IOWA RAIL ROUTE ALTERNATIVES ANALYSIS

PREPARED FOR
IOWA DEPARTMENT OF TRANSPORTATION

PREPARED BY
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Table of Contents

Section 1. Introduction 1-1

Section 2. Route Analysis 2-1

Market Analysis 2-1
Conservative Scenario Results 2-16
Operating Plan and Timetables 2-19
Conservative Scenario Train Technology 2-24
Operating Plan Assumptions 2-24
Operating Cost Assumptions 2-26
Infrastructure Analysis 2-30
Route Alternatives Financial Analysis 2-35

Section 3. Segment Analysis 3-1

Market Analysis 3-1
Operating Plan Timetables 3-4
Moderate Scenario Train Technology 3-6
Operating Costs 3-8
Infrastructure Costs 3-10
Segment Infrastructure Costs 3-11
Segment Analysis Financial Results 3-12

Section 4. Conclusions 4-1

Appendix 1. *COMPASS*^{Ó} Model System and Results Appendix 1-1

Appendix 2. Narrative Description of IAIS Infrastructure Assessment and Detailed Tables on Infrastructure Cost Appendix 2-1

Section 1. Introduction

The development of new rail systems in the first part of the 21st century is the result of a wide range of trends that are making it increasingly difficult to maintain regional mobility using the two dominant intercity travel modes, auto and air. These trends include the changing character of the economic structure of industry. The character of the North American industrial structure is moving rapidly from a manufacturing base to a service based economy. This is increasing the need for business travel while the increase in disposable income due to higher salaries has promoted increased social and tourist travel. Another trend is the change in the regulatory environment. The trend towards deregulation has dramatically reduced the willingness of the airlines to operate from smaller airports and the level of service has fallen due to the creation of hub and spoke systems. While new air technology such as regional jets may mitigate this trend to some degree in medium-size airports, smaller airports will continue to lose out. Finally, increasing environmental concerns have reduced the ability of the automobile to meet intercity travel needs because of increased suburban congestion and limited highway capacity in big cities.

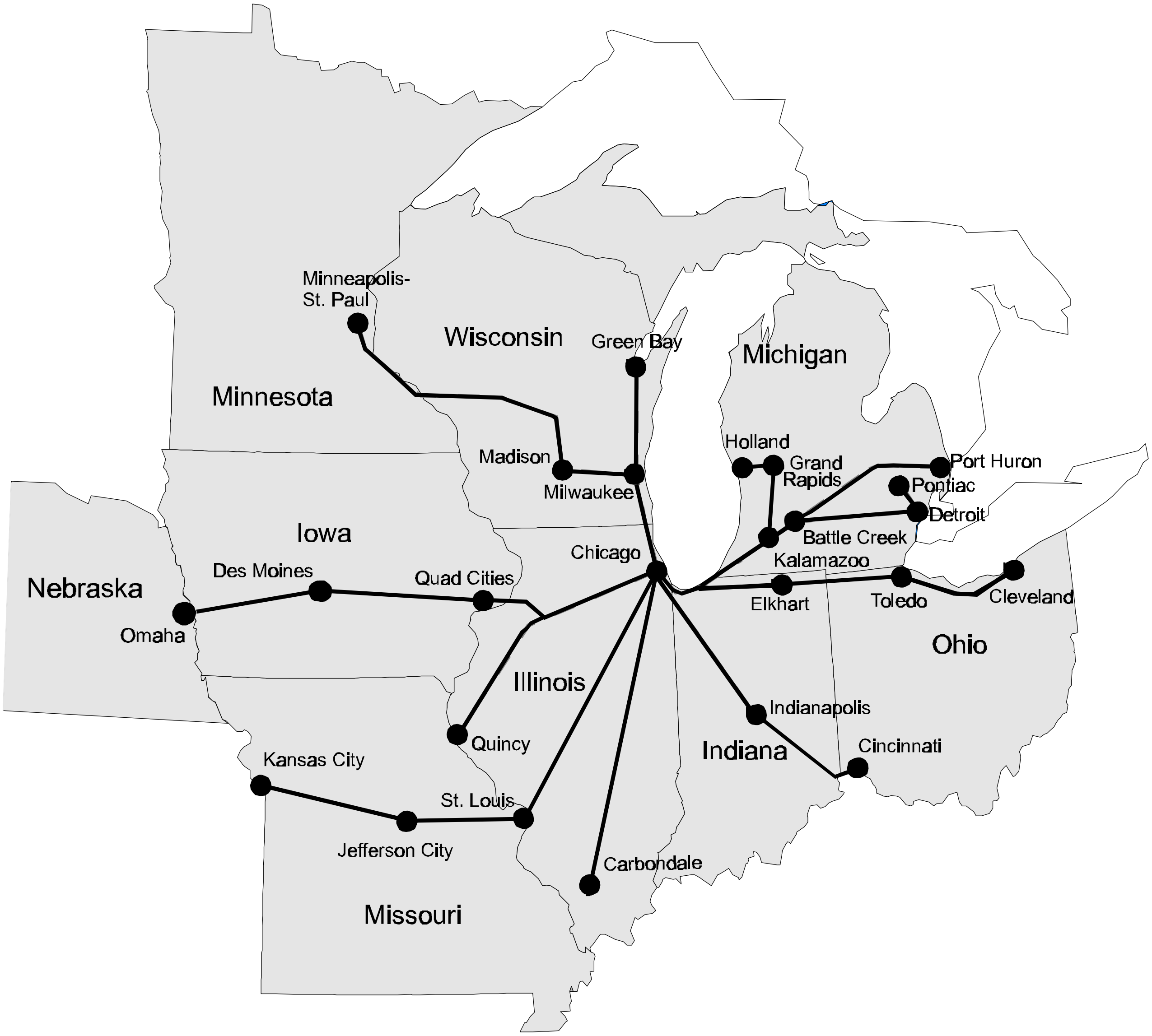
Against this background the rail mode offers new options due to first, the existing rail rights-of-way offering direct access into major cities that, in most cases, have significant capacity available and, second, a revolution in vehicle technology that makes new rail rolling stock faster and less expensive to purchase and operate.

This study is designed to evaluate the potential for rail service making an important contribution to maintaining regional mobility over the next 30 to 50 years in Iowa. The study evaluates the potential for rail service on three key routes across Iowa and assesses the impact of new train technology in reducing costs and improving rail service. The study also considers the potential for developing the system on an incremental basis. The service analysis and recommendations do not involve current Amtrak intercity service. That service is presumed to continue on its current route and schedule.

The study builds from data and analyses that have been generated for the Midwest Rail Initiative (MWRI) Study. For example, the zone system and operating and capital unit cost assumptions are derived from the MWRI study. The MWRI represents a cooperative effort between nine Midwest states, Amtrak and the Federal Railroad Administration (FRA) contracting with Transportation Economics & Management Systems, Inc. to evaluate the potential for a regional rail system. The system is to offer modern, frequent, higher speed train service to the region, with Chicago as the connecting hub. Exhibit 1-1 illustrates the size of the system, and how the Iowa route fits in to the whole.

Exhibit 1-1

MWRI Regional System [1]



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[1] The map represents the system including the decision on the Iowa route derived from the current study.

The MWRI data and analysis framework, which has been supplemented by additional research and on-site investigation, is used to provide the alternative analysis of three potential rail routes linking Chicago and Omaha. The routes and technology were initially explored as part of the MWRI. In particular that study assessed three scenarios:

> Conservative – minimal capital investments to increase speeds to 79 and 90 mph where feasible; conventional locomotive-hauled trains; and increased train frequencies to attract new riders.
>
> Moderate – greater capital investments to increase speeds to 110 mph where warranted (balancing investment required with attainable speed); modern diesel multiple unit (DMU) train technology; higher frequencies than the Conservative Scenario.
>
> Aggressive – significant capital investments to increase speeds to 125 mph where feasible; modern high-speed locomotive-hauled trains; greater frequencies than the Moderate Scenario.

The MWRI study concluded that the Aggressive scenario was not a cost-effective option and that the Moderate scenario produced the best financial return in terms of meeting operating costs. It also found that DMU technology was far more cost effective than locomotive-hauled trains. These findings have been adopted for this study, which is concerned with the evaluation of three routes and selection of a preferred route.

Each route (see Exhibit 1-2) has very different implications for passenger transportation and mobility in the state of Iowa and poses very different development questions.

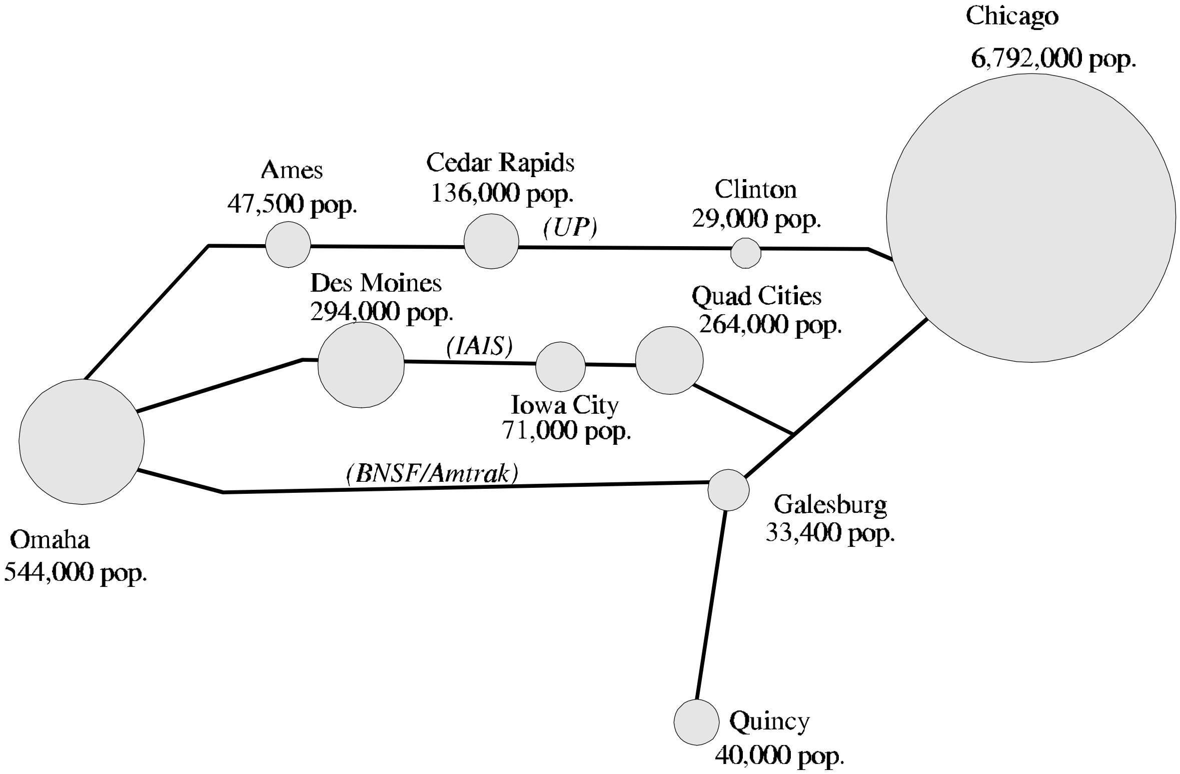
Route 1 is the Burlington Northern-Santa Fe (BNSF) Route. This line is used by the current long distance intercity Amtrak service. It runs from Chicago to Galesburg to Omaha with connections to Quincy. This 503 mile route, while connecting a number of small towns such as Burlington, Mt. Pleasant, Osceola, Creston, and Ottumwa with Omaha and Chicago misses the major centers of population in Iowa, such as Des Moines, Quad Cities (Illinois and Iowa), Cedar Rapids and Iowa City. As a result, the current long distance Amtrak rail service is limited in its ability to provide an effective alternative to auto and air travel in the state.

Route 2 is the Iowa Interstate (IAIS) Route, which is 479 miles long, and runs between Chicago, Quad Cities, Iowa City, Des Moines, and Omaha. This route connects three of Iowa’s major cities, Davenport, Iowa City and Des Moines, that rank third, sixth and first in population. Because of good access and geography, this route more effectively reflects the center of gravity of the state's population.

Route 3 is the Union Pacific (UP) Route. It is 491 miles long and connects Chicago with Clinton, Cedar Rapids, Ames and Omaha. Cedar Rapids ranks second in population in the state. As such, this provides a more effective route than the BNSF route but is less densely populated than the IAIS route.

Exhibit 1-2

Alternative Routings



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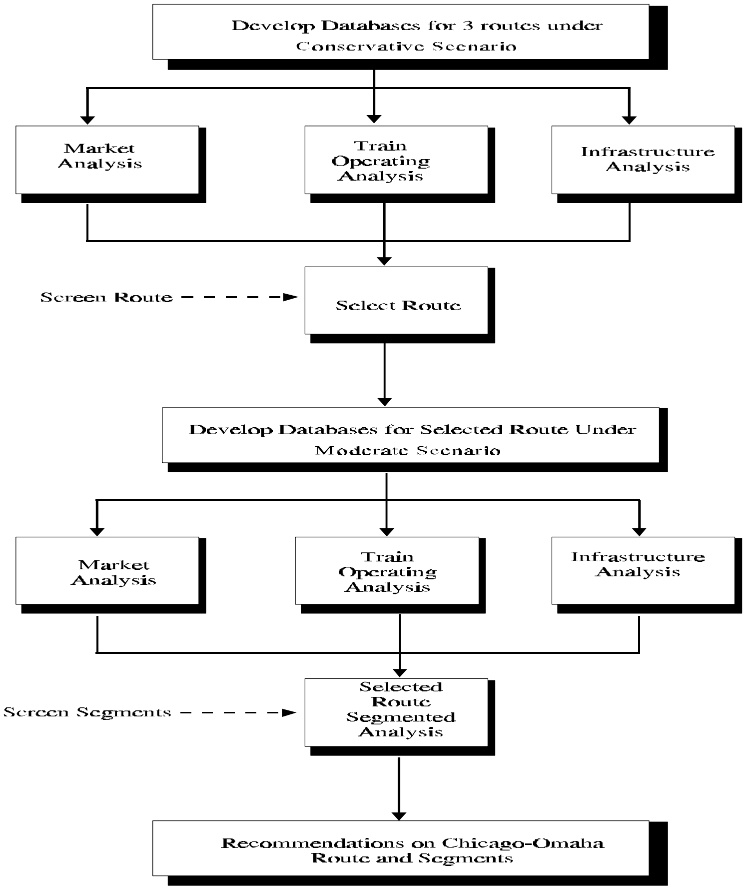
Given the differences in the routes in terms of population and thus potential ridership levels, the route lengths and the differences in capital to upgrade each route, and the differences in operating costs to serve each route, the Iowa Department of Transportation requested that TEMS undertake an *alternatives analysis* to establish two things:

> The most effective route that maximizes rail ridership, revenue and regional mobility under the MWRI Conservative scenario.
>
> The relative advantage of building different segments of the selected route and minimizing the capital and operating costs of providing rail service under the MWRI Moderate scenario.

The Conservative and Moderate scenarios were to include the same level of infrastructure investment for the Iowa portions of the route(s), with the Moderate scenario varying in the train technology and the frequency of service. This allowed Iowa DOT to evaluate implications of a range of service options. The project scope permitted four analyses. The study was therefore conducted in two phases. The first phase involved the screening of the three candidate routes, through comparisons of markets, operations and infrastructure requirements. Once the screening was completed, a more in-depth analysis of the chosen option was conducted to evaluate segments of the route, to assess whether operating train service on less than the full route would be more cost-effective than full route services to Omaha. In this way, the study identifies the most effective route and segment structure for the Chicago-Omaha Corridor. In undertaking this work the study process illustrated in Exhibit 1-3 was utilized.

Exhibit 1-3

Study Process



Section 2. Route Analysis

The first step in the study was to identify the most effective route that maximizes rail ridership, revenue and regional mobility under the Midwest Rail Initiative (MWRI) Conservative scenario. To meet this need, three analyses were carried out:

Market Analysis
Train Operating Analysis
Infrastructure Analysis

The details of the database and analysis procedures used are described in detail in the technical appendices. Appendix 1 contains a description of the *COMPASS*© demand forecasting model and the detailed model output. Appendix 2 includes the details of the infrastructure cost by route. The following section outlines the work undertaken for the three analyses and the results for the MWRI Conservative scenario.

Market Analysis

Introduction

The development of rail service between Chicago and Omaha offers the opportunity to investigate three rail corridors between Omaha and Chicago: the Burlington Northern - Santa Fe (BNSF) Route, the Iowa Interstate (IAIS) Route, and the Union Pacific (UP) Route. The routes vary somewhat in length and pose very different engineering problems. They are also remarkably different in market terms (See Exhibit 1-1). The route currently used by Amtrak, the BNSF, while providing access to Galesburg and Quincy in Illinois, and Omaha in Nebraska, does little to serve the rapidly growing cities of central Iowa such as Des Moines, Cedar Rapids, Iowa City, and Ames, or even the third largest urban area of the corridor, Quad Cities. A review of the different city populations along the IAIS or the UP Routes makes it clear that these represent much more effective corridors for a regional rail system than the current BNSF Route in terms of serving population centers and attracting riders.

To provide an evaluation of the potential rail market for these three routes, the databases, demand models, and forecasting assumptions of the MWRI Conservative scenario were adopted, as specified in the scope by Iowa DOT. As briefly described in Section 1, three scenarios were developed for the MWRI, varying in the level of infrastructure improvement to attain different operating speeds, and also varying in train technologies, frequencies of service, fare levels and amenities. Besides Conservative, Moderate and Aggressive scenarios were evaluated, with the Aggressive scenario eliminated part way through the process. The Conservative scenario is based on improving track levels to achieve 79 mph speeds, with new locomotive-hauled trains and with frequencies improved above the level of current service. The ridership forecasting process is described briefly in the following pages, and is described in detail in Appendix 1.

Market Database

As part of the MWRI, a comprehensive database was developed for nine Midwest states. The database was built on a 337 zone system of which 38 were in Iowa, 55 in Illinois, and 21 in Nebraska. The Chicago-Omaha Corridor consists of 21 Nebraska, 38 Iowa, and 16 Illinois zones or 75 total zones (Exhibit 2-1). It is assumed to be connected with all the rest of the Midwest Rail Initiative on the basis of similar train services to the whole region. Zones are the basic units used in demand forecasting to identify patterns of transportation relationships (from zone to zone). Generally, the more densely populated an area, the greater the number of zones that are developed, to represent the area in finer detail. Zones typically follow county, city or other standard boundary areas. Zones may be named or defined by the city(ies) that provide the major population of the zone.

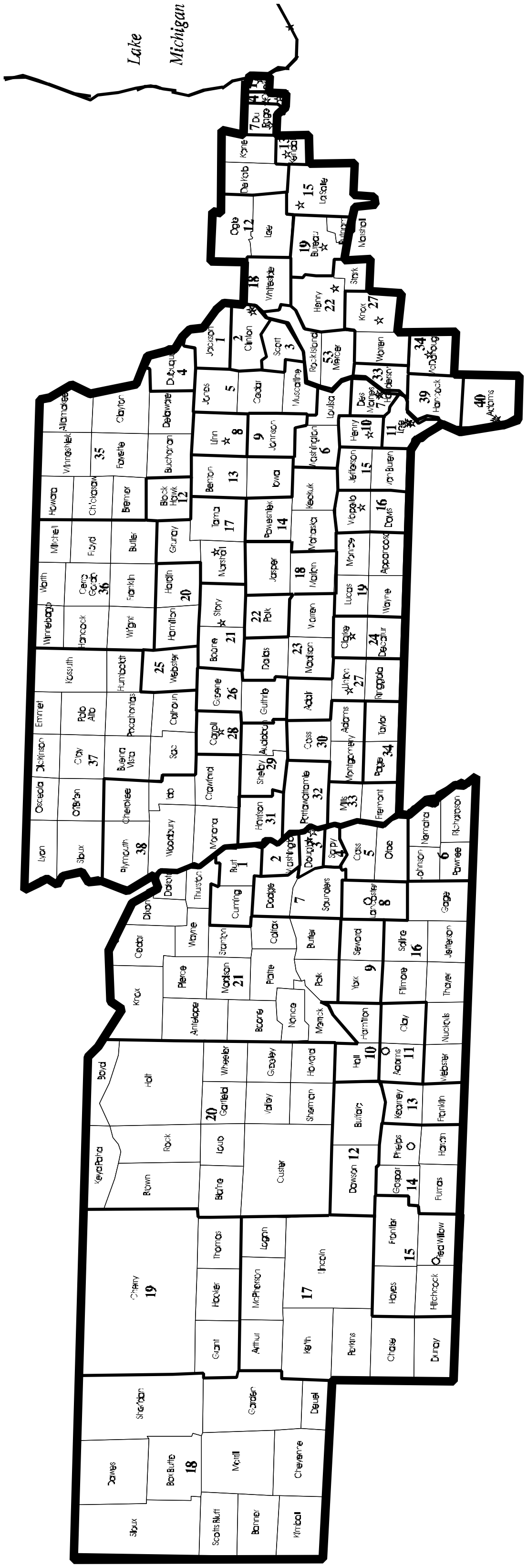


Exhibit 2-1
Chicago-Omaha Corridor Zone System

For each zone, a comprehensive database was established that included

Socioeconomic data
Origin-Destination data
Modal Network data

Socioeconomic Data

The socioeconomic data for Iowa, Nebraska and Illinois were derived from Bureau of Economic Analysis sources and are displayed in Tables 2-1 to 2-3. Sources are as follows:

> County Projections to 2040, US Department of Commerce, Economics and Statistics Department, BEA, Regional Economic Analysis Division, Washington, DC, 1992.
>
> BEA Regional Projections to 2045, Volume 1, State Projections, US Department of Commerce, Economics and Statistics Department, BEA, Regional Analysis Division, Washington, DC, August 1995.
>
> REIS-Regional Economic Information System 1969-1993, US Department of Commerce, Economics and Statistics Department, BEA, Regional Economic Measurement Division, Washington, DC, May 1995.

Table 2-1
Average Annual Growth Rate Summaries: Population

Year	Illinois	Iowa	Nebraska
1990-1995	0.7	0.4	0.7
1995-2000	0.7	0.4	0.7
2000-2005	0.7	0.4	0.6
2005-2010	0.7	0.4	0.6
2010-2015	0.7	0.5	0.6
2015-2025	0.7	0.6	0.6
2025-2045	0.5	0.5	0.5

Table 2-2
Average Annual Growth Rate Summaries: Per Capita Income

Year	Illinois	Iowa	Nebraska
1990-1995	0.6	0.5	1.0
1995-2000	1.2	1.5	1.5
2000-2005	1.1	1.3	1.3
2005-2010	0.9	1.0	1.0
2010-2015	0.8	0.9	0.8
2015-2025	0.7	0.7	0.7
2025-2045	0.9	0.9	0.9

Table 2-3
Average Annual Growth Rate Summaries: Employment

Year	Illinois	Iowa	Nebraska
1990-1995	0.6	0.5	1.0
1995-2000	1.2	1.5	1.5
2000-2005	1.1	1.3	1.3
2005-2010	0.9	1.0	1.0
2010-2015	0.8	0.9	0.8
2015-2025	0.7	0.7	0.7
2025-2045	0.9	0.9	0.9

It can be seen that throughout the corridor, modest growth is expected in all the key socioeconomic factors. The changes in Illinois, Iowa, and Nebraska population, employment, and income growth are graphically shown in Exhibits 2-2, 2-3 and 2-4.

Exhibit 2-2
State-Level Population, Income, and Employment Projections for Illinois

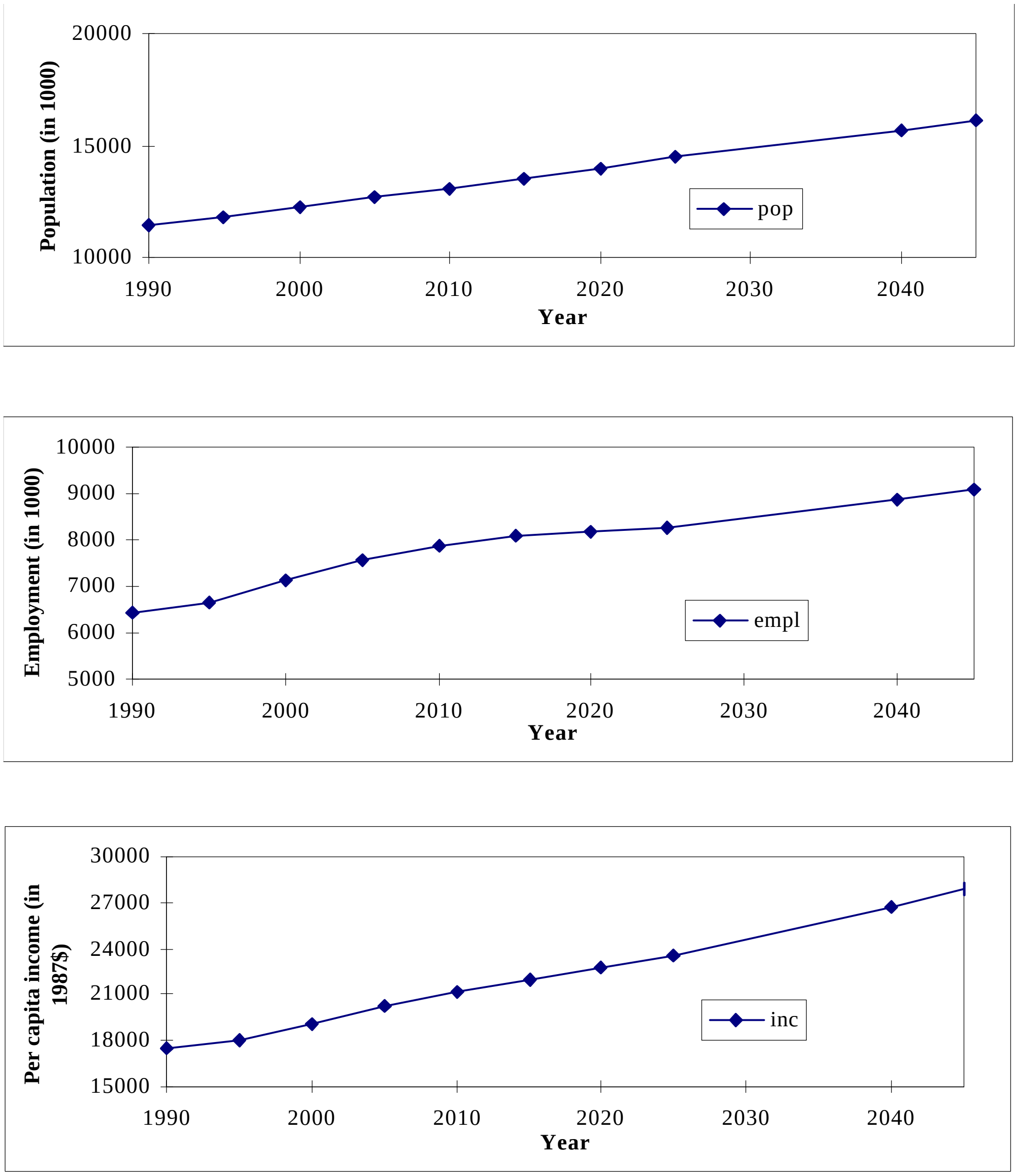


Exhibit 2-3
State-Level Population, Income, and Employment Projections for Iowa

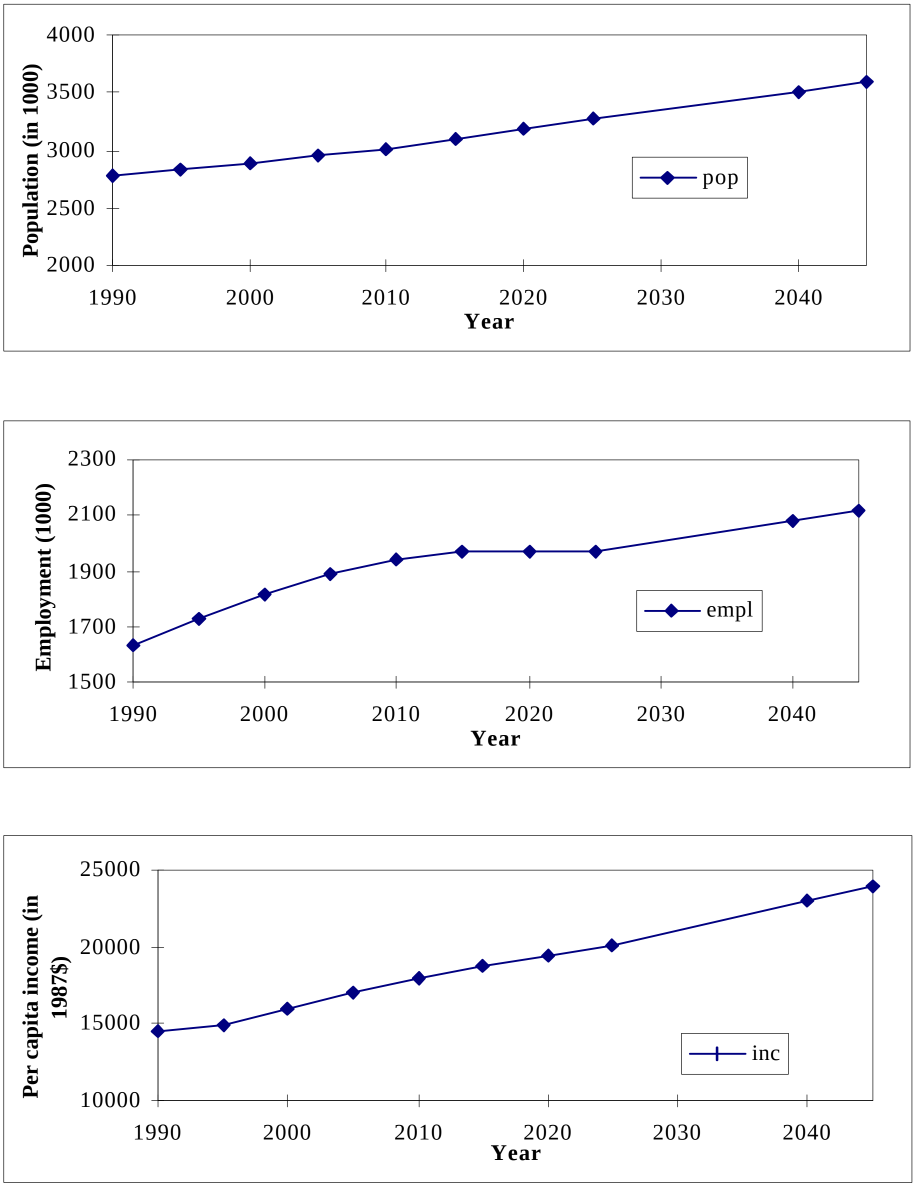
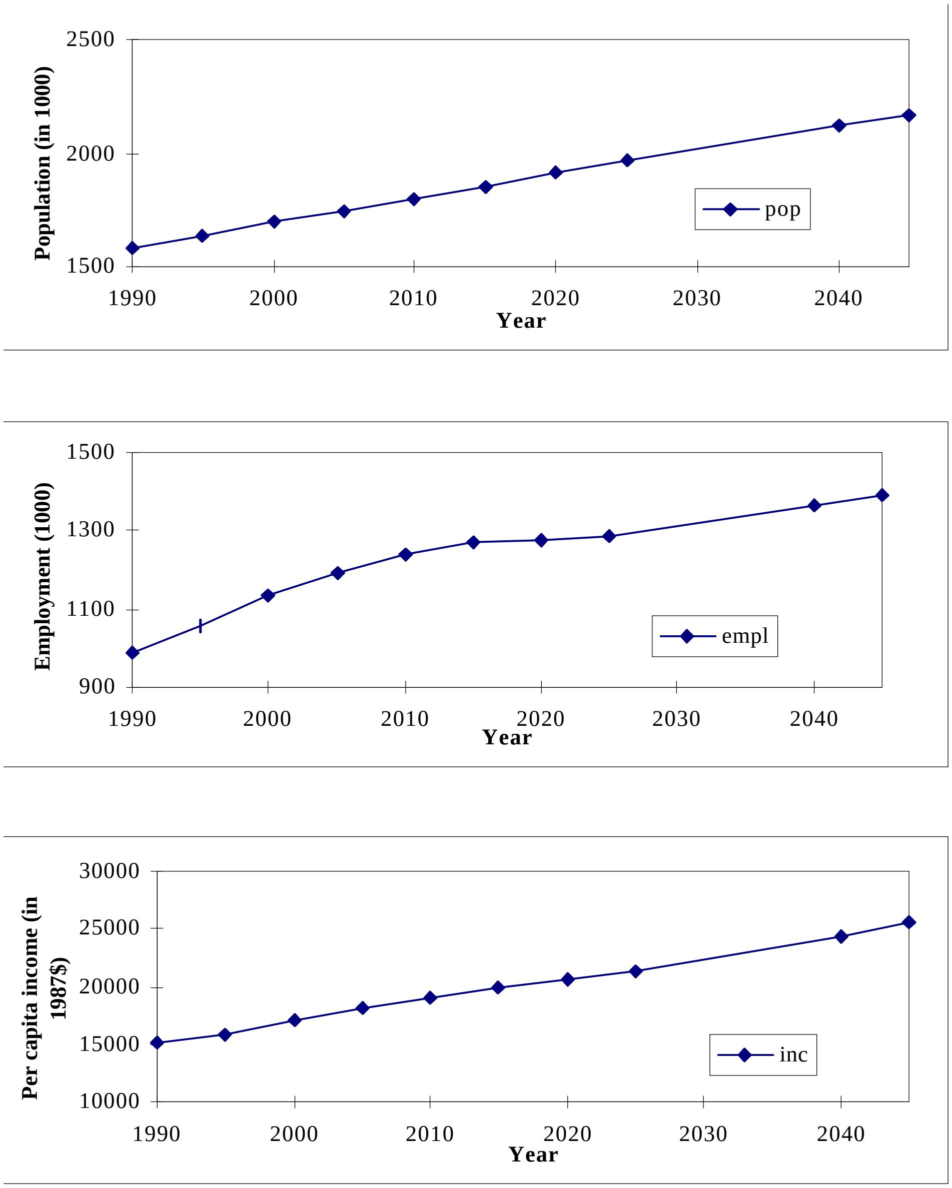


Exhibit 2-4
State-Level Population, Income, and Employment Projections for Nebraska



Origin-Destination Data

The base year data for the corridor were developed from a variety of sources and then synthesized to develop a comprehensive Origin-Destination Database by four modes: auto, bus, air, and rail and two trip purposes: business and nonbusiness (*i.e.* commuter, educational, social, recreational, tourism) travel.

Key data sources for the Midwest Rail Initiative that were also used for the Iowa study include:

RAIL	Amtrak Ticketing Data
	Station-to-Station Passenger Volume
	Access/Egress Simulation[1]*
AIR	10 Percent Sample of All Air Tickets
	Airport-to-Airport Passenger Volume
	Access/Egress Simulation*
BUS	Bus Schedules - Bus Counts
	Basic Passenger Volumes Simulated
	Access/Egress Simulation*
AUTO	Statewide and Urban O/D Studies
	Trip Simulation for Door-to-Door Movement

Table 2-4 identifies data sources by state. Data sources from all states in the MWRI are listed, as each states' data were used to enrich the rest, and data items for states with missing modal data were generated from other states' data, based on similarities of socioeconomic and network characteristics.

Table 2-4
Sources of Origin-Destination Data by State

State	Source
Illinois	Illinois Rail Study (1995)
	Illinois Statewide Highway Model (1987)
	Illinois Rail Passenger Survey (1993)
Indiana	Statewide Auto Trip Tables (Estimated from AADT)
Iowa	Highway Traffic Volumes
Michigan	Statewide Travel Demand Model

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[1] * Access/egress simulation is the process whereby trips to an airport, train station or bus station are distributed to the appropriate origin or destination zones (places of residence or business), since the data collected are terminal to terminal.

State	Source
	Intercity Passenger Rail Surveys (1995)
Minnesota	Highway Traffic Volumes
	Travel Survey for Twin Cities Metro Area
	Tri-State High Speed Rail Study (1991)
Missouri	Highway Traffic Volumes
Nebraska	Statewide Transportation Model
Ohio	High Speed Rail Ridership Study (1988)
	Pittsburgh-Cleveland Rail Corridor Study (1995)
Wisconsin	Chicago-Milwaukee Rail Corridor Study (1995)
	Statewide Travel Demand Model
Other Sources:	Amtrak Ticket Count Data
	FAA 10% Sample

The following matrix categorizes the data generated from the previously identified sources by mode and state.

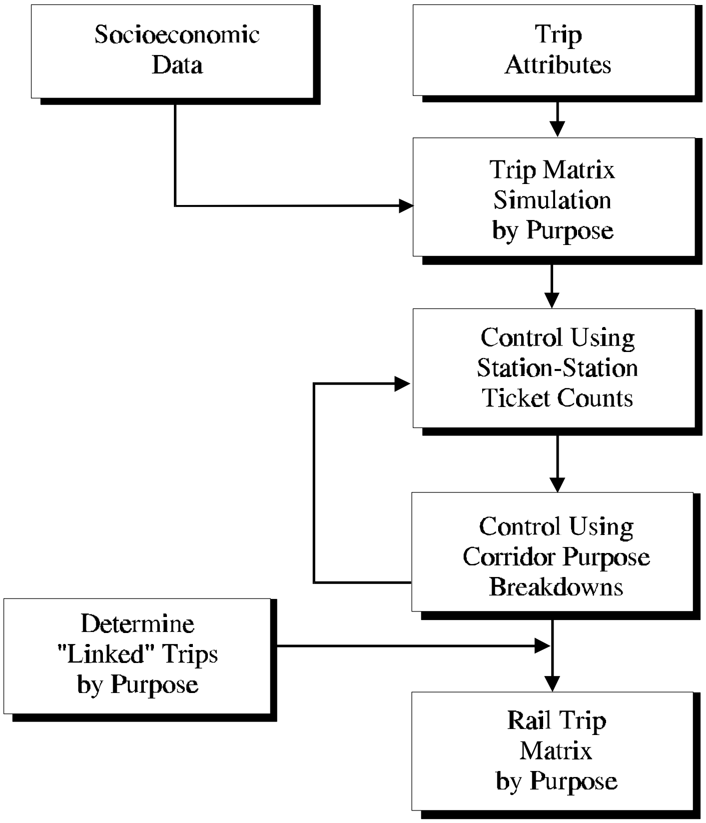
Table 2-5
Origin/Destination Data by State and Mode

State	Air	Rail	Bus	Auto
Illinois				
Indiana				
Iowa				
Michigan				
Minnesota				
Missouri				
Nebraska				
Ohio				
Wisconsin				

Validation Process

Data, particularly data from disparate sources that are collected for a multitude of purposes, cannot simply be treated as equal units. Data must be verified and compared with actual counts, or surrogates of counts. Exhibit 2-5 depicts the steps that are undertaken to generate rail mode trips between each zone pair.

Exhibit 2-5
Rail Trip Matrix Generation and Validation



Similar processes are used for other modes, chiefly differing in the source for the control total. Air travel control totals are based on the Federal Aviation Administration (FAA) airline ten percent sample data. Control totals for highways are based on each State's highway model origin-destination matrix and on highway traffic volumes. Bus control totals are based on scheduled bus runs with assumptions on passenger volumes as a portion of bus capacity.

The major passenger flows for the base year are estimated as follows:

> Key city to city (zone to zone) base year flows for air (more than 20,000 trips per year) include Omaha-Chicago, Des Moines-Chicago, Cedar Rapids-Chicago, and Quad Cities-Chicago.
>
> Key trips for auto (more than 200,000 trips per year), include Quad Cities-Chicago (over 1.6 million), Des Moines-Omaha (over 600,000), Des Moines-Chicago (almost 400,000), Cedar Rapids-Chicago (over 385,000), and Iowa City- Chicago, Omaha-Chicago, and Clinton-Chicago, each with about 290,000 trips per year.

Table 2-6 provides an example of the estimated baseline trips to and from Chicago and Omaha from other major corridor cities by mode. Please note that city names are used for convenience of reference; the model actually evaluates zone to zone travel, with cities represented by one or more zones. The trips are identified based on zone of origin of the traveler. Therefore, for example, Des Moines and Iowa City exhibit a small number of rail trips in the baseline, for travelers driving to Osceola or Mt. Pleasant to catch the current Amtrak long-distance train. Similarly, travelers from Clinton that drive to another city to connect with air or bus service are represented as air and bus travelers in the baseline travel estimate.

Table 2-6
Estimated Baseline Trips by Mode and Trip Purpose for Major Corridor Cities (1998) [2]

City Pair		AIR			BUS		
		Business	NonBusiness	Total	Business	NonBusiness	Total
Ames	**Chicago**	8,794	10,692	19,485	78	1,395	1,474
Waterloo/CF	**Chicago**	748	487	1,234	27	429	456
Cedar Rapids	**Chicago**	18,782	8,437	27,218	170	2,478	2,648
Clinton	**Chicago**	1,239	1,272	2,510	52	257	308
Des Moines	**Chicago**	98,265	48,990	147,255	485	4,156	4,640
Iowa City	**Chicago**	6,890	4,663	11,553	214	3,197	3,411
Quad Cities	**Chicago**	13,723	8,400	22,123	316	5,321	5,637
Omaha	**Chicago**	157,126	111,744	268,870	484	3,784	4,268
Ames	**Omaha**	3	13	15	25	1,108	1,134
Waterloo/CF	**Omaha**	74	22	96	6	202	208
Cedar Rapids	**Omaha**	217	64	281	28	835	863
Clinton	**Omaha**	32	155	187	9	44	53
Des Moines	**Omaha**	35	59	94	214	5,089	5,303
Iowa City	**Omaha**	71	37	107	32	920	952
Quad Cities	**Omaha**	399	1,056	1,455	32	858	889

City Pair		AUTO			RAIL		
		Business	NonBusiness	Total	Business	NonBusiness	Total
Ames	**Chicago**	32,593	75,168	107,761	0	0	0
Waterloo/CF	**Chicago**	50,850	117,646	168,496	0	0	0
Cedar Rapids	**Chicago**	116,040	269,580	385,620	0	0	0
Clinton	**Chicago**	84,659	205,766	290,425	0	0	0
Des Moines	**Chicago**	117,253	278,602	395,855	394	1,411	1,805
Iowa City	**Chicago**	93,505	200,229	293,734	94	291	385
Quad Cities	**Chicago**	448,990	1,163,942	1,612,932	0	0	0
Omaha	**Chicago**	83,457	204,766	288,223	842	3,797	4,638
Ames	**Omaha**	40,746	82,789	123,535	0	0	0
Waterloo/CF	**Omaha**	11,094	22,119	33,213	0	0	0
Cedar Rapids	**Omaha**	20,943	41,764	62,707	0	0	0
Clinton	**Omaha**	5,244	10,785	16,029	0	0	0
Des Moines	**Omaha**	197,530	424,516	622,046	12	56	68
Iowa City	**Omaha**	16,846	30,983	47,829	9	36	45
Quad Cities	**Omaha**	21,890	47,731	69,621	0	0	0

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[2] Detail by trip purpose may not add to total due to rounding

Modal Network Data

The network data consists of two parts: travel characteristics that provide a description of the times and costs involved in a journey, and the value individuals put on each characteristic.

Time and Cost Data

Network data describing the times and costs of travel in the Midwest Rail Initiative region were developed on a mode and trip purpose basis. The description of the *COMPASS*© model in Appendix 1 provides greater detail on the theoretical basis for the model and the specific coefficients developed. However, in brief, estimates of travel utility for a transportation network are generated as a function of generalized cost of travel. The generalized cost variable is used to estimate the impact of improvements in the transportation system on the overall level of trip-making. It therefore needs to incorporate all the key modal attributes that affect an individual's decision to make trips, such as travel time (access time, wait time, etc.), travel cost, schedule convenience and reliability.

As a result, networks were developed for auto, bus, air, and rail for both business and nonbusiness travel. The network data included the following information:

Public Modes (Bus, Air, Rail)

access time and costs
terminal wait times
line haul times and costs
egress times and costs
service reliability

Auto Mode

travel time and cost
tolls (where applicable)
parking costs (where applicable)

The networks were coded for base and forecast years, namely 1998, 2000, 2010, 2020, and 2040. This provided a comprehensive assessment of the travel characteristics individuals would face in deciding whether to travel, where to travel, and which mode to select. In order to be able to combine these travel time and cost characteristics into a single measure of travel *independence*, a stated preference survey was carried out to measure values of time, frequency, and reliability. Values of time, frequency and reliability by mode and trip purpose are basically factored by the particular time, cost, and other network aspects of each zone pair (controlled by the base year travel volumes, with growth from socioeconomic factors) to identify the travelers by zone pair, trip purpose and mode.

Values of Time

Surveys completed as part of the Midwest Rail Initiative Study produced a wide range of data on travel behavior. The following exhibits, 2-6 and 2-7, show the values of time and frequency produced as a part of this analysis. A comparison of these results with results found by TEMS in studies elsewhere shows that the results are in-line if slightly lower than those developed previously. Therefore the models developed for this study are slightly more conservative (less optimistic) than studies conducted elsewhere.

