EAST CENTRAL IOWA COMMUTER RAIL FEASIBILITY STUDY

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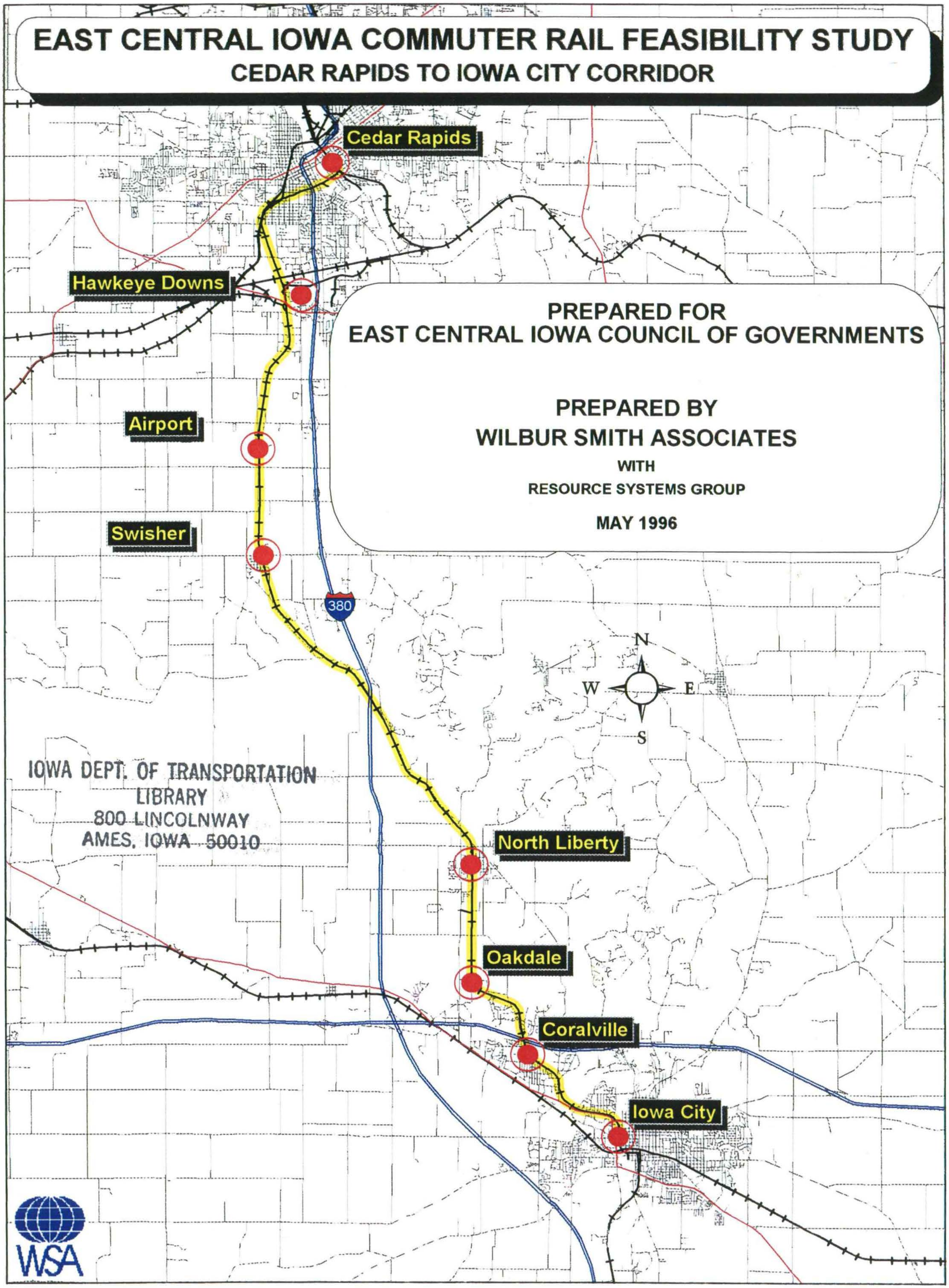

PREPARED FOR
EAST CENTRAL IOWA COUNCIL OF GOVERNMENTS

PREPARED BY
WILBUR SMITH ASSOCIATES
WITH
RESOURCE SYSTEMS GROUP

MAY 1996

WSA

FINAL REPORT

EAST CENTRAL IOWA COMMUTER RAIL FEASIBILITY STUDY

East Central Iowa Council of Governments

Submitted By:

WILBUR SMITH ASSOCIATES

with

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May 10, 1996

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The *East Central Iowa Commuter Rail Feasibility Study* focused on examining the reasonableness of restoring rail passenger service in the Cedar Rapids to Iowa City transportation corridor on the Cedar Rapids and Iowa City Railway (CRANDIC). The study was a collaborative undertaking of the East Central Iowa Council of Governments (ECICOG); Johnson County Council of Governments (JCCOG); Linn County Regional Planning Commission (LCRPC); Five Season's Transit in Cedar Rapids; and the cities of Coralville, Iowa City and the University of Iowa. This study was financed by an appropriation from the state's General Fund by the Iowa General Assembly under Senate File 2217. The legislative enactment requires a detailed passenger ridership analysis be conducted and a comprehensive list of capital requirements and estimated costs be developed in conjunction with the ridership analysis.

INTRODUCTION

Rail passenger service had been provided by the CRANDIC electric interurban railway continuously from October 2, 1904 until May 30, 1953. The restoration of rail passenger service in the CRANDIC corridor is one of several public transportation improvement programs currently under study by the ECICOG as part of its long range transportation improvement planning process. The impetus for the study came from suggestions by citizens interested in possible commuter rail service in the corridor.

OBJECTIVES

The Iowa General Assembly under Senate File 2217 directed that a detailed, comprehensive and objective analysis of the restoration of rail passenger service in the CRANDIC corridor be accomplished. The objectives of the *East Central Iowa Regional Rail Feasibility Study* are to:

- Determine demand for commuter rail service in the Cedar Rapids to Iowa City corridor and detail the expense of establishing service.
- Determine the benefits and costs of establishing and operating commuter rail service in the corridor using the CRANDIC Railway.
- Determine how the service would help meet the economic development and transportation objectives of the region.
- Determine what capital facilities are required to establish commuter rail service using the existing CRANDIC rail line.

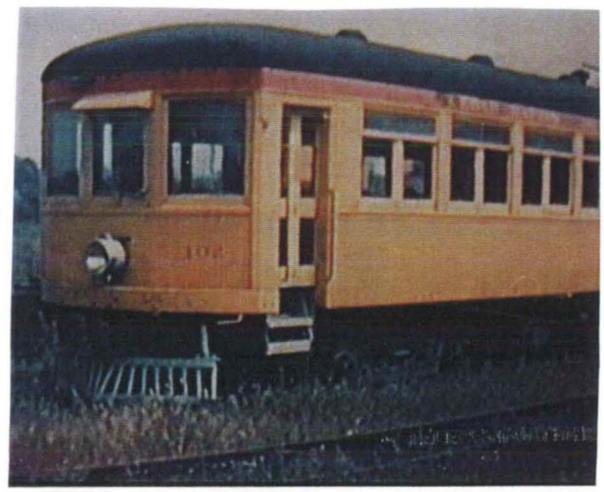
- Determine what technologies are available to assist with the provision of commuter rail service.
- Address the applicability of the proposed commuter rail service and identify alternatives to the proposal.

STUDY PURPOSE

The primary purpose of this study is to determine the viability of rail passenger service in the CRANDIC corridor.

HISTORICAL PERSPECTIVE

The CRANDIC provided interurban rail passenger service between its two namesake cities continuously from October 2, 1904 to May 30, 1953. When service began in 1904, the CRANDIC operated 13 daily round trips. The scheduled running time for the trip from Cedar Rapids to Iowa City was 75 minutes. The CRANDIC carried 554,306 annual riders in 1920 and continued to grow through the 1920's. Service and ridership on the line began to decline during the Great Depression. By 1932 schedules were cut to only 8 round trips daily. Service and ridership increased as the national economy improved. However, even as early as 1939, the automobile had already begun cutting into ridership and becoming the preferred mode of travel of Americans everywhere. Most interurban railways in other parts of the country were abandoned by 1939. Ridership on the CRANDIC had sunk below 200,000 annually by 1940. Gas rationing, rubber shortages and patriotism curtailed the use of automobiles during the war years. From 1940 to 1943, ridership increased from 442 average daily riders to over 1,061 in 1943. The CRANDIC transported more than 573,000 passengers in 1945, the highest total annual ridership in its entire history, and operated hourly service with 16 daily round trips. Annual ridership plummeted from its peak in 1945 to 30,000 in 1950. This amounted to only 90 passengers on an average weekday. The CRANDIC last ran passenger service on May 30, 1953. Many of the CRANDIC interurban railway passenger cars still carry passengers at trolley museums throughout the United States.



EXISTING RAIL INFRASTRUCTURE

Today the CRANDIC is a prosperous short line freight railroad owned by IES Industries. The subdivision of the CRANDIC under study still provides freight train service from Cedar Rapids to Iowa City operating one train per day, generally at night. The remaining heavy freight activity is industrial switching near the CRANDIC yards in Cedar Rapids. A physical inspection of the right-of-way revealed that the existing track structure cannot support passenger train service at speeds required to provide service schedules competitive with automobile travel times on the parallel I-380 freeway. The track would have to be upgraded to FRA Class 4 design standards permitting speeds up to 80 mph. Installation of centralized train control and improved grade crossing protection adds to the cost of right-of-way improvements.

STATIONS

In addition to the terminal stations in Cedar Rapids and Iowa City, six intermediate stations would have to be constructed. These stations would be located near Hawkeye Downs, the Cedar Rapids Municipal Airport, Swisher, North Liberty, Oakdale, and Coralville.

ALTERNATIVES ANALYSIS

Based on a comprehensive review of several alignments and operating options, two rail and one express bus alternatives were selected for further financial feasibility analysis:

- **Primary Rail Alternative** - The option selected as being the most competitive with automobile travel times would begin immediately across the street from the Cedar Rapids Ground Transportation Center (GTC) and would be connected by pedestrian bridge. The terminal structure would require the adaptive reuse of existing historic structures on the east bank of the Cedar River. From here the alignment would extend west across a new bridge and new tracks constructed in a boulevard median of a reconstructed 4th Avenue SW to the Union Pacific right-of-way and then south to the CRANDIC junction. The alignment then would extend south along the existing CRANDIC right-of-way to downtown Iowa City terminating at the renovated CRANDIC station 2½ blocks from the Iowa City Transit Mall. The distance of this alignment is 27.1 miles and the scheduled running time between the terminal stations is 32 minutes.

- **Secondary Rail Alternative** - Under this option, the rail passenger service would begin near the site of the former Union Depot across from Green Park. The terminal station would be a simple platform, shelter and suitable landscaping. From here, the alignment runs north along the Union Pacific right-of-way through the Quaker Oats plant and then westbound across the existing bridge spanning the Cedar River. The alignment turns south on the west bank of the river and follows the existing Union Pacific right-of-way to the junction with the CRANDIC at Wilson Avenue. The alignment follows the CRANDIC right-of-way south to downtown Iowa City exactly like the Primary Rail Alternative and utilizes the same stations. The route is 28 miles long and requires 48 minutes of scheduled running time.

■ Express Bus Alternative - This option was evaluated as the only reasonable alternative to rail passenger service in the corridor. The terminal station in Cedar Rapids is the GTC. The terminal station in Iowa City would be the existing intercity bus depot located 4 blocks from the Iowa City Transit Mall. This alternative follows the same route between Cedar Rapids and Iowa City as existing Greyhound and Burlington Trailways buses. This is a 26 mile non-stop route utilizing I-380 for most of the distance. The scheduled running time for the express bus option is 35 minutes.

SUMMARY OF FINDINGS

The decision to restore rail passenger service in the CRANDIC corridor is difficult to justify on economic grounds when confronted with the major findings of this feasibility study.

The decision ultimately rests with the people of East Central Iowa and the public officials elected to represent them. The decision must be made based on what they believe to be is in the best long-term interest of the region and its residents. The decision should consider the following major findings of the feasibility study:

■ **Regional Population** - Linn and Johnson Counties combined have a total population of 264,886 people. The population in the region has been growing at an annual rate of 1 percent. The smallest urbanized area in the United States with rail transit service has a population of 1 million. It will take over 143 years for the population in the region to grow to 1 million people.

■ **Transportation Corridor Population** - The population of the transportation corridor is more relevant than the aggregate population of the region. The market potential for transportation service is defined by the geographic location of the route and stations. The land use and population density adjacent to the rail line defines the total market potential for a corridor. The CRANDIC corridor connects its two namesake cities with a combined urbanized population of 170,972. The balance of the corridor can be characterized as rural. The total population living within a two mile distance from the center line of the CRANDIC rail line is 139,000.

■ **Station Area Population** - The population in a transportation corridor is relevant only to the extent that those people live (and work or go to school etc.) within reasonable access and egress distance from rail stations. For purposes of the ridership forecast, the walking distance was assumed to be ½ mile and the reasonable driving distance was assumed to be 3-miles from the station. This would maximize ridership potential from each station location. The total population living within the combined station influence areas in the corridor is 157,400. This is extremely low. In Singapore, for example, there are over 300,000 people living within ¼ mile walking distance of each of the Metro Rail stations.

■ **Rail Passenger Service Options** - The CRANDIC Railway is parallel to I-380. Motorists can travel between Cedar Rapids and Iowa City in the relative comfort of an air conditioned automobile at speeds of between 55 and 65 mph. The average motorist can travel the 26 miles between the two cities in less than 30 minutes. Intercity bus service in the corridor has a scheduled running time of 35 minutes. Rail passenger service schedules must compete with this travel time. To upgrade the CRANDIC right-of-way to FRA Class 4 track and construct the infrastructure needed to support a scheduled running time of 35 minutes would require a capital expenditure of over $ 84 million. This includes the purchase of 5 trainsets capable of operating the schedule. Each trainset is valued at $ 3.5 million. This capital investment dictates that service levels must be relatively high in order to attract as many riders as possible from the limited market influence areas in the corridor. Passenger train schedules were developed with 20 minute peak hour and 40 minute off-peak service frequency. The cost of operating this train schedule would amount to over $ 6.4 million annually.

■ **Highway Congestion** - An analysis of highway travel demand in the I-380 corridor revealed that daily vehicle miles travelled (DMVT) per lane-mile is 5,941 which is less than half of the undesirable congestion index of 13,000 DMVT per lane-mile. Further analysis based upon the Avenue of the Saints transportation model indicated that future growth in DMVT per lane-mile would not reach the undesirable 13,000 threshold until the year 2030. Highway traffic counts conducted specifically for this study further revealed that current passenger automobile traffic volume on I-380 generated by people living in Linn and Johnson County account for only 30 percent of the total volume on the freeway. The balance of the traffic volume is generated by truck traffic and automobiles from outside the CRANDIC corridor. The future growth in traffic volume and possible congestion that could occur on I-380 emanates from households outside the market influence area of the rail line.

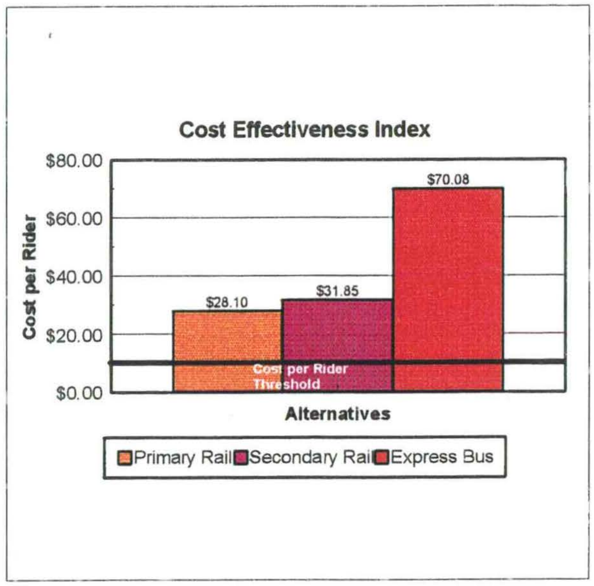
■ **CRANDIC Rail Passenger Ridership: Forecasted** - Rail passenger demand forecasts are based upon the transportation models developed by Linn and Johnson Counties. The transportation planning models for each county had to be modified to account for intercounty trip origins and destinations. U.S. Census Bureau journey-to-work data supplemented by origin-destination travel surveys conducted specifically for this feasibility study were utilized to develop synthetic trip tables by traffic analysis zones (TAZ). In addition to this data, the residence addresses of the student population registered at Kirkwood Community College and the University of Iowa were input into the population data base and special trip generator tables for journey-to-school trips were developed by TAZ. A nested logit model previously developed by utilizing stated preference survey data for another commuter rail study with characteristics similar to the CRANDIC corridor was modified to fit the local travel demand conditions. A nested logit model is a sophisticated mathematical technique used to determine the probability of people making mode choices based upon a given set of variables. The application of this model resulted in preliminary ridership estimates for the Primary, Secondary and Express Bus Alternatives:

Primary	1,670 daily riders
Secondary	1,336
Express Bus	100

The annualized ridership is:

Primary	447,328 annual riders
Secondary	357,862
Express Bus	30,000

- **Cost Effectiveness Indices** - The Federal Transit Administration has established threshold values of the cost per new rider index that would need to be met for a proposed project to continue receiving federal financial support through the various stages of the federally mandated planning process. To progress from systems level planning to the "major investment study" phase, the preliminary estimate of the cost per new rider must be less than $10; to move from alternatives analysis to preliminary engineering, the estimated cost per new rider can not exceed $6. None of the alternatives satisfy the reasonableness indices criteria.



- **Funding Options** - A 1 percent sales tax would generate sufficient revenue to support local initiatives to restore rail passenger service in the CRANDIC corridor.

CONCLUSIONS

The *East Central Iowa Commuter Rail Feasibility Study* has found very low ridership potential in the corridor to support restoration of a high speed interurban rail passenger service that would be competitive with automobile travel times.

At population growth rates currently being experienced in the region, it would take 111 to 143 years before Linn and Johnson Counties could achieve the level of urbanization marginally required to support urban rail passenger service. Expected growth in traffic volumes on I-380 will not produce undesirable measures of congestion until the year 2030. Even then, the congestion would result from traffic generated by travel demand outside the rail passenger station influence areas. Only 30 percent of traffic on I-380 comes from passenger automobiles registered to people in the two county area. The balance of the traffic is generated by trucks and by cars from outside the two county area.

The East Central Iowa commuter rail service in the CRANDIC corridor fails to hurdle generally accepted marginal thresholds of economic reasonableness. The capital costs are extremely high, the ridership is very low and the requirements for annualized public subsidy is nearly double the total operating expenses of all the other regional public transit providers combined.

High capacity interurban rail passenger service between Cedar Rapids and Iowa City on the CRANDIC Railway is an idea whose time has long since past and has not yet come again. The taxpayers of Linn and Johnson County should not resurrect interurban rail service in the CRANDIC corridor in the intermediate future.

RECOMMENDATIONS

1) Further consideration of resurrecting rail passenger service discontinued by the CRANDIC Railway in 1953 is not justified now or in the foreseeable future. No further study of the entire CRANDIC corridor is recommended.

2) The existing right-of-way has intrinsic value as a transportation corridor. Public sentiment in the region to preserve the CRANDIC right-of-way for future transportation uses should be acknowledged. The right-of-way should be preserved for continued rail freight service or future alternate transportation modes if the CRANDIC decides to abandon the Iowa City subdivision. Preservation of the corridor for recreational uses such as hiking and bicycle trails should be considered in long range transportation plans for Linn and Johnson County.

3) The ridership analysis found evidence that a smaller segment of the corridor (North Liberty to Iowa City) could be an emergent market for medium capacity rail transit service. Vintage trolley service is a medium capacity transit operation that could serve this emergent market. Perhaps limited rail passenger service in this short segment of the corridor would be feasible. A vintage trolley operation also would be a marvelous tourist attraction adding to the economic development potential of the region

4) The development of a vintage trolley service in East Central Iowa is worth studying. In fact, another vintage trolley service could operate from Cedar Rapids to the Amana Colonies as a tourist line along a different route alignment. The economic development potential and tourist appeal of these operations should be examined.

5) Because growth and development patterns change, ECICOG should consider examining rail passenger and interurban bus service options on a regular basis as a part of their long range planning process. It is recommended that the CRANDIC corridor be examined after the next census in the year 2000.

Section 1

INTRODUCTION

Section 1
INTRODUCTION

This report documents the findings of a study to determine the feasibility of restoring rail passenger service on the Cedar Rapids and Iowa City Railway (CRANDIC). The CRANDIC links its two namesake cities located at opposite ends of a 26 mile travel corridor. The study was a collaborative undertaking of the East Central Iowa Council of Governments (ECICOG); Johnson County Council of Governments (JCCOG); Linn County Regional Planning Commission (LCRPC); Five Season's Transit in Cedar Rapids; and the cities of Coralville, Iowa City and the University of Iowa.

Rail passenger service had operated in this corridor as an electric interurban railway continuously from October 2, 1904, until May 30, 1953. The restoration of rail passenger service in the CRANDIC corridor is one of several public transportation improvement programs currently under study by the ECICOG as part of its long range transportation improvement planning process. This study was financed by an appropriation from the state's General Fund by the Iowa General Assembly under Senate File 2217. The legislation requires that the feasibility study evaluate the potential benefits of the development of passenger rail service in the CRANDIC corridor. The legislative enactment also requires a detailed passenger ridership analysis be conducted and a comprehensive list of capital requirements and estimated costs be developed in conjunction with the ridership analysis.

The balance of this introductory section describes the objectives and purpose of the feasibility study and outlines several study issues and assumptions. This is followed by other sections of the study which describe the historical context of the planning effort, baseline demographic characteristics, existing transportation infrastructure, the conditions and improvements required of the railroad infrastructure, technology options, ridership projections, operating plans, financial assessments, funding options and measures of reasonableness. The study concludes with a discussion of the major findings and recommendations for the CRANDIC corridor.

OBJECTIVES AND PURPOSE

The Cedar Rapids and Iowa City Railway abandoned rail passenger service on May 30, 1953. The railroad abandoned rail passenger service because of declining ridership and increased costs. There has been growing sentiment in the community to examine the feasibility of restoring rail passenger service in this corridor as an alternate to increasing the capacity of the parallel interstate highway. In response to this growing public interest, the Iowa Department of Transportation was required to prepare an interim report on the feasibility of restoring limited rail passenger service in the CRANDIC corridor. The Iowa DOT issued its interim report to the Iowa General Assembly on Section 49 of Senate File 2403 in 1991. The Iowa DOT interim report was criticized by advocates for the restoration of rail passenger service as being inconclusive. It was acknowledged that a more detailed analysis of costs, benefits and patronage might be more conclusive and result in a different conclusion.

Objectives

The Iowa General Assembly under Senate File 2217 directed that a more detailed, comprehensive and objective analysis of the restoration of rail passenger service in the CRANDIC corridor be accomplished. The objectives of the *East Central Iowa Regional Rail Feasibility Study* are to:

- Determine demand for rail passenger service in the Cedar Rapids to Iowa City corridor and detail the expense of establishing service;
- Determine the benefits and costs of establishing and operating rail passenger service in the corridor using the CRANDIC Railway;
- Determine how the service would help meet the economic development and transportation objectives of the region;
- Determine what capital facilities that would be required to establish rail passenger service using the existing CRANDIC rail line;
- Determine what technologies are available to assist with the provision of rail passenger service; and,
- Address the applicability of the proposed rail passenger service and identify alternatives to the proposal.

Study Purpose

The primary purpose of this study is to determine the viability of rail passenger service in the CRANDIC corridor based upon an objective evaluation of whether the estimated ridership is sufficient to satisfy measures of economic reasonableness. In order to determine whether it is feasible to establish rail passenger service in the Cedar Rapids to Iowa City corridor, it is necessary to determine the demand for such a service and assess whether the benefits of the service outweigh the costs of establishing and operating a regional rail passenger line. Some of these ancillary benefits could possibly include:

- Reduced congestion on I-380;
- Alternate transportation for special events;
- Alternate ground transportation access to Cedar Rapids Municipal Airport;
- Reduced air pollution;
- Reduced dependence on the automobile for regional mobility;
- Enhanced development of a regional public transportation system;
- Enhanced intermodal passenger connectivity throughout the region; and,
- Preservation of a transportation corridor right-of-way.

STUDY ISSUES

The feasibility assessment of restoring rail passenger service on the CRANDIC Railway involves a series of investigations regarding the suitability of the existing rail line to support passenger train operation. An array of alternative rail service options must be analyzed and compared. This includes an investigation of conflicts with freight railroad operations on a privately-owned right-of-way, train operating concepts, technology options and equipment needs.

Existing Freight Operations

The CRANDIC Railway has continued its profitable freight operations since the abandonment of rail passenger service in 1953. The major issue to be examined and resolved is the conflicts the passenger schedules may pose for freight operations in the corridor. Trackage rights, liability and other corollary issues are often major impediments to the introduction of passenger train traffic on freight railroad rights-of-way. These issues must be discussed and analyzed in concert with the host railroad.

Passenger Train Operations

Passenger trains usually operate at higher speeds than freight trains. These operating conditions alter design standards and maintenance practices for track, signals and grade crossing protection to satisfy regulations promulgated by the Federal Railroad Administration (FRA). The FRA requires different design standards, levels of inspection and maintenance depending on the speed of train operation. Track designed to permit 79 mph passenger train speeds (FRA Class 4 track) requires higher levels of maintenance and inspection than FRA Class 3 track designed to permit 59 mph passenger train speeds. Moreover, operating at a speed of 79 mph dictates that more positive train control systems be in place to address safety considerations. Timetables and speed options have to be examined relative to the capital cost of upgrading the existing track to support passenger train operations and the operating costs related to operating fast or slow schedules. The relative impact of these schedules on the placement of passing sidings and ridership also has to be analyzed.

Technology Options

The CRANDIC originally was an electric interurban railway. After passenger service was discontinued, the CRANDIC commissioned a study to determine the optimum motive power for the freight operations. The 1953 study determined that the railroad could save $100,000 per year (1953 dollars) if freight operations were converted from electric to diesel-electric motive power. In October 1953, the electric power distribution system was dismantled and the railroad converted to 100 percent diesel operation. However, because of the advantages offered by today's modern electric powered equipment, this study examined both diesel and electric propulsion options for passenger service. After analyzing operating scenarios, the equipment needs of the contemplated service can be determined.

STUDY ASSUMPTIONS

To guide the analyses and evaluations certain assumptions had to be made. These assumptions are briefly noted:

- This study examined a low cost means of restoring rail passenger service on existing right-of-way. The study examined new track alignments only in the segment of the corridor where conflicts with existing freight train movements were the greatest.
- It was assumed that the host railroad would be willing to consider sharing its right-of-way with a passenger service operator and might be interested in being a contracted service provider.
- The study examined single track operations with passing sidings as needed.
- The ridership analysis would be based on regional transportation models developed by Linn and Johnson Counties modified for regional rail passenger forecasting utilizing U.S. Census Bureau journey-to-work data and the ridership forecasting methodology presented in the Interim Report dated June 19, 1995.

- The estimations for capital and operating costs would be based on generally accepted planning level order-of-magnitude techniques and methodology.

- The running time calculations and envisaged schedules assumed that local municipalities will not impose restrictions on train speeds below the effective speed limits of the train performance models.

- Fares and parking fees will be consistent with existing practices and policies in the region.

- Local bus systems will adjust and revise routes and schedules to provide reasonable feeder bus services. Feeder bus service will not be considered as a rail system cost.

Section 2

HISTORICAL PERSPECTIVE

Section 2
HISTORICAL PERSPECTIVE

This section describes the broad trends that affect public transportation demand in general and provides historical reference points for understanding the ridership forecasts and feasibility assessments presented in following sections of the study. In addition, it discusses the trends affecting rail passenger and intercity bus service throughout the United States and presents a brief history of the CRANDIC passenger service including ridership trends before, during and after World War II.

> "Study the past if you would divine the future."
>
> \- Confucius

PUBLIC TRANSPORTATION

After the end of the Second World War, the United States experienced unparalleled economic growth and prosperity. Factories were converted from war time production to consumer durables to satisfy pent up demand for such products. Europe and Japan needed to be rebuilt and the Marshall Plan created added demand for industrial products and services. American factories were busy and average real disposable household incomes continued to rise during this period. As disposable incomes rose, people could afford automobiles. In 1945, there were only 25.7 million automobiles registered in the United States. By 1955, this figure had doubled to 51.9 million. Today there are over 145.7 million automobiles registered in the United States.[1] In 1969 just under 80 percent of all American households owned at least one automobile. By 1990 that figure was up to almost 91 percent, with nearly 58 percent of households owning more than one car.[2]

With the advances in automotive engineering and improvements in the highway network, interurban travel became more comfortable and travel times were significantly reduced for automobile trips. Over 43,000 miles of interstate highways have been constructed. Consequently, rail passenger and intercity bus ridership have continued to decline as a percentage of the total commercial travel market. Travel market share for commercial carriers between 1945 and 1992 is outlined in Table 2-1.

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[1] *Highway Statistics*, United States Department of Transportation, Federal Highway Administration

[2] *1990 Census of the United States*; United States Bureau of the Census

Table 2-1

Intercity Travel Market Share
Commercial Carriers
(percentage)

Year	Air	Bus	Rail
1945	3.4	21.9	74.7
1950	14.4	35.2	50.4
1955	29.6	30.5	39.9
1960	43.7	26.5	29.8
1965	56.5	25.0	18.5
1970	75.2	17.3	7.5
1975	79.4	14.7	5.9
1980	84.2	11.3	4.5
1985	88.8	7.6	3.6
1990	90.5	6.0	3.5
1991	90.1	6.3	3.6
1992	91.0	6.0	3.0

Source: Association of American Railroads, Interstate Commerce Commission, Eno Foundation

Rail Passenger Service

Most interurban railroads were abandoned by 1939. By the start of the Second World War only a small percentage of the once flourishing interurban systems continued in operation. The Class I railroads also suffered passenger losses during the Great Depression; but, were able to off-set passenger losses with growing freight revenue. By the start of the war, ridership had once again increased. For example, rail passenger ridership fell from 780 million passengers in 1929 to 450 million in 1939. During the war, rail passenger ridership grew to over 910 million passengers annually by 1944. Ridership fell from the peak war years to just over 703 million by 1947. By 1955, rail passenger ridership was less than 432 million.

From 1945 to the creation of the National Railroad Passenger Corporation (Amtrak) in 1971, the Class I railroads lost a considerable amount of money on passenger service despite heavy investment in new equipment after the end of World War II. Between 1946 and 1958, over $1.3 billion was invested in new passenger train equipment. The American railroads *gambled on the traveling public and lost...the public abandoned the railroads and for perfectly understandable reasons: bigger and better highways, the flexibility and comfort of the family automobile and the speed of commercial airliners.*[3] Class I passenger railroads carried over 117 million intercity rail passengers in 1962. By 1992, Amtrak carried a little over 22 million intercity passengers. This is an 81 percent decline in intercity rail passenger ridership over the 30 year period and a 98 percent decline since 1945. [4]

Intercity Bus Service

Unlike rail passenger service, bus ridership actually increased between 1945 and 1966. This trend was due in large measure to improvements in bus technology, improvements in highway infrastructure and the discontinuance of railroad passenger service in many small towns served by the bus industry. Bus ridership peaked in 1966 at about 180 million passengers. In 1966, bus ridership began its decline. By 1990, ridership had declined to just under 40 million.[5] This represents a 78 percent decline in ridership since 1966. This decline can be traced to a number of factors including the introduction of 43,000 miles of interstate highways nationally, the ascendancy of the automobile as the mode of choice for most intercity travel, increasing competition from regional airlines and increasing industry operating costs.

Throughout the 1970's and 1980's service reductions and route abandonments marked the declining ridership trends of the industry. Nationally, the intercity bus system was downsized from a route system that served over 16,000 cities and towns in 1965 to fewer than 6,000 today.[6] Iowa did not escape these trends and changes in intercity bus service. Service frequencies and route miles were reduced.

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[3] Goodfellow, Thomas M., President of the Association of American Railroads, remarks to the Subcommittee on Surface Transportation of the Senate Commerce Committee; Washington, DC; September 23, 1969

[4] *Annual Report*; National Railroad Passenger Corporation (Amtrak); *Annual Report;* Association of American Railroads

[5] *Fact Book*, American Bus Association; Washington, DC

[6] American Bus Association, ibid

The CRANDIC

Unique among the interurban passenger railways of the Midwest were the short line interurban railways in Iowa. Some of these interurban railways were developed as connectors to the transcontinental railroads that traversed the State. These short lines developed cordial relationships with the major Class I railroads. This permitted the free interchange of carload freight traffic which allowed many of these short lines to survive financially. Many of these short lines still exist and continue to operate freight only service. Almost half of these lines operated passenger service well after World War II. The CRANDIC continues to be one of the most prosperous of all the Iowa interurban railroads.

The CRANDIC provided interurban rail passenger service between its two namesake cities continuously from October 2, 1904, to May 30, 1953. When service began in 1904, the CRANDIC operated 13 daily round trips. The scheduled running time for the trip from Cedar Rapids to Iowa City was 75 minutes. Service and ridership on the line continued to grow through the 1920's. The CRANDIC carried 554,306 annual riders in 1920. In 1926, 16 daily round trips were scheduled providing service every hour. The CRANDIC operated connecting motor bus service running between Chicago, Omaha and Denver.

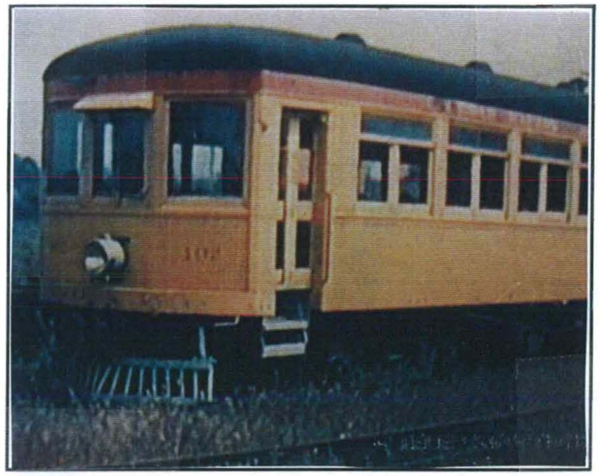

Exhibit 2-1 Original CRANDIC Interurban Railway Car, Circa 1904

Interurban rail passenger service declined during the Great Depression. By 1932 schedules were cut to only 8 round trips daily. Service and ridership increased as the national economy improved. By 1937, 10 round trips were being scheduled. To bolster ridership, the CRANDIC purchased 6 interurban railway cars from the former Cincinnati and Lake Erie Railroad in 1938. These cars were the famous lightweight "Red Devils" manufactured by the Cincinnati Car Company in 1930 that raced an airplane during a 1932 publicity stunt in the waning days of interurban service in Ohio. However, as in other parts of the country, the automobile had already begun cutting into ridership and was becoming the preferred mode of travel in the corridor.

Ridership had sunk below 200,000 annually by 1940. However, like most other public transportation operators, passenger ridership peaked during World War II. Gas rationing, rubber shortages and patriotism curtailed the use of automobiles during the war years. From 1940 to 1943, ridership increased from 442 average daily riders to over 1,061 in 1943. The CRANDIC transported more than 573,000 passengers in 1945, the highest total annual ridership in its entire history, and operated hourly service with 16 daily round trips.

Between 1945 and 1950 ridership again declined. In 1950 the total passengers carried on CRANDIC trains dropped to 30,000 from its peak in 1945. This is an incredible 95 percent decrease in ridership which amounted to only 90 passengers on an average weekday. In July 1952, the service was cut to 6 daily round trips and was reduced to 2 round trips in November. When it was finally time to replace the ancient passenger equipment and upgrade the electrical distribution system, passenger service was discontinued and the CRANDIC railway converted its remaining freight operation to diesel motive power. The CRANDIC last ran passenger service on May 30, 1953. Over 300 people were issued a souvenir for the occasion. Although the CRANDIC no longer operates passenger service, the CRANDIC interurban railway passenger cars still carry passengers at trolley museums throughout the United States.

Exhibit 2-2 CRANDIC "Comet", Circa 1950

Today the CRANDIC is a prosperous short line freight railroad owned by Iowa Electric (IES Industries). The subdivision of the CRANDIC under study still provides freight train service from Cedar Rapids to Iowa City operating one train per day, generally at night. The remaining heavy freight activity is industrial switching near the CRANDIC yards in Cedar Rapids. Section 5 outlines in more specific detail the existing freight operations.

FACTORS AFFECTING PUBLIC TRANSPORTATION DEMAND

Planning for a new public transportation service must begin with an estimate of total patronage. This is accomplished by examining total travel demand in the region and disaggregating this data by mode share. This data is then presented as current and future passenger boardings. Many factors affect demand for commercial transportation services. These factors include population and income growth, highway traffic congestion, gasoline prices and other public transportation system investments. Service related factors also affect demand. These service related factors include frequency of service, convenience of departure times, system accessibility, travel time, schedule reliability, marketing and fare policy.

Intercity Bus Demand

The demand for intercity bus service is a function of total trip demand for the routes operated by the bus carriers. An area's need for and ability to support any intercity public transportation service depends partly on the size and distribution of its population and partly on transportation need characteristics of that population. The transportation need factor affecting demand for intercity bus service are income, availability of a personal automobile, age and employment status.[7] Surveys of Greyhound passengers reveal that riders include all income and age groups, but the elderly, military and student populations are highly represented in the survey data distribution. The existence of a large university or military base creates favorable market conditions for intercity bus service in a region. The University of Iowa in Iowa City with 27,000 students coming from nearly every community in Iowa creates a large market area to draw upon. Although this market is large, the mode share for intercity bus service has been deteriorating since 1965.

However, the CRANDIC corridor is an interurban corridor with travel demand more similar to long distance local transit service. Commuter bus service in many parts of the country now exceeds 11 miles on average.[8]

Local Transit Demand

Over 65 percent of transit trips are for journey-to-work or journey-to-school trip purposes with travel occurring during the morning and evening peak hours.[9] Feeder bus service to urban rapid transit and commuter rail stations is quite high in those markets that utilize extensive feeder bus networks.

However, empirical evidence suggests that local transit is not a significant mode of access to either rail passenger or intercity bus stations. Access to Amtrak stations by transit service ranges from 0 in Richmond, Virginia[10] to a high of 11.6 percent in Chicago.[11] The inconvenience of

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7 Ecosometrics, *Intercity Bus Transportation*; Georgia Department of Transportation; June 1994

8 *Travel Behavior Issues in the 90's*; US Department of Transportation, July 1992

9 *Travel Behavior Issues in the 90's*; ibid

10 Wilbur Smith Associates; *Richmond Multimodal Transportation Center Feasibility Study;* Richmond, VA ; February 1995

11 Wilbur Smith Associates with Environdyne; *Chicago-Milwaukee High Speed Rail Feasibility Study*; Milwaukee, WI; January 1993

coordinating schedules of transit to rail passenger service and the issues of baggage conveyance, transfer and carriage are significant problems. The use of public transportation as a mode of access to rail passenger stations is a function of the trip type, level of transit service provided by the local transit agency and size of the city.

TRANSPORTATION MARKET SEGMENTATION

Examining ridership data and passenger survey information from transit systems, commuter railroads and intercity bus companies are useful in further refining market boundaries for proposed stations. Market segmentation in transportation is a relatively new concept. Transportation carriers have discovered that the travel market is differentiated by potential customers needs, desires and interests. Market segmentation is the subdividing of a large undifferentiated population into relatively small homogenous subsets, where any subset may conceivably be the target market to be reached by the transportation carrier. There are different ways to subdivide the large population into meaningful potential customer groups. These subgroups are usually broad classes of people who have distinguishable demographic characteristics or purchasing susceptibilities.

A large number of variables can be used to segment a market. Most of the important categories fall into several major categories: geographic, demographic, and buyer-behavior variables. Transportation services are usually segmented on the bases of income, age, family size and the availability of an automobile in the household. Additional variables are utilized when they can shed additional light on buyer-behavior.

Geographic Segmentation

Transportation carriers, by their very nature, segment the population by geography. The route structure of the transportation carrier determines the first element of the market boundary. The route coverage of a geographic region defines the service area. This geographic area is often called the ridership catchment area in which potential riders either reside or work. The type of service provided by the transportation carrier determines the trip purposes for which the service can be used. For example, local transit agencies attempt to provide service to a broad area of a metropolitan region to satisfy demand for the home based journey-to-work trips. Intercity ground transportation carriers attempt to provide routes that link cities together that permit home-based, other and non-home based trip demand in an efficient and cost effective manner. The catchment areas for these services are significantly different and relate to both trip purpose and mode of access. The catchment area is generally defined as a measurement of distance from the center line of the route segment or the station site. For local rail transit, the catchment area is ¼ to ½ mile, which is considered to be the convenient walking distances. Commuter rail catchment area can be extended to 2 to 5 miles from the station accounting for convenient driving distances for park-and-ride. Intercity ground transportation routes can have catchment areas extending from 2 to 30 miles depending on the nature of the service. High speed rail could have even a larger catchment area.

Demographic Segmentation

Ridership surveys collect data that attempts to distinguish passengers on the bases of demographic variables. These variables include age, household income, sex, ethnic heritage, occupation, education, and social class. These variables have long been the most popular bases for differentiating a population because these variables are easily measurable and correlate well to buyer behavior.

Benefit Segmentation

Benefit segmentation is the oldest form of market segmentation. The advertiser distinguishes one product or service from the others by highlighting the real and perceived benefits derived from using the advertised product or service. In transportation, benefit segmentation is what killed the passenger railroad business in the 1950's. Airlines marketed the time savings of air travel versus train travel. The convenience and flexibility of the automobile has seriously eroded transit's market share in the journey-to-work market. The automobile industry has advertised the convenience and flexibility of using the family car.

The feasibility of the regional rail service will greatly depend on the benefits perceived by the "individual choice" riders.

Section 3

CRANDIC CORRIDOR CHARACTERISTICS

Section 3

CRANDIC CORRIDOR CHARACTERISTICS

The feasibility of any commuter rail system depends on a variety of social and economic factors. The more common factors include the locations of large population densities and employment centers. There are travel need characteristics and special generators that influence commuter rail feasibility. These include:

- Median Income - People living in low income households tend to be more transit dependent because access to an automobile or multiple automobiles is limited;
- Age - Elderly individuals become transit dependent as their ability to drive declines, students generally do not have regular access to automobiles;
- Access to Parking - Cheap and convenient parking promotes single occupant vehicle commuters, while expensive and limited parking promotes transit; and,
- Special Events - Traffic congestion and parking costs create an incentive to use transit at large special events, such as football and basketball games or concerts.

Each of these characteristics typically play important roles in the ability of any commuter rail service to operate efficiently and to compete as a viable transportation alternative to the automobile. This section will examine these characteristics in detail and how they may influence potential interurban rail ridership in the CRANDIC corridor. The general characteristics and demographic information of Johnson and Linn County will be presented first, followed by more in-depth analysis of the CRANDIC corridor's demographics.

JOHNSON AND LINN COUNTIES

Population

Commuter rail demand depends greatly on the existing population levels and the forecasted growth trends within the study corridor. The population in both Cedar Rapids and Iowa City has been growing at a steady rate over the last twenty years. In contrast, the population of the state of Iowa has been declining over that same period. An overall understanding of the counties' population growth trends, as well as the location of those people and places, is essential to the development of commuter ridership forecasts.

Population levels rose approximately twelve percent since 1970 (an average annual increase of 0.6 percent) in the Johnson and Linn County area as indicated in Table 3-1. The majority of that growth, approximately 80 percent, was in Johnson County. This has been led by Iowa City and Coralville which are experiencing fairly rapid growth, due primarily to the University. However, the large underemployed workforce, access to University amenities, and access to efficient transportation has also brought in several non-University related industries. Conversely, Cedar Rapids which relies primarily on its manufacturing base, has not seen the largest growth rates found in Linn County.

Table 3-1
POPULATION TRENDS

County	1970	1980	1990	2010	Average Annual Growth	
					1970 to 90	1990 to 2010
Johnson	72,127	81,717	96,119	122,490	1.4%	1.2%
Linn	163,213	169,775	168,767	198,340	0.2%	0.8%
Total	235,340	251,492	264,886	320,830	0.6%	1.0%
Iowa	2,825,000	2,914,000	2,777,000	2,981,000	(0.1)%	0.4%

Source: U.S. Department of Commerce, Bureau of Census and Iowa State University.

Labor Force

Like population, the Johnson and Linn County employment statistics have also outpaced the State's employment growth rates. The relatively high county employment growth rates has been lead principally by the Cedar Rapids and Iowa City growth rates. Johnson County experienced a 2.8 percent annual employment growth rate between 1980 and 1990. The lower Linn County growth rate of 0.7 was still greater than the State's overall growth rate of 0.1 percent, as shown in Table 3-2. Based on similar anticipated labor force rates as a percentage of population, the Johnson and Linn County anticipated annual labor force growth rate of 1.0 percent between 1990 and 2010 is expected to outpace the overall State growth rate of 0.4%. By 2010, the combined Johnson and Linn County labor force is forecasted to rise from 153,700 (in 1990) to 186,300.

Table 3-2
LABOR FORCE TRENDS

County	1980	1990	2010[1]	Average Annual Growth	
				1980 to 90	1990 to 2010
Johnson	43,720	57,600	73,400	2.8%	1.2%
Linn	89,620	96,100	112,900	0.7%	0.8%
Total	133,340	153,700	186,300	1.4%	1.0%
Iowa	1,432,000	1,448,000	1,555,000	0.1%	0.4%

Source: Iowa State University
(1) Based on 1990 labor force per population ratios

Automobile Ownership

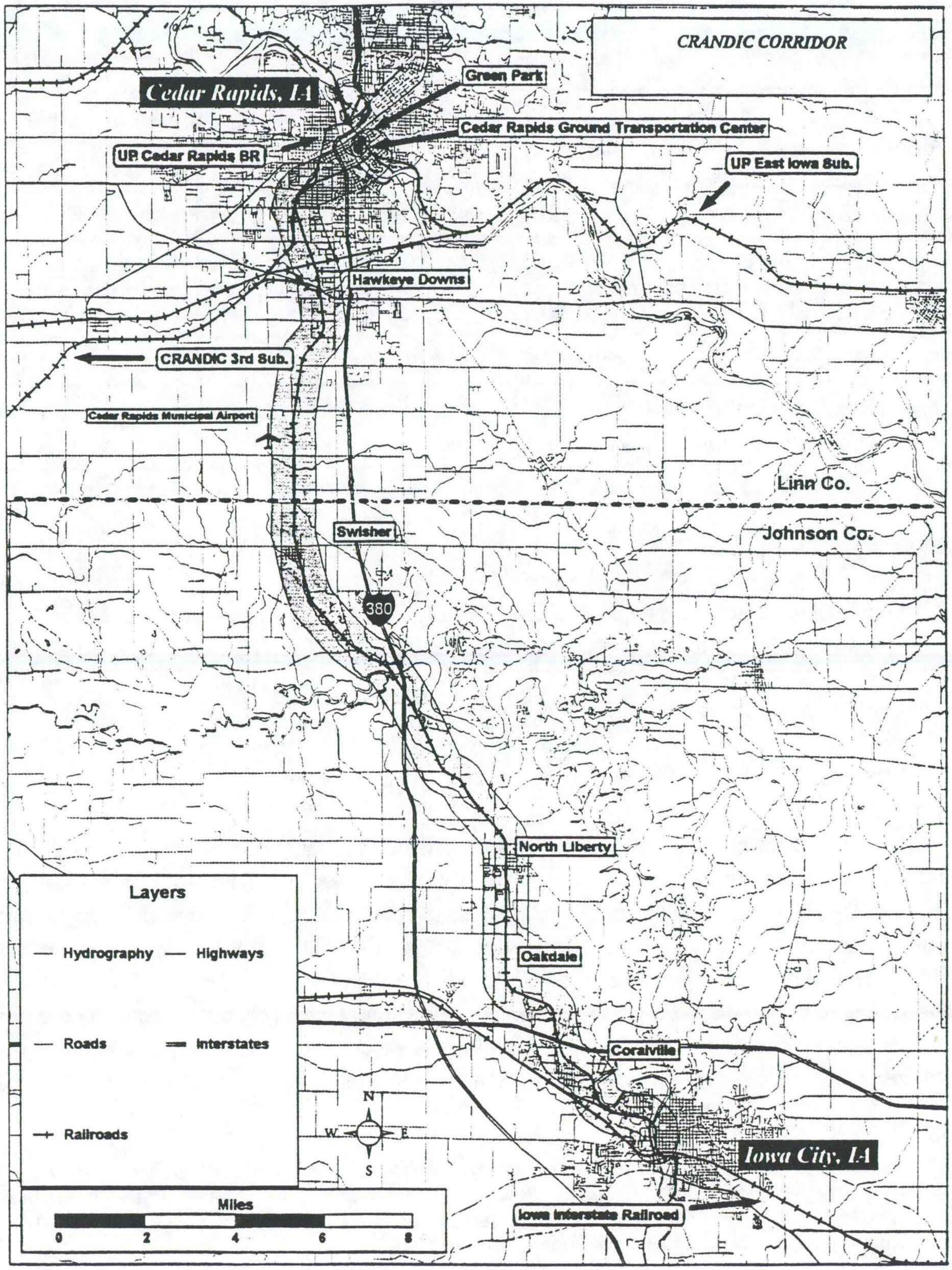
The combined automobile registrations of Johnson and Linn Counties was 173,982 in 1990. Between 1984 and 1994 automobile registrations increased from 147,969 to 187,311, an average annual change of 2.5 percent. The 1990 automobile per person ratio was 0.66, and the automobile per household ratio was 1.72.

STUDY CORRIDOR

The *East Central Iowa Commuter Feasibility Study* corridor follows the existing 27 mile CRANDIC rail line between Cedar Rapids and Iowa City, as shown in Exhibit 3-1. The existing rail line begins in Cedar Rapids running south through Swisher, North Liberty, Oakdale, and ending near downtown Iowa City. It runs parallel to Interstate 380 and Highway 965 for the majority of that distance. The exhibit also shows a two-mile buffer encircling the rail line. As will be shown, potential ridership attraction to an urban passenger rail system typically is assumed to be greatest within walking distance of a home or office. This buffer represents the area where the commuter service could expect to reasonably draw patrons and serves as the study boundary.[1]

[1] The 1990 National Personal Transportation Survey Databook (Vol.1) indicates that when a public transportation stop or station for bus, elevated rail, commuter rail or streetcar is located within 2 miles of a person's residence 3.1 percent of all trips are conducted by public transportation, versus 0.4 percent if the stop or station is over 2 miles from one's residence.

Exhibit 3-1


CRANDIC CORRIDOR
Cedar Rapids, IA
Green Park
Cedar Rapids Ground Transportation Center
UP Cedar Rapids BR
UP East Iowa Sub.
Hawkeye Downs
CRANDIC 3rd Sub.
Cedar Rapids Municipal Airport
Linn Co.
Johnson Co.
Swisher
380
North Liberty
Oakdale
Coralville
Iowa City, IA
Iowa Interstate Railroad
Layers
Hydrography
Highways
Roads
Interstates
Railroads
N
W
E
S
Miles
0
2
4
6
8

The physical geography along the CRANDIC Railway is fairly typical for the eastern part of Iowa. The rail line crosses the Cedar River in downtown Cedar Rapids and the Iowa River just south of Swisher and again near downtown Iowa City. The Iowa River crossing near Swisher is actually the tail end of the Coralville Reservoir. The terrain is generally slow, rolling farmland except where it enters populated areas.

Population

The study corridor population density (people per square mile) is shown in Exhibit 3-2. Areas with high population densities (500 per square mile) improve the likelihood of using the commuter service. In other words, a large number of people within a reasonable distance to a commuter rail station creates the opportunity for more demand for the service. The exhibit shows the greatest population density within the urban areas; declining farther away from town. The total population within the study corridor is 139,446 based on the two-mile buffer zone around the CRANDIC rail line. (This represents approximately 53 percent of the Johnson and Linn County total population.) The non-urban land adjacent to the CRANDIC line, especially to the east, tends to have a higher population density than other rural areas in either county. This supports the belief that above average development is occurring in the Cedar Rapids to Iowa City corridor.

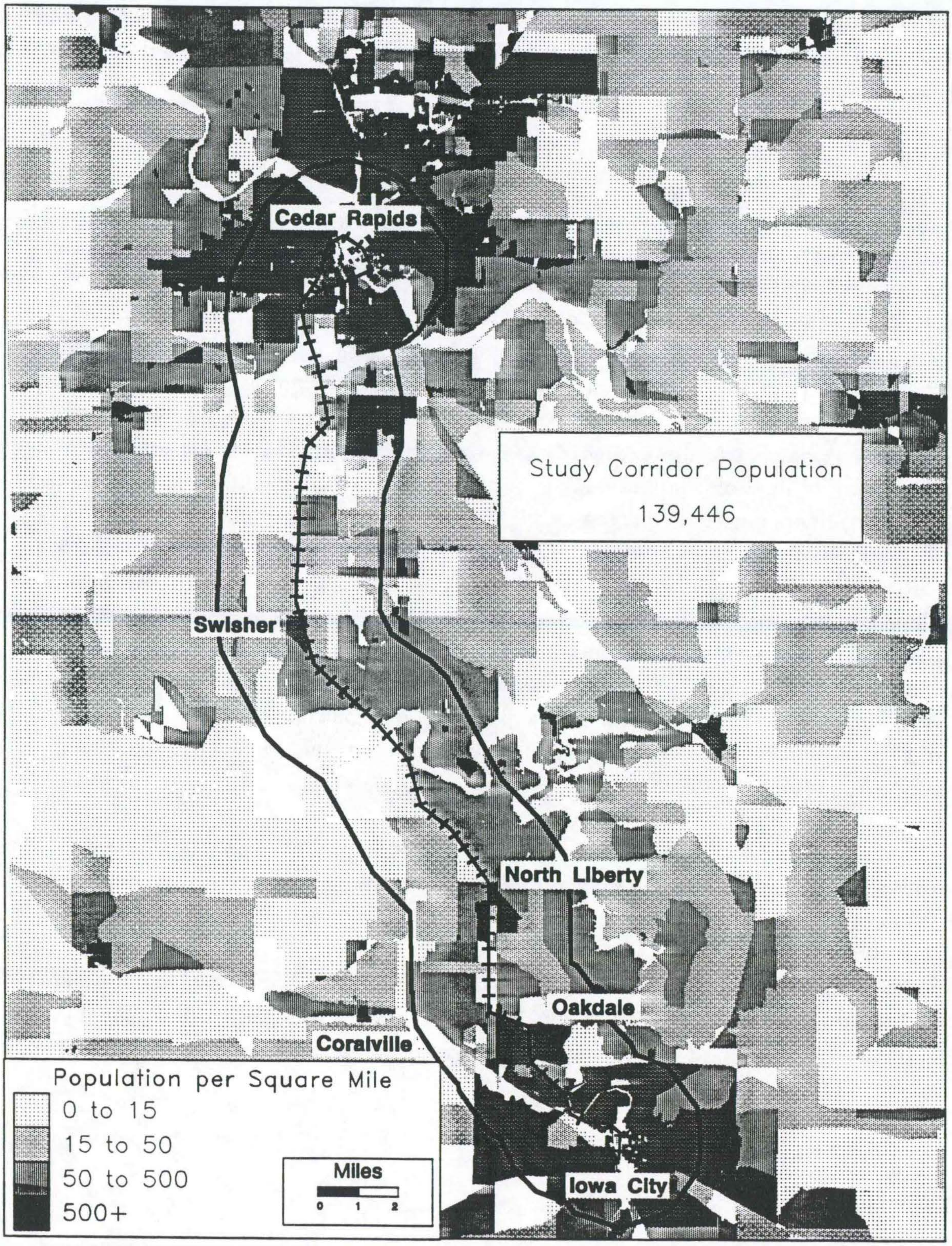
Age Distribution

The patrons of a commuter rail line come from varying age groups, each with distinct reasons for using the rail line. The elderly increasingly rely on public transit as their driving skills decline. Temporarily impoverished students who cannot afford an automobile also are more reliant on public transit. Working adults use public transit principally for work related trips, albeit to much a lesser degree than the elderly and the students.

Recent information published by the National Personal Transportation Survey (NPTS) discovered interesting national trends about various age groups' usage of public transportation. National transit usage declined between 1983 and 1990 by all age groups, except for the age group 20 to 29. In addition, people in the age group over 50, generally the most frequent users of public transportation, showed the greatest decline in public transportation usage, reflecting the increasing incomes and driving ability of the older population. The other traditionally high segment of public transportation users, the 5 to 15 age group, also experienced a significant decline.[2]

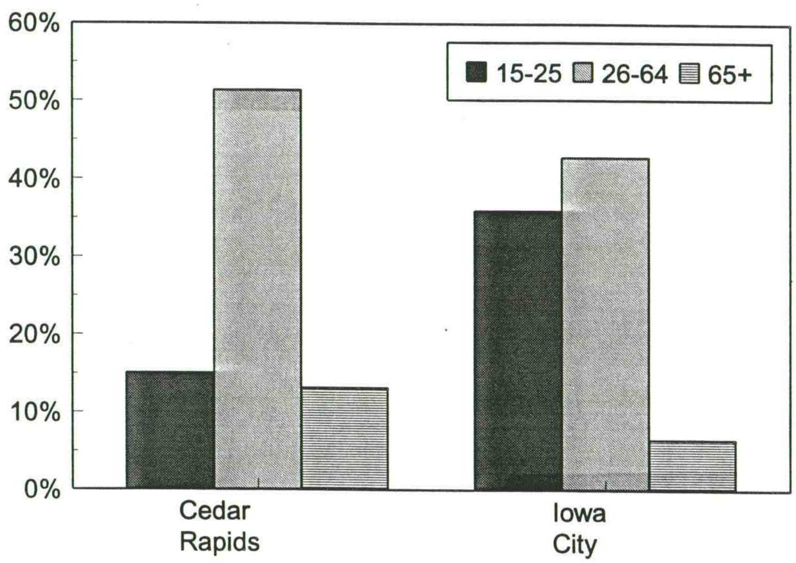
[2] "Travel Behavior Issues In The 90's", U.S. Department of Transportation, 1992

Figure 3-2
POPULATION DENSITY



In the CRANDIC corridor, Iowa City has a predominately young population base because of the University, with the average age of 23.9 years and only 6.6 percent of the population over age sixty-five. Cedar Rapids, on the other hand, follows more closely the state averages. In Cedar Rapids, the average age is 32.5 and 13.7 percent of the population is over age sixty-five, versus the State's average age of 33.2 with 15.3 percent over age sixty-five. The three distinct age categories for Iowa City and Cedar Rapids are presented in Table 3-3.

Table 3-3
AGE DISTRIBUTION
Percent of Total Population



Therefore, the Cedar Rapids ridership base would consist primarily of elderly riders. Iowa City's ridership base would consist primarily of students. Both population groups are usually more transit dependent than the average citizen.

Employment

Industries located close to the CRANDIC rail line are important trip attractors and would contribute to the succcess of rail passenger service. The major employment centers within the study corridor are presented on Exhibit 3-3. More specifically, the major employers located within one-half mile of the CRANDIC rail line were identified and telephone surveys were conducted to determine the number of employees. Table 3-4 presents each employer and their approximate number of employees.

Exhibit 3-3
MAJOR EMPLOYMENT CENTERS in the CRANDIC CORRIDOR

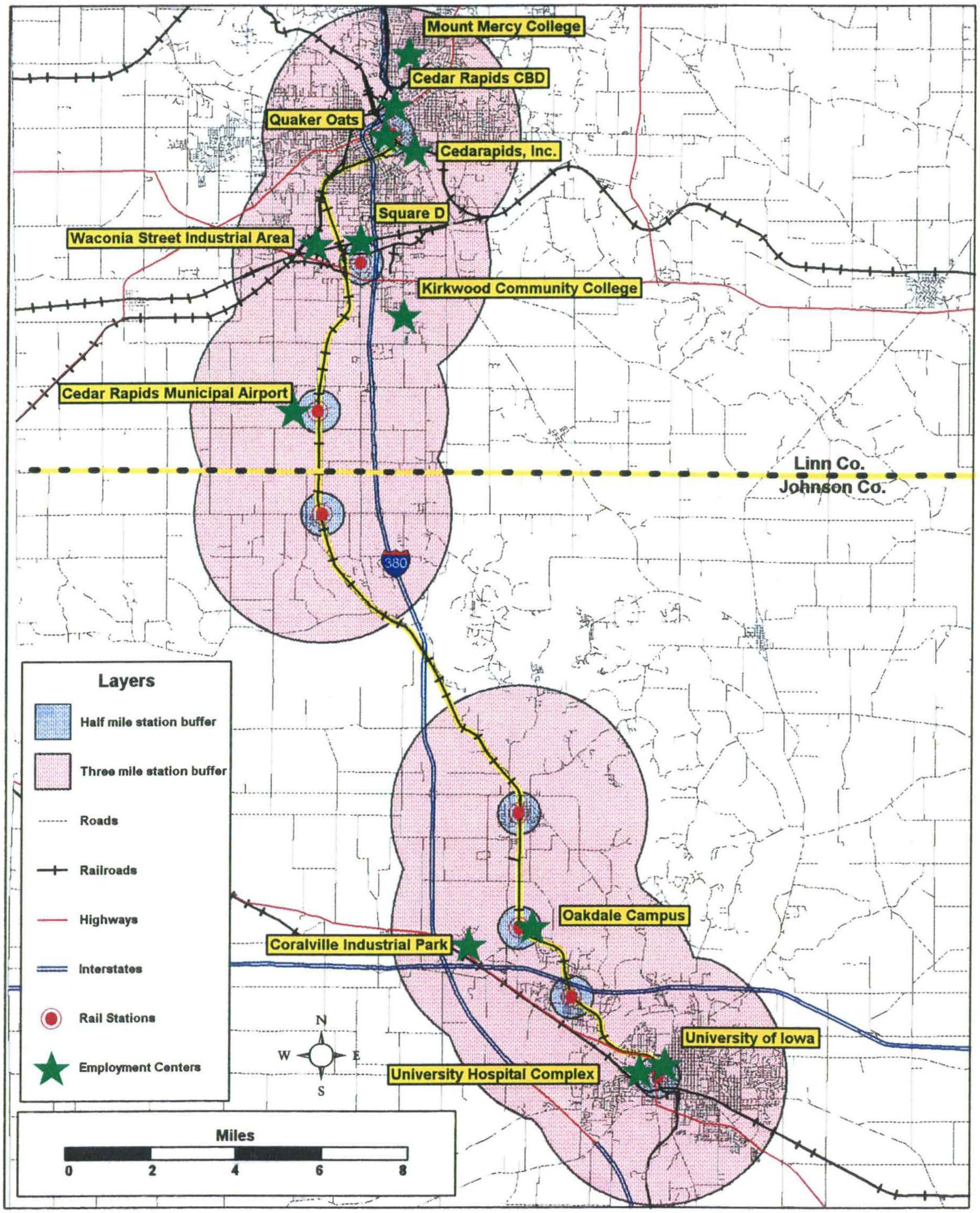


Table 3-4
MAJOR TRIP ATTRACTORS WITHIN ½ MILE OF THE CRANDIC RAIL LINE

Businesses	**Number of Employees**
Amana Refrigeration	3,320
American Profol	40
Apache Hose	100
Archer Daniels Midland	280
Cargill Soybean Processing - East Plant	60
Cargill Soybean Processing - West Plant	60
Cedar River Paper Company	n.a.
Cedar Rapids Airport	450
Cedarapids, Inc.	600
Centro, Inc.	250
Downtown Cedar Rapids	13,000
Downtown Coralville	1,000
Downtown Iowa City	3,000
Evergreen Packaging	500
Galt Sand	n.a.
Genencor	80
General Mills	700
Gordon Sevig Truck Company	35
IES Utilities	75
Kirkwood Community College	550
Midland Forge	200
Penford Products Company	350
PDM Steel Service Center	40
PMX Industries	460
Ralston Foods	250
Square D	700
Quaker Oats	1,250
University of Iowa	12,500
Webster Offset Printing	50
Wyerhaeuser	150
W.R. Grace	350
Worley Warehouse	100
SUBTOTAL	40,500

MAJOR COLLEGES AND UNIVERSITIES	**Number of Students**
COE College	1,350
Kirkwood Community College	9,000
Mount Mercy College	1,400
University of Iowa	28,000
SUBTOTAL	39,750
TOTAL EMPLOYEES AND STUDENTS	81,250

Source: CRANDIC Rail Line, Wilbur Smith Associates Telephone Surveys

More specifically, the major employers located within one-half mile of the CRANDIC rail line were identified and telephone surveys were conducted to determine the number of employees.

Colleges and Universities

Colleges and universities also are important trip attractors that could contribute to the viability of rail passenger service. The major colleges and universities located in the CRANDIC corridor include COE College, Kirkwood Community College, Mount Mercy College and the University of Iowa. The combined student population of these institutions is 81,250. Table 3-4 also indicates the student populations for each one.

Households

Between Johnson and Linn Counties the 1990 Census documented a total of 101,360 households, indicating a ratio or 2.6 persons per household. Figure 3-4 shows the housing density (housing units per square mile) within the study corridor. Like population density, housing density is greater within the urban areas and higher than average along the eastern edge of the rail line.

Housing density within a reasonable distance to a commuter rail station is important. Nationwide, property renters are three times more likely to use public transit as property owners for journey to work trips.[3] Several reasons are responsible for this statistic. Property owners are typically above the poverty line and are less likely to be transit dependent. Premium land values in densely populated metropolitan areas spur the development of multi-family housing. This trend is also demonstrated in the CRANDIC corridor where a large percent of the Iowa City population are university students (i.e. renters) who use public transit.

Journey to Work

Review of 1990 detailed Census data yield journey to work characteristics for Cedar Rapids, Iowa City and the State. The percentage of the work force in the Corridor that use public transit is greater than the State average of 1.2 percent, as shown below in Table 3-5. In Iowa City, a very high 10.2 percent of the work force use public transit. Cedar Rapids also demonstrates higher than average public transit use with 2.0 percent of the work force. Based on these percentages and the 1990 employment levels in the CRANDIC corridor, a rough estimate of daily public transit work trips would be around 4,500 in 1990. This indicates a relatively high propensity of public transit use by Corridor residents relative to the rest of the State. Roughly six percent of the State's population lives in Cedar Rapids and Iowa City, which comprise nearly thirty percent of the public transit work trips.

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[3] "Commuting Alternatives in the United States: Recent Trends and a Look to the Future" (U.S. Department of Transportation, 1994) found that in 1991 ,8.9% of home renters use public transit versus 2.8% of home owners.

Exhibit 3-4
HOUSING DENSITY

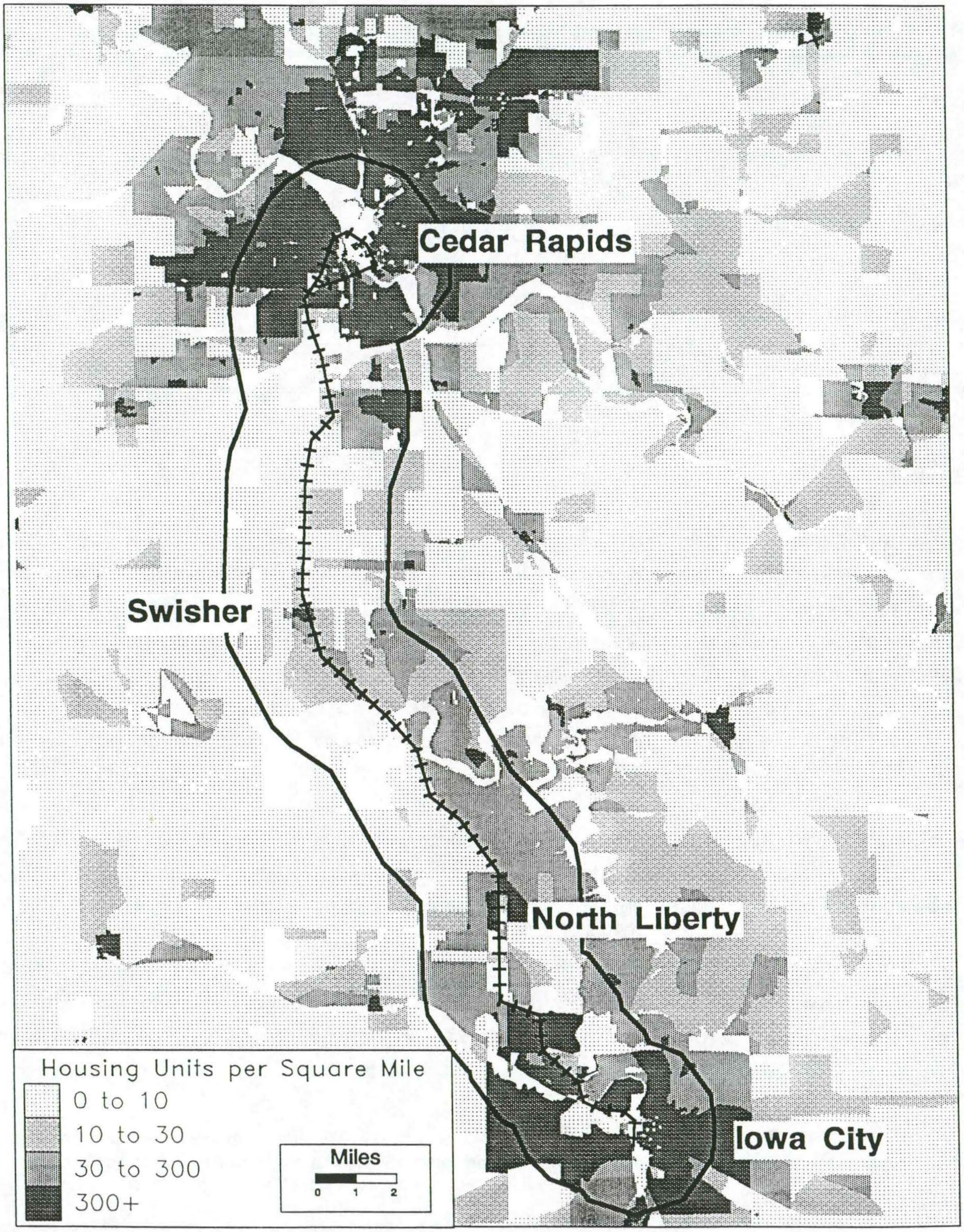


Table 3-5 JOURNEY to WORK TRIPS - 1990				
	Population	Workers Age 16 & Older	Work Trips Using Public Transit	
			Percent	Number
Iowa City	59,738	32,580	10.2%	3,320
Cedar Rapids	108,751	55,524	2.0%	1,110
Combined	168,489	88,104	5.0%	4,430
Iowa	2,776,755	1,322,064	1.2%	15,865
source: U.S. Department of Commerce, Bureau of the Census				

Income

The expense of owning and operating an automobile and paying for parking creates a large burden on a community's lower income residents. Likewise, large low income families cannot generally afford the two or three cars necessary for transportation. Therefore, income plays a major role in the use of a commuter rail system.[4] However, the National Personal Transportation Survey discovered in the 1990 survey that low income populations are shifting away from transit towards single occupant private vehicles. This may be because of increased access to private vehicles, reductions in transit service, and the trend of job opportunities moving out to areas not served by transit.

Another important income measure is the percent of families living under the poverty line. Johnson County has about 7.1 percent of its families and Linn County has about 5.8 percent of its families living below the poverty line. The combined total families under the poverty line for the CRANDIC corridor is estimated at 6,340.

Another measure of income is the median family income as it compares to other areas of the state. The median family income for Johnson and Linn Counties, respectively, are $39,606 and

[4] The 1990 National Personal Transportation Survey Databook (Vol.1) shows that 3.7 percent of all person trips made by people from households with a combined annual income under $10,000 are by public transportation. This percentage declines as household income rises. The highest earning households, $40,000 and more, use public transportation for 1.2 percent of all person trips.

$38,142. Compared to a state median family income of $31,659, both communities have median incomes higher than the state average.

Access to Parking

Telephone interviews with several major employers in the CRANDIC corridor show that the vast majority of firms provide free on-site parking to their employees. The ease and convenience of parking creates a large incentive for commuters to use their automobiles instead of a transit alternative. However, the two largest employment centers, the University of Iowa and the Cedar Rapids downtown, have limited parking.

Special Events

The study corridor contains several facilities that potentially generate significant demand for atypical trips. For example, Iowa City experiences significant increases in traffic and traffic related problems on a football Saturday. The limited parking or additional cost to park creates an additional demand for trips to these special events. The major facilities that sponsor these special events are illustrated on Exhibit 3-5.

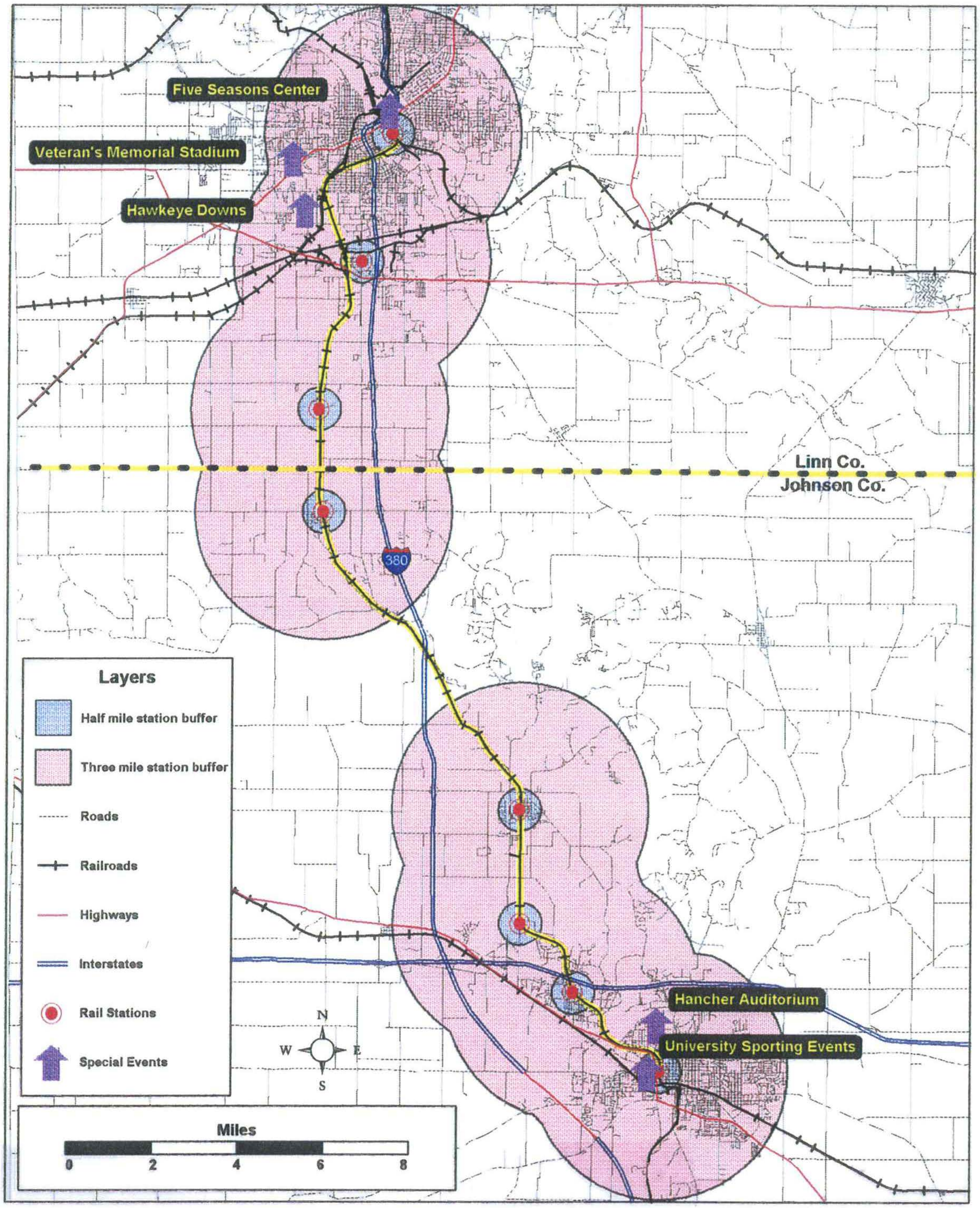
Each facility was contacted to determine the seating capacities and the annual number of patrons, which are shown on Table 3-6. Kinnick Stadium is limited to the six home football games, while Hawkeye Downs sponsors a variety of events. In fact, the annual number of patrons at Hawkeye Downs is nearly impossible to determine because they put on shows ranging from stock car races to agricultural events to the *All Iowa Fair*. Therefore, the annual patronage for Hawkeye Downs is merely a rough estimate.

Table 3-6
SPECIAL EVENT CHARACTERISTICS

Facilities	Seating Capacity	Events	Annual Patronage
Hancher Auditorium	2,533	na	na
Carver-Hawkeye	15,500	40	314,000
Kinnick Stadium	70,000	6	420,000
Five Seasons Center	10,000	10-8	274,280
Hawkeye Downs	7,500	?	700,000
Veteran's Memorial	6,00	85	147,000
Total			1,855,280

Source: Wilbur Smith Associates telephone surveys

Exhibit 3-5
SPECIAL EVENT LOCATIONS



STATION LOCATIONS

It is generally understood that people are more likely to use urban rail transit if they can walk to the station. The next best scenario would be if a station was located within a short drive of household location. In fact, research conducted by Douglas and Douglas, Inc., in the Washington, D.C. area found that transit mode share for nearby office buildings dropped by 2 percent for every 100 feet that the building lies away from the station. Thus, the more developed an area is around a transit station, the greater the likelihood of capturing transit users. Furthermore, it was found in a recent study that walking to transit is generally viewed as more attractive than driving, because once an individual is behind the wheel of an automobile it may seem more reasonable to drive the entire distance.[5]

To better ascertain potential ridership levels on an urban passenger rail system between Iowa City and Cedar Rapids, the population, employment and households located within walking distance and/or driving distance of logical station locations were identified. Eight station locations were identified as logical station locations and provided the basis for the ridership forecasts that are generated in Section 7.

Walking distance is considered to be within one-half mile of the station. Driving distance is considered to be within three miles of the station. To determine the population, employment and household levels within walking and/or driving distance Atlas GIS 3.0 software was used. As shown below in Table 3-7, the Johnson and Linn County population, employment and households are compared to those within a three mile radius and a half mile radius of the eight station locations. The information in this table forms the basis of the ridership estimates developed in Section 7.

Table 3-7
POTENTIAL RIDERSHIP INDICATORS - 1990

	Population	Employment	Households
Johnson and Linn Counties	264,886	150,935	101,360
Within Station Proximity			
Driving Distance (3 miles)	146,974	77,910	58,363
Walking Distance (½ mile)	12,492	33,288	4,335

source: Census Transportation Planning Package, U.S. Department of Transportation, and Atlas GIS software

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5 Parsons Brinckerhoff Quade & Douglas, Inc., Triangle Fixed Guideway Study, Triangle Transit Authority, 1994

The stations include the two terminals anchoring the rail line in Cedar Rapids and Iowa City, which provide egress to downtown business employment and maximizes rail access to the local feeder bus network. Interim stations were selected based on adjacent land use, including population, household and employment densities, especially those within walking distance. In examining I-380 congestion (see Section 4) the segments of I-380 corridor with some measure of congestion are from Hawkeye Downs to downtown Cedar Rapids which suggests that a station could provide park and ride access which could mitigate the interstate's urban congestion. The Hawkeye Downs station also was selected based on the assumption that it could provide the dual purpose of additional quick and easy access to downtown Cedar Rapids as a park-and-ride facility and as a special events destination station. Since the proposed rail line would pass within 500 feet of the Cedar Rapids Municipal Airport, it would provide an attractive alternative to driving and parking at the airport. The Swisher and North Liberty stations were historical rail stops on the former CRANDIC interurban railway. Currently, Swisher and North Liberty are the only two centrally located communities in the Corridor that demonstrate any urban characteristics. The Oakdale station was selected for the reason that it is a University of Iowa commuter parking facility that attracts students and university employees. Lastly, the Coralville station was selected due to its connectivity to the local bus system.

Section 4

EXISTING TRANSPORTATION INFRASTRUCTURE

Section 4

EXISTING TRANSPORTATION INFRASTRUCTURE

This Section of the report describes the existing transportation infrastructure in the study corridor. The vast majority of existing trips between Cedar Rapids and Iowa City occur on Interstate 380. Express bus service is provided by Greyhound Lines and Burlington Trailways. Two transportation modes located in the corridor, the Cedar Rapids Municipal Airport and the city transit systems, do not provide connections between the two cities but could improve the feasibility of regional rail passenger service. Another mode, intercity rail passenger service provided by Amtrak, does not presently exist in the corridor but potentially could be an additional attraction in the future. All these transportation modes could potentially impact the feasibility, either positively or negatively, of proposed regional rail passenger service. This section discusses the issues surrounding each existing mode of transportation and how they relate to the proposed regional rail passenger service.

INTERSTATE 380

The principal transportation alternative between Cedar Rapids and Iowa City is Interstate 380. The facility operates as a typical interstate highway with 65 mph speed limits for the majority of the distance between the two cities. Based on traffic statistics provided by the Iowa Department of Transportation (IDOT), the traffic volumes over the last 10 years have increased substantially on Interstate 380. The highway segment between the Cedar Rapids Airport and Cedar Rapids shows the largest increase with an eight percent annual increase since 1982. Exhibit 4-1 provides the bi-annual traffic counts for various I-380 segments since 1982.

The existing average daily traffic ranges from 12,300 near the I-80 interchange to 40,400 near the 33rd Street interchange in Cedar Rapids, as demonstrated by the band widths on Exhibit 4-2. The band widths show traffic declining gradually from Cedar Rapids to Iowa City, suggesting a fairly even distribution of traffic between the two communities.

Traffic counts of north and south bound traffic conducted at the Shueyville Road exit on I-380 on Tuesday, August 7, 1995 suggest that the combined Linn and Johnson Counties' passenger car share of total traffic volumes is approximately 30 percent, or 8,300 vehicles per day. Based on an average passenger vehicle occupancy of 1.2, the maximum potential ridership base for an intercity urban passenger rail service in the CRANDIC corridor is estimated at 9,900 people.

Exhibit 4-1
HISTORIC AVERAGE DAILY TRAFFIC VOLUMES

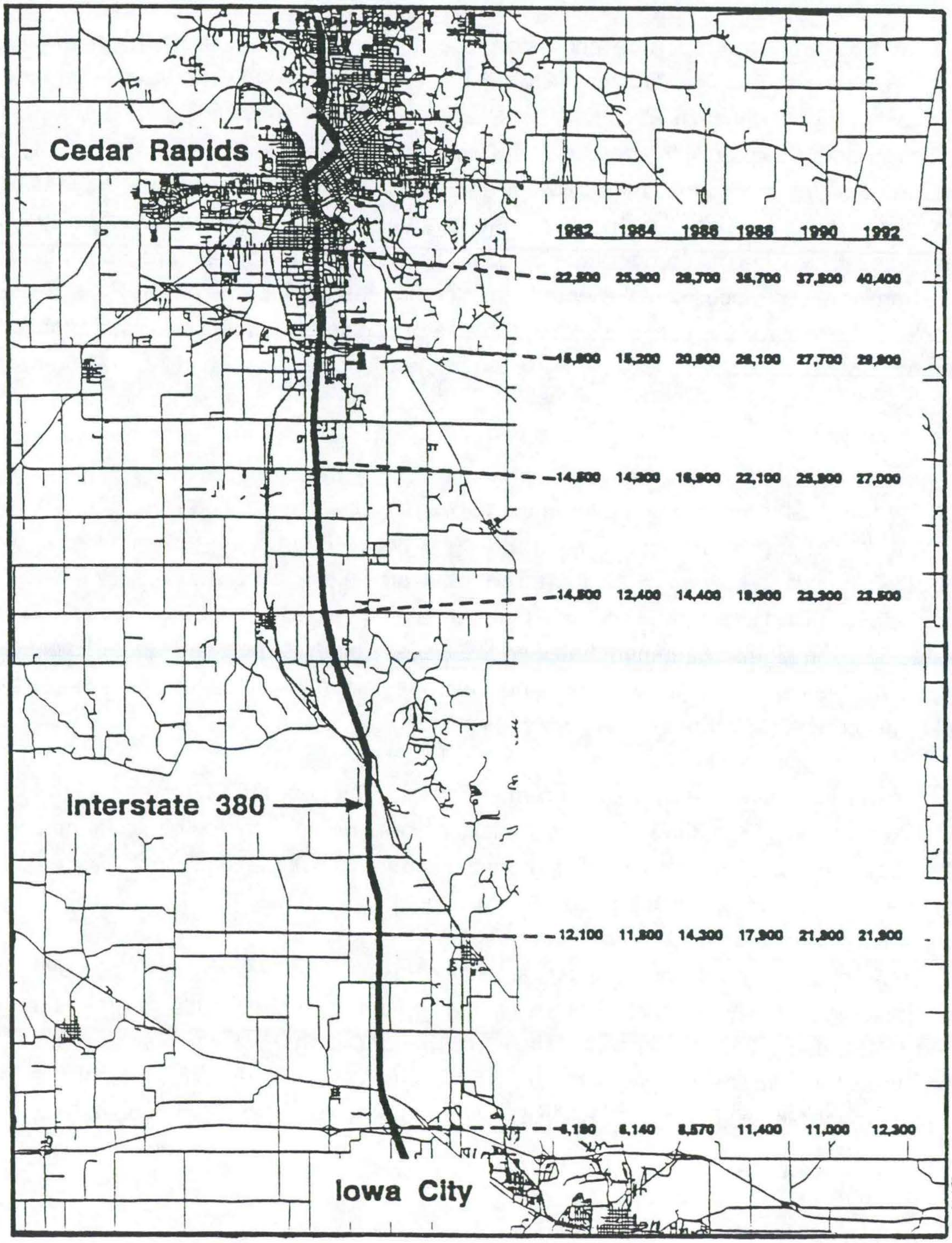
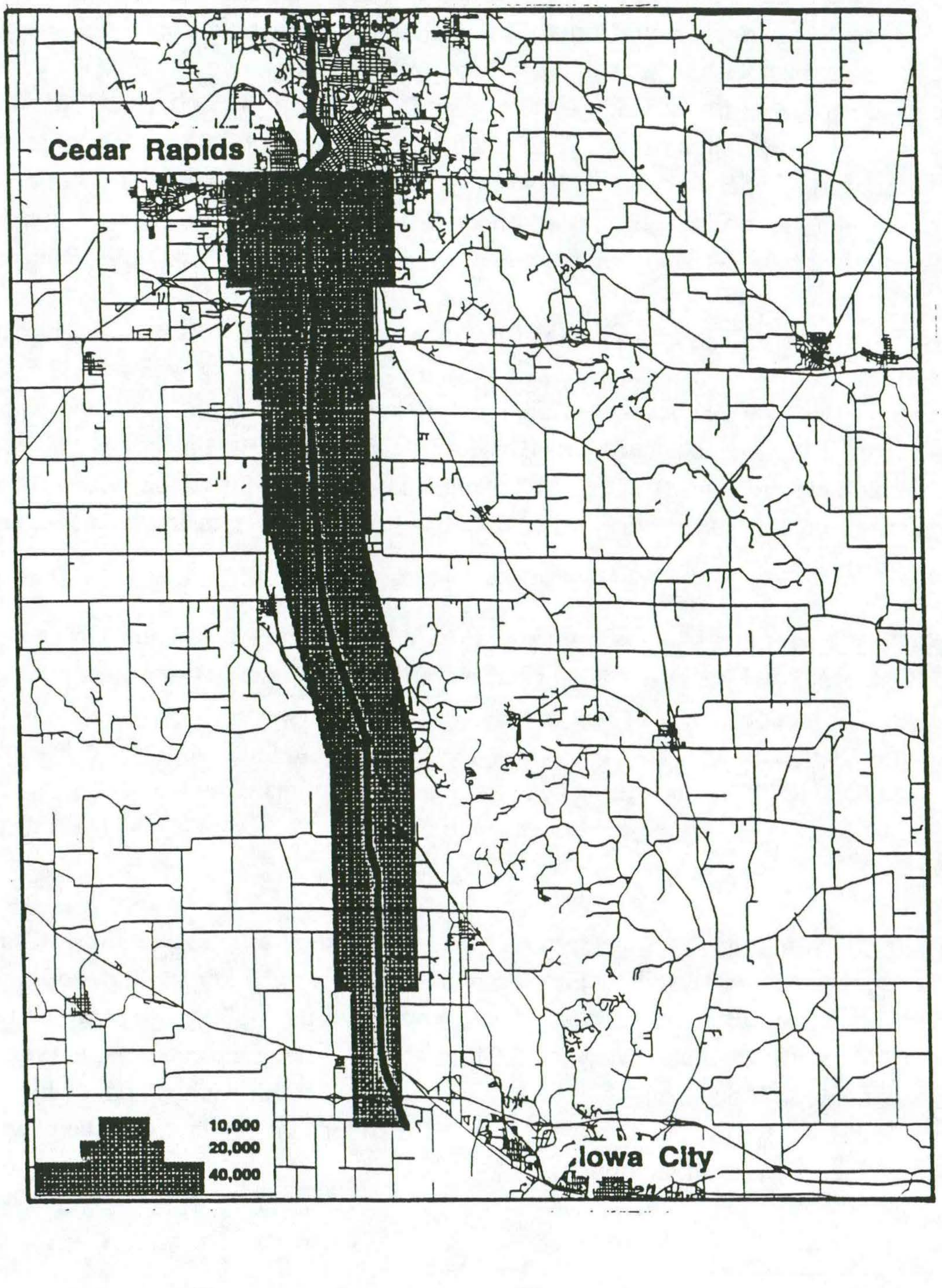


Exhibit 4-2
AVERAGE DAILY TRAFFIC VOLUMES



Interstate Congestion

Concerns expressed during the study suggested that the recent high traffic growth rates on I-380 could lead to congestion problems. To evaluate the magnitude of interstate highway congestion in the corridor, it is useful to compare daily vehicle miles traveled (DVMT) per lane-mile. When area-wide freeway travel volumes exceed an average of 13,000 DVMT per lane-mile, undesirable levels of congestion occur[1]. The DVMT per lane-mile in 1990 were estimated for the I-380 corridor between Cedar Rapids and Iowa City. These DVMT per lane-mile in the corridor are then compared with the top 50 metropolitan areas. Different growth rates are then applied to the DVMT in the corridor to ascertain when the corridor will approach the 13,000 DVMT threshold.

Average 1990 DVMT per Lane Mile - The year 1990 weighted average daily traffic volume on the I-380 corridor between Iowa City and downtown Cedar Rapids was 27,559 AADT. The interstate spans a little over 20 miles and is four lanes between Iowa City and the US 30 interchange (13.8 miles) where it expands to 6 lanes. The Corridor lane miles total 94.3 miles. As shown in Table 4-1, the weighted average DVMT of 560,275 results in an average DVMT per lane mile of 5,941, which indicates that the current Iowa City to Cedar Rapids interstate traffic is well below the undesirable congestion level of 13,000.

1990 DVMT per Lane Mile in Congested Urban Areas - In fact, as shown in Table 4-2, the CRANDIC Corridor's DVMT per lane mile currently is well below the top 50 freeway congested urban areas. The table also shows the 21 cities with existing urban rail systems, of which 18 (86%) have DVMT per lane mile greater than 12,000. It is also interesting to note that of the 27 cities with DVMT greater than 12,000, 18 (67%) cities currently have urban rail systems. The worst capacity problems in the CRANDIC Corridor are actually on I-80 through Coralville and Iowa City. Additional lanes are planned for I-80.

Future DVMT in the I-380 Corridor - As noted above, the traffic volume growth in the I-380 corridor has risen at an annual rate of eight percent between the 1982 and 1992 period. Should the traffic volumes continue to increase at this high annual rate the I-380 corridor would reach the undesirable DVMT of 13,000 around the year 2001. In addition, the completion of the Avenue of the Saints Corridor between Minneapolis-St. Paul and St. Louis will facilitate long distance travel though the I-380 corridor. This leads to the issue: "Will the I-380 corridor's interstate congestion levels reach levels that require urban rail transportation?"

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[1] Estimates of Urban Roadway Congestion, 1990, FHWA Office of Traffic Management and Intelligent Vehicle Highway Systems

Table 4-1
DAILY VEHICLES MILES TRAVELED per LANE MILE by SEGMENT
CRANDIC Corridor - Interstate 380, Iowa City to Cedar Rapids
1990

I-380 Section	Section Length (miles)	AADT	DVMT /a	Lanes	Lane Miles /b	DVMT per Lane Mile /c
I80 and US 218 Interchange to						
South limits of Coralville	0.69	21,800	15,042	4	2.8	5,450
North limits of Coralville	1.35	21,800	29,430	4	5.4	5,450
Co. Rd. F28 Interchng.	2.01	21,800	43,818	4	8.0	5,450
Co. Rd. F12 Interchng.	6.82	23,300	158,906	4	27.3	5,825
Johnson-Linn Co. Line	0.95	25,900	24,605	4	3.8	6,475
South limits of Cedar R.	0.22	25,900	5,698	4	0.9	6,475
Co. Rd. E70 Interchng.	1.80	25,900	46,620	4	7.2	6,475
US 30/151/218 Interchng.	2.52	27,700	69,804	6	15.1	4,617
33rd Ave. Interchng.	1.25	37,600	47,000	6	7.5	6,267
Wilson Ave. Interchng.	0.76	42,300	32,148	6	4.6	7,050
5th Ave. SW Interchng.	1.07	47,300	50,611	6	6.4	7,883
IA 922 Interchng.	0.55	38,900	21,395	6	3.3	6,483
IA 94 & 1st Interchng.	0.34	44,700	15,198	6	2.0	7,450
Corridor Totals / Weighted Average	*20.33*	*27,559*	*560,275*	*4.64*	*94.3*	*5,941*

a/ AADT x Section Length
b/ Section Length x Lanes
c/ DVMT / Lane Miles

Before this question can be answered, further analysis of I-380's traffic volumes and projected growth is required. Two reasons emerged that cast doubt on continued high annual traffic volume increases. First, the annual traffic volume increases along the corridor may be leveling off. Between 1988 and 1992 the average annual increase declined to 4.9 percent, and between 1990 and 1992 the annual traffic volume increases declined further to 1.8 percent. Second, the extensive area traffic forecasting conducted during the *Avenue of the Saints Corridor Study* in 1989 suggest that the corridor's annual traffic volume is expected to increase at an annual rate of 1.9 percent through the year 2010. A moderate annual growth rate of 2.0 percent after 1992 indicates that the corridor's DVMT per lane mile would not reach the undesirable 13,000 vehicle level until the year 2030.

Table 4-2
DVMT per LANE MILE, POPULATION and URBAN RAIL SYSTEMS by URBAN AREA

Urban Area	1990 Pop. (000's)	Urban Area (Sq.Mi.)	Pop Density Per/Sq.Mi	1990 Freeway Mileage and Travel Vol. DVMT (000's)	Lane Miles	Avg. No. of Lanes	DVMT per Lane Mile	DVMT per 1000 Persons	Existing Urban Rail Systems CR	LRT	RT
Los Angeles	11,420	2,190	5,210	110,350	5,230	8.2	21,100	9.66	•	•	•
San Francisco-Oakl.	3,680	850	4,330	42,590	2,390	6.8	17,820	11.57	•	•	•
Washington, D.C.	3,100	840	3,690	25,340	1,530	5.3	16,560	8.17	•		•
San Bern.-Riverside	1,170	490	2,390	14,580	900	7.1	16,200	12.46			
San Diego	2,300	710	3,240	27,690	1,730	7.4	16,010	12.04		•	
Chicago	7,510	1,990	3,770	38,030	2,430	5.7	15,650	5.06	•		•
Seattle-Everett	1,730	730	2,370	18,920	1,210	6.0	15,640	10.94			
Houston	1,200	1,640	730	28,230	1,920	6.3	14,700	23.53			
Boston	2,960	1,070	2,770	21,610	1,520	5.9	14,220	7.30	•	•	•
Atlanta	1,880	1,550	1,210	24,260	1,710	6.1	14,190	12.90			•
Miami	1,850	480	3,850	8,570	610	5.4	14,050	4.63	•		•
New York	16,780	3,190	5,260	82,920	5,900	5.6	14,050	4.94	•		•
Dallas	1,990	1,440	1,380	23,680	1,710	5.9	13,850	11.90	•	•	
New Orleans	1,080	360	3,000	4,970	360	5.8	13,810	4.60		•	
San Jose	1,410	450	3,130	15,780	1,160	6.6	13,600	11.19		•	
Honolulu	660	140	4,710	4,620	340	5.2	13,590	7.00			
Portland	1,030	420	2,450	7,470	560	5.1	13,340	7.25		•	
Detroit	4,000	1,260	3,170	22,650	1,700	5.8	13,320	5.66			
Milwaukee	1,230	550	2,240	7,690	600	5.6	12,820	6.25			
Denver	1,580	890	1,780	11,270	890	5.2	12,660	7.13		•	
Baltimore	1,990	550	3,620	15,800	1,250	5.4	12,640	7.94	•	•	•
Cincinnati	1,140	570	2,000	11,380	910	5.7	12,510	9.98			
Cleveland	1,790	650	2,750	13,700	1,100	4.7	12,450	7.65		•	•
Sacramento	1,100	360	3,060	9,260	750	6.9	12,350	8.42		•	
Phoenix	1,900	980	1,940	7,670	630	5.6	12,170	4.04			
Philadelphia	4,220	1,130	3,730	18,330	1,510	5.1	12,140	4.34	•	•	•
Tampa	700	450	1,560	3,630	300	4.9	12,100	5.19			
Austin	510	350	1,460	5,440	450	5.6	12,090	10.67			
Minneapolis/St. Paul	2,010	1,020	1,970	17,790	1,480	4.9	12,020	8.85			
Jacksonville	720	540	1,330	5,380	450	4.6	11,960	7.47			
Fort Lauderdale	1,270	430	2,950	7,110	600	5.4	11,850	5.60	•		
Fort Worth	540	850	640	11,840	1,020	5.8	11,610	21.93			
Norfolk	930	820	1,130	5,450	470	4.6	11,600	5.86			
St. Louis	1,960	730	2,680	19,120	1,700	5.5	11,250	9.76		•	
San Antonio	1,170	490	2,390	9,280	830	5.3	11,180	7.93			
Memphis	860	430	2,000	4,340	390	5.4	11,130	5.05			
Albuquerque	530	260	2,040	2,400	220	5.0	10,910	4.53			
Hartford	610	360	1,690	6,230	580	5.5	10,740	10.21			
Indianapolis	950	440	2,160	8,050	760	5.3	10,590	8.47			
Louisville	810	380	2,130	6,200	590	4.6	10,510	7.65			
Salt Lake City	800	470	1,700	5,330	510	5.6	10,450	6.66			
Columbus	850	310	2,740	8,350	800	5.8	10,440	9.82			
Nashville	570	500	1,140	5,000	490	4.6	10,200	8.77			
Orlando	850	410	2,070	5,950	590	4.9	10,080	7.00			
Oklahoma City	740	500	1,480	6,940	720	5.1	9,640	9.38			
El Paso	2,880	210	13,710	3,330	350	5.2	9,510	1.16			
Kansas City	1,160	610	1,900	12,560	1,360	4.4	9,240	10.83			
Corpus Cristi	280	180	1,560	1,560	190	5.4	8,210	5.57			
Pittsburgh	1,870	740	2,530	8,200	1,000	4.3	8,200	4.39		•	
Charlotte	450	240	1,880	2,300	300	4.2	7,670	5.11			
CRANDIC	140	300	470	560	94	4.6	5,960	4.00			

source: Estimates of Urban Roadway Congestion - 1990, FHWA, March 1993; Iowa Department of Transportation; Iowa State University; and Wilbur Smith Associates

Interstate 380 Summary

The rapid growth in I-380 traffic volumes between 1982 to 1992 and the near completion of the Avenue of the Saints Corridor suggests that traffic volumes in the I-380 corridor may grow at high annual rates. This could lead to traffic congestion as the interstate highway traffic volumes approach the 13,000 DVMT per lane mile, and strengthen the case for the need of urban passenger rail. Conversely, recent data indicates a leveling-off of annual traffic growth rates. The extensive Avenue of the Saints traffic modeling forecast suggested a lower growth rate of 1.9 percent. In addition, the study area's low population, employment, registered vehicles and overall declining public transportation ridership levels suggest that transient traffic will compose a large portion of future interstate traffic volumes increases. In fact, the traffic counts discovered that only 30 percent of the traffic were passenger cars from Linn and Johnson Counties.

Such low regional growth rates indicate that a more effective solution to any I-380 congestion problems may be the construction of additional lanes in the urban areas where high DVMT per lane mile is likely to occur, such as Cedar Rapids. Therefore, it appears that I-380 may require a lane expansion in each direction between the years 2010 and 2030 (15 to 35 years) assuming that the actual annual traffic volume growth rate average is between 4.0 and 2.0 percent.

It appears doubtful that the creation of an urban passenger rail system between Iowa City and Cedar Rapids will greatly deter I-380's expansion needs. The low percentage (30%) of passenger vehicle traffic on the interstate between Iowa City and Cedar Rapid suggest that the total potential ridership base would be 9,900. Assuming a Statewide public transit usage of 1.2 percent of the workforce, a rough estimate would indicate a potential ridership level of about 120 people, with a slow growth rate of approximately 1.0 percent per annum. Section 7 analyzes ridership potential in more detail.

INTERCITY BUS SERVICE

Three intercity bus companies provide transportation between Cedar Rapids and Iowa City, including Jefferson Lines, Greyhound, and Burlington Trailways. Burlington Trailways and Jefferson Lines interline their service, providing through service to St. Louis and St. Paul. The bus for Cedar Rapids leaves Iowa City at 12:40 p.m. and the bus for Iowa City to Cedar Rapids leaves at 2:00. Greyhound operates three buses from Iowa City and Cedar Rapids and two buses from Cedar Rapids to Iowa City. The scheduled trip time is 35 minutes for all scheduled trips for a one way fare of $4.75. Table 4-3 illustrates the bus schedules for all three lines.

The intercity bus schedules between Cedar Rapids and Iowa City are determined by connections to other destinations, such as Minneapolis, St. Louis or Chicago. Therefore, they do not provide transportation at appropriate times for commuters between Iowa City and Cedar Rapids. Currently, the use of intercity bus service as a viable transportation alternative between Cedar Rapids and Iowa City is limited. Those individuals not restricted by time and with no other viable alternative would use this service.

Table 4-3
INTERCITY BUS SCHEDULES
Greyhound, Jefferson Lines, and Burlington Trailways

Departing Cedar Rapids to Iowa City	Departing Iowa City to Cedar Rapids
11:50 a.m. (Greyhound)	5:10 a.m. (Greyhound)
2:00 p.m. (JL and BT)	12:40 p.m. (JL and BT)
5:35 p.m. (Greyhound)	1:50 p.m. (Greyhound)
	5:50 p.m. (Greyhound)

Source: Greyhound, Burlington Trailways, and Jefferson Lines

PUBLIC TRANSPORTATION

Cedar Rapids, Coralville and Iowa City have existing public transit systems within close proximity to the CRANDIC rail line that could be used in coordination with rail passenger service. The central transit hub in Iowa City serves all three transit systems and the Cedar Rapids GTC serves all of the routes operating in Cedar Rapids. Coordinating schedules and station locations would allow people living farther away to use the transit system to get to the rail line without worrying about parking or accessibility.

The local general public transportation services' ridership and system characteristics are summarized in Table 4-4. Corridor wide, the 89 vehicles in 1994 served 7.8 million passengers who rode 4.1 million miles. Available data on historical annual ridership levels is shown in Table 4-5.

Johnson County

Johnson County has three operating transit systems and a para-transit system. These include Coralville Transit, Iowa City Transit, and Cambus. Coralville Transit and Iowa City Transit

Table 4-4
GENERAL PUBLIC TRANSPORTATION SYSTEM SUMMARY
CRANDIC Corridor - FY 1993

	Cedar Rapids (Five Seasons)	Coraville (Coraville Transit)	Iowa City (Iowa City Transit)	Univ. of Iowa (Cambus)
SERVICE TYPE	Fixed Route, Demand-Response, Subscriptiion	Fixed Route, Demand-Response, Subscriptiion	Fixed Route, Demand-Response	Fixed Route, Demand-Response
RIDERSHIP (FY 1993)				
Annual Volume	1,469,968	458,968	1,542,023	3,957,368
Percent Breakdown:				
Elderly	10.0%	3.0%	6.0%	0.5%
Disabiled	6.0%	1.0%	4.0%	1.0%
Student/Headstart/Child.	29.0%	3.0%	8.0%	0.5%
Other	55.0%	93.0%	82.0%	98.0%
Total	100.0%	100.0%	100.0%	100.0%
Annual Revenue Miles	1,071,118	194,750	777,568	592,123
SYSTEM CHARATERISITICS				
Revenue Vehicles				
Large Bus	37	10	21	17
Small Bus	5	--	--	4
Van	1	--	--	--
Minivan	1	--	--	--
Auto	--	--	--	--
Total	44	10	21	21
PEAK VEHICLE REQUIREMENTS	34	6	16	17

Table 4-5
ANNUAL RIDERSHIP on GENERAL PUBLIC TRANSIT SYSTEMS
CRANDIC Corridor

Year	Cedar Rapids (5 Seasons)	Coraville Transit	Iowa City Transit	CAMBUS
1983	na	520,000	2,500,000	3,000,000
1984	na	540,000	2,400,000	3,350,000
1985	na	480,000	2,300,000	3,375,000
1986	na	475,000	2,200,000	3,250,000
1987	na	450,000	1,800,000	2,600,000
1988	na	435,000	1,450,000	3,000,000
1989	na	425,651	1,486,350	3,380,217
1990	1,594,598	421,000	1,508,837	3,635,000
1991	1,534,819	425,000	1,515,000	3,650,000
1992	1,466,673	448,863	1,514,217	3,906,818
1993	1,469,968	458,968	1,542,023	3,957,368
1994	1,474,338	na	na	na

sources: Five Seasons Transport, Iowa City Urbanized Area Transit Plan, Transit Contacts Service Summary, Region 10 Transit Development Plan, U.S. Department of Transportation - Transit Profiles provide access to downtown Iowa City from their respective communities. Cambus operates a free transit system around the University. It also provides direct service to the Oakdale Campus that is currently being used as a park-and-ride facility for commuters to the University. Elderly and disabled para-transit service is provided by Johnson County SEATS.

Coralville Transit - owns 10 buses and operates a maximum of 6 buses during peak periods. Transit operations are conducted Monday through Saturday, primarily within the Coralville city limits. Service is provided to a population base of approximately 71,400 people within 30 square mile, which includes connections to the other two transit systems at a center transfer point in Iowa City. The annual ridership is approximately 460,000, with three percent being elderly, one percent disabled persons, and three percent students. Adult cash fares are $0.50 per one way trip.

Iowa City Transit - also services a population base of 71,400 people within a 30 square mile area. It operates a maximum of 16 buses during peak periods (owns 21), Monday through Saturday, entirely within the city limits of Iowa City. The annual ridership is approximately 777,600, with six percent being elderly, four percent disabled persons, and eight percent students. The existing transit hub is located approximately one block from the CRANDIC rail line. Adult cash fares are $0.50 per one way trip. The Johnson County Council of Governments (JCCOG) conducted an on-board survey of Iowa City Transit users in 1990 that revealed:

- The predominant use of Iowa City Transit (92%) was for persons going to school or work;
- The two main reasons people use the Iowa City Transit were because they have no other means of transportation available (29%) and because of parking problems (25%).
- Most people who ride Iowa City Transit (59%) are between age 26 and 59 (the working age group). The next highest usage was among those age 18-25 (27%, college age group). School children and the elderly comprise a small percentage of users.

Cambus - is owned and operated by the University, and operates a maximum of 17 buses (owns 21) seven days a week, primarily to University locations. Cambus operates a free service open to the general public, and a demand response system which serves the University campus. The annual ridership is approximately four million, primarily University of Iowa students.

SEATS - Johnson County SEATS specializes in transportation of the elderly and disabled in Iowa City, Coraville and University Heights. Door-to-door transportation is offered seven days a week to persons with disabilities and persons 60 years of age and older for a suggested donation of $1.00 per trip. Scheduled requests are required at least 24 hours in advance.

Linn County

Linn County has two public transit systems--Five Seasons and LIFTS.

Five Seasons Transportation - operates the municipal transit system in Cedar Rapids with a maximum of 34 buses (owns 44) in peak service. Service is provided Monday through Saturday mainly in the Cedar Rapids area. The transit hub is located at the Ground Transportation Center (GTC) located in downtown Cedar Rapids, within close proximity to the CRANDIC rail corridor. The facility also houses intercity carriers. The annual ridership is approximately 1.5 million, with ten percent being elderly, six percent persons with disabilities, and twenty-nine percent students and children. Adult cash fares are $0.50 per one way trip.

LIFTS - owns 17 buses and 8 vans, and operates a modified fixed route and provides 24 hour advance service for the elderly, persons with disabilities and the general public. Service is available Monday through Friday from Cedar Rapids to Iowa City, and typically ranges between 5 and 15 one- way trips per day.

IOWA AMTRAK SERVICE[2]

Passenger service in Iowa currently operates over two routes, those of the *California Zephyr* and the *Southwest Chief.* The *Desert Wind* and the *Pioneer* are combined with the *Zephyr* through Iowa, as shown in Exhibit 4-3. The *California Zephyr* currently provides service between Chicago and San Francisco, with one eastbound and one westbound train passing daily through Iowa with stations in the communities of Burlington, Mt. Pleasant, Ottumwa, Osceola, and Creston along the Burlington Northern (BN) main line. At Salt Lake City, the *Desert Wind* splits off to Los Angeles and at Denver, the *Pioneer* heads through Wyoming to Seattle. Iowa's other route, the *Southwest Chief*, has only one Iowa stop at Fort Madison. The *Southwest Chief* provides daily two-way service between Chicago and Los Angeles over the Santa Fe Railway.

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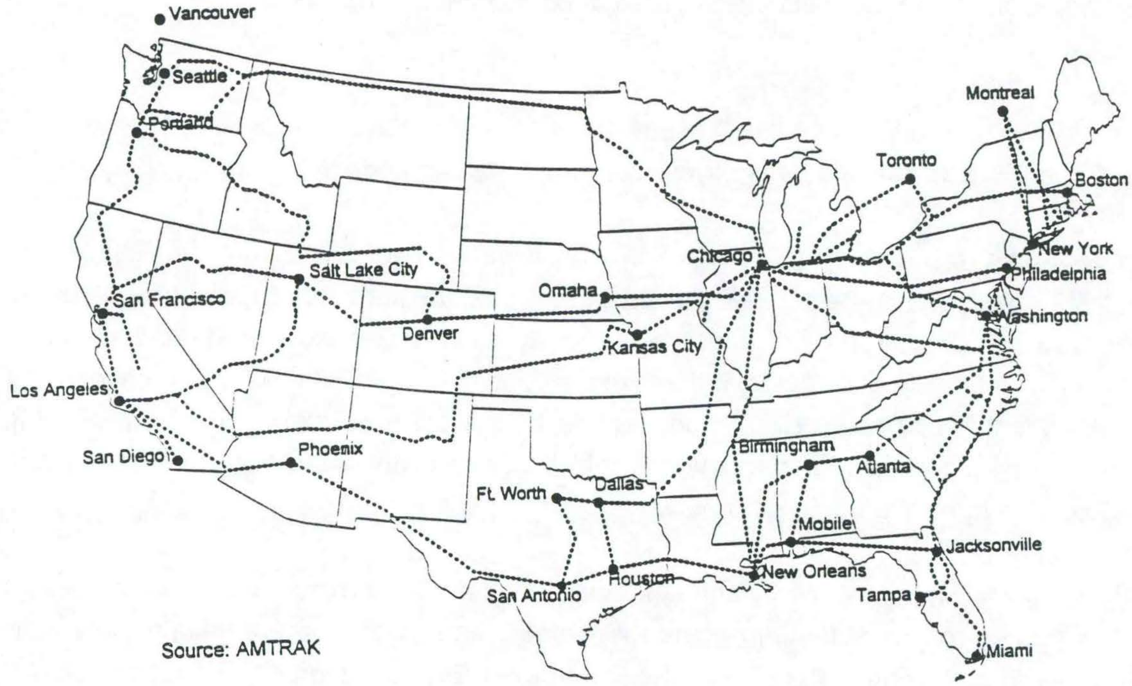
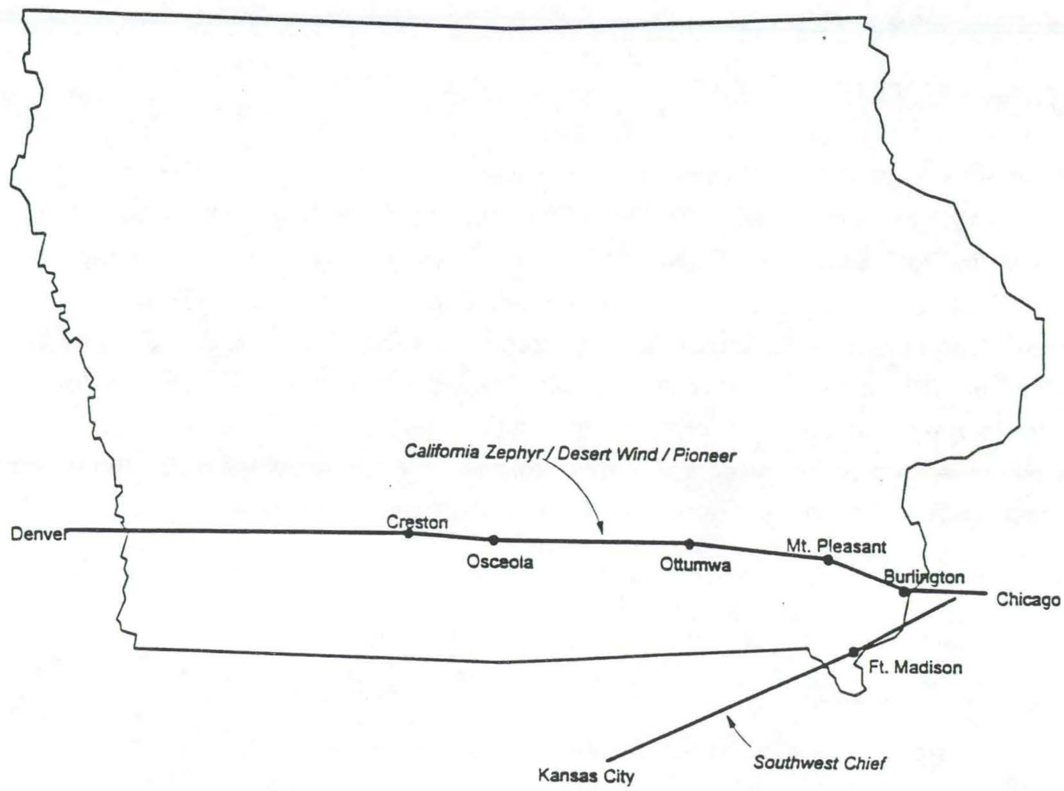
[2] Wilbur Smith Associates; *Iowa Rail Plan*, Iowa Department of Transportation, 1995.

Exhibit 4-3
EXISTING AMTRAK SYSTEM - 1994
The United States and Iowa



Source: AMTRAK



The total number of passengers arriving and departing from Iowa Amtrak stations has declined steadily since 1985, as shown in Exhibit 4-4. The total number of Iowa passengers on the *California Zephyr* has decreased from 45,750 in 1985 to 41,617 in 1993, representing a loss of over 4,000 annual passengers (9 percent), see Table 4-6. The *Southwest Chief's* Fort Madison station has lost over 4,900 passengers per year or a 50 percent loss since the mid 1980s. More specifically, every rail passenger station in Iowa has experienced between a 4 and 50 percent decline in passengers with the exception of Osceola. The number of passengers using the station at Osceola has increased by 60 percent since the mid 1980s, with over 13,500 passengers in 1993.

Proposed Service to Central Iowa

Communities located along the Union Pacific (UP)[3] route serving Clinton, Cedar Rapids, Ames and Carroll have long expressed a strong interest in the initiation of Amtrak rail passenger service through central Iowa. Amtrak has evaluated several proposals for service to central Iowa including moving the entire *California Zephyr/Desert Wind/Pioneer* service from southern Iowa to central Iowa, moving the *Desert Wind/Pioneer* service to central Iowa, and adding additional rail passenger service through central Iowa from Chicago to Omaha.

This interest was originally expressed as a desire to have *the California Zephyr/Desert Wind/Pioneer* service rerouted from the present BN route in southern Iowa to the UP route. Amtrak considered this proposal in 1987. However, the modest gains in revenue projected for the UP route would have been largely offset by the estimated cost of establishing a crew base at Clinton, equipping Amtrak locomotives with UP cab signals, and longer westbound travel times.

In 1990, Congress passed Public Law 101-322, referred to as the Amtrak Re-authorization and Improvement Act of 1990. The act directed Amtrak to study "the economic feasibility of providing new service, if such service will have the potential of covering the operating costs associated with such service, to areas not served by the Corporation as of the date of enactment of this Act." It also more specifically directed Amtrak to study "the short-term and long-term revenue and cost implications of separating the existing California Zephyr/Desert Wind/Pioneer train into two service routes serving separate western destinations via a southern route and a central route through Iowa."

[3] Note that CNW was recently acquired by the Union Pacific Railroad (UP).

Exhibit 4-4
HISTORIC AMTRAK RIDERSHIP in IOWA
1985 to 1993

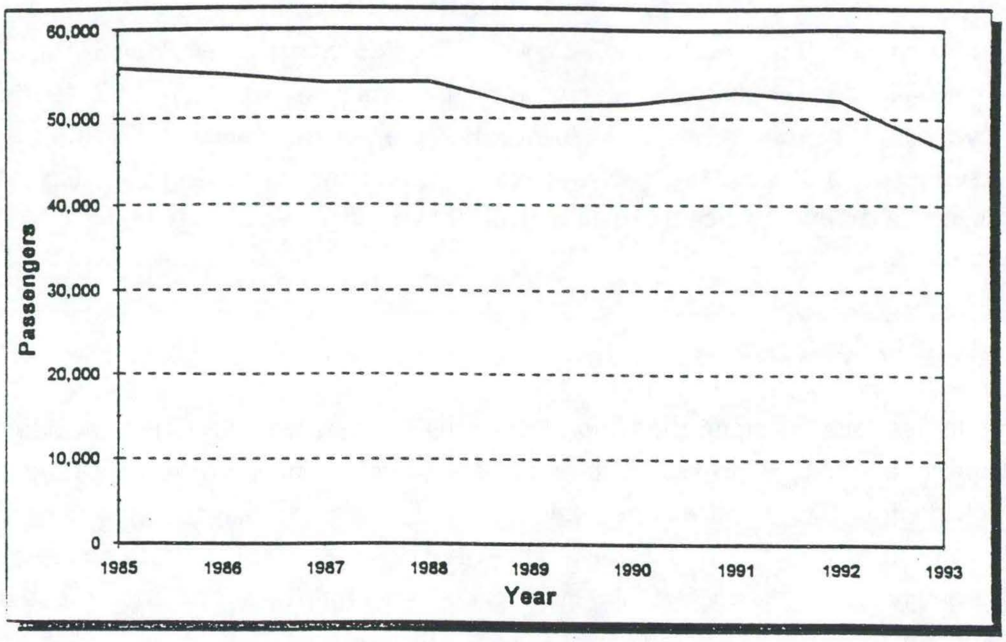


Table 4-6
HISTORIC AMTRAK RIDERSHIP in IOWA
1985 to 1993

Iowa Stations	1985	1986	1987	1988	1989	1990	1991	1992	1993
Burlington	10,850	10,849	11,105	9,569	8,955	9,058	9,145	8,900	7,365
Mount Pleasant	8,369	9,362	8,773	9,488	8,913	9,077	9,459	9,044	8,023
Ottumwa	12,838	10,947	10,611	10,700	10,055	9,916	10,714	10,111	9,433
Osceola	8,482	8,572	9,704	11,278	11,766	12,289	13,301	13,921	13,537
Creston	5,211	5,086	4,580	4,747	3,973	4,668	3,974	3,790	3,259
Subtotal California Zephyr	45,750	44,816	44,773	45,782	43,662	45,008	46,593	45,766	41,617
Fort Madison	9,911	10,055	9,169	8,342	7,640	6,711	6,365	6,148	4,986
Subtotal Southwest Chief	9,911	10,055	9,169	8,342	7,640	6,711	6,365	6,148	4,986
Total	55,661	54,871	53,942	54,124	51,302	51,719	52,958	51,914	46,603

Source: Amtrak

Amtrak responded to the mandate with its report to Congress in 1991. It indicated that the new route would require two locomotives and 53 cars to initiate a separate operation. In the report, Amtrak recommended that Iowa and Illinois explore the operation of a 403(b) service between Chicago and Omaha. Section 403(b) of the Rail Passenger Service Act allows states to request additional service with the stipulation that costs for such services would be shared by those states.

Proposed 403(b) Service

Following the release of Amtrak's report, the states of Iowa, Illinois and Nebraska requested Amtrak to study the feasibility of 403(b) service between Chicago and Omaha through central Iowa. The proposed service through central Iowa would use existing UP track and have stations at Clinton, Cedar Rapids, Marshalltown, Ames, Carroll, and Omaha/Council Bluffs. There would also be a coordinated bus service to the Ames station from Des Moines. Amtrak concluded that the proposed route was feasible. The 403(b) train would require between \$3.7 to \$10.8 million for initial capital expenditures for equipment. The annual operating subsidy required by Amtrack from Iowa is estimated to be \$1.8 million in the first year and \$1.7 million in subsequent years. Each city served would be expected to provide a suitable rail passenger station.

The Iowa Legislature passed a bill mandating the proposed service be further evaluated and, in 1992, created the passenger rail service revolving fund and provided for administration of the program. The Iowa DOT was required to begin discussions with Illinois and Nebraska, the then CNW Railroad, Amtrak, and the Iowa Congressional Delegation to facilitate the proposed rail passenger service. The following are the results of those discussions.

Discussions with Illinois and Nebraska - Meetings were held with officials from both Illinois and Nebraska to discuss their interest in the proposed 403(b) service. Both states expressed interest in such a proposal. Illinois is currently one of largest participants in 403(b) service and has the legislative authority to begin additional service contingent on receiving the necessary appropriations. However, they are looking to Iowa to demonstrate their ability to meet the funding obligations prior to making an appropriations request.

Nebraska officials were also interested in a 403(b) service, especially the proposed service to Omaha. They are also exploring similar service between Lincoln and Omaha as well as Omaha and Kansas City. Like Illinois, Nebraska officials are waiting for a funding commitment from Iowa before pursuing the project.

Both Illinois and Nebraska have expressed a strong interest in bringing 403(b) service to their states. Some preliminary discussion of dividing costs between the states has been initiated, but future discussions are not warranted prior to Iowa's funding commitment. In other words, the stage is set for a multi-state agreement on the proposed 403(b) service depending on Iowa's ability to obtain funding.

Discussions with Amtrak - The Iowa DOT held a meeting with Amtrak to discuss the development of a service agreement and a cost-effective method of acquiring the locomotives and rail cars. Amtrak outlined several steps that must be accomplished. The first step is for the states to prepare a funding agreement to splitting the 70 percent match required for operating shortfalls, plus the entire capital equipment cost. The Rail Passenger Service Act allows for Amtrak to use UP lines for passenger service and Amtrak would be responsible for negotiating access to the line. In general, Amtrak was cooperative and enthusiastic about helping the states reach their passenger service goals.

Discussions with UP - Meetings were held with UP officials to discuss service plans, costs of service, compensation, use of trackage, and timetables for implementation. UP expressed their interest in providing passenger service contingent on recovering its costs and a lack of interference with its freight operations.

Discussions with Iowa's Congressional Delegation - Iowa DOT staff worked closely with Iowa Congressional Delegation offices to discuss new authorizations and additional appropriations for the proposed 403(b) service.

Central Service Conclusions - The Iowa DOT believes the state should continue its push to acquire passenger service on the UP line through central Iowa. The basis for such an opinion is reflected in:

- Cities along the route have committed to financing stations, platforms and maintenance costs;
- Strong interest and cooperation have been expressed by the bordering states of Illinois and Nebraska;
- Amtrak officials have been very cooperative and supportive;
- There has been excellent cooperation and assistance from Iowa's Congressional Delegation;
- UP management has been very cooperative and willing to establish service;
- The General Assembly enacted enabling legislation establishing a revolving fund and providing for its administration;

- The Iowa Transportation Commission and Iowa DOT staff are providing strong support; and,
- There is continued strong support from the public at large.

North-South Service

The same legislation resulted in Amtrak examining another route that would serve Iowa running between Minneapolis and Kansas City using UP's north-south main track. A direct connection at Chariton with the *California Zephyr* and with the *Southwest Chief* at Kansas City would be possible and Des Moines would be served. It was estimated that three locomotives and nine cars would be required for the service at an estimated capital cost of $14.9 million. The annual subsidy requirement was estimated at $800 to $900 thousand.

Amtrak and CRANDIC

If Amtrak decides to expand service to northern Iowa, the CRANDIC rail line could provide connector service from Iowa City. Amtrak has estimated that a new route would generate around 90,000 passengers per year. Passengers arriving and departing in Cedar Rapids could be expected to range between 5,000 and 15,000 passengers per year. Based on mode of access studies completed for other rail passenger feasibility reports, it is not expected that many passengers would transfer from the CRANDIC to Amtrak.

CEDAR RAPIDS MUNICIPAL AIRPORT

The Cedar Rapids Municipal Airport is adjacent to the proposed regional rail passenger service. The airport is currently used by business travelers, students, and the general population in both Cedar Rapids and Iowa City. The location of the airport between Cedar Rapids and Iowa City and its proximity to the existing rail line would provide a public transportation alternative for trips to both communities from the airport.

The Federal Aviation Administration (FAA) currently classifies the Cedar Rapids Municipal Airport as a small air traffic hub, handling a variety of major, commuter, regional, and cargo airlines. The average annual number of air passengers has increased by 3.3 percent per year since 1980. In 1994, the Cedar Rapids Municipal Airport handled over 789,045 passengers or 2,170 per day. Table 4-7 indicates the growth in air passengers at the Airport since 1980. Based on a three percent annual growth rate, passenger traffic volumes in the year 2010 will be approximately 1.26 million, an overall growth of 60.5 percent.

The air passengers are currently served by four national and five regional airlines. The national airlines include United, Northwest, U.S. Air and Transworld Airlines. The regional airlines include American Eagle, Chicago Express, Comair, Northwest Airlink, and Transtate Airlines. These airlines provide direct, non-stop flights to St. Louis, Waterloo, Chicago, Cincinnati, Kansas City, Minneapolis, and Denver.

Current ground transportation used to and from the airport consists primarily of four rental car dealers (Avis, Hertz, National, and Budget), several hotel shuttle services, three taxi companies, and one limousine service. All these services rely on I-380 for ground access to Cedar Rapids or Iowa City from the Airport.

Table 4-7
ANNUAL AIR PASSENGERS
Cedar Rapids Municipal Airport

Year	Air Passengers
1980	498,821
1981	412,396
1982	385,888
1983	417,972
1984	485,571
1985	553,477
1986	791,185
1987	819,000
1988	765,204
1989	734,163
1990	810,922
1991	779,231
1992	793,349
1993	769,303
1994	789,045

Source: Cedar Rapids Municipal Airport

Section 5

RAILROAD INFRASTRUCTURE

Section 5
RAILROAD INFRASTRUCTURE

The key elements of re-introducing passenger service on an existing freight-only railroad are the suitability of the existing facilities to support joint freight and passenger operations and the willingness of the railroad to accommodate passenger train operations. The CRANDIC has expressed a willingness to work with the East Central Iowa Council of Governments to re-introduce rail passenger service in the Cedar Rapids to Iowa City corridor. Thus, this report section will focus on existing freight operations and infrastructure conditions in the corridor; identification of improvements needed to support joint rail freight and passenger operations in conformity with Federal Railroad Administration (FRA) regulation and track standards; and, development of capital funding requirements.

CORRIDOR CHARACTERISTICS

The Cedar Rapids to Iowa City rail corridor begins at Green Park located between 3rd and 4th Avenue Southeast (near the site of CRANDIC's former interurban passenger station) in the Cedar Rapids Central Business District (CBD) and terminates at the CRANDIC's depot on the University of Iowa's campus just south of Burlington Street in Iowa City, a distance of approximately 27.1 miles. Between these two points the route passes through the communities of Swisher, North Liberty, Oakdale and Coralville. The trackage comprising the corridor, illustrated in Exhibit 5-1, is owned by two different railroads and is classified as branch line or yard and industrial switching trackage.

Union Pacific Railroad (UP)

The UP owns the first 1,500 feet of the corridor located in downtown Cedar Rapids between 3rd Avenue Southeast and 8th Avenue Southeast. This trackage is a portion of the UP's Cedar Rapids Branch. This segment of trackage has high density commercial land use adjacent to the right-of-way.

Cedar Rapids and Iowa City Railway (CRANDIC)

The next 1.7 miles of the corridor are owned by the CRANDIC and are comprised of yard and interchange trackage known as Vera Yard or the Corridor Track. This segment of track is located between 8th Avenue Southeast and the CRANDIC Shops (MP 0.0) in southwestern Cedar Rapids and includes a crossing of the Cedar River south of the CBD. Medium density industrial land use and older residential neighborhoods lie along the right-of-way west of the Cedar River. This segment of track is devoted to industrial switching and CRANDIC yard operations.

The remaining 25.1 miles of the corridor are a portion of the CRANDIC's First Subdivision that extends from the CRANDIC's Shops in Cedar Rapids to the depot in Iowa City (MP 25.1). The land use adjoining this segment of the corridor is primarily suburban development and rural farm land marked by rolling hills. Enroute to Iowa City the line crosses the Iowa River near the Coralville Reservoir, part of Lake McBride, and runs through the Oakdale campus of the University of Iowa.

The CRANDIC-owned portion of the corridor is governed by yard limit rules that restrict the maximum speed of operation to yard speed. Yard speed is defined as a speed that will permit stopping within one half the range of vision short of a train, engine, railroad car, on track equipment or stop signal, not to exceed 20 mph. Additional speed restrictions on the route include a 5-mph speed restriction over the UP's trackage in the Cedar Rapids CBD, 10-mph restrictions between the CBD and MP 3.5 in Cedar Rapids and from MP 22.3 to MP 25.1 in Iowa City, and three 15-mph restrictions through the communities of Swisher, North Liberty and Oakdale.

EXISTING RAILROAD OPERATIONS AND FACILITY CONDITIONS

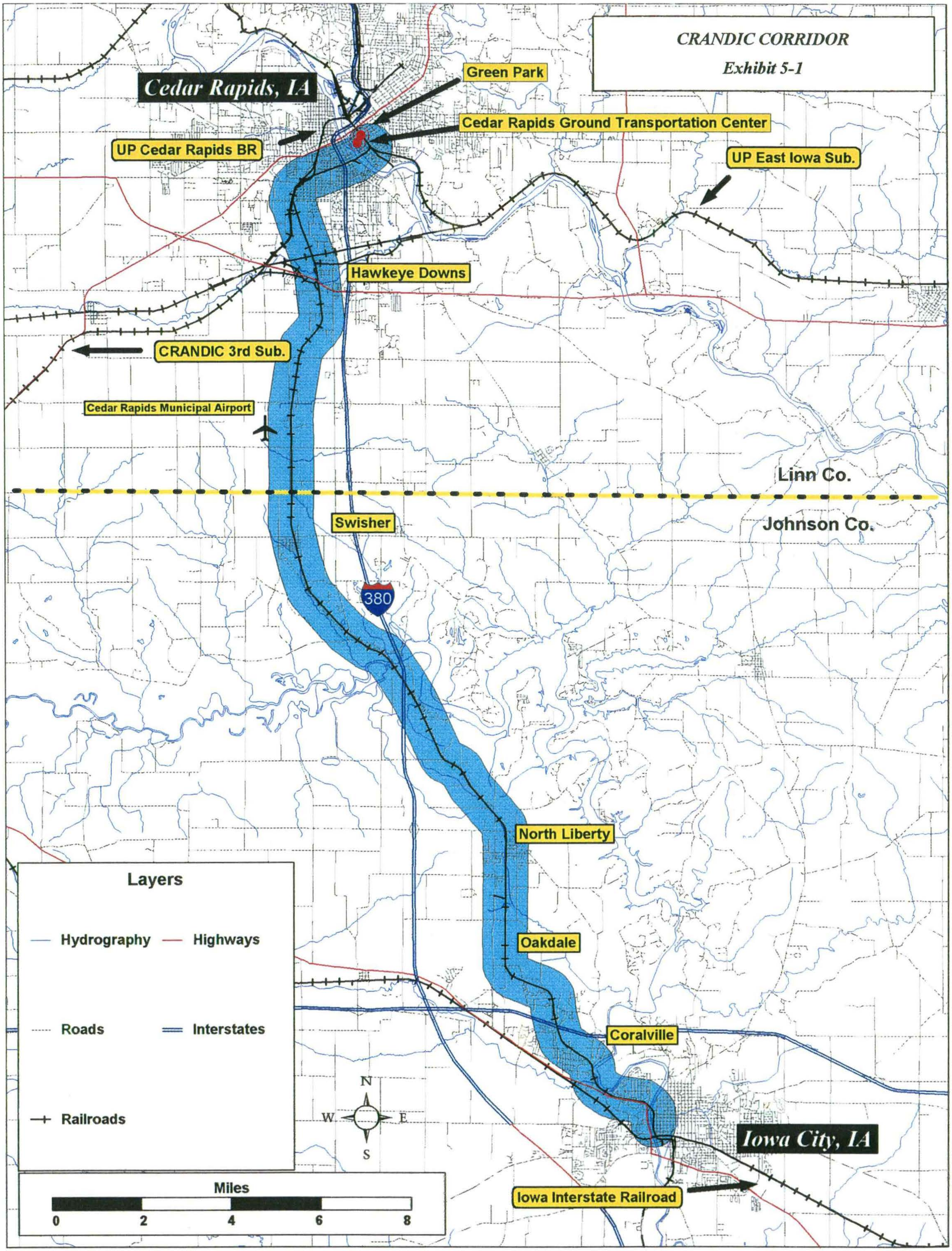
During the course of the study the Consultant met with CRANDIC operating and engineering officials to discuss current and future freight operations, and perform a field inspection of corridor trackage.

Freight Operations and Potential Conflicts

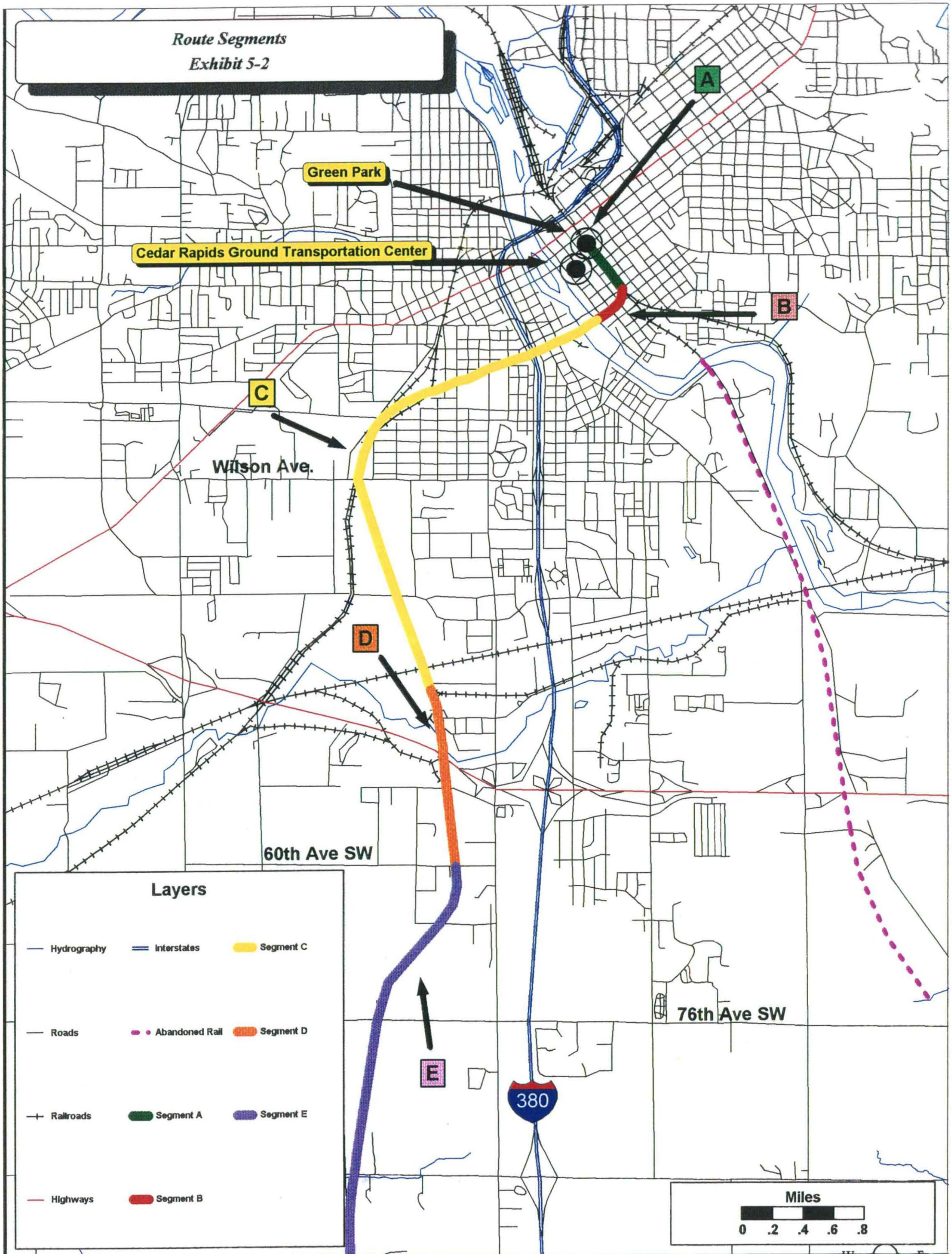
Rail usage varies significantly over specific segments of track within the corridor. Thus, to aid in the analysis, the corridor was subdivided into several segments based on ownership and usage levels. The limits of each segment are described in the following paragraphs and shown in Exhibit 5-2.

Segment A - UP trackage in Cedar Rapids between 3rd Avenue Southeast and 8th Avenue Southeast, approximately 1,500 feet in length.

Segment B - The CRANDIC Corridor trackage between 8th Avenue Southeast and 1st Street Southeast in Cedar Rapids, approximately 1,500 feet in length.



CRANDIC CORRIDOR
Exhibit 5-1
Cedar Rapids, IA
Green Park
Cedar Rapids Ground Transportation Center
UP Cedar Rapids BR
UP East Iowa Sub.
Hawkeye Downs
CRANDIC 3rd Sub.
Cedar Rapids Municipal Airport
Linn Co.
Johnson Co.
Swisher
380
North Liberty
Oakdale
Coralville
Iowa City, IA
Iowa Interstate Railroad
Layers
Hydrography
Highways
Roads
Interstates
Railroads
N
W
E
S
Miles
0
2
4
6
8


Route Segments
Exhibit 5-2
A
Green Park
Cedar Rapids Ground Transportation Center
B
C
Wilson Ave.
D
60th Ave SW
76th Ave SW
E
380
Layers
Hydrography
Interstates
Segment C
Roads
Abandoned Rail
Segment D
Railroads
Segment A
Segment E
Highways
Segment B
Miles
0 .2 .4 .6 .8

Segment C - A combination of CRANDIC's Corridor trackage and a portion of the CRANDIC's First Subdivision between 1st Street Southeast and Pinney (MP 2.1) in Cedar Rapids, approximately 3.5 miles in length.

Segment D - A portion of the CRANDIC's First Subdivision between Pinney (MP 2.1) and 60th Street Southwest (MP 3.1), a distance of approximately 1.0 mile.

Segment E - A portion of the CRANDIC's First Subdivision between 60th Street Southwest (MP 3.1) and Iowa City (MP 25.1), a distance of approximately 22.0 miles.

Operations within each segment are discussed in the following paragraphs:

Segment A - As previously described, Segment A is a portion of UP's Cedar Rapids Branch that diverges from UP's East Iowa Subdivision at Beverly and loops through Cedar Rapids before rejoining the main line at Otis. The UP serves a number of industries from this line, but Quaker Oats located three blocks north of Green Park is far and away the UP's biggest customer on the line. To serve this facility requires that the railroad make multiple back-and-forth switching moves over the segment several times per day 7 days a week. In addition, the Chicago Central and Pacific Railroad Company (CCP), Iowa Northern Railway (IANR), CRANDