dollars)			
	Fare		Passengers			Passenger Miles					Rail	Deficit
Speed (mph)	Increase (percent)	Frequency (trains/day)	Rail	Other	Total	Rail	Other	Total	Rail Revenue	Rail Cost	Profit (loss)	per Passenger
45	0%	1	137	8,699	8,836	26,979	852,486	879,465	$ 978	$ 3,249	$ (2,270)	$ 22.73
		2	201	8,650	8,851	38,006	848,949	886,955	1,377	4,598	(3,221)	21.95
		3	225	8,637	8,862	42,497	847,846	890,343	1,540	5,947	(4,407)	26.86
		5	256	8,621	8,877	48,307	846,441	894,748	1,750	8,645	(6,895)	36.97
		8	282	8,608	8,890	53,391	845,230	898,621	1,935	12,692	(10,758)	52.19
80	0	1	246	8,664	8,910	49,892	848,007	897,899	1,810	95,510	(93,701)	521.64
		2	357	8,594	8,951	69,854	842,549	912,403	2,532	96,927	(94,395)	361.82
		3	399	8,576	8,975	78,035	840,816	918,851	2,828	98,344	(95,515)	327.74
		5	453	8,553	9,006	88,600	838,628	927,228	3,211	101,176	(97,966)	296.07
		8	500	8,534	9,034	97,831	836,758	934,589	3,545	105,426	(101,881)	278.85
80	10	1	217	8,673	8,890	43,833	849,201	893,034	1,749	95,510	(93,762)	592.63
		2	311	8,614	8,925	60,715	844,524	905,239	2,420	96,927	(94,506)	416.76
		3	347	8,598	8,945	67,842	842,980	910,822	2,705	98,344	(95,639)	377.46
		5	394	8,578	8,972	77,052	841,023	918,075	3,072	101,176	(98,105)	340.92
		8	435	8,561	8,996	85,101	839,347	924,448	3,393	105,426	(102,033)	321.04
80	20	1	193	8,682	8,875	38,908	850,191	889,099	1,693	95,510	(93,817)	666.56
		2	273	8,631	8,904	53,406	846,136	899,542	2,323	96,927	(94,604)	474.28
		3	305	8,617	8,922	59,688	844,749	904,437	2,596	98,344	(95,748)	429.50
		5	347	8,598	8,945	67,809	842,987	910,796	2,949	101,176	(98,228)	387.87
		8	383	8,583	8,966	74,909	841,474	916,383	3,258	105,426	(102,168)	365.19
150	0	1	413	8,620	9,033	86,260	841,722	927,982	3,129	166,098	(162,969)	540.20
		2	593	8,528	9,121	119,959	834,004	953,963	4,348	168,031	(163,683)	378.04
		3	662	8,504	9,166	133,853	831,520	965,373	4,852	169,965	(165,113)	341.74
		5	750	8,475	9,225	151,764	828,419	980,183	5,501	173,832	(168,331)	307.26
		8	828	8,449	9,277	167,385	825,799	993,184	6,067	179,633	(173,566)	287.24
150	30	1	291	8,656	8,947	60,363	846,367	906,730	2,846	166,098	(163,252)	769.00
		2	404	8,597	9,001	81,779	841,206	922,985	3,854	168,031	(164,178)	556.30
		3	452	8,578	9,030	91,329	839,349	930,678	4,304	169,965	(165,661)	502.61
		5	512	8,557	9,069	103,656	837,009	940,665	4,884	173,832	(168,948)	451.59
		8	566	8,537	9,103	114,421	835,014	949,435	5,392	179,633	(174,241)	421.91
150	50	1	239	8,673	8,912	49,513	848,421	897,934	2,694	166,098	(163,404)	935.86
		2	328	8,625	8,953	66,281	844,302	910,583	3,604	168,031	(164,427)	687.47
		3	366	8,611	8,977	74,051	842,736	916,787	4,026	169,965	(165,939)	620.97
		5	416	8,592	9,008	84,088	840,753	924,841	4,572	173,832	(169,260)	557.77
		8	459	8,576	9,035	92,858	839,057	931,915	5,049	179,633	(174,584)	520.95

Table A-2

OPERATING STATISTICS--ALTERNATIVE ROUTE 2
Detroit-Lansing-Battle Creek-Kalamazoo-Chicago

Speed (mph)	Fare Increase (percent)	Frequency (trains/day)	Daily One-Way Passenger Data: Passengers			Passenger Miles			Annual Cost Data (thousands of dollars): Rail Revenue	Rail Cost	Rail Profit (loss)	Deficit per Passenger
			Rail	Other	Total	Rail	Other	Total				
45	0%	1	102	5,967	6,069	20,678	681,718	702,396	$ 772	$ 3,210	$ (2,437)	32.73
		2	143	5,940	6,083	28,425	679,548	707,973	1,062	4,502	(3,440)	32.94
		3	160	5,932	6,092	31,792	678,732	710,524	1,188	5,794	(4,606)	39.44
		5	182	5,922	6,104	36,151	677,687	713,838	1,350	8,378	(7,028)	52.92
		8	201	5,913	6,114	39,967	676,787	716,754	1,493	12,254	(10,761)	73.30
80	0	1	187	5,940	6,127	38,702	677,832	716,534	1,445	91,479	(90,034)	659.61
		2	261	5,900	6,161	53,023	674,296	727,319	1,980	92,836	(90,856)	477.34
		3	291	5,889	6,180	59,253	672,955	732,208	2,213	94,193	(91,980)	432.43
		5	331	5,874	6,205	67,305	671,255	738,560	2,513	96,906	(94,393)	390.69
		8	366	5,861	6,227	74,343	669,803	744,146	2,776	100,976	(98,200)	367.96
80	10	1	164	5,948	6,112	33,936	678,863	712,799	1,394	91,479	(90,085)	751.66
		2	227	5,914	6,141	46,067	675,824	721,891	1,891	92,836	(90,944)	549.95
		3	253	5,904	6,157	51,491	674,630	726,121	2,115	94,193	(92,078)	498.15
		5	288	5,890	6,178	58,505	673,113	731,618	2,403	96,906	(94,503)	449.98
		8	318	5,879	6,197	64,638	671,813	736,451	2,655	100,976	(98,321)	423.74
80	20	1	146	5,954	6,100	30,074	679,711	709,785	1,347	91,479	(90,132)	847.66
		2	199	5,925	6,124	40,507	677,069	717,576	1,815	92,836	(91,021)	625.97
		3	223	5,916	6,139	45,285	675,998	721,283	2,029	94,193	(92,163)	566.94
		5	253	5,904	6,157	51,466	674,635	726,101	2,306	96,906	(94,600)	512.05
		8	280	5,893	6,173	56,872	673,464	730,336	2,548	100,976	(98,428)	482.12
150	0	1	320	5,906	6,226	67,859	672,153	740,012	2,532	159,087	(156,555)	669.32
		2	444	5,852	6,296	92,581	666,883	759,464	3,455	160,939	(157,484)	485.86
		3	496	5,835	6,331	103,343	664,883	768,226	3,857	162,791	(158,934)	439.24
		5	562	5,816	6,378	117,224	662,385	779,609	4,375	166,495	(162,120)	394.96
		8	620	5,799	6,419	129,336	660,274	789,610	4,827	172,051	(167,224)	369.22
150	30	1	224	5,934	6,158	47,260	676,245	723,505	2,293	159,087	(156,794)	959.70
		2	302	5,899	6,201	63,037	672,678	735,715	3,059	160,939	(157,880)	715.50
		3	338	5,887	6,225	70,422	671,184	741,606	3,417	162,791	(159,374)	646.50
		5	383	5,872	6,255	79,960	669,301	749,261	3,880	166,495	(162,615)	580.92
		8	423	5,859	6,282	88,293	667,695	755,988	4,284	172,051	(167,767)	542.73
150	50	1	183	5,947	6,130	38,677	678,033	716,710	2,165	159,087	(156,922)	1,172.01
		2	245	5,919	6,164	51,060	675,166	726,226	2,859	160,939	(158,080)	884.52
		3	274	5,908	6,182	57,063	673,908	730,971	3,195	162,791	(159,596)	799.02
		5	311	5,896	6,207	64,822	672,314	737,136	3,629	166,495	(162,866)	717.76
		8	343	5,885	6,228	71,605	670,948	742,553	4,009	172,051	(168,042)	670.39

Table A-3

OPERATING STATISTICS--ALTERNATIVE ROUTE 3
Detroit-Ann Arbor-Jackson-Battle Creek-Kalamazoo-Chicago

Speed (mph)	Fare Increase (percent)	Frequency (trains/day)	Daily One-Way Passenger Data: Passengers			Passenger Data			Annual Cost Data (thousands of dollars)			Deficit per Passenger
			Rail	Other	Total	Rail	Other	Total	Rail Revenue	Rail Cost	Rail Profit (loss)	
45	0%	1	102	10,306	10,408	21,053	870,911	891,964	$ 811	$ 3,079	$ (2,268)	$ 30.46
		2	144	10,256	10,400	28,845	867,973	896,818	1,111	4,319	(3,208)	30.62
		3	161	10,243	10,404	32,268	866,971	899,239	1,243	5,558	(4,316)	36.83
		5	183	10,226	10,409	36,700	865,691	902,391	1,413	8,037	(6,624)	49.70
		8	202	10,212	10,414	40,583	864,584	905,167	1,563	11,756	(10,193)	69.16
80	0	1	186	10,270	10,456	39,171	866,775	905,946	1,508	87,758	(86,250)	635.43
		2	260	10,200	10,460	53,492	862,231	915,723	2,059	89,060	(87,000)	459.25
		3	290	10,182	10,472	59,796	860,650	920,446	2,302	90,361	(88,059)	415.82
		5	330	10,157	10,487	67,948	858,645	926,593	2,616	92,964	(90,348)	375.44
		8	364	10,137	10,501	75,078	856,929	932,007	2,890	96,869	(93,978)	353.43
80	10	1	182	10,271	10,453	38,657	866,837	905,494	1,503	87,758	(86,256)	648.16
		2	254	10,201	10,455	52,704	862,322	915,026	2,049	89,059	(87,011)	469.40
		3	283	10,183	10,466	58,916	860,750	919,666	2,290	90,361	(88,071)	425.02
		5	323	10,158	10,481	66,949	858,757	925,706	2,603	92,964	(90,361)	383.74
		8	356	10,138	10,494	73,976	857,050	931,026	2,876	96,869	(93,993)	361.24
80	20	1	179	10,271	10,450	38,240	866,886	905,126	1,497	87,758	(86,261)	658.90
		2	249	10,202	10,451	52,076	862,394	914,470	2,040	89,060	(87,020)	477.84
		3	279	10,183	10,462	58,214	860,830	919,044	2,280	90,361	(88,081)	432.66
		5	317	10,159	10,476	66,152	858,847	924,999	2,591	92,964	(90,373)	390.64
		8	350	10,139	10,489	73,094	857,150	930,244	2,863	96,869	(94,005)	367.73
150	0	1	243	10,314	10,557	56,391	864,309	920,700	2,142	152,616	(150,474)	849.12
		2	461	10,130	10,591	98,101	853,402	951,503	3,773	154,392	(150,619)	447.96
		3	514	10,106	10,620	109,540	851,028	960,568	4,213	156,169	(151,956)	404.70
		5	584	10,073	10,657	124,303	848,058	972,361	4,781	159,722	(154,941)	363.60
		8	644	10,047	10,691	137,191	845,545	982,736	5,277	165,052	(159,776)	339.69

Table A-3 (Concluded)

Speed (mph)	Fare Increase (percent)	Frequency (trains/day)	Daily One-Way Passenger Data: Passengers: Rail	Passengers: Other	Passengers: Total	Passenger Data: Rail	Passenger Data: Other	Passenger Data: Total	Annual Cost Data (thousands of dollars): Rail Revenue	Rail Cost	Rail Profit (loss)	Deficit per Passenger
150	30%	1	228	10,316	10,544	54,245	864,553	918,798	$2,117	$152,616	$(150,499)	$906.07
		2	438	10,133	10,571	94,867	853,755	948,622	3,727	154,392	(150,665)	471.58
		3	489	10,108	10,597	105,932	851,415	957,347	4,162	156,169	(152,007)	426.03
		5	555	10,077	10,632	120,212	848,487	968,699	4,723	159,722	(154,999)	382.76
		8	612	10,050	10,662	132,679	846,009	978,688	5,213	165,052	(159,839)	357.58
150	50	1	221	10,318	10,539	53,346	864,658	918,004	2,103	152,616	(150,513)	932.28
		2	428	10,135	10,563	93,561	853,903	947,464	3,704	154,392	(150,688)	481.85
		3	478	10,110	10,588	104,473	851,579	956,052	4,136	156,169	(152,033)	435.32
		5	543	10,078	10,621	118,557	848,669	967,226	4,694	159,722	(155,028)	391.10
		8	599	10,052	10,651	130,852	846,208	977,060	5,181	165,052	(159,871)	365.38
250	0	1	346	10,293	10,639	81,115	859,639	940,754	3,080	188,887	(185,807)	734.87
		2	646	10,081	10,727	140,106	846,359	986,465	5,387	190,994	(185,608)	393.31
		3	721	10,052	10,773	156,313	843,436	999,749	6,010	193,102	(187,092)	355.30
		5	818	10,014	10,832	177,202	839,808	1,017,010	6,813	197,316	(190,503)	319.07
		8	902	9,983	10,885	195,415	836,771	1,032,186	7,513	203,638	(196,124)	297.82
250	30	1	326	10,295	10,621	78,174	859,961	938,135	3,046	188,887	(185,841)	782.10
		2	615	10,085	10,700	135,688	846,815	982,503	5,325	190,994	(185,670)	413.49
		3	686	10,056	10,742	151,387	843,933	995,320	5,941	193,102	(187,161)	373.52
		5	778	10,019	10,797	171,622	840,358	1,011,980	6,735	197,316	(190,581)	335.42
		8	858	9,988	10,846	189,267	837,363	1,026,630	7,428	203,638	(196,210)	313.08
250	50	1	317	10,296	10,613	76,940	860,101	937,041	3,028	188,887	(185,860)	803.79
		2	602	10,086	10,688	133,899	847,010	980,909	5,293	190,994	(185,701)	442.27
		3	672	10,057	10,729	149,391	844,147	993,538	5,906	193,102	(187,195)	381.45
		5	762	10,021	10,783	169,359	840,591	1,009,950	6,696	197,316	(190,620)	342.56
		8	841	9,990	10,831	186,771	837,619	1,024,390	7,385	203,638	(196,253)	319.75

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