Exhibit 2-6
Value of Time by Trip Purpose and Mode

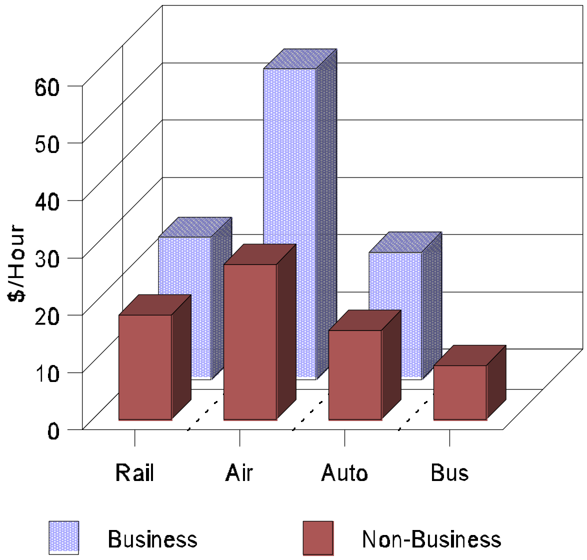
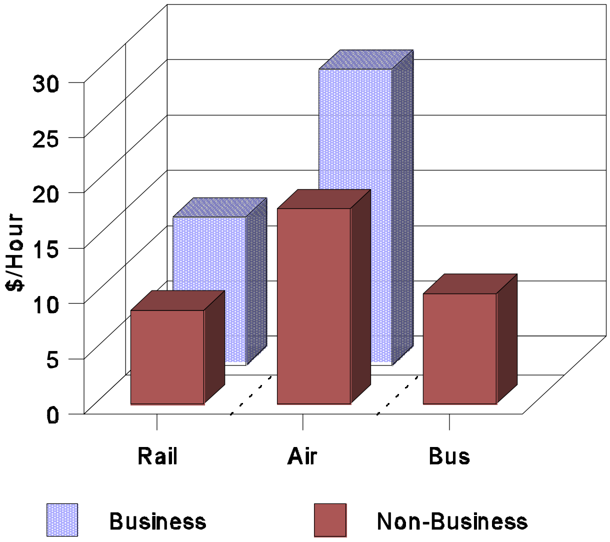


Exhibit 2-7
Value of Frequency by Trip Purpose and Mode



The values that travelers on the different modes place on time and frequency suggest how they are likely to respond to time versus fare changes, and thus how they will react when significant changes occur in a mode (such as rail). For example, in Exhibit 2-6, it is apparent that the business air traveler places a very high value on time, compared to all other travelers. Therefore, a business traveler would only be expected to change his mode of travel from air to rail if door-to-door rail travel times approach air travel times. Because of this the forecasts do not project significant numbers of long distance air business passengers being diverted from air to rail.

Both the business and leisure auto traveler, by contrast, demonstrate values of time very similar to rail, suggesting that a speedy, comfortable alternative to the automobile could attract significant numbers of auto drivers, although auto will remain the dominant mode at over 96 percent of all trips. For example, one factor leading to auto's high market share is group travel, as auto travelers with two or more to a vehicle can spread the cost over a larger number of riders.

Business travelers represent a very small portion of the intercity bus travel market- slightly less than eight percent of the bus travelers in Table 2-6. Because so few business travelers use the bus, it is also difficult to obtain a statistically reliable sample of bus business travelers from which to derive values of time or frequency. Therefore, bus business travelers are not included in the value of time and value of frequency results.

As mentioned above, the survey results are use to derive unique values of time, frequency and reliability for each mode and trip purpose. These values are factored by the unique zone to zone network attributes for each mode, such as travel time, access and egress time, travel cost, and service reliability, to estimate the passenger travel by mode and trip purpose. Total travel demand between zones across all modes for any given future year is derived from the base year trip tables expanded by socioeconomic factors of population, employment, and per capita income growth.

Conservative Scenario Results

The Conservative scenario includes track, signaling, station, train technology and schedule improvements, compared to current Amtrak Intercity service, that are expected to result in significant ridership and revenue increases. Operations and infrastructure descriptions are provided in the sections that follow. The impact of improvements varies by route, mostly related to the population served by the route. Table 2-7 summarizes the forecasts for Routes 1, 2, and 3. Note that the revenues presented here include only fare revenues; other operating revenues such as those generated through same-day parcel service activities are included in the summary revenue and operating cost tables.

Table 2-7
Ridership and Revenue Forecast Comparison by Route

Data Item and Year	Route 1: BNSF	Route 2: IAIS	Route 3: UP
Rail Passengers (000s)			
2000 [3]	359	514	439
2010	423	605	517
2020	483	689	588
Passenger Miles (millions)			
2000	74.5	111.6	99.8
2010	87.6	131.2	117.1
2020	99.9	149.1	133.1
Revenues (millions)			
2000	14.4	22.2	19.8
2010	17.0	26.1	23.2
2020	19.3	29.6	26.4

It can be seen from Table 2-7 that for the year 2010 the IAIS Route has the most rail ridership at 605 thousand trips with 131 million passenger miles compared with 517 thousand and 117 million passenger miles on the UP Route, and 423 thousand and 88 million passenger miles on the BNSF Route. This reflects in a higher rail market share: 0.8 percent of total market for the IAIS against 0.68 percent for the UP Route and 0.61 percent for the BNSF Route. The *COMPASS*© output tables in Appendix 1 provide the details of total corridor demand and market share by mode and trip purpose by study year for each alternative.

In terms of revenues, the IAIS Route generates $26 million in 2010 compared with $23 million for the UP Route and $17 million for the BNSF Route. Between 1998 and 2020, revenues increase by nearly 40 percent as socioeconomic growth (population, per capita income and employment) increases the total travel market.

The make up of the rail demand in 2010 is shown in Exhibit 2-8. Over two thirds of the demand is due to diversion from auto, air, and bus trips. Diversions from other modes are estimated from the modal split model, as discussed in Appendix 1. For the year 2010, about 67percent of the 402,000

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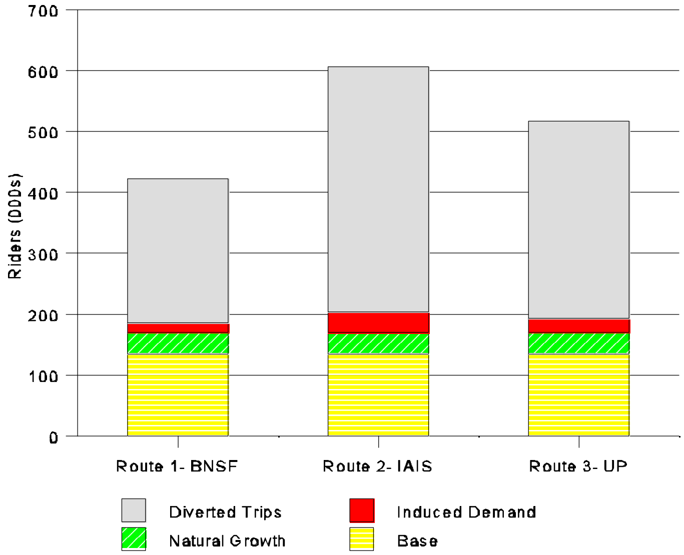
[3] Ridership in year 2000 assuming the Conservative scenario system is in place.

diverted trips are from auto, reducing auto's market share by a fraction of a percent, from 96.64 to 96.22 percent. Twenty-four percent of the diverted trips are from air, with the remaining 9 percent from bus. By contrast, induced demand represents trips that would not have been made without the introduction of the rail system. These are new trips, due to the convenience and low cost of the service. It is analagous to the increased use of air for spur of the moment travel when the low-cost providers such as People's Express and Southwest initiated service. As seen in the graph, induced demand represents only 5.5 percent of the forecast amount. Again, IAIS demonstrates the highest ridership levels, due to corridor population.

Exhibit 2-8
Estimated 2010 Ridership Sources by Route



Note that base demand relates to current corridor traffic.

Operating Plan and Timetables

The corridor between Chicago and Omaha is well served with rail routes that reflect the historic importance of both rail passenger and freight service to the region. The three competitive routes can be compared in terms of meeting the needs of the Chicago-Omaha passenger service.

These routes are shown in Exhibit 2-9. The BNSF Route is currently used by Amtrak to service Omaha, Denver and Salt Lake City as part of the long distance service from Chicago to Sacramento and San Francisco and will continue service. Neither the IAIS nor the UP have passenger service at the present time.

Development of the Conservative Scenario Operating Plans and Conservative Timetables

To enable an effective evaluation of the routes a Conservative timetable was prepared for each route. The schedules were designed, first, to attract the business traveler and second, the social traveler. A business-oriented schedule-building practice, providing early-morning and late-afternoon service, was enhanced with maximum-speed, limited-stop trains. Mid-morning through midday schedules which are focused on leisure travelers provide greater access to the en route towns and attractions by having a greater number of stops.

The Conservative scenario proposes that there should be four train services per day to and from Omaha and Chicago. In each case, the service would stop in all the principle towns en route. However, a skip stop pattern was employed in relation to smaller communities, to provide faster trip times. Each stop creates a delay, in terms of the direct stopping time and the acceleration and deceleration time. The skip stop pattern is particularly employed on the sections between Chicago and Galesburg on the BNSF Route and Chicago and Wyanet on the IAIS Route, because the intermediate stations are also served by trains to and from Quincy. In addition to the skip stop character of the timetable, the schedules were designed to meet the needs of different markets, as mentioned above.

The cities served by each route, the mileage from Chicago, and the travel time from Chicago, are identified in Tables 2-8, 2-9 and 2-10.

Table 2-8

Exhibit 2-9
Chicago-Omaha Rail Corridor Alternatives - Conservative Scenario

LEGEND

Rail Line	━
City with Rail Station	
City with Population > 500,000	■
City with Population between 500,000 and 200,000	●
City/Town with Population < 200,000	●
City/Town with Population < 200,000 Without Rail Station	•

Route 1. Chicago-Galesburg-Omaha (BNSF) Cities Served

Station/City	Mile Post	Scheduled Time with Typical Stops	Express Travel Time (Limited Stops)
Chicago	0	0:00	0:00
(La Grange Road)	14		
(Naperville)	28.4	0:33	
(Plano)	51.5		
(Mendota)	82.6		
(Princeton)	104.4		
(Kewanee)	131.1		
Galesburg	162.4	2:16	2:05
Omaha Branch			
Burlington	206.8	2:57	
Mt. Pleasant	234.6	3:27	3:10
Ottumwa	281	4:11	
Osceola	361.3	5:23	4:58
Creston	394.3	5:54	
Omaha	503	7:26	6:56
Quincy Branch			
Macomb	202.3	3:19	2:55
Quincy	258	4:04	3:39

Notes on Timetable: The service to Quincy is displayed because the services complement one another and provide additional schedule frequencies on the portion of the route from Galesburg to Chicago. The Illinois cities in parentheses are not served by every train (not every train stops at each smaller city); therefore indicating times would be misleading. For example, the scheduled time with typical stops shown to Galesburg (2:16) omits stops at La Grange Road, Plano, Princeton and Kewanee and represents a typical travel time for non-express service. The express times identified include only the stops indicated.

Table 2-9
Route 2. Chicago-Des Moines-Omaha (IAIS) Cities Served

Station/City	Milepost	Scheduled Time with Typical Stops	Express Travel Time (Limited Stops)
Chicago	0.0	0:00	0:00
(La Grange Road)	14		
Naperville	28.4	0:25	0:25
(Plano)	51.5		
(Mendota)	82.6		
(Princeton)	104.4	1:23	
Omaha Branch			
Quad Cities (Rock Island)	165.5	2:24	2:20
Iowa City	221.0	3:25	3:16
Newton	306.7	4:45	4:37
Des Moines	341.9	5:28	5:20
Atlantic	424.2	6:44	6:35
Omaha	479	7:41	7:33
Quincy Branch			
Kewanee	131.1	1:51	1:51
Galesburg	162.4	2:16	2:16
Macomb	202.3	2:53	2:53
Quincy	258	3:38	3:38

Notes on Timetable:

The service to Quincy is displayed because the services complement one another and provide additional schedule frequencies on the portion of the route from Princeton to Chicago. The Illinois cities in parentheses are not served by every train; therefore indicating times would be misleading. The scheduled time shown to Quad Cities omits La Grange Road and Plano. Express trains stop at all cities in Iowa for this evaluation. The timetable is for planning purposes only, to forecast demand and operating costs at different travel times. Actual implementation schedules and stopping patterns would be likely to vary.

Table 2-10
Route 3. Chicago-Cedar Rapids-Omaha (UP) Cities Served

Station/City	Milepost	Scheduled Time	Time with Skipped Stops (Example)
Chicago	0	0:00	0:00
(Wheaton)	25.0	0:29	0:29
(DeKalb)	58.3	1:02	
Clinton	141.1	2:22	2:15
Cedar Rapids	217.6	3:31	3:25
Marshalltown	294.3	4:37	4:31
Ames	328.3	5:13	5:07
Denison	443.1	6:52	
Omaha	491.0	7:41	7:29

Notes on Timetable:
Either Wheaton or DeKalb in Illinois is skipped on some trips. The Iowa cities chosen for alternating skip stops are Marshalltown and Denison. The timetable is for planning purposes only, to forecast demand and operating costs at different travel times.

Rationale for Timetable Development and Application of Data

Different categories of travelers have different expectations and requirements for travel times, in terms of desired arrival and departure schedules. The business traveler is more likely to prefer an early morning departure, to facilitate a business meeting during the working day, with a return later that same day. This pattern of travel is clearly apparent in airline departure schedules which seek to serve the business market. These demonstrate a cluster of timed departures and arrivals in the early morning and late evening. The social and leisure traveler typically wishes for a later mid-morning or afternoon service that allows a midday or evening arrival, with a potential overnight or longer stay in a destination city. Proposed timetables are designed to cater to these market differences.

The timetables for each route were the basis for the operating expense and ridership and revenue forecasts for the respective services. The timetables are not included in this report, as they were prepared for specific forecasting purposes, and would need to be fine-tuned and finalized prior to implementation of the service. The base timetables that were developed for the Conservative scenario reflect the minimum capital expenditure on the right-of-way, and a train technology consistent with current Amtrak practice of using a diesel locomotive (specifically, the AMD103) hauling standard Amtrak (Amfleet) cars. For the Conservative scenario, the maximum line speeds were 90 mph between Chicago and Galesburg, which affects both the BNSF and IAIS Routes. This higher speed is due to investments already made by the freight railroads and Illinois DOT. All other parts of the routes had a maximum of 79 mph except where engineering restrictions on curves or bridges held speeds down to a maximum of 60 mph or slower.

Conservative Scenario Train Technology

One of the locomotives currently in service with Amtrak, the GE AMD103 model, was selected as the generic locomotive technology for the Conservative option. It has a top speed of 110 mph with a train of up to six cars. It weighs 268,000 lbs, with a relatively high axle weight of 34 tons. The manufacturer offers a maintenance contract system for daily servicing, monthly maintenance and annual overhaul.

The standard Amtrak coach, known as Amfleet, has been taken as the generic car for this option. Cars are assumed to operate in a three-car train consist, with 180 seats per train. The coach seats are assumed to be reversible so that the trains can be reversed at the end of the route without incurring additional time and mileage costs to turn the coaches. No buffet or bar cars are required as the food service is to be catered with in-seat airline-style trolley service using the center gangway. The coach is assumed to meet a high standard of quality in terms of comfort, seating design, and interior layout. Seats provide ample leg room and a wide range of *in-seat* facilities. These are to include video, fax, phone, laptop plugs, and working spaces.

Operating Plan Assumptions

The operating plan for the Conservative scenario includes a set of assumptions on costs and quality of service both on board the trains and at stations. A review of operating plan assumptions follows:

Fleet Operations

The fleet is assumed to be dispatched, supervised and operated under current Amtrak pay scales, agreements and union work rules. However, the number of staff required to manage the system was quantified for the MWRI through a “bottom up” staff identification effort for a stand- alone system. This effort identified full crew (operating and replacement personnel) and all levels of supervision and management required for a specific scheduled service, to verify estimates of cost per mile developed from other sources. The analysis was validated through independent assessment by Amtrak.

Fleet Maintenance

Fleet equipment maintenance is assumed to be contracted out to an independent contractor.

Food Service

For fleet planning purposes, no separate dining cars are provided; all food and beverage service is provided via moveable trolleys, operated by on-board service personnel (OBS). For operating plan purposes, it is assumed that food service operations run at a 30 percent deficit under the Conservative scenario and must be subsidized.

Seating Arrangements

All seating is assumed to be coach class. No first class, custom class or reserved seats are provided. However, any corridor service can be customized and it would be possible to have both premium seating and premium fares. The proposed seating in the Amfleet car is luxurious, with 43 inches between seats. This compares to 31 inches between seats on a standard coach-class aircraft and will give a 'big seat' feel to passengers.

Train Amenities

Video facilities (similar to airline movies), fax machines, phones, and sets of facing seats for mini-conferences or families would be available for each car.

Station Amenities

Baggage handling will be available at certain staffed stations via the ticket agent. Baggage carts will also be available. No baggage handling will be available at unstaffed stations. Food services will be provided through private contracts, with the variety, type and level dependent on station size and market attractiveness. Other shopping and services (such as newsstands, office support (copy/fax service), dry-cleaning, florists, etc.) will also depend on the market, but can be encouraged through leasing terms, etc.

Station Connections

It is anticipated that car rental desks, direct phone links, or contact information (depending on station size) will be available at terminal and main stations. Likewise, active taxi stands, direct taxi phone links, or contact information (depending on station size) will be available, as well as information kiosks or wall displays for local transit service information.

Ticketing

Ticketing will be available at staffed stations until approximately five minutes prior to boarding time; at that time the ticket agent will be moving baggage to platforms for loading. Most stations are not expected to have the volume of baggage that would necessitate additional station crew. Self-service ticket machines will be available on board the trains. Tickets will also be available on board trains from the conductor, for both staffed and unstaffed stations, using hand-held units capable of validating credit cards, printing tickets and printing receipts. Tickets will be available via the Internet and through travel agents as well. Each three- to six- car train set is planned to have a crew of three: one engineer, with one conductor and one assistant conductor to issue tickets and assist passengers. On-board service staff are additional to the train staff.

Operating Cost Assumptions

This section presents the assumptions and source documentation for the development of the operating costs. Table 2-11 presents the summary costs for the Conservative scenario.

Table 2-11
Summary of Annual Operating Costs ($ in millions)

Conservative Scenario			
Item	**BNSF Route**	**IAIS Route**	**UP Route**
Track & ROW Maint.	$8.41	$7.97	$8.12
Train Equipment Maint.	8.99	8.52	8.68
Fuel & Energy	1.88	1.78	1.82
Train Crew	11.26	10.68	10.89
On-board Service Crew	2.49	2.36	2.40
Station Costs	.75	1.07	.92
Administration	4.33	4.12	4.21
Sales & Marketing	.86	1.24	1.06
Insurance	.55	.78	.67
Operating Profit	1.91	1.89	1.89
Total Operating Cost per Year in 1996 $	**$41.43**	**$40.41**	**$40.66**

In deriving the operating costs, the following premises were adopted:

> The operating costs were based on results of recent studies in the Midwest region by TEMS and other consultancy groups, and validated with Amtrak. Total costs are calculated on a per-unit basis (e.g., train equipment maintenance cost per train mile multiplied by total train miles), with the units associated with each cost category described below.
>
> Train operating practices adopt existing Amtrak work rules.

Track and ROW Maintenance Costs (Track Access Fees)

Typically, track and ROW maintenance costs, while subject to negotiation, are anticipated to vary with scale of operation, and the level of track class desired. However, for the Iowa routes under the Conservative scenario only, with 3 to 5 services per day being considered, the level of use is relatively light. As a result, most maintenance work will be concerned more with safety than replacement of 'worn out' track components. Therefore, inspection will represent the bulk of track maintenance cost. The FRA standard for twice-weekly inspection for class 4, 5 and 6 track does not vary with more intensive passenger-rail activity, and is thus essentially a fixed cost. The biggest factor in determining maintenance costs is the length of the route. Unit cost is on a per-train mile basis.

Train Equipment Maintenance

Cost is determined based on the manufacturer's suggested direct maintenance cost for new Standard configuration passenger equipment. The figures were provided by Amtrak for a 'contracted out' service. The cost includes all labor, overhead, servicing and overhauls. Unit cost is on a per-train mile basis.

Fuel and Energy

Locomotive-hauled fuel cost is based on manufacturers specifications and accounting data from Midwest studies. It includes both train running and idling costs. Unit cost is on a per-train mile basis.

Train Crew

The costs for train crew include both crew and supervision. Costs are calculated on the basis of train miles, consistent with the MWRI methodology. Costs are based on Amtrak operating practices. Crewing is based on three people per train, *i.e.*, one engineer, one conductor and one assistant conductor, with an additional crew on routes exceeding four hours in length. These staff will be responsible for ticket issue for all unstaffed stations, as well as general boarding passengers. Rates were developed from a range of studies. The analysis assumed fringe benefit rates of 35 percent for salaried workers and 55 percent for union workers and include health and welfare, FICA, worker's compensation (FELA), and pension. An overtime allowance of 16 percent is applied. In the general MWRI analysis, 42 percent of the runs are anticipated to exceed four hours; an additional train crew is added for all such runs. This assumption was used for the Iowa routes, because while trips to Quincy and Quad Cities will require less than four hours, trips to Des Moines and Omaha will require more than four hours. A 20 percent allowance for absenteeism and "spares" is added. To account for overhead such as management costs, an additional $0.81 per hour is included; plus an additional $0.28 per train mile for yard operation transportation crews at Union Station.

The fleet is assumed to be dispatched, supervised and operated under current Amtrak pay scales, agreements and union work rules; however, the number of staff required to operate and manage the system has been quantified through a "bottom up" staff identification effort for a stand alone system. The "bottom up" labor values serve to validate ratios of direct operations and management labor developed in this and other studies. Unit cost is on a per-train mile basis.

On-Board Service (OBS) Crew

Based on Amtrak operating practices, rates were developed from a range of studies. To account for overhead such as management costs, a 10 percent surcharge is included. For the Conservative scenario, OBS revenue is assumed to be 70 percent of OBS cost. As a result, OBS service is subsidized by 30 percent. Unit cost is on a per-train mile basis.

Stations

Cost is calculated per passenger, including transfer passengers. The cost is based on the Midwest costs that are derived as follows. In the Midwest system there are 100 stations, 36 staffed, 63 unstaffed. The Chicago hub station is assumed to be 50 percent of all staffed station costs. The annual cost per station is assumed to be $230,000 for a staffed station and $20,000 for an unstaffed station. It is assumed that staffed stations have three staff at an annual cost including overhead of $61,000 each (assuming one staff person available per shift). The other maintenance costs per station are assumed to be $47,000 for a staffed station and $20,000 for an unstaffed station. It is assumed in each scenario that all stations will have been rebuilt, ticket sales will be conducted on-board the train, and checked baggage will only be handled at staffed stations. Unit cost is on a per passenger basis.

Administration

The figure is calculated as a minimum value of $22 million for the Conservative option for the entire MWRI system that is apportioned to each route. This equates to approximately 10.5 percent of all directly operated service costs excluding insurance, with a minimum value of $4.1 million for the Chicago-Omaha route. This includes administrative staff and facilities and equipment not accounted for elsewhere.

Sales and Marketing

Cost is calculated per passenger (not including transfer passengers). This covers all costs associated with the sales function and marketing, excluding wages which are accounted for within the Administrative budget. It is assumed that the increase in train frequency will encourage general boarding and increased ticket sales at stations and on board the train. Information on fares and schedules is provided by automated telephone lines.

It is assumed that the Midwest Regional Rail System will not have a reservation system; telephone sales will not be offered. This will reduce the cost significantly from the current Amtrak national system. Telephone information support is estimated at $0.30 per passenger.

Media advertising is programmed to be similar to the rate per passenger currently used by Amtrak for the Midwest 403.B, *i.e.*, Illinois, Wisconsin, Michigan and Missouri. Unit cost is on a per passenger basis.

Insurance Liability

Insurance liability was initially calculated on a per passenger mile basis, then converted to a per passenger basis. The estimate is based on Amtrak's annual report for system-wide insurance costs (1996), divided by total passenger miles (not including transfer passengers). However, the Amtrak cost is discounted by one-third because of the greater safety of the rail infrastructure in the Midwest compared with rail infrastructure across the country. This will be especially true with the implementation of the Midwest Rail System which will improve track quality, grade crossings and signaling.

Operating Profit

An operating gross profit margin of 10 percent (excluding insurance and privatized or externally contracted services such as equipment maintenance, on-board services, and right-of-way access fees) is assumed. Externally contracted services are presumed to already include profit.

Installation Repayment and Interest on Rolling Stock

The cost of rolling stock purchase is not included in the operating costs as it is assumed to be a capital item. In calculating the capital costs of rolling stock, it is assumed that the Chicago-Omaha services will be run as part of the Midwest system, therefore a bulk purchase price would prevail *i.e.* more than 60 units would be purchased. Given these assumptions, it is estimated that for the Conservative scenario, each trainset will cost $7.8 million. This is made up of a locomotive cost of

$2.4 million and three-car set costing $1.8 million per car. All prices are as quoted by manufacturers for an order of approximately 60 sets, financed at a 4 percent real interest rate over 15 years.

Infrastructure Analysis

This section describes track infrastructure improvements and related capital costs required to assess the three alternative routes *i.e.,* BNSF, IAIS, and the UP. Cost assumptions for the actions are presented, and then aggregated into capital cost estimates for each of the alternatives for the Midwest Rail Initiative Conservative scenario.

Methodology Used to Estimate Infrastructure Costs

Estimating infrastructure costs required an iterative process involving review of technical reports, discussions with representatives of Iowa, Illinois, and Amtrak, and production, review and revision of technical reports. The specific steps in the process are as follows:

> Condensed profile track data from the three alternative routes were entered into the *Trackman©* program. *Trackman©* data have previously been supplied to Iowa DOT.
>
> Previous engineering reports from the Midwest Region were reviewed. Representative unit costs for infrastructure improvements were derived from these reports for use in the Iowa Rail Route Alternative Analysis Study.
>
> A workshop was conducted with representatives of Iowa DOT. A separate meeting was held with the engineering department of Amtrak in Chicago. Telephone conference calls were held with representatives of the Illinois DOT concerning associated rail within Illinois. A joint meeting of representatives of Iowa and Illinois Departments of Transportation was conducted in Chicago. During the meetings and calls, track conditions were discussed with the states. Track was reviewed using the *Trackman©* program, and required improvements along each alternative route were considered.
>
> Unit costs were agreed upon by the Iowa DOT, Illinois DOT, and Amtrak.
>
> > Track unit costs were discussed and agreed upon at the meetings.
> > Unit costs to be used for stations were agreed upon throughout the Midwest region with input from the states and Amtrak.
> > The philosophy on public/private crossings was reviewed during workshop and meetings, and agreement was reached as to the dollars allocated for closures and improvements.

The infrastructure improvements and associated unit costs are categorized in Table 2-12, below. Descriptions of the levels of track and station improvements follow the table.

Track charts were provided to Iowa DOT and Illinois DOT for review and comment. Comments received were incorporated into the *Trackman*© program.

The potential to accommodate passenger services on freight lines was discussed during the workshop by reviewing the amount of freight traffic within each alternative route. A ton mile density map for the entire railroad system within the state was provided by the Iowa DOT, from which the number of freight trains was estimated.

A visual inspection was conducted of a major portion of the IAIS Route, the condition of which was previously relatively unknown to Amtrak and TEMS rail engineers. The conditions of the rail, crossings, culverts, and bridges were observed and taken into consideration in estimating the costs of the infrastructure improvements required for the preferred alternative.

The estimate of infrastructure costs by each alternative route for the Iowa Rail Route Alternative Analysis Study was presented for review by both Iowa and Illinois DOTs. Comments were received, adjustments were made as appropriate, and final infrastructure costs were prepared. Details by route are provided in Appendix 2.

Table 2-12
Summary of Infrastructure Improvement Actions and Unit Costs

Improvement Type	Description	Unit Cost
Construct High Speed Rail Main Track	On existing Roadbed On new Roadbed	$780,000 per mile $850,000 per mile
Timber and Surface	With 33% tie replacement With 66% tie replacement	$120,000 per mile $198,000 per mile
Relay Track	Relay track with 136# Continuous Welded Rail (CWR)	$280,000 per mile
Track Right-of-Way Improvements	33 % tie replacement Full surfacing Fencing Rebuilding of crossings	$500,000 per mile
Sidings	9,000 linear feet per 50 miles	$1,224,000 each
High Speed Turnout	Switch package Rail (136#) Concrete ties Ballast Filter fabric	$498,000 each
Crossings	Public crossing w/full width barrier Private crossing (closure)	$500,000 each $50,000 each
Bridges and Culverts	Minor Upgrade Major Upgrade/Replacement Replace Culverts	$100,000 to $200,000 $500,000 to $2,000,000 $100,000
Fencing		$43,000 per mile
Signals& Communications	Remote control interlocking Turnouts Crossovers Intermediate locations Electric lock locations Repeaters for crossings Dispatching office	$125,000 per mile
Terminal Stations	Conservative Moderate	$500,000 each $1,000,000 each
Stations	Conservative (if required) Moderate	$250,000 each $500,000 each
Maintenance Facilities	Conservative/Moderate	$2,000,000 each

Distinctions among track and station improvements that may not be obvious from the category improvement type and description are as follows:

Construct High Speed Rail Main Track on existing roadbed includes labor, material, equipment, engineering, and a 15 percent construction contingency to prepare the existing roadbed and reshape the exiting sub-ballast and drainage; install 12 inches of new top ballast under the tie area; install new mainline crossties; lay new 136# continuous welded rail (CWR) with new tie plates, rail anchors, and track spikes. For construction on a new roadbed, the additional work will include site clearing, roadbed preparation, installation of sub-ballast and new drainage.

Timber and Surface of one track mile of main track using either 33 percent or 66 percent tie replacement includes labor, material, equipment, engineering, and a 15 percent construction contingency to rework the ballast and replace or add approximately 1200 tons of ballast per track mile and replace deteriorated ties.

Relay Track with 136# CWR includes labor, material, equipment, engineering, and a 15 percent construction contingency needed to pick-up one track mile of existing jointed rail (salvage value considered in costs) and install on existing ties and ballast one track mile of 136# CWR with new tie plates, rail anchors, and track spikes.

Track right of Way Improvements includes labor, material, equipment, engineering, and a 15 percent construction contingency timber and surfacing with 33 percent tie replacement while retaining the existing rail, fencing 50 percent of the route with 4 foot woven wire fencing, and rebuilding of grade crossings.

Terminal Stations include the cost (estimated at $1,000,000 for the moderate scenario in the Midwest Regional Rail Initiative) to renovate an existing structure to serve as a terminal for operations in Des Moines or the Quad Cities. *Stations* include the cost (estimated at $500,000 in the moderate scenario) to renovate an existing structure to serve as a manned station in Atlantic, Newton, and Iowa City. Since the Iowa route is scheduled to be constructed during the moderate scenario phase of the Midwest region, the cost of renovation for the moderate scenario has been used.

Philosophy Associated with the Conservative Scenario

The process described above reflects the unit cost approach used for this analysis. Through discussions with Iowa and Illinois DOTs and Amtrak, various approaches were developed for the Conservative scenario. The following describes the key features of the Conservative scenario. This scenario represents the most modest incremental investment in track and rolling stock proposed by the Midwest Rail Initiative. Given the relative low density of the corridor, this was judged by Iowa DOT to be the most realistic option to use for a comparative study of the three potential routes.

Conservative

Train technology conventional locomotive haul
Top speed 79 or 90 mph (via ROW improvements)
New locomotives
Improved track alignments and connections
Install advanced signaling technology: Incremental Train Control System (ITCS) that is tower-based, or Automated Train Control System (such as ATCS Phase I) that is train-based.
Grade crossing upgrade & elimination program (3 percent/year)
Increasing the potential to accommodate passenger services on freight lines
Upgrade stations at appropriate locations

A critical factor associated with determining the infrastructure needs of the Conservative scenario was the potential for accommodating passenger services on freight lines. Specifically, it was agreed that where the level of freight traffic was high, separate track would be developed for passenger services. Elsewhere, where freight traffic was moderate or low it was agreed that freight and passenger services could be accommodated by providing sidings every 50 miles.

Specifically, it was determined by the consultant and the States that the level of freight traffic on the UP alignment (Route 3) from Omaha to Chicago would not accommodate the increased passenger trains necessary for the Conservative scenario. Given the expected growth of freight traffic, the expected schedule for passenger operations could not be maintained. As a result, the cost estimate for that line includes a new track dedicated to passenger train travel for that segment. The BNSF alignment (Route 1) has moderate freight traffic levels, while the IAIS Railroad alignment (Route

2) has limited freight traffic. For these two routes, the capital cost assumptions include provision for a siding every 50 miles. This does not constitute a cost optimization, but provides a reasonable assumption given current and anticipated freight traffic levels. See Table 2-13 for a summary of capital costs.

Table 2-13
Summary of Infrastructure Costs by Route in 1996 $

Alternative Route	Conservative
Route 1 BNSF: Chicago-Galesburg-Omaha	$116,500,000
Route 2 IAIS: Chicago-Quad Cities-Omaha	$197,244,000 *
Route 3 UP: Chicago-Clinton-Omaha	$514,705,000

* $197,244,000 represents the cost for the entire route. Illinois has separately identified improvements for the Conservative and Moderate scenarios from Wyanet to Chicago; excluding those improvements the cost is $195,554,000.

Route Alternatives Financial Analysis

The results of the Route Alternatives Analysis under the Midwest Conservative scenario are shown in Table 2-14. Note that the operating revenues include farebox revenues as described in Table 2-7, as well as revenues from same-day package delivery services and on-board services.[4] Operating and capital expenses are in current, 1996 dollars. Slight increases in operating expense relate to the need to add additional cars (operating four-car trainsets rather than three-car sets) as passenger levels increase over time due to increases in population, income and employment.

It can be seen that while none of the routes produces either a positive operating ratio or can pay for its infrastructure from the farebox, the operating ratio is highest for the IAIS Route at 58 percent in 1998 (the theoretical first year of service, with ridership and revenues representing only the impact of the system), and 69 percent in 2010. The 1998 operating ratio for UP is 52 percent, and for the BNSF is 39 percent. IAIS produces an operating net present value (NPV) at five percent through 2020 of -$236 million, compared with a NPV of -$271 million for the UP Route and -$325 million for the BNSF.

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[4] The MWRI service plan includes revenues from a proposed service to provide same-day package delivery throughout the Midwest region, based on the frequency of service and the interconnectivity through Chicago. In addition, on-board food and beverage services are expected to recover 70 percent of costs in the Conservative scenario (to be fully self-supporting in the Moderate scenario); the revenues offsetting portions of the cost are included as Operating revenues.

From this analysis, it is clear that for the Conservative scenario, these routes cannot cover their operating costs from farebox and other operating revenues; much less begin to cover capital costs. This was also the case for most of the corridors analyzed as part of the MWRI. However, the route analysis shows that the IAIS and UP Routes are far more useful routes in meeting the needs of Iowa population than the BNSF Route, as indicated by the population of the cities served by each line, and that the IAIS provides the best service in terms of supporting regional mobility in Iowa, as indicated by the potential ridership on the line. Furthermore, the IAIS Route has the lowest overall cost at $494 million in terms of NPV for both operating and capital costs, as the upgrading of the UP Route is more than twice as expensive as the IAIS Route in infrastructure costs. This is due to the substantial freight traffic on the UP Route and the need for significant additional infrastructure if passenger service is to be feasible. Across all measures, the IAIS Route has the best financial performance under the Conservative scenario.

Table 2-14

Summary Financial Statistics, Conservative Scenario

$ in millions			**Route 1**	**Route 2**	**Route 3**
			BNSF	**IAIS**	**UP**
Operating					
	Revenue	1998[5]	15.96	23.28	21.05
	Operating Cost	1998	41.43	40.41	40.66
	Operating Ratio	1998	39%	58%	52%
	Revenue	2010	19.43	28.45	25.66
	Operating Cost	2010	41.95	41.19	41.32
	Operating Ratio	2010	46%	69%	62%
Capital					
	Infrastructure		116.55	195.554	514.705
	Train Sets		8	8	8
	Trains		62.4	62.4	62.4
	Total Capital		178.95	257.954	577.105
Net Present Value					
	Operating through 2020[6] discounted @ 5%		-324.96	-236.378	-270.835
	Total NPV (Operating and Capital)		-503.91	-494.332	-847.940

---

[5] "1998" represents a theoretical first year of service, with ridership and revenue not impacted by population, income or employment growth on the corridor.

[6] 2020 is selected as the year for net present value operating analysis as 20 years (from 2000 to 2020) represents the designated study period for the MWRI. 2010 data are presented for operations comparisons as an appropriate mid-point analysis, with good potential for full MWRI system implementation by that date.

In summary, the route analysis resulted in the following conclusions:

> The development of the IAIS Route is the most effective option for a regional rail system with the highest NPV and the highest ridership because it serves the most densely populated regions in the state. The IAIS Route is projected to carry 605,000 passengers per year by 2010.
>
> The UP Route is second to the IAIS Route in terms of the ridership it would attract, projected at 517,000 passengers per year by 2010, or 15 percent less than IAIS. It is also second in the operating revenue it would generate. However, it would require considerable extra capital investment over the IAIS and BNSF Routes due to heavy current and anticipated future freight traffic.
>
> The BNSF Route is the least attractive route with the lowest potential ridership and revenue for regular Midwest service because there is little population along the corridor. Ridership on this route is projected at 423,000 per year by 2010, or 30 percent less than IAIS. However, long distance Amtrak service would be maintained along this route.

Section 3. Segment Analysis

Given a decision to select the Iowa Interstate (IAIS) route as the most effective in terms of regional mobility and financial return, an analysis was made using the Midwest Rail Initiative (MWRI) Moderate scenario assumptions to compare the financial returns of building the entire route with specific segments such as Chicago-Quad Cities and Chicago-Des Moines. The MWRI Moderate scenario raises train speeds to 110 miles per hour on portions of routes (none in Iowa) and adopts the latest in European Diesel Multiple Unit (DMU) train technology. The Moderate scenario is the chosen option for the MWRI. The train operating costs are significantly lower per train mile than the Conservative scenario costs, while ridership and revenues are higher due to improved service levels and quality of service. As a result, most corridors under the Moderate scenario were able to achieve positive operating ratios early in the MWRI study. One of the reasons for the current study was that the Iowa BNSF route failed to achieve a positive operating ratio under the Moderate timetables in early stages of analysis. This phase of the current analysis compares route segments, to test the effect on riders, revenues and costs of developing only part of the IAIS route.

Market Analysis

Increasing the train performance in terms of travel time between Chicago, Quad Cities, Des Moines and Omaha will clearly have an impact on the rail market. Applying the MWRI Moderate scenario with its 110 mile per hour maximum speed on portions of the route and increased frequencies increases ridership on the selected route.

Table 3-1 shows the impact of the increased train speed and the reduced train times, based on the demand and ridership models. It can be seen that the Moderate option significantly raises rail demand to a 1.3 percent market share with over 800,000 annual trips in 1998 compared to a 0.8 percent market share and 1998 ridership of just under 500,000 trips for the conservative scenario. Annual revenues in the Moderate scenario increase to $35.7 million in 1998 from $20.3 million under the Conservative scenario. Note that revenues do not include same-day parcel service and on-board service revenues that are included in the summary financial analysis.

In terms of growth over time, the Moderate scenario grows by 23 percent in the twelve year period between 1998 and 2010 in terms of both ridership and revenue. This is an annual growth rate of 1.6 percent per year in rail traffic. By 2020, riders and revenue increase by another 14 percent and 13 percent respectively. These increases are primarily due to natural growth in regional travel demand related to increased population, household income and employment.

The corridor defined for the study includes service from Wyanet to Chicago, as well as the extension to Quincy. It is understood that Illinois will be responsible for the capital costs from Chicago to Wyanet and Quincy. The capital cost differences between the Conservative and Moderate scenarios for this route all take place on the Illinois portion of the route, as programmed by Illinois. The decreases in trip times that result from Illinois' investment benefit Iowa in terms of increased riders. The Quincy extension is included in ridership, revenue and cost estimates because it significantly contributes to the positive return of the line.

Table 3-1
Route 2 IAIS Chicago-Des Moines-Omaha Corridor

	Conservative		**Moderate**	
	Ridership (thousands)	**Revenue** ($ millions)	**Ridership** (thousands)	**Revenue** ($ millions)
1998	493.1	20.3	805.9	35.7
2010	605.4	26.1	991.6	43.9
2020	688.8	29.6	1,128.8	49.7

With respect to the ridership and revenues for segments of the IAIS corridor, analyses were made that assumed the rail line stopped at Des Moines for the first case and stopped at Quad Cities for the second case. It can be seen from Table 3-2 that stopping the line in Des Moines and only providing a feeder bus service to Omaha reduces ridership by 11 percent and revenue by 23 percent. In the Quad Cities case (also with feeder bus to Omaha), ridership falls by 40 percent and revenues by 61 percent. The increased reduction in revenues over ridership is due to the loss of passengers traveling the full length of the system (i.e. Omaha to Chicago) who clearly have a longer trip length. As a result, the fall in ridership and particularly revenue is significant with the reduced segments. The associated *COMPASS*© runs are provided in Appendix 1.

Table 3-2
Chicago-Des Moines-Omaha Corridor

	Annual Ridership (thousands)		Annual Revenue ($ millions)	
	1998	2010	1998	2010
Full Line Chicago-Omaha	805.9	991.6	35.7	43.9
Two-thirds Line Chicago-Des Moines	717.9	883.9	27.8	34.1
One-third Line Chicago-Quad Cities	484.3	599.5	13.8	17.1

The *COMPASS*© runs also demonstrate market shares by mode. Table 3-3 is derived from the *COMPASS*© model output to illustrate the impact of the recommended Moderate service to Omaha on corridor travel patterns. As may be seen, market shares for air, bus and auto all decline somewhat from the 1996 base with demand diverted to rail. However, after an initial drop in total air and bus volumes (slight in the case of air), air volumes recover to exceed baseline levels by the year 2000, while bus volumes recover by 2020. Note also that the bus mode numbers do not include the feeder bus service, which will contribute to growth of the bus industry.

Table 3.3
Total Corridor Demand and Market Shares[1] - IAIS Moderate Scenario - Service to Omaha

	Corridor Demand	Air		Bus		Auto		Rail	
	(000s)	Market Share	Trip Volume	Market Share	Trip Volume	Market Share	Trip Volume	Market Share	Trip Volume
1996	58,661	2.85%	1,672.7	0.28%	164.5	96.65%	56,694.2	0.23%	134.1
1998	61,496	2.64%	1,621.3	0.20%	127.2	95.85%	58,945.4	1.31%	805.9
2000	64,408	2.64%	1,702.8	0.20%	132.1	95.85%	61,736.6	1.30%	840.1
2010	77,212	2.66%	2,055.2	0.20%	154.4	95.86%	74,014.1	1.28%	991.6
2020	88,317	2.65%	2,344.1	0.20%	177.1	95.87%	84,670.6	1.28%	1,128.8

---

[1] Units may not add to totals and percentages may not add to 100% due to computer rounding.

Operating Plan Timetables

Moderate timetables were developed for the selected route (IAIS). These timetables were developed using the same business concepts and leisure market concepts as discussed for the Conservative timetables. The timetables reflect the DMU technology and its acceleration and ability to traverse curves at higher speeds. In addition, under the Moderate scenario for the MWRI, Illinois provides substantial investment on the rail corridor to Chicago, thereby increasing allowable travel speeds for portions of the route.

This route, because of its population density, required a comprehensive timetable. The length of the line and location of key cities called for extra services from Quad Cities and Des Moines to Chicago, to provide a better spread of departure and arrival times. A train from Omaha cannot serve the early morning traffic between either Des Moines or Quad Cities and Chicago.

The timetable developed to support operating cost and ridership and revenue projections includes an early morning service to Chicago from Quad Cities (arriving before 8:30) for commuters and an early morning business service for Des Moines to Chicago arriving before 11:00 a.m. Three round trips per day are identified for the Omaha-Chicago service. A train departs for Quad Cities at midday, with an evening train to serve Quad Cities commuter traffic and Des Moines business traffic departing from Chicago after 5:30 p.m. This balanced timetable gives the Quad Cities five trains a day, Des Moines and Iowa City four trains per day and Omaha three trains per day.

To permit analysis of the segmented options, two further timetables were produced, with terminations in Quad Cities and Des Moines. The stops, mileposts and travel times for the Moderate scenario are provided in Table 3-4.

Table 3-4

Route 2. Chicago-Des Moines- Omaha (IAIS) Cities Served

Station/City	Milepost	Scheduled Time with Typical Stops	Express Travel Time (Limited Stops)
Chicago	0.0	0:00	0:00
(La Grange Road)	14		
Naperville	28.4	0:21	
(Plano)	51.5		
(Mendota)	82.6		:54
(Princeton)	104.4	1:13	
Omaha Branch			
Quad Cities	165.5	2:08	2:01
Iowa City	221.0	3:06	3:00
Newton	306.7	4:21	4:15
Des Moines	341.9	5:02	4:55
Atlantic	424.2	6:14	6:08
Omaha	479	7:11	7:05
Quincy Branch			
Kewanee	131.1	1:51	1:51
Galesburg	162.4	2:16	2:16
Macomb	202.3	2:53	2:53
Quincy	258	3:30	3:30

Notes on Timetable:

The service to Quincy is displayed because the services complement one another and provide additional schedule frequencies on the portion of the route from Princeton to Chicago. The Illinois cities in parentheses are not served by every train. The scheduled time with typical stops shown to Quad Cities presents an average trip, in this case omitting La Grange, Plano and Mendota. The express services under this scenario stop in all designated Iowa cities. Although the Conservative and Moderate scenarios are based on the same infrastructure improvements for the Iowa portion of the trip, travel times in Iowa are slightly faster than under the Conservative scenario, because of the acceleration, deceleration and curve-speed characteristics of the DMU technology, discussed below, compared to the locomotive-hauled train technology of the Conservative scenario.

Moderate Scenario Train Technology

The generic train technology to operate these Moderate timetables is assumed to be diesel multiple unit (DMU), similar to the Adtranze IC3 Flexliner. The DMU was developed in 1991 by ABB (Adtranze) for Danish Railways (DSB). The diesel IC3 and its electric cousin, the IR4 (EMU) have been successfully operated in Europe for 6 years and represent the best in European DMU technology. The IC3 has been operated in North America over the last year on trial, particularly between St. Louis - Kansas City and Chicago - Milwaukee. The standard unit is comprised of three cars, which provides 152 coach class seats. Higher density seating is possible, but would not be suitable for long intercity trips. The same seating density as for the Amfleet stock has been assumed with 43 inches between seats, compared with 31 inches in a standard airline coach seat. The DMU concept is that it is an integral unit with the engines under the floor and the driver's compartment as part of the coach. To increase its consist size in the current analysis additional cars are added where necessary.

A principle advantage of the DMU is that it does not have to be turned or separated for servicing and maintenance. It is also lightweight, which reduces fuel consumption. Its mechanical components are modular in design, reducing time and expense for equipment repair. The unconventional design was chosen for the flexibility. (See Exhibit 3-1). The rubber structure on the front measures 3m x 3m so that when two trainsets or more are joined together the rubber noses form a tight, fixed gangway between them. As a result the trainsets can be coupled while they are moving. It takes only two minutes to convert two separate trainsets into one with a fixed gangway between them.

Exhibit 3-1
North American Flexliner Train (DMU) - [Photo for this page on introductory Web page]

These elements provide a significant advantage in terms of operating costs over locomotive hauled stock. Danish Railways has conducted life cycle side-by-side tests of DMUs and loco haul coaches, and claims that the operating costs of a six-car IC3 are approximately half of that of an equivalent locomotive and five coaches.

Seating is flexible, with half the seats facing one way, and the other half the other way. The large European windows give a modern airy feel to the car. At each seat the business traveler has facilities for a modem connection for computers and communication including a telephone socket. There is in addition a pay phone and telefax machine in the train vestibule. The luggage racks above each seat contain a socket for a 5-channel stereo system and information channel. The train has an electronic information system. Displays in each of the passenger compartments provide continually updated information about arrival and departure times. A low noise level is achieved through the use of special vibration- absorbing mounting of the modules on the car bodies and extensive sound proofing.

Operating Costs

The operating cost assumptions for the Moderate scenario differ from the Conservative in five areas. Train equipment maintenance and fuel unit costs are reduced due to the DMU's modular, easy to maintain design, and its light weight. Track and right-of-way maintenance and administration costs are consistent with the MWRI Moderate scenario assumptions. Finally, on-board services are assumed to be fully privatized and operating without a deficit under the Moderate scenario, consistent with MWRI assumptions. The operating costs for the Moderate scenario, including the segment analysis based on the timetables described above, are displayed in Table 3-5.

Table 3-5

Summary of 1998 Costs ($ in Millions)

Moderate Scenario			
Item	**IAIS Omaha**	**IAIS Quad Cities**	**IAIS Des Moines**
Track & ROW maintenance	$10.17	$6.44	$8.81
Train equipment maintenance	7.57	4.80	6.56
Energy	.63	.40	.55
Train crew	13.29	8.41	11.51
OBS crew	3.01	1.91	2.61
Station costs	1.75	1.05	1.56
Administration	3.75	2.38	3.25
Sales & marketing	1.35	.81	1.20
Insurance	1.28	.77	1.14
Operating Profit	2.08	1.13	1.81
Total Operating Cost	**$44.88**	**$28.10**	**$39.00**

Infrastructure Costs

For the preferred IAIS route, an analysis was made of the implication of upgrading the route consistent with MWRI Moderate scenario and subsequently assessing the costs for given route segments. The first step in the process was to carry out a detailed route evaluation given the lack of current information on track condition.

Appendix 2 provides the detailed narrative evaluation of the route for two key sections, Council Bluffs to Adair, Iowa and Des Moines to east of Iowa City, Iowa.

To develop infrastructure costs for the IAIS route for the Midwest Regional Rail Initiative the following Moderate scenario assumptions were adopted (see Table 3-6).

Table 3-6
Infrastructure Analysis - Moderate Scenario

Route 2 IAIS Description	Moderate ($ 000s)
Omaha-Wyanet (79 mph) (Iowa portion of route)	$195,554 [2]
Wyanet-Chicago (79/110 mph) (Illinois portion)	$68,380
Total Route Cost excluding Quincy	$263,934

MODERATE

Top speed 110 mph (via equipment and ROW improvements)
DMU rolling stock (e.g., IC3 Flexliner with steerable trucks)
Grade crossing upgrade & elimination program (5-7 %/year)
Increasing potential to accommodate passenger service on freight lines
Station upgrade program

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[2] Same cost as the Conservative scenario.

The key features of this scenario are the increased speed of 110 mph on large portions of the system, (although not in Iowa) and the use of steerable DMU equipment that is not just low cost, but provides a higher speed in curves.

The infrastructure costs for the Moderate Scenario (Table 3-6) using the same unit cost factors previously described in the Route Analysis section are $263,934,000, excluding the Quincy line. The Wyanet to Chicago portion of the line is $68,380,000, which includes upgrading some segments to 110 mph. The Iowa portion of $195,554,000 represents the same level of investment as the Conservative scenario, which improves the line to 79 mph.

Segment Infrastructure Costs

The segmented infrastructure costs for the Moderate scenario for the IAIS are shown in Table 3-7. The cost of the line from Chicago to Quad Cities is $96.0 million. It requires an additional $91 million to extend the line from Quad Cities to Quincy, which is an Illinois responsibility but contributes riders and revenues to the corridor. Improving the route as far as Des Moines increases the cost to $193 million excluding Quincy. Finally, the cost of the entire route is $264 million excluding the Quincy route.

Table 3-7
Infrastructure Cost Summary in 1998 $

Route 2 IAIS	Without Quincy Line ($ 000s)
Chicago-Quad Cities (One Third of Route)	$95,954
Chicago-Des Moines (Two Thirds of Route)	$193,529
Chicago-Omaha (Whole Route)	$263,934

Segment Analysis Financial Results

The results of the Segment Analysis (Table 3-8) demonstrate that under the MWRI Moderate scenario, there is a substantial improvement in the financial results compared to the Conservative scenario, as is the case with other MWRI corridors. The increase in train service frequencies to Quad

Cities, higher speeds and overall improved timetables create conditions under which a positive operating ratio can be achieved if the entire corridor from Chicago to Omaha is operated. From 1998 to 2010, the operating ratio increases from 0.9 to 1.07 giving a positive operating ratio in the year 2005. This is partly due to the lower operating costs of running DMU technology versus loco hauled technology and partly due to the improvement in service. With the new service, Quad Cities would be just over 2 hours from Chicago, Iowa City 3 hours from Chicago, and Des Moines 5 hours from Chicago and 2 hours from Omaha. Exhibit 3-2 displays the recommended route, with planned bus network connections.

Table 3-8

Summary Financial Statistics, Moderate Scenario Segment Analysis

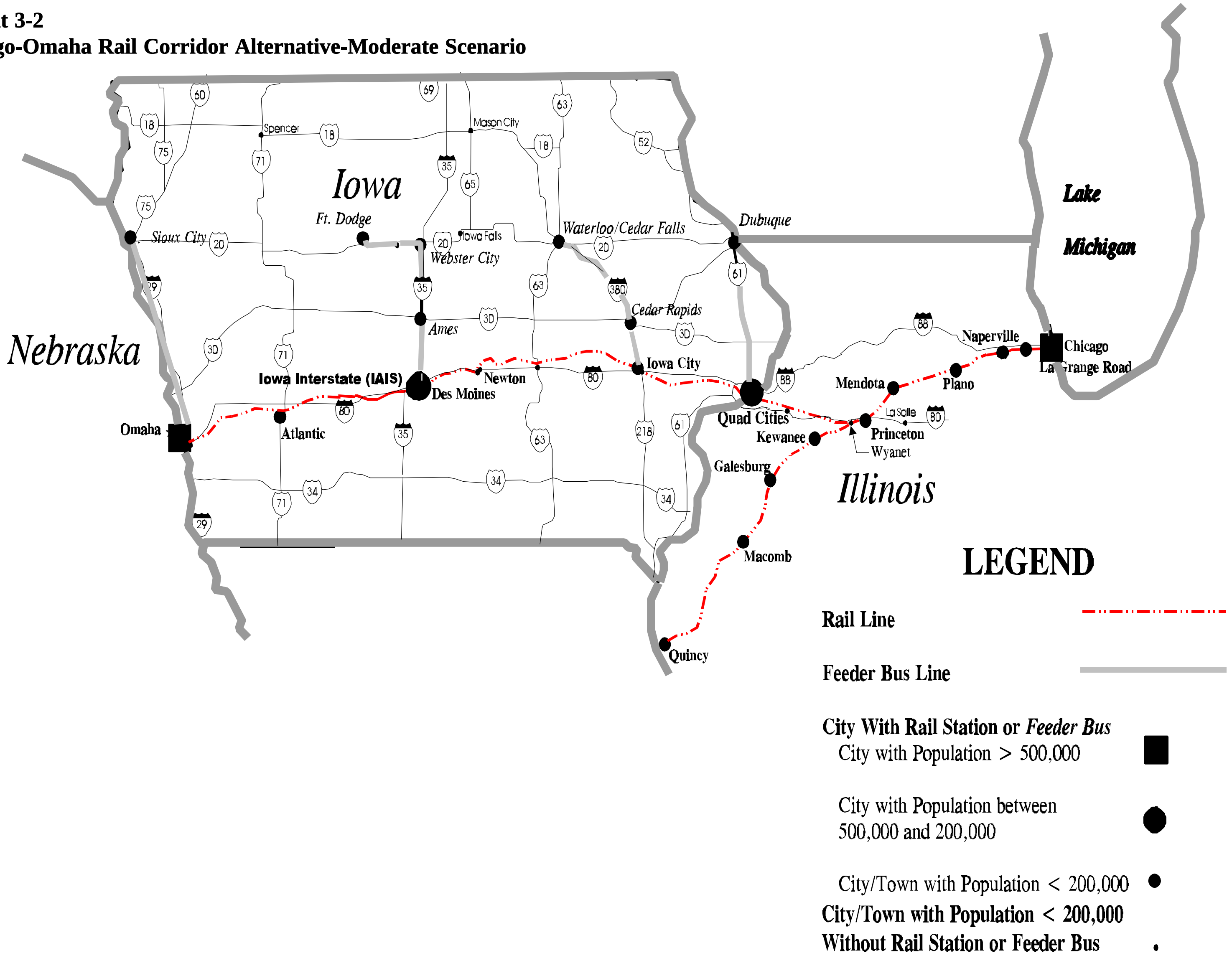
$ in millions			**Chicago-Quincy-Quad Cities**	**Chicago-Quincy-Des Moines**	**Chicago-Quincy-Omaha**
			1/3 of Route	**2/3 of Route**	**Entire Route**
Operating					
	Revenue	1998[3]	16.42	30.92	39.27
	Operating Cost	1998	28.10	39.00	44.88
	Operating Ratio	1998	58%	79%	88%
	Revenue	2010	20.03	37.76	47.93
	Operating Cost	2010	28.94	39.95	45.96
	Operating Ratio	2010	69%	95%	104%
Capital (without Quincy line)					
	Infrastructure		95.95	193.53	263.93
	Train Sets		6	8	10
	Trains		25.8	34.4	43.0
	Total Capital		121.75	227.93	306.93
Net Present Value					
	Operating through 2020[4] discounted @ 5%		-145.34	-79.68	-41.97
	Total NPV (Operating and Capital)		-267.09	-307.61	-348.90

---

[3] "1998" represents a theoretical first year of service, with ridership and revenue not impacted by population, income or employment growth on the corridor.

[4] 2020 is selected as the year for net present value operating analysis as 20 years (from 2000 to 2020) represents the designated study period for the MWRI. 2010 data are presented for operations comparisons as an appropriate mid-point analysis, with good potential for full MWRI system implementation by that date.

Exhibit 3-2
Chicago-Omaha Rail Corridor Alternative-Moderate Scenario



Furthermore, the analysis shows that there is no advantage in merely operating to Quad Cities or Des Moines, as the connection to Omaha is necessary to produce a positive operating ratio. The net present value (NPV) for operating to Quad Cities over twenty years is -$145 million, while that for operating to Des Moines is -$80 million. With population, income and employment growth in the region, and with the additional ridership impetus of the MWRI, the full route to Omaha achieves a positive operating ratio by approximately 2006.

The capital costs for the full Omaha-Chicago route include $263.9 million in infrastructure and $43 million in rolling stock (excluding Quincy). By being a part of the MWRI, in which capital costs are to be shared with a federal match of 80 percent, the capital cost for the corridor borne by Illinois, Iowa, and Nebraska would be approximately $61.4 million ($306.9 million times 20 percent). This would be an investment of $43 million in rolling stock and another $18.4 million in station and local infrastructure ($61.4 minus $43 million) which might be shared with local communities, the private sector, or the rail operator.

Summary conclusions of Segment Analysis:

> The analysis of operating costs, operating revenues and capital costs by segment revealed that operating the full line to Omaha is the only option to generate a positive cost-recovery ratio by the year 2010.
>
> For 2010, projected passenger trips are approximately 12 percent higher than service operated to Des Moines, and 65 percent higher than service operated only to Quad Cities.
>
> Projected revenues (passenger and other operating revenues) are approximately 27 percent higher than service operated to Des Moines, and 139 percent higher than service operated only to Quad Cities. The greater difference in revenue is due to the longer trip length for Omaha riders.
>
> The 20 year net present value (NPV) for operations is best for the full route to Omaha.

Capital cost for infrastructure and rolling stock is approximately $96 million for the segment to Quad Cities (not including the Quincy line); with an additional $98 million required to improve the line to Des Moines; and $70 million more to complete upgrades to Omaha.

Section 4. Conclusion

The analysis of the Chicago-Omaha Corridor has resulted in the following conclusions.

Route Analysis

- The route analysis shows that the development of the Iowa Interstate (IAIS) route is the most effective option for a regional rail system.

- The Union Pacific (UP) Route is second to IAIS in effectiveness, but requires considerable extra capital investment over the IAIS due to the existence of heavy current and expected future freight traffic flows.

- The Burlington Northern and Santa Fe (BNSF) service is the least attractive route because there is little population, but it would continue to maintain long distance Amtrak service.

Segment Analysis

- The Segment Analysis shows that the only option that achieves a positive operating ratio is that of developing the entire corridor from Chicago to Omaha.

- Shortening the corridor to Des Moines or Quad Cities results in lower financial operating returns.

Preferred Option

- The analysis of the Chicago-Omaha route shows that the preferred option is to implement the Midwest Rail Initiative Moderate scenario on the IAIS route.

- Developing the route to only Quad Cities or Des Moines results in a lower operating ratio with NPV operating costs respectively of $145 million and $80 million. The capital costs rise from $96 million to Quad Cities, to $194 million to Des Moines and $264 million to Omaha.

The Midwest Rail Initiative Recommendations

The consultants' recommendation is that the IAIS Route should be developed to 79/100-mph operation with DMU technology and with operation commencing in the year 2006.

Tables 4-1 and 4-2 summarize key operating and capital statistics for the conservative and moderate alternatives route analysis.

Table 4-1
Summary Alternatives Comparison – Route Analysis

	CONSERVATIVE SCENARIO				MODERATE SCENARIO
	Base Service	**Route 1**	**Route 3**	**Route 2**	**IAIS Route**
	Existing BNSF Route	**BNSF Route**	**UP Route**	**IAIS Route**	
Population Centers: Direct Connections	Burlington, Ottumwa, Mt. Pleasant	Burlington,Ottumwa, Mt. Pleasant	Ames, Cedar Rapids, Clinton	Des Moines, Iowa City, Quad Cities	Des Moines, Iowa City, Quad Cities
Route Miles	503	503	491	479	479
Route Miles in Iowa	296	296	350	314	314
Service Specifications					
Frequency (daily round trips)					
Omaha-Chicago		4	4	3	3
Central Iowa-Chicago		4	4	4	4
Mississippi River-Chicago		4	4	5	5
Quincy/Galesburg (IL)-Chicago		2		2	4
Track Speed (Maximum)					
In Iowa	79	79	79	79	79
In Illinois	79	90	90	90	110
Type of Service/ Markets	Long Distance Leisure Basic service	Short/Medium Business & Discretionary Conservative Scenario	Short/Medium Business & Discretionary Conservative Scenario	Short/Medium Business & Discretionary Conservative Scenario	Short/Medium Business & Discretionary Moderate Scenario
	National Focus	Regional Hub	Regional Hub	Regional Hub	Regional Hub
Number of Stops	13	13	8	11	11
Stops in Iowa	5	5	5	5	5

Table 4-1 continued

	CONSERVATIVE SCENARIO				MODERATE SCENARIO
	Base Service	Route 1	Route 3	Route 2	IAIS Route
	Existing BNSF Route	BNSF Route	UP Route	IAIS Route	
Fastest Travel Times from Chicago	hrs:min	hrs:min [1]	hrs:min	hrs:min	hrs:min
To: Omaha	9:10	7:56	7:29	7:27	7:05
Mid-Iowa	7:00	4:58	5:07	5:20	4:55
Mississippi River	4:20	2:57	2:15	2:20	2:01
Average Speed-acceleration, deceleration, stops					
Entire Route	55	72	65	63	68
In Illinois		78	63	75	86
Capital and Operating Statistics					
Capital cost – Infrastructure (Track, signals, crossings, stations) ($ in millions)					
Improvements to primarily benefit Iowa routes		$114.5 to Galesburg-79 mph	$513.71 to Chicago-79 mph	$195.55 to Wyanet-79 mph	$195.55 to Wyanet-79 mph
Improvements planned by llinois		$2.05 Galesburg to Chicago	0	$1.69 Wyanet to Chicago 79 mph	$68.38 Wyanet to Chicago 79/110 mph
TOTAL		$116.55	513.71	$197.24	$263.93
Capital cost- Equipment (Train sets)					
$ in millions		$62.40	62.40	$62.40	$43.00
Ridership (thousands)					
1998 estimate [2]	140	344	421	493	806
2010 estimate	171	423	517	605	992
Passenger Miles (thousands)					
1998 estimate	28,904	71,623	95,868	107,227	169,585
2010 estimate	35,333	87,582	117,131	131,183	207,606
Train Miles (thousands)					
1998 estimate		1,868	1,805	1,770	2,260
2010 estimate		1,868	1,805	1,770	2,260
Fare Revenue (millions)					
1998 estimate	$4.69	$13.85	$18.96	$21.26	$35.71
2010 estimate	$5.73	$16.99	$23.25	$26.10	$43.87
Operating Revenue (including same day parcel service) (millions)					
1998 estimate	N/A	$15.96	$21.05	$23.28	$39.27
2010 estimate	N/A	$19.43	$25.66	$28.45	$47.93
Operating Costs (millions)					
1998 estimate		$41.43	$40.66	$40.41	$44.88
2010 estimate		$41.95	$41.32	$41.19	$45.96

---

[1] For its fastest scheduled time, the BNSF makes only two stops in Iowa, as the cities along the route are small. The IAIS makes all 5 stops in Iowa, skipping some stops in Illinois. The UP skips one Iowa city stop. See Tables 2-8 through 2-10 for details.

[2] 1998 represents a hypothetical first year of full service implementation, prior to increases in corridor demand, riders and revenues that would result from regional growth in population, per capita income and employment.

Table 4-1 continued

	CONSERVATIVE SCENARIO				MODERATE SCENARIO
	Base Service	Route 1	Route 3	Route 2	IAIS Route
	Existing BNSF Route	BNSF Route	UP Route	IAIS Route	
Performance Comparison Statistics					
Operating Ratio (Revenue/Cost)					
1998 estimates	39%	52%	58%	88%	
2010 estimates	46%	62%	69%	104%	
Average Passengers on Board					
1998 estimates	38.3	53.1	60.6	75.0	
2010 estimates	46.9	64.9	74.1	91.9	
Average Fare Revenue per Passenger Mile					
1998 estimates	$0.193	$0.198	0.198	$0.211	
2010 estimates	$0.194	$0.198	0.199	$0.211	
Average Passenger Trip Length (Miles)					
1998 estimates	208.1	227.5	217.4	210.4	
2010 estimates	244.3	226.8	216.7	209.4	
Average Revenue per Train Mile					
1998 estimates	$8.54	$11.66	$13.15	$17.57	
2010 estimates	$10.40	$14.21	$16.07	$21.21	
Average Operating Cost per Train Mile					
1998 estimates	$22.18	$22.52	$22.83	$19.86	
2010 estimates	$22.46	$22.89	$23.27	$20.33	

Table 4-2
Summary Alternatives Comparison – Segment Analysis

	Omaha to Chicago (full route)	Des Moines to Chicago	Quad Cities to Chicago
Capital and Operating Statistics			
Route Miles	479.0	341.9	165.5
Capital Cost – Infrastructure (Track, signals, crossings, station) ($ in millions)			
Improvements that primarily benefit Iowa Route To Wyanet – 79 mph	$195.55	$125.15	$27.57
Improvements Planned by Illinois Wyanet – Chicago 79/110 mph	$68.38	$68.38	$68.38
Total Infrastructure	$263.93	$193.53	$95.95
Capital Cost – Equipment (Train Sets)			
$ in millions	$43.00	$34.40	$25.80
Train Sets	10	8	6
Ridership (thousands)			
1998 estimate	805.9	717.9	484.3
2010 estimate	991.6	883.9	599.5
Passenger Miles (thousands)			
1998 estimate	169,585	130 401	64,793
2010 estimate	207,606	159,612	79,678
Train Miles (thousands)			
1998 estimate	2,260.18	1,957.76	1,431.59
2010 estimate	2,260.18	1,957.76	1,431.59
Fare Revenue (millions)			
1998 estimate	$35.71	$27.75	$13.82
2010 estimate	$43.87	$34.10	$17.07
Operating Revenue (Including same day parcel service) (millions)			
1998 estimate	$39.27	$30.92	$16.42
2010 estimate	$47.93	$37.76	$20.03
Operating Costs (millions)			
1998 estimate	$44.88	$39.00	$28.10
2010 estimate	$45.96	$39.95	$28.94
Performance Comparison Statistics			
Operating Ratio (Revenue/Cost)			
1998 estimate	88%	79%	58%
2010 estimate	104%	95%	69%
Average Passengers on Board			
1998 estimate	75.0	66.6	45.3
2010 estimate	91.9	81.5	55.7
Average Revenue per Passenger Mile (Fare per Mile)			
1998 estimate	$0.211	$0.213	$0.213
2010 estimate	$0.211	$0.214	$0.214
Average Passenger Trip Length (Miles)			
1998 estimate	210.4	181.7	133.8
2010 estimate	209.4	180.6	132.9
Average Revenue per Train Mile			
1998 estimate	$17.57	$15.59	$11.47
2010 estimate	$21.21	$19.29	$13.99

APPENDIX 1

COMPASS© MODEL SYSTEM AND RESULTS

Appendix 1
COMPASS© Model System and Results

The *COMPASS*© Model System is a flexible multimodal demand forecasting tool that provides comparative evaluations of alternative socioeconomic and network scenarios. It also allows input variables to be modified to test the sensitivity of demand to various parameters such as elasticities, values of time, and values of frequency.

The *COMPASS*© Model System is structured on two principal models: a Total Demand Model and a Hierarchical Modal Split Model. For this study, these two models were calibrated separately for two trip purposes, *i.e.*, business and nonbusiness (commuter, personal, and social). Moreover, since the behavior of short distance trip-making is significantly different from long distance trip-making, the database was segmented by distance and independent models were calibrated for long trips and short trips. For each market segment, the models were calibrated on origin-destination trip data, network characteristics, and base year socioeconomic data.

The models are calibrated on the base data. In applying the models for forecasting, an incremental approach known as the “pivot point” method is used. The “pivot point” method preserves unique travel flows present in the base data which are not captured by the model variables by applying model growth rates to the base data observations. Details on how this method is implemented are provided in this Appendix.

Total Demand Model

The total demand Model, shown in Equation 1, provides a mechanism for assessing overall growth in the travel market.

$$T_{ijp} \quad e^{\;0p}(SE_{ijp})^{\;1p}\; e^{\;2p\,U_{ijp}} \tag{1}$$

where e = Base of the natural logarithm

T_{ijp} = Number of trips between zones i and j for trip purpose p

SE_{ijp} = Socioeconomic variables for zones i and j for trip purpose p

U_{ijp} = Total utility of the transportation system for zones i to j for trip purpose p

$þ_{0p}, þ_{1p}, þ_{2p}$ = Coefficients for trip purpose p

As shown in Equation 1, the total number of trips between any two zones for all modes of travel, segmented by trip purpose, is a function of the socioeconomic characteristics of the zones and the total utility of the transportation system that exists between the two zones. For this study, trip purposes included business and nonbusiness, and socioeconomic characteristics included population, employment, and per capita income. The utility function provides a logical and intuitively sound method of assigning a value to the travel opportunities provided by the overall transportation system.

In the Total Demand Model, the utility function provides a measure of the quality of the transportation system in terms of the times, costs, reliability and level of service provided by all modes for a given trip purpose. The Total Demand Model equation may be interpreted as meaning that travel between zones will increase as socioeconomic factors such as population and income rise or as the utility (or quality) of the transportation system is improved by providing new facilities and services that reduce travel times and costs. The Total Demand Model can therefore be used to evaluate the effect of changes in both socioeconomic and travel characteristics on the total demand for travel.

Socioeconomic Variables

The socioeconomic variables in the Total Demand Model show the impact of economic growth on travel demand. The *COMPASS*© Model System, in line with most intercity modeling systems, uses three variables (population, employment, and per capita income) to represent the socioeconomic characteristics of a zone. Different combinations were tested in the calibration process and it was found, as is typically found elsewhere, that the most reasonable and stable relationships consists of the following formulations:

Trip Purpose	Socioeconomic Variable
Business	$E_iE_j(I_i + I_j)/2$
Nonbusiness	$P_iP_j(I_i + I_j)/2$

where E = Employment

I = Per capita income

P = Population

The business formulation consists of a product of employment in the origin zone, employment in the destination zone and the average per capita income of the two zones. Since business trips are usually made between places of work, the presence of employment in the formulation is reasonable. The nonbusiness formulation consists of a product of population in the origin zone, population in the destination zone and the average per capita income of the two zones. Nonbusiness trips encompass many types of trips, including social, tourist and personal business travel, but the majority are home-based and thus, greater volumes of trips are expected from zones from higher population.

Travel Utility

Estimates of travel utility for a transportation network are generated as a function of generalized cost (GC), as shown in Equation 2:

$$U_{ijp} \quad f(GC_{ijp}) \tag{2}$$

where

GC_{ijp} = Generalized cost of travel between zones i and j for trip purpose p

Because the generalized cost variable is used to estimate the impact of improvements in the transportation system on the overall level of trip-making, it needs to incorporate all the key modal attributes that affect an individual's decision to make trips. For the public modes (rail, bus, air), the generalized cost of travel includes all aspects of travel time (access, egress, in-vehicle times), travel cost (fares, tolls, parking charges), schedule convenience (frequency of service, convenience of arrival/departure times) and reliability.

The generalized cost of travel is typically defined in travel time (*i*.e., minutes) rather than dollars. Costs are converted to time by applying appropriate conversion factors, as shown in Equation 3. The generalized cost (GC) of travel between zones i and j for mode m and trip purpose p is calculated as follows:

$$GC_{ijmp} \quad TT_{ijm} \quad \frac{TC_{ijmp}}{VOT_{mp}} \quad \frac{VOF_{mp}\ x\ OH}{VOT_{mp}\ x\ F_{ijm}\ x\ C_{ijm}} \quad \frac{VOR_{mp} exp(\ OTP_{ijm})}{VOT_{mp}} \qquad (3)$$

where

TT_{ijm} = Travel time between zones i and j for mode m (in-vehicle time + station wait time + connection wait time + access/egress time + interchange penalty), with waiting, connect and access/egress time multiplied by a factor (greater than 1) to account for the additional disutility felt by travelers for these activities

TC_{ijmp} = Travel cost between zones i and j for mode m and trip purpose p (fare + access/egress cost for public modes, operating costs for auto)

VOT_{mp} = Value of Time for mode m and trip purpose p

VOF_{mp} = Value of Frequency for mode m and trip purpose p

VOR_{mp} = Value of Reliability for mode m and trip purpose p

F_{ijm} = Frequency in departures per week between zones i and j for mode m

C_{ijm} = Convenience factor of schedule times for travel between zones i and j for mode m

OTP_{ijm} = On-time performance for travel between zones i and j for mode m

OH = Operating hours per week

Station wait time is the time spent at the station before departure and after arrival. Air travel generally has higher wait times because of security procedures at the airport, baggage checking and the difficulties of loading a plane. Air trips were assigned wait times of 45 minutes while rail trips were assigned wait times of 30 minutes and bus trips were assigned wait times of 20 minutes. On trips with connections, there would be additional wait times incurred at the connecting station. Wait times are weighted higher than in-vehicle time in the generalized cost formula to reflect their higher disutility as found from previous studies. Wait times are weighted 70 percent higher than in-vehicle time for business trips and 90 percent higher for nonbusiness trips.

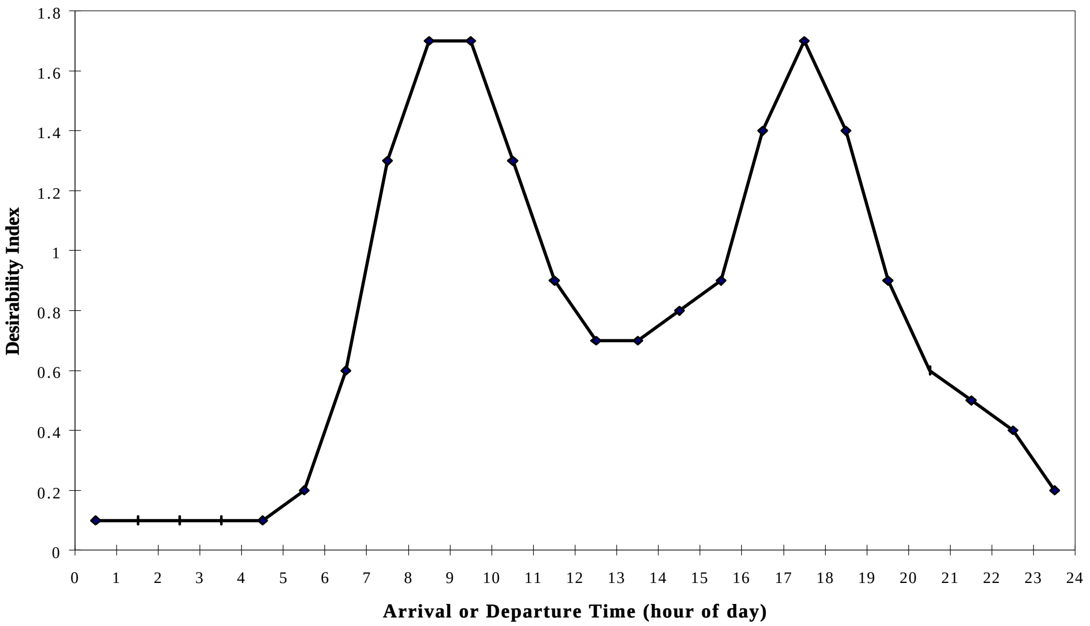
Similarly, access/egress time has a higher disutility than in-vehicle time. Access time tends to be more stressful for the traveler than in-vehicle time because of the uncertainty created by trying to catch the flight or train. Based on previous work, access time is weighted 30 percent higher than in-vehicle time for air travel and 80 percent higher for rail and bus travel.

TEMS has found from previous studies that the physical act of transferring trains (or buses or planes) has a negative impact beyond the times involved. To account for this disutility, interchanges are penalized time equivalents. For both air and rail travel, each interchange for a trip results in 40 minutes being added to the business generalized cost and 30 minutes being added to the nonbusiness generalized cost. For bus travel, the interchange penalties are 20 minutes and 15 minutes for business and nonbusiness, respectively.

The third term in the generalized cost function converts the frequency attribute into time units. Operating hours divided by frequency is a measure of the headway or time between departures. It is this measure on which tradeoffs are made in the stated preference surveys resulting in the value of frequencies. Although there may appear to some double counting because the station wait time in the first term of the generalized cost function is included in this headway measure, it is not the headway time itself that is being added to the generalized cost. The third term represents the impact of perceived frequency valuations on generalized cost. TEMS has found it very convenient to measure this impact as a function of the headway.

The convenience of the departure/arrival times was modeled only for the rail mode. It is incorporated in the generalized cost as a factor (C_{ijm}) multiplying the frequency. The factor is based on assigning each departure and arrival time in the timetable a desirability index corresponding to the graph shown in Exhibit 1. This graph was derived from responses given by rail passengers about preferred arrival and departure times in the *1993 Illinois Rail Passenger Survey*. Note that the peak times are 8 AM to 9 AM and about 5 PM. The product (F_{ijm} x C_{ijm}) can be interpreted as an effective level of service. The modeling of schedule times is more important for rail than the other modes because current timetables result in trains, especially long-distance trains, arriving (or departing) from some stations in the very early morning (1 AM to 5 AM). To explain the lower ridership from these stations, the schedule time must be considered in addition to the frequency of service. One such station currently is Cleveland where the two daily trains are scheduled to stop at 3:01 AM, 3:16 AM, 4:09 AM, and 6:17 AM.

Exhibit 1
Modeling Convenience of Schedule Times



The fourth term of the generalized cost function is a measure of the value placed on reliability of the mode. Reliability statistics in the form of on-time performance (fraction of trips considered to be on time) were obtained for the rail and air modes only. The negative exponential form of the reliability term implies that improvements from low levels of reliability have slightly higher impacts than similar improvements from higher levels of reliability.

Calibration of the Total Demand Model

In order to calibrate the Total Demand Model, the coefficients are estimated using linear regression techniques. Equation 1, the equation for the Total Demand Model, is transformed by taking the natural logarithm of both sides, as shown in Equation 4:

$$log(T_{ijp}) \qquad {}_{0p} \qquad {}_{1p}log(SE_{ijp}) \qquad {}_{2p}(U_{ijp}) \tag{4}$$

This provides the linear specification of the model necessary for regression analysis.

The segmentation of the database by trip purpose and trip length resulted in four sets of models. Trips which would cover more than 160 miles on the road are considered long trips. This cutoff was chosen because travel behavior switches significantly around this level with travellers considering faster modes such as air and high speed rail over the automobile. In the base data, the average trip length for the short distance model is approximately 80 miles while the average trip length for the long distance model is about 310 miles. The results of the calibration for the Total Demand Models are given in Exhibit 2.

In evaluating the validity of a statistical calibration, there are two key statistical measures: *t*-statistics and R^2. The *t*-statistics are a measure of the significance of the model's coefficients; values of 1.95 and above are considered *good* and imply that the variable has significant explanatory power in estimating the level of trips. The R^2 is a statistical measure of the “goodness of fit” of the model to the data; any data point that deviates from the model will reduce this measure. It has a range from 0 to a perfect 1, with 0.4 and above considered *good* for large data sets.

Based on these two measures, the total demand calibrations are excellent. The *t*-statistics are very high, aided by the large size of the Midwest dataset. There are about five times as many long distance observations as short distance observations, resulting in higher *t*-statistics for the long distance models. The R^2 values imply very good fits of the equations to the data.

As shown in Exhibit 2, the socioeconomic elasticity values for the Total Demand Model are close to 0.7, meaning that each 1 percent growth in the socioeconomic term generates approximately a 0.7 percent growth in trips. Since each component of the socioeconomic term will have this elasticity, a one percent increase in population (or employment) of every zone combined with a one percent increase in income will result in a 2.1 percent growth in trips.

The coefficient on the utility term is not exactly an elasticity but it can be used as an approximation. Thus, the transportation system or network utility elasticity is higher for short distance trips than long distance trips, with each 1 percent improvement in network utility or quality as measured by generalized cost (*i.e.*, travel times or costs) generating approximately an 0.7 percent increase for long trips and 1.1 percent increase for short trips. The higher elasticity on short trips is partly a result of the scale of the generalized costs. For short trips, a 30 minute improvement would be more meaningful than the same time improvement on long trips, reflecting in the higher elasticity on the short distance model.

Exhibit 2
Total Demand Model Coefficients(1)

Long Distance Trips (*more than 160 miles driving distance*)

Business $\log(T_{ij})$ =
$-13.4 \; +$ $0.710\ SE_{ij}$
$+\ 0.684\ U_{ij}$ $R^2 = 0.91$
(146)

(123)

where $U_{ij} = \log[\exp(-1.12 + 0.679\ U_{Pub}) + \exp(-0.00460\ GC_{Car})]$

Nonbusiness $\log(T_{ij})$ =
$-13.4 \; +$ $0.708\ SE_{ij}$
$+\ 0.744\ U_{ij}$ $R^2 = 0.92$
(176)

(172)

where $U_{ij} = \log[\exp(-2.77 + 0.685\ U_{Pub}) + \exp(-0.00557\ GC_{Car})]$

Short Distance Trips (*þ 160 miles driving distance*)

Business $\log(T_{ij}) = -11.4 + \underset{(15)}{0.759\ SE_{ij}} + \underset{(15)}{0.933\ U_{ij}}$ $R^2 = 0.68$

where $U_{ij} = \log[\exp(-6.69 + 0.965\ U_{Pub}) + \exp(-0.0153\ GC_{Car})]$

Nonbusiness $\log(T_{ij}) = -7.00 + \underset{(31)}{0.636\ SE_{ij}} + \underset{(31)}{1.231\ U_{ij}}$ $R^2 = 0.63$

where $U_{ij} = \log[\exp(-7.73 + 0.658\ U_{Pub}) + \exp(-0.0155\ GC_{Car})]$

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(1) *t-statistics are given in parentheses.*

The utility functions are functions of the generalized costs of the modes of travel. In deriving the total utility term, a special "logsum" approach is used in which utilities are built up from individual modes in a recursive fashion. Thus, the total utility is derived from car generalized cost and the public mode utility which itself is derived from the generalized costs of its constituent modes (i.e. air, rail, bus). The exact form for the public mode utility function is determined from the calibration process for the modal split models to be described in the next section.

Incremental Form of The Total Demand Model

The calibrated Total Demand Models could be used to estimate the total travel market for any zone pair using the population, employment, income and the total utility of all the modes. However, there would be significant differences between estimated and observed levels of trip-making for many zone pairs despite the good fit of the models to the data. For example, travel to summer cottages in the Michigan Upper Peninsula cannot be explained well by the socioeconomic measures used. To preserve the unique travel patterns contained in the base data, the incremental approach or "pivot point" method is used for forecasting.

In the incremental approach, the base travel data assembled in the database are used as "pivot" points and forecasts are made by applying trends to the base data. The total demand equation as described in equation (1) can be rewritten into the following incremental form which can be used for forecasting:

$$\frac{T^{f}_{ijp}}{T^{b}_{ijp}} \quad \left(\frac{SE^{f}_{ijp}}{SE^{b}_{ijp}}\right)^{1p} e^{2p(U^{f}_{ijp} \quad U^{b}_{ijp})} \tag{5}$$

where

T^{f}_{ijp} = Number of trips between zones i and j for trip purpose p in forecast year

Se^{f}_{ijp} = Socioeconomic variables for zones i and j for trip purpose p in forecast year

U^{f}_{ijp} = Total utility of the transportation system for zones i to j for trip purpose p in forecast year

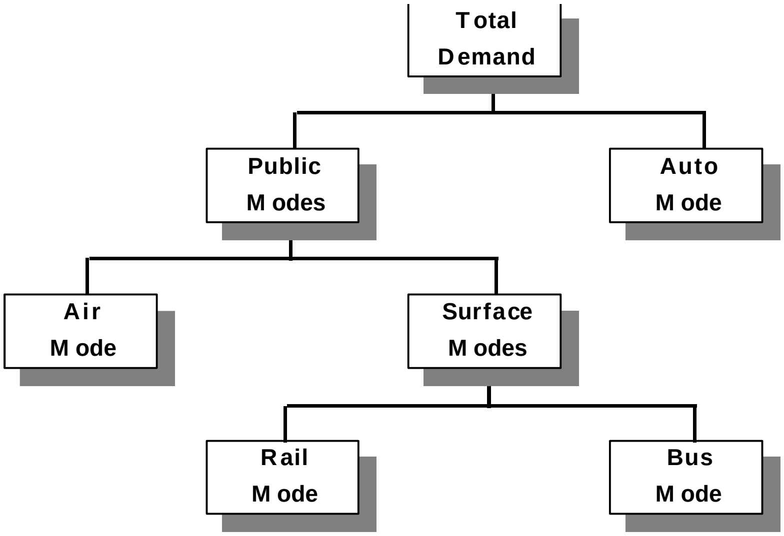
Variables with superscript b refer to base year values.

In the incremental form, the constant term disappears and only the elasticities are important.

Modal Split Model

The role of the Modal Split Model is to estimate relative modal shares, given the Total Demand Model estimate of the total market. The relative modal shares are derived by comparing the relative levels of service offered by each of the travel modes. The *COMPASS*© Modal Split Model uses a nested logit structure, which has been adapted to model the intercity modal choices available in the study area. As shown in Exhibit 3, three levels of binary choice were calibrated.

Exhibit 3
Hierarchical Structure of the Modal Split Model



The main feature of the Hierarchical Modal Split Model structure is the increasing commonality of travel characteristics as the structure is descended. The first level of the hierarchy separates private auto travel—with its spontaneous frequency, low access/egress times, low costs, and highly personalized characteristics—from the public modes. The second level of the structure separates air—the fastest, most expensive, and perhaps most frequent and comfortable public mode—from the rail and bus surface modes. The lowest level of the hierarchy separates rail, a potentially faster, more reliable, and more comfortable mode, from the bus mode.

Form of the Modal Split Model

To assess modal split behavior, the logsum utility function, which is derived from travel utility theory, has been adopted. As the modal split hierarchy is ascended, the logsum utility values are derived by combining the generalized costs of travel. Advantages of the logsum utility approach are, one, the introduction of a new mode will increase the overall utility of travel and, two, a new mode can readily be incorporated into the Modal Split Model, even if it was not included in the base-year calibration.

As only two choices exist at each level of the modal split hierarchical structure, a Binary Logit Model is used, as shown in Equation 5:

$$P_{ijmp} \quad \frac{e^{U_{ijmp}/}}{e^{U_{ijmp}/} \quad e^{U_{ijnp}/}} \tag{6}$$

where

P_{ijmp} = Percentage of trips between zones i and j by mode m for trip purpose p

U_{ijmp}, U_{ijnp} = Utility functions of modes m and n between zones i and j for trip purpose p

þ = nesting coefficient

In Equation 6, the utility of travel between zones i and j by mode m for trip purpose p is a function of the generalized cost of travel. Where mode m is a composite mode (*e.g.*, the surface modes in the third level of the Modal Split Model hierarchy, which consist of the rail and bus modes), the utility of travel, as described below, is derived from the utility of the two or more modes it represents.

Utility of Composite Modes

Where modes are combined, as in the upper levels of the modal split hierarchy, it is essential to be able to measure the *inclusive value* of the composite mode, *e.g.*, how the combined utility for bus and rail compares with the utility for bus or rail alone. The combined utility is more than the utility of either of the modes alone, but it is not simply equal to the sum of the utilities of the two modes. A realistic approach to solving this problem, which is consistent with utility theory and the logit model, is to use the logsum function. As the name logsum suggests, the utility of a composite mode is defined as the natural logarithm of the sum of the utilities of the component modes. In combining the utility of separate modes, the logsum function provides a reasonable proportional increase in utility that is less than the combined utilities of the two modes but reflects the value of having two or more modes available to the traveler. For example:

suppose

Utility of Rail or $U_{rail} = \text{þ} + \text{þ}GC_{rail}$

Utility of Bus or $U_{bus} = \text{þ}GC_{bus}$

then

Inclusive Utility of Surface Modes, or $U_{surface} = \log(e^{Urail} + e^{Ubus})$

It should be noted that improvements in either rail or bus will result in improvements to the inclusive utility of the surface modes.

In a nested binary logit model, the calibrated coefficients associated with the inclusive values of composite modes are called the nesting coefficients and take on special meaning. If one of these coefficients is equal to 1, then that level of the hierarchical model collapses and two levels of the hierarchy essentially become one. At this point, the Modal Split Model is a multinomial logit model that is analyzing three or more modes, *i.e.*, all the modes comprising the composite mode as well as the other modes in that level of the hierarchy. If one of the coefficients is greater than 1, then the hierarchy has been incorrectly specified and counterintuitive forecasts will result. Because of the assumptions behind the Modal Split Model, the coefficients must decrease as the modal split hierarchy is ascended or counterintuitive results will occur. Thus, the coefficients provide a check on whether the Modal Split Model hierarchy has been specified correctly.

Calibration of the Modal Split Model

Working from the bottom of the hierarchy up to the top, the first analysis is that of the rail mode versus the bus mode. As shown in Exhibit 4, the model was effectively calibrated for the two trip purposes and the two trip lengths, with reasonable parameters and R^2 and t values. All the coefficients have the correct signs such that demand increases or decreases in the correct direction as travel times or costs are increased or decreased, and all the coefficients appear to be reasonable in terms of the size of their impact. Rail travelers are more sensitive than bus travelers to time and cost. This is as expected, given the general attitude that travelers, and in particular business travelers, have toward the bus mode. The higher coefficients on the short distance models are partly due to the scale effect where the same time or cost improvements would be more meaningful on shorter trips.

Exhibit 4

Rail versus Bus Modal Split Model Coefficients(1)

Long Distance Trips (*more than 160 miles driving distance*)

Business

$$\log(P_{Rail}/P_{Bus}) = \underset{(5.7)}{3.76} - \underset{(7.7)}{0.00446\, GC_{Rail}} + \underset{(4.4)}{0.00413\, GC_{Bus}} \qquad R^2 = 0.62$$

Nonbusiness

$$\log(P_{Rail}/P_{Bus}) = \underset{(11)}{2.36} - \underset{(16)}{0.00297\, GC_{Rail}} + \underset{(9.5)}{0.00196\, GC_{Bus}} \qquad R^2 = 0.40$$

Short Distance Trips (*þ 160 miles driving distance*)

Business

$$\log(P_{Rail}/P_{Bus}) = \underset{(3.4)}{3.12} - \underset{(5.2)}{0.00640\, GC_{Rail}} + \underset{(2.2)}{0.00499\, GC_{Bus}} \qquad R^2 = 0.46$$

Nonbusiness

$$\log(P_{Rail}/P_{Bus}) = \underset{(2.2)}{0.82} - \underset{(10)}{0.00445\, GC_{Rail}} + \underset{(9.4)}{0.00352\, GC_{Bus}} \qquad R^2 = 0.42$$

---

(1) t-statistics are given in parentheses.

The constant term in each equations indicates the degree of bias towards one mode or the other. Since the terms are positive in all the market segments, there is a bias towards rail travel that is not explained by the variables (times, costs, frequencies, reliability) used to model the modes. As expected, this bias is larger for business travelers who tend to have very negative perceptions of intercity bus.

For the second level of the hierarchy, the analysis is of the surface modes (rail and bus) versus air. Accordingly, the utility of the surface modes is obtained by deriving the logsum of the utilities of rail and bus. As shown in Exhibit 5, the model calibrations for both trip purposes are all statistically significant, with good R^2 and *t* values and reasonable parameters. As indicated by the air coefficients, short distance travelers are less sensitive to changes in the air costs than long distance travelers. One explanation is some short distance air trips are special trips responding to personal or businesss emergencies and are thus, cost insensitive. As indicated by the constant terms, there is a large bias towards air travel for long distance trips. However, for short trips, there is only a small bias towards air for business travelers and for nonbusiness travel, the bias, which is large, is actually towards the surface modes.

Exhibit 5
Surface versus Air Modal Split Model Coefficients(1)

Long Distance Trips (*more than 160 miles driving distance*)

Business $\log(P_{Surf}/P_{Air}) = \underset{(13)}{-5.91} + \underset{(19)}{1.258\ U_{Surf}} + \underset{(12)}{0.00880\ GC_{Air}}$ $R^2 = 0.77$

where $U_{Surf} = \log[\exp(3.76 - 0.00446\ GC_{Rail}) + \exp(-0.00413\ GC_{Bus})]$

Nonbusiness $\log(P_{Surf}/P_{Air}) = \underset{(22)}{-3.22} + \underset{(29)}{1.051\ U_{Surf}} + \underset{(27)}{0.00536\ GC_{Air}}$ $R^2 = 0.48$

where $U_{Surf} = \log[\exp(2.36 - 0.00297\ GC_{Rail}) + \exp(-0.00196\ GC_{Bus})]$

Short Distance Trips (*þ 160 miles driving distance*)

Business $\log(P_{Surf}/P_{Air}) = \underset{(2.3)}{-1.10} + \underset{(7.3)}{1.078\ U_{Surf}} + \underset{(5.0)}{0.00380\ GC_{Air}}$ $R^2 = 0.53$

where $U_{Surf} = \log[\exp(3.11 - 0.00640\ GC_{Rail}) + \exp(-0.00499\ GC_{Bus})]$

Nonbusiness $\log(P_{Surf}/P_{Air}) = \underset{(8.5)}{3.01} + \underset{(14)}{1.387\ U_{Surf}} + \underset{(4.1)}{0.00155\ GC_{Air}}$ $R^2 = 0.55$

where $U_{Surf} = \log[\exp(0.82 - 0.00445\ GC_{Rail}) + \exp(-0.00352\ GC_{Bus})]$

---

(1) t-statistics are given in parentheses.

The analysis for the top level of the hierarchy is of auto versus the public modes. The public modes are comprised of air and the surface modes (rail and bus). The utility of the public modes is obtained by deriving the logsum of the utilities of the air, rail, and bus modes.

As shown in Exhibit 6, the model calibrations for both trip purposes are all statistically significant, with good R^2 and *t* values and reasonable parameters in most cases. The R^2 value for the nonbusiness, short distance model is a bit low and marginally acceptable. Part of the reason for the poor fit is that local transit trips are not included in the public trip database causing some of the observations to deviate significantly from the model equation. The constant terms show that there is a bias towards the auto mode with the bias increasing with shorter trip length.

Exhibit 6
Public versus Auto Modal Split Model Coefficients(1)

Long Distance Trips (*more than 160 miles driving distance*)

Business $\log(P_{Pub}/P_{Auto}) = \underset{(13)}{-1.12} + \underset{(46)}{0.679\ U_{Pub}} + \underset{(69)}{0.00460\ GC_{Auto}}$ $R^2 = 0.62$

where $U_{Pub} = \log[\exp(-5.91 + 1.258\ U_{Surf}) + \exp(-0.00880\ GC_{Air})]$

Nonbusiness $\log(P_{Pub}/P_{Auto}) = \underset{(55)}{-2.77} + \underset{(47)}{0.685\ U_{Pub}} + \underset{(96)}{0.00557\ GC_{Auto}}$ $R^2 = 0.66$

where $U_{Pub} = \log[\exp(-3.22 + 1.051\ U_{Surf}) + \exp(-0.00536\ GC_{Air})]$

Short Distance Trips (*þ 160 miles driving distance*)

Business $\log(P_{Pub}/P_{Auto}) = \underset{(24)}{-6.69} + \underset{(8.8)}{0.965\ U_{Pub}} + \underset{(15)}{0.0153\ GC_{Auto}}$ $R^2 = 0.51$

where $U_{Pub} = \log[\exp(-1.10 + 1.078\ U_{Surf}) + \exp(-0.00380\ GC_{Air})]$

Nonbusiness $\log(P_{Pub}/P_{Auto}) = \underset{(49)}{-7.73} + \underset{(12)}{0.658\ U_{Pub}} + \underset{(18)}{0.0155\ GC_{Auto}}$ $R^2 = 0.38$

where $U_{Pub} = \log[\exp(3.01 + 1.387\ U_{Surf}) + \exp(-0.00155\ GC_{Air})]$

---

(1) *t-statistics are given in parentheses.*

Incremental Form of the Modal Split Model

Using the same reasoning as described above, the modal split models are applied incrementally to the base data rather than imposing the model estimated modal shares. Different regions of the corridor may have certain biases toward one form of travel over another and these differences cannot be captured with a single model for the entire Midwest Corridor. Using the "pivot point" method, many of these differences can be retained. To apply the modal split models incrementally, the following reformulation of the modal split models is used:

$$\left(\frac{P^{f}_{A}}{P^{f}_{B}}\right)/\left(\frac{P^{b}_{A}}{P^{b}_{B}}\right) \quad e^{(GC^{f}_{A} \quad GC^{b}_{B}) \qquad (GC^{f}_{B} \quad GC^{b}_{B})} \tag{7}$$

where

P^{f}_{A} = Percentage of trips using mode A in the forecast year

GC^{f}_{A} = Generalized cost for mode A in the forecast year

þ,þ = Estimated coefficients

Variables with superscript b refer to base year values.

For modal split models that involve composite utilities instead of generalized costs, the composite utilities would be used in the above formula in place of generalized costs. Once again, the constant term is not used and the drivers for modal shifts are changes in generalized cost from base conditions.

Another consequence of the "pivot point" method is that **extreme** changes from current trip-making levels and current modal shares are rare. Thus, since very few short distance commuter trips are currently being made on Amtrak, the forecasted growth in these trips will be limited despite the huge auto market.

COMPASS© Model Output

The model output results for the Conservative scenarios for the three routes and for the Moderate Scenario segment analysis of the IAIS route are presented below.

Reading across, the first five columns, in whole numbers, represent the components of rail ridership. Base year demand represents current rail ridership. Natural growth represents the influence of growth in population, income and employment. Induced growth represents new trips generated by the system. Diverted trips represents trips diverted from air, bus and auto. The fifth column, Total Rail Demand, is the sum of the first four columns.

The sixth column, Corridor Demand, is presented in thousands, and represents demand for all four modes. Columns 7 through 10 present percentage markets shares for air, bus, auto and rail.

Column 11, Consumer Surplus, represents the user benefit, and measures the value of the time savings, convenience, and quality of the improved rail system. The value is presented in millions of dollars. It represents what the system user would be willing to pay, over and above the actual fare paid. Revenue in Column 12 is fare revenue only, and is also presented in millions of dollars. Passenger Miles in Column 13 is equivalent to the passenger trips (total rail demand) times the miles traveled by each passenger, and is also presented in millions. Passenger miles divided by passenger trips (total rail demand) can be used to estimate average trip length.

Reading down, 1996 represents the base, prior to implementation of service. Trip purposes are business and other, as discussed in the Model description. As noted above, 1998 represents the initiation of service with minimal impacts from socioeconomic growth factors.

Conservative Output

Route 1 BNSF Alignment

```
COMPASS Strategic Transportation Planning Model
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   CONSUMER SURPLUS REPORT

               Revenue in millions of 1996 $
               Passenger miles in millions


Consumer Surplus File  : OPTC.RCT
Parameter File         : PARMC.CMP

Reporting Date         : 11/26/97
Reporting Time         : 13:13:44


CORRIDOR:  Chicago-Quincy-Omaha

            Base Year    Natural    Induced    Diverted  Total  Rail   Corridor        Market Shares          Consumer                Passenger
1996       Rail Demand   Growth     Growth      Trips      Demand       Demand   Air   Bus   Auto   Rail   Surplus     Revenue      Miles
----     --------------------------------------------------------------------------------------------------------------------------------------
Business      25794          0          0          0       25794       13354   4.75  0.04  95.03  0.19     0.000       1.046        5.118
Other        108318          0          0          0      108318       40085   2.34  0.33  97.07  0.27     0.000       3.463       22.670
Total        134112          0          0          0      134112       53439   2.94  0.25  96.56  0.25     0.000       4.510       27.788


1998
----
Business      25794       1446       2241      35178       64659       14280   4.63  0.03  94.90  0.45     2.672       3.093       12.656
Other        108318       3941      10038     157229      279526       41725   2.26  0.29  96.78  0.67    10.223      10.758       58.967
Total        134112       5387      12280     192407      344186       56005   2.86  0.22  96.30  0.61    12.895      13.851       71.623


2000
----
Business      25794       2974       2367      37340       68476       15269   4.60  0.03  94.94  0.45     2.827       3.270       13.377
Other        108318       8029      10411     163313      290071       43425   2.27  0.29  96.78  0.67    10.610      11.158       61.157
Total        134112      11004      12778     200653      358548       58694   2.87  0.22  96.30  0.61    13.437      14.428       74.534


2010
----
Business      25794       9138       2863      45792       83587       19293   4.50  0.03  95.04  0.43     3.449       3.974       16.257
Other        108318      27276      12148     191418      339160       51224   2.28  0.29  96.78  0.66    12.419      13.016       71.325
Total        134112      36414      15011     237210      422747       70517   2.89  0.22  96.30  0.60    15.868      16.990       87.582


2020
----
Business      25794      12757       3152      50752       92456       21729   4.45  0.03  95.10  0.43     3.812       4.379       17.913
Other        108318      47322      13971     220660      390272       59008   2.30  0.29  96.76  0.66    14.305      14.956       81.949
Total        134112      60079      17124     271413      482729       80737   2.88  0.22  96.31  0.60    18.117      19.336       99.862


2040
----
Business      25794      22390       3925      63740      115849       27821   4.38  0.03  95.18  0.42     4.777       5.460       22.330
Other        108318      94942      18313     289500      511075       76687   2.34  0.29  96.71  0.67    18.758      19.570      107.221
Total        134112     117332      22239     353240      626925      104508   2.88  0.22  96.30  0.60    23.535      25.030      129.551
```

Conservative Output

Route 2 Iowa Interstate Alignment

```
COMPASS Strategic Transportation Planning Model
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   CONSUMER SURPLUS REPORT

              Revenue in millions of 1996 $
              Passenger miles in millions


Consumer Surplus File   : OPTCB.RCT
Parameter File          : PARMC.CMP

Reporting Date          : 11/25/97
Reporting Time          : 19:06:32


CORRIDOR:  Chicago-Quincy-Omaha

            Base Year   Natural    Induced     Diverted  Total  Rail  Corridor         Market  Shares              Consumer                  Passenger
1996       Rail Demand  Growth     Growth        Trips     Demand      Demand    Air    Bus    Auto    Rail     Surplus      Revenue       Miles
----       -------------------------------------------------------------------------------------------------------------------------------------------
Business        25794         0          0           0      25794       14545   4.65   0.04   95.14   0.18      0.000        1.046        5.118
Other          108318         0          0           0     108318       43912   2.26   0.36   97.14   0.25      0.000        3.463       22.670
Total          134112         0          0           0     134112       58457   2.86   0.28   96.64   0.23      0.000        4.510       27.788


1998
----
Business        25794      1446       6191       80005     113437       15552   4.46   0.03   94.79   0.73      5.128        5.923       24.024
Other          108318      3941      20956      246491     379706       45740   2.16   0.31   96.71   0.83     15.203       15.334       83.203
Total          134112      5387      27148      326497     493144       61292   2.74   0.23   96.22   0.80     20.331       21.257      107.227


2000
----
Business        25794      2974       6541       84710     120020       16616   4.43   0.03   94.82   0.72      5.426        6.258       25.382
Other          108318      8029      21709      255684     393741       47579   2.16   0.31   96.71   0.83     15.765       15.895       86.240
Total          134112     11004      28251      340394     513762       64195   2.75   0.23   96.22   0.80     21.192       22.153      111.622


2010
----
Business        25794      9138       7938      103316     146187       20924   4.35   0.03   94.93   0.70      6.610        7.596       30.805
Other          108318     27276      25235      298336     459165       56038   2.18   0.30   96.70   0.82     18.399       18.503      100.378
Total          134112     36414      33173      401653     605353       76962   2.77   0.23   96.22   0.79     25.009       26.099      131.183


2020
----
Business        25794     12757       8727      113965     161244       23518   4.31   0.03   94.99   0.69      7.293        8.354       33.876
Other          108318     47322      28951      342954     527544       64514   2.20   0.30   96.69   0.82     21.153       21.239      115.207
Total          134112     60079      37678      456919     688789       88032   2.76   0.23   96.23   0.78     28.447       29.592      149.083


2040
----
Business        25794     22390      10866      142445     201496       30044   4.24   0.03   95.06   0.67      9.128       10.397       42.160
Other          108318     94942      37793      448409     689463       83834   2.24   0.30   96.64   0.82     27.658       27.750      150.520
Total          134112    117332      48660      590855     890959      113878   2.77   0.23   96.22   0.78     36.786       38.147      192.680
```

Conservative Output

Route 3 Union Pacific Alignment

```
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   CONSUMER SURPLUS REPORT

              Revenue in millions of 1996 $
              Passenger miles in millions

Consumer Surplus File  : OPTCC.RCT
Parameter File         : PARMC.CMP

Reporting Date         : 11/26/97
Reporting Time         : 11:58:08


CORRIDOR:  Chicago-Quincy-Omaha

            Base Year   Natural   Induced  Diverted  Total  Rail  Corridor         Market Shares          Consumer                Passenger
1996      Rail Demand    Growth    Growth     Trips     Demand     Demand    Air    Bus   Auto   Rail    Surplus    Revenue      Miles
----      ---------------------------------------------------------------------------------------------------------------------------------
Business        25794         0         0         0      25794     14488   4.65   0.04  95.15   0.18      0.000      1.046      5.118
Other          108318         0         0         0     108318     44089   2.24   0.35  97.16   0.25      0.000      3.463     22.670
Total          134112         0         0         0     134112     58577   2.84   0.27  96.66   0.23      0.000      4.510     27.788


1998
----
Business        25794      1446      5000     60473      92713     15483   4.49   0.03  94.89   0.60      1.779      5.134     20.801
Other          108318      3941     13634    202746     328640     45876   2.15   0.30  96.84   0.72      7.334     13.829     75.067
Total          134112      5387     18635    263219     421353     61359   2.73   0.23  96.35   0.68      9.113     18.963     95.868


2000
----
Business        25794      2974      5272     63974      98015     16542   4.46   0.03  94.92   0.59      1.887      5.421     21.962
Other          108318      8029     14126    210348     340823     47723   2.15   0.30  96.84   0.71      7.618     14.335     77.809
Total          134112     11004     19398    274322     438838     64265   2.74   0.23  96.35   0.68      9.505     19.756     99.771


2010
----
Business        25794      9138      6349     77668     118950     20831   4.38   0.03  95.03   0.57      2.303      6.559     26.570
Other          108318     27276     16418    245578     397590     56206   2.16   0.30  96.84   0.71      8.949     16.687     90.561
Total          134112     36414     22767    323246     516541     77037   2.76   0.22  96.35   0.67     11.253     23.247    117.131


2020
----
Business        25794     12757      6947     85418     130917     23413   4.33   0.03  95.09   0.56      2.553      7.200     29.164
Other          108318     47322     18842    282520     457003     64709   2.18   0.30  96.82   0.71     10.332     19.156    103.947
Total          134112     60079     25790    367938     587920     88122   2.75   0.22  96.36   0.67     12.886     26.356    133.111


2040
----
Business        25794     22390      8598    106331     163113     29911   4.27   0.03  95.16   0.55      3.221      8.940     36.212
Other          108318     94942     24633    369997     597891     84078   2.22   0.30  96.77   0.71     13.580     25.039    135.865
Total          134112    117332     33231    476328     761005    113989   2.76   0.23  96.35   0.67     16.801     33.980    172.076
```

```
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   CONSUMER SURPLUS REPORT

            Revenue in millions of 1996 $
            Passenger miles in millions


Consumer Surplus File   : OPTM4E.RCT
Parameter File          : PARMM.CMP

Reporting Date          : 01/24/98
Reporting Time          : 14:30:34
```

Moderate Output
Quad Cities

```
CORRIDOR:  Chicago-Quincy-Omaha

           Base Year   Natural    Induced   Diverted  Total  Rail  Corridor        Market Shares               Consumer             Passenger
1996     Rail Demand    Growth     Growth      Trips     Demand    Demand   Air    Bus   Auto   Rail    Surplus   Revenue      Miles
----     ----------------------------------------------------------------------------------------------------------------------------------
Business       25794         0          0          0      25794     13169  4.27   0.04  95.51   0.20      0.000     1.046      5.118
Other         108318         0          0          0     108318     39628  2.25   0.31  97.18   0.27      0.000     3.463     22.670
Total         134112         0          0          0     134112     52797  2.75   0.24  96.76   0.25      0.000     4.510     27.788


1998
----
Business       25794      1446      10893      83877     122011     14096  4.07   0.03  95.04   0.87     -1.008     4.322     16.564
Other         108318      3941      27276     222703     362238     41271  2.16   0.26  96.70   0.88     -2.367     9.502     48.229
Total         134112      5387      38170     306580     484250     55367  2.64   0.20  96.28   0.87     -3.374    13.823     64.793


2000
----
Business       25794      2974      11528      89109     129405     15075  4.04   0.03  95.08   0.86     -1.052     4.572     17.521
Other         108318      8029      28305     231518     376172     42955  2.16   0.26  96.70   0.88     -2.465     9.856     50.018
Total         134112     11004      39833     320627     505578     58030  2.65   0.20  96.28   0.87     -3.517    14.428     67.539


2010
----
Business       25794      9138      14027     109520     158480     19061  3.96   0.03  95.18   0.83     -1.249     5.562     21.304
Other         108318     27276      33109     272300     441005     50681  2.18   0.26  96.70   0.87     -2.881    11.505     58.374
Total         134112     36414      47137     381821     599486     69742  2.66   0.19  96.28   0.86     -4.129    17.067     79.678


2020
----
Business       25794     12757      15488     121662     175702     21478  3.92   0.03  95.24   0.82     -1.299     6.142     23.521
Other         108318     47322      38135     314498     508272     58384  2.20   0.26  96.68   0.87     -3.311    13.232     67.123
Total         134112     60079      53624     436160     683975     79862  2.66   0.20  96.29   0.86     -4.610    19.374     90.644


2040
----
Business       25794     22390      19399     153486     221069     27518  3.86   0.03  95.32   0.80     -1.453     7.695     29.461
Other         108318     94942      50001     412904     666164     75870  2.24   0.26  96.63   0.88     -4.350    17.320     87.848
Total         134112    117332      69400     566390     887233    103388  2.67   0.20  96.28   0.86     -5.803    25.015    117.308
```

```
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   CONSUMER SURPLUS REPORT

              Revenue in millions of 1996 $
              Passenger miles in millions


Consumer Surplus File   : OPTM4D.RCT
Parameter File          : PARMM.CMP

Reporting Date          : 01/24/98
Reporting Time          : 13:58:19
```

Moderate Output
Des Moines

```
CORRIDOR:  Chicago-Quincy-Omaha

1996         Base Year   Natural    Induced    Diverted  Total  Rail  Corridor          Market Shares            Consumer              Passenger
----        Rail Demand  Growth     Growth      Trips      Demand      Demand      Air    Bus   Auto   Rail    Surplus     Revenue      Miles
          -------------------------------------------------------------------------------------------------------------------------------------
Business       25794          0          0          0       25794       14459     4.68   0.04  95.11   0.18      0.000       1.046       5.118
Other         108318          0          0          0      108318       43648     2.27   0.35  97.13   0.25      0.000       3.463      22.670
Total         134112          0          0          0      134112       58107     2.87   0.27  96.63   0.23      0.000       4.510      27.788


1998
----
Business       25794       1446      16015     137756      181012       15463     4.37   0.03  94.44   1.17      7.175       8.655      33.298
Other         108318       3941      44233     380348      536839       45448     2.12   0.27  96.43   1.18     14.190      19.096      97.103
Total         134112       5387      60249     518105      717852       60911     2.69   0.21  95.93   1.18     21.365      27.751     130.401


2000
----
Business       25794       2974      16930     145969      191669       16520     4.34   0.03  94.48   1.16      7.579       9.146      35.179
Other         108318       8029      45845     394650      556843       47279     2.12   0.27  96.43   1.18     14.675      19.787     100.601
Total         134112      11004      62775     540620      748512       63799     2.70   0.21  95.93   1.17     22.255      28.932     135.781


2010
----
Business       25794       9138      20552     178256      233742       20809     4.26   0.03  94.59   1.12      9.191      11.090      42.651
Other         108318      27276      53381     461160      650135       55693     2.14   0.27  96.43   1.17     17.001      23.010     116.962
Total         134112      36414      73934     639416      883877       76502     2.71   0.20  95.93   1.15     26.192      34.100     159.612


2020
----
Business       25794      12757      22632     196959      258143       23394     4.22   0.03  94.65   1.10     10.138      12.199      46.908
Other         108318      47322      61334     530766      747743       64123     2.16   0.27  96.41   1.17     19.478      26.413     134.240
Total         134112      60079      83967     727726     1005887       87517     2.71   0.20  95.94   1.15     29.615      38.612     181.148


2040
----
Business       25794      22390      28241     246730      323156       29890     4.16   0.03  94.74   1.08     12.704      15.196      58.421
Other         108318      94942      80249     694917      978425       83334     2.20   0.27  96.37   1.17     25.386      34.526     175.443
Total         134112     117332     108491     941648     1301581      113224     2.71   0.20  95.94   1.15     38.090      49.722     233.864
```

```
COMPASS Strategic Transportation Planning Model
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   CONSUMER SURPLUS REPORT

             Revenue in millions of 1996 $
             Passenger miles in millions

Consumer Surplus File  : OPTM4B.RCT
Parameter File         : PARMM.CMP

Reporting Date         : 01/12/98
Reporting Time         : 15:01:38
```

Moderate Output
Omaha

```
CORRIDOR:  Chicago-Quincy-Omaha

            Base Year   Natural    Induced   Diverted  Total  Rail  Corridor          Market  Shares              Consumer                Passenger
1996       Rail Demand  Growth     Growth      Trips     Demand      Demand    Air     Bus    Auto    Rail     Surplus      Revenue       Miles
----      -------------------------------------------------------------------------------------------------------------------------------------------
Business       25794        0          0          0      25794       14588    4.64    0.04   95.15   0.18       0.000        1.046        5.118
Other         108318        0          0          0     108318       44073    2.26    0.36   97.14   0.25       0.000        3.463       22.670
Total         134112        0          0          0     134112       58661    2.85    0.28   96.65   0.23       0.000        4.510       27.788


1998
----
Business       25794     1446      16820     149890     193951       15600    4.30    0.03   94.44   1.24      10.897       10.091       38.890
Other         108318     3941      50723     448930     611912       45896    2.07    0.27   96.33   1.33      26.080       25.615      130.696
Total         134112     5387      67543     598821     805863       61496    2.64    0.20   95.85   1.31      36.976       35.706      169.586


2000
----
Business       25794     2974      17781     158814     205364       16667    4.28    0.03   94.47   1.23      11.520       10.665       41.098
Other         108318     8029      52580     465850     634778       47741    2.07    0.27   96.33   1.33      27.026       26.556      135.484
Total         134112    11004      70361     624665     840143       64408    2.64    0.20   95.85   1.30      38.546       37.222      176.583


2010
----
Business       25794     9138      21588     193954     250475       20986    4.20    0.03   94.59   1.19      14.009       12.948       49.883
Other         108318    27276      61238     544297     741128       56226    2.09    0.27   96.33   1.32      31.451       30.922      157.724
Total         134112    36414      82826     738251     991603       77212    2.66    0.20   95.86   1.28      45.460       43.870      207.607


2020
----
Business       25794    12757      23768     214233     276553       23586    4.16    0.03   94.65   1.17      15.433       14.244       54.870
Other         108318    47322      70353     626218     852213       64731    2.11    0.26   96.32   1.32      36.082       35.505      181.077
Total         134112    60079      94121     840452    1128766       88317    2.65    0.20   95.87   1.28      51.515       49.749      235.947


2040
----
Business       25794    22390      29646     268186     346016       30128    4.10    0.03   94.73   1.15      19.260       17.736       68.313
Other         108318    94942      92025     819483    1114768       84114    2.15    0.27   96.27   1.33      47.060       46.413      236.673
Total         134112   117332     121671    1087670    1460784      114242    2.66    0.20   95.86   1.28      66.320       64.149      304.986
```

APPENDIX 2

NARRATIVE DESCRIPTION OF
IAIS INFRASTRUCTURE ASSESSMENT
AND
DETAILED TABLES ON
INFRASTRUCTURE COSTS

Appendix 2

Narrative Description of IAIS Infrastructure Assessment and Detailed Tables on Infrastructure Costs

Alignment

The preferred route for passenger service begins in Omaha, Nebraska on track owned by either the Burlington Northern Santa Fe Railroad Company (BNSF) or the Union Pacific Railroad Company (UP) crossing the Missouri River into Council Bluffs, Iowa, since the terminus of the Iowa Interstate Railroad (IAIS) is Council Bluffs, Iowa. From Council Bluffs, the alignment follows the IAIS eastward through Iowa near the Interstate 80 corridor. The IAIS crosses the Mississippi River between Davenport, Iowa and Moline, Illinois (Quad Cities) and continues to Wyanet, Illinois. New track connecting the IAIS to the BNSF at Wyanet needs to be constructed. From Wyanet, the passenger service continues to Union Station in Chicago, Illinois.

The infrastructure costs required to improve the IAIS were determined by unit measurement using track charts from *TRACKMAN©* software and unit costs from the Midwest Rail Initiative Study. In order to verify basic assumptions associated with the unit costs and unit measurement used in the calculation of infrastructure costs, a visual engineering review was conducted of two sections of the IAIS from Council Bluffs to Adair and from immediately east of Des Moines to the intersection of the IAIS and U.S. 6 approximately 15 miles east of Iowa City.

Council Bluffs, Iowa to Adair, Iowa

Council Bluffs is a city in western Iowa that adjoins Omaha, Nebraska. The BNSF and the UP have several rail lines that enter the city from the north, west, and east prior to crossing the Missouri River into Omaha. The IAIS enters the city from the west.

The UP crosses 35th Street and Interstate 29 prior to crossing the Missouri River to Omaha. A telecommunication service center of UP is located at the intersection of 35th Street and 14th Avenue. An Ameristar Casino is in the general area of the river crossing and could be considered as a station stop.

The Council Bluffs railroad terminal, located on the west section of the city, appears to be under renovation for conversion to a rail museum. Also in the west section is a series of railroad crossings along 16th Street property in an area owned by Council Bluffs Railroad Company. Passenger service through this area will be at slow speeds due to the activity within the rail yard. The rail yard sits in the north side of the intersection of Interstate 80 and Interstate 29. The BNSF rail yard is near the intersection of Interstate 80 and IA 92.

A visual inspection of the track infrastructure indicates that the bridges over Madison Avenue appear to be in fair to good condition. However, the bridge over Franklin Avenue is a timber structure and must be replaced for to support passenger rail service. An inspection of the track located approximately five miles east of Council Bluffs near the intersection of U.S. 6 with the IAIS revealed the rail, ties, ballast and sub-ballast are in fair to good condition. The rail ties in this area are periodically replaced. A 3-span steel bridge carrying the railroad over U.S. 6 is in excellent condition.

Between the U.S. 6 exit on Interstate 80 and the Madison Avenue exit, a four or five span timber bridge carries the railroad over a creek and a secondary roadway. This structure must be replaced for passenger rail service. The railroad in this area is on embankment and is not prone to any poor drainage conditions.

The IAIS parallels County Road G30 and is on embankment approximately 1/4 mile east of the highway. At the intersection of 320th Street and Magnolia Rd, the IAIS crosses this street approximately 1/4 mile east of the intersection. The crossing is marked only by cross bucks. A timber structure carries the roadway over the railroad. The rail bed is in an area of very poor drainage. The ballast and sub-ballast needs to be upgraded in this area for passenger rail service. IAIS has substantial right of way in this area.

County Road L66 passes over the IAIS. L66 is a two-lane paved highway. The drainage in this area appears to be fair. However, the entire ballast and 66% of the ties must be replaced. This is a single track area. Sufficient right of way exists for construction of sidings.

The crossing of County Road M16 with the IAIS is at-grade designated by signals only. The crossing has poor drainage and 66% tie replacement and installation of full ballast is required for passenger service. In general, the crossing is in poor condition.

In this vicinity, Magnolia Road parallels IAIS. Magnolia Rd is unpaved. Several unpaved streets intersect with Magnolia Road. These streets are carried over the IAIS by timber bridges. These timber bridges are in poor condition and shows signs of washout at the piers. Poor drainage conditions exist along the rail bed between these crossings. However, the IAIS is on embankment in a portion of this area which minimizes the drainage problems. It is estimated that 50% of the roadway is on embankment (minimal drainage problems) and 50% is in a valley (poor drainage conditions).

The crossing of 400th Street and the IAIS is posted with a weight limit of 17 tons. The rail bed in this area has very poor drainage.

The crossing of 410th Street and the IAIS is a timber bridge in poor condition subject to washout at the piers.

The crossings in the City of Hancock are marked only by cross bucks. A siding for a commercial facility is in Hancock. Near the intersection of 450th Street and Mahogany Street (GL30) is another rail siding approximately one mile in length. Inspection of the rail bed indicates that 66% tie replacement with full ballast is necessary. It appears that the ballast in this area is not 12 inches and that there is very minimal sub-ballast. The intersection of 460th Street and the IAIS is marked by cross bucks. 460th Street is an unpaved roadway.The intersection of IAIS with M41 is at-grade. The condition of the crossing is poor.

The Rock Island Terminal in Atlantic is located at the end of the main street. The terminal needs extensive rehabilitation. The location of the terminal is excellent and has sufficient parking. The IAIS is located on the northern edge of Atlantic and has several spurs that access commercial properties. The railroad is double track entering Atlantic. A five span steel bridge crosses the river and a commercial/industrial area. The piers of the bridge have been protected from scouring. However, the piers appear to be in poor condition. This bridge will require replacement or major repairs for passenger rail service.

North of Atlantic U.S. 6 crosses over the IAIS. The IAIS follows State Highway 83 North. Immediately east of Wiota, a 4-span timber bridge with spans of approximately eight feet each carries the railroad over a streambed. This timber bridge is in poor condition and needs to be replaced for 79 mph passenger rail service operation. The rail ties is this area are also in very poor condition.

Immediately east of Wiota is a series of timber culverts that are in very poor condition. These culverts must be replaced for passenger rail service operation. The railroad in this area is higher than the elevation of State Highway 83, which parallels the railroad. However, 66% tie replacement and installation of full ballast is required. The at-grade crossings in this area must be significantly upgraded for passenger rail service operation. Most of the crossings are only protected by cross bucks. Ten miles east of Wiota, the elevation of the railroad is lower than the elevation of the highway. Drainage is very poor. The ballast does not appear to be full depth. The rail ties are in poor condition and most needs to be replaced.

The IAIS continues through the southern section of Oneida. East of Oneida the railroad is elevated approximately five feet above grade. A five span timber structure with a steel center span is located approximately two miles east of Oneida. This structure needs to be upgraded. A six span timber structure located approximately five miles east of Oneida is in fairly poor condition and must be replaced. The rail bed in this area has very poor drainage.

Des Moines, Iowa to east of Iowa City, Iowa

A visual engineering review was undertaken from the east side of Des Moines to the intersection of U.S. 6 with the IAIS approximately fifteen miles east of Iowa City. The IAIS follows the Interstate 80 corridor between Des Moines and Davenport.

The crossing in Altoona consists of flashing signals and gates. The condition of the railroad is fair and requires 66 percent tie replacement and full ballast to permit passenger rail service. The crossing in Mitchellville is flashing lights and is in fair condition. The rail ties are in poor condition and need complete replacement. The track consists of jointed rail at this location.

The IAIS continues south of Interstate 80 and crosses State Highway 117. The railroad continues through the town of Colfax. The crossing has overhead flashers with one lane gates. In the Colfax area, the railroad ties are in very poor shape with poor drainage. The track requires 66 percent tie replacement and full ballast.

The IAIS crosses over U.S. 6/14. The bridge is in excellent condition. The railroad follows the U.S. 6 corridor into downtown Newton. IAIS crosses over U.S. 6 with a low clearance bridge of 14 feet. It is a concrete bridge and appears to be in excellent condition. The railroad parallels 11th

Avenue. The tracks approaching the bridge carrying the railroad over U.S. 6 have new ballast and some new rail ties, although a portion of the ties are in poor condition. Several crossings on side streets in Newton are guarded with flashing lights. The IAIS serves the Maytag Plant in Newton, a community with a population of 16,000. A Marriott Hotel and a Radisson Hotel are located in Newton. The railroad in the Maytag area is in good condition. This area has potential for the location of a new terminal since it has parking and is in proximity to the hotels and the downtown area. However, there is an existing terminal in Newton called the Rock Island Terminal. The rail bed east of the Rock Island Newton Terminal is in very poor condition. Also, the Rock Island Terminal is about ten blocks from downtown Newton and is located near a commercial area. The Rock Island Railroad was double-tracked in this location.

Amana Colony, a tourist area in Iowa, is located east of Newton. The IAIS parallels U.S. 6 and is on embankment. At the intersection of U.S. 151 and U.S. 6 is a timber structure that is in poor condition and must be replaced or substantially upgraded. The ballast is in fair shape. The rail is jointed and the rail ties are in very poor shape. The IAIS crosses U.S. 6 in this area. The crossing is in excellent condition but is only protected by flashing lights. The ties and ballasts for approximately 100 feet on each side of the new crossing are in excellent condition. However, beyond these points the ties are poor and ballast is in poor to fair to fair condition. Timber and surface with 66 percent tie replacement is necessary for passenger rail service operation. Along U.S. 6, there are several local crossings that are only protected by flashers. Several crossings with unpaved roads are only protected by cross bucks without flashers.

A visual review was conducted of the section where the IAIS parallels U.S. 6 immediately west of Iowa City. The track is in poor condition and must be timbered and surfaced with 66 percent tie replacement. Additionally, work will be required on all crossings in the vicinity since the crossing are only protected by cross bucks without flashers. The railroad near the intersection of southeast Deer Creek Road and U.S. 6 in the vicinity of an entrance to an asphalt plant, quarry and a ready-mix concrete plant is in poor condition. The crossing is protected by flashers.

The IAIS continues to parallel U.S. 6 approximately 50 feet to the south. Several culverts, approximately ten foot span, are in very poor condition and will have to be replaced for passenger rail service operation. Although most of the track between Amana Colony and Iowa City is single track, the track entering Iowa City is a double track. The crossing at 10th Avenue is protected by stop signs and cross bucks without flashers. The crossing is in very poor condition and the railroad bed and ties are also in very poor with several of the ties buckled.

Approaching Iowa City, a steel structure carrying the railroad over a stream or river is in poor to fair condition and needs a major upgrade. The railroad continues on the south side of U.S. 6 near the University of Iowa Softball field. The railroad crosses over Second Street. The bridge is in fair condition but needs to be painted and shows signs of lack of maintenance. The railroad is on embankment in this area.

The IAIS crosses U.S. 6 on a major steel bridge structure. Major maintenance work was underway during October, 1997, The bridge was constructed in 1901 for two tracks. However, it is now a one track structure. The bridge carrying the railroad over U.S. 6 also crosses the Iowa River and then continues across another city street. The bridge is in fair condition but requires a major upgrade for passenger rail service.

The IAIS passes through a residential area in the southern section of Iowa City. Therefore, a definite need exists to improve the crossing protection system at all street at-grade crossings. The track is in fair condition since a tie replacement program is underway. The Rock Island Terminal is located along the tracks. If the terminal were to be used to support passenger rail service, major renovation and the construction of an additional parking area would be necessary. The terminal is near a commercial and residential area and is located several blocks from the downtown. A redevelopment area is located within two blocks. The rail yard for the IAIS is within one mile of the terminal.

The intersection of the IAIS and U.S. 6 is only protected with cross bucks and flashing lights. This crossing must be upgraded. The rail ties and ballast are in poor condition. Timber and surfacing with 66 percent tie replacement is required for passenger rail service operations.

Following is the detail on infrastructure improvements for the Conservative scenario for the three routes, and the Moderate improvements by segment for the IAIS.

Route 1 BNSF: Omaha to Chicago via the Burlington Northern Santa Fe			
Scenario	**Conservative**		
Improvements	**Units**	**Unit Cost**	**Total**
		($000)	**($000)**
Omaha to Galesburg (79 MPH)			
Timber & Surface w/33% Tie Replacement	338	120	40,560
Signals	338	125	42,250
Public/Private Crossings Improvement/Elimination	283	50	14,150
Sidings	7	1,224	8,568
High Speed Turnouts	14	498	6,972
Bridge (Under) Minor Upgrade	0	2,000	0
Bridge (Under) Major Upgrade/Replacement	0	50	0
Replace Culverts	0	100	0
Stations [1]	4	500	2,000
Subtotal (from Midwest Regional Study)			114,500
Galesburg to Chicago (90 MPH/110 MPH)			
Signals to Galesburg	5	110	550
Public/Private Crossing Improvements	30	50	1,500
Subtotal			2,050
Total Improvements by Scenario			116,550

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[1] Number of stations requiring renovations based on information from Amtrak.

Route 2 IAIS: Omaha to Des Moines to Chicago via the Iowa Interstate Railroad						
Scenario	**Conservative**			**Moderate**		
Improvements	**Units**	**Unit Cost**	**Total**	**Units**	**Unit Cost**	**Total**
		($000)	**($000)**		**($000)**	**($000)**
Omaha to Des Moines (79 MPH)						
Timber & Surface w/66% Tie Replacement	135	$198	$26,730	135	$198	$26,730
Relay Track w/ 136# CWR	17	280	4,760	17	280	4,760
Signals	135	125	16,875	135	125	16,875
Public/Private Crossings Improvement/ Elimination	130	50	6,500	130	50	6,500
Sidings	2	1,224	2,448	2	1,224	2,448
High Speed Turnouts	4	498	1,992	4	498	1,992
Bridge (Under) Minor Upgrade	16	100	1,600	16	100	1,600
Bridge (Under) Major Upgrade/Replacement	4	2,000	8,000	4	2,000	8,000
Replace Culverts	10	100	1,000	10	100	1,000
Terminal Atlantic	1	500	500	1	500	500
Subtotal			70,405			70,405
Des Moines to Quad Cities (79 MPH)						
Timber & Surface w/66% Tie Replacement	175	198	34,650	175	198	34,650
Relay Track w/136# CWR	37	280	10,360	37	280	10,360
Signals	175	125	21,875	175	125	21,875
Public/Private Crossings Improvement/ Elimination	251	50	12,550	251	50	12,550
Sidings	2	1,224	2,448	2	1,224	2,448
High Speed Turnout	4	498	1,992	4	498	1,992
Bridge (Under) Minor Upgrade	22	100	2,200	22	100	2,200
Bridge (Under) Major Upgrade/Replacement	3	500	1,500	3	500	1,500
Mississippi River Arsenal Bridge	1	5,000	5,000	1	5,000	5,000
Replace Culverts	10	100	1,000	10	100	1,000
Terminal Des Moines	1	1,000	1,000	1	1,000	1,000
Stations Newton, Iowa Cities	2	500	1,000	2	500	1,000
Maintenance Facilities	1	2,000	2,000	1	2,000	2,000
Subtotal			97,575			97,575

Scenario	Conservative			Moderate		
Improvements	**Units**	**Unit Cost**	**Total**	**Units**	**Unit Cost**	**Total**
		($000)	**($000)**		**($000)**	**($000)**
Quad Cities to Wyanet (79 MPH)						
Timber & Surface w/66% Tie Replacement	55	198	10,890	55	198	10,890
Signals	55	125	6,875	55	125	6,875
Public/Private Crossing Improvement/Elimination	56	50	2,800	56	50	2,800
Sidings	1	1,224	1,224	1	1,224	1,224
High Speed Turnout	2	498	996	2	498	996
Bridge (Under) Minor Upgrade	5	100	500	5	100	500
Connecting Track Wyanet IDOT 92 Study	1	3,289	3,289	1	3,289	3,289
Replace Culverts	5	100	500	5	100	500
Terminal Quad Cities	1	500	500	1	500	500
Subtotal			27,574			27,574
Wyanet to Chicago (79/110 MPH)						
Track Right of Way Improvements				122	500	61,000
Signals Union Station to Wyanet	4	110	440	4	110	440
Public/Private Crossing Improvements	25	50	1,250			
Sidings				2	1,224	2,448
High Speed Turnouts				4	498	1,992
Stations [2]				5	500	2,500
Subtotal			1,690			68,380
Total Improvements by Scenario			197,244			263,934
Less Wyanet to Chicago			1,690			68,380
Omaha to Wyanet			195,554			195,554

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[2] Per Illinois DOT, no stations were to be renovated under the Conservative Scenario.

Route 3 UP: Omaha to Des Moines to Chicago via the Union Pacific			
November 24, 1997			
Scenario	**Conservative**		
Improvements	**Units**	**Unit Cost**	**Total**
		($000)	**($000)**
Omaha to Mississippi River (79 MPH)			
Timber & Surface w/33% Tie Replacement	0	$120	$0
Construct HSR Main on Existing Roadbed	200	780	156,000
Construct HSR Main on New Roadbed	144	850	122,400
Signals	344	125	43,000
Public/Private Crossings Improvement/Elimination	280	50	14,000
Sidings	7	1,224	8,568
High Speed Turnouts	14	498	6,972
Bridge (Under) Minor Upgrade	94	200	18,800
Bridge (Under) Major Upgrade/Replacement	2	2,000	4,000
Extend Culverts	10	100	1,000
Stations	5	500	2,500
Subtotal			377,240
Mississippi River to Chicago (79 MPH)			
Timber & Surface w/33% Tie Replacement	37	120	4,440
Construct HSR Main on Existing Roadbed	71	780	55,380
Construct HSR Main on New Roadbed	27	850	22,950
Signals	115	125	14,375
Public/Private Crossings Improvement/Elimination	150	50	7,500
Sidings	1	1,224	1,224
High Speed Turnouts	2	498	996
Bridge (Under) Minor Upgrade	98	200	19,600
Bridge (Under) Major Upgrade/Replacement	4	2,000	8,000
Extend Culverts	10	100	1,000
Stations	4	500	2,000
Subtotal			137,465
Total Improvements by Scenario			$514,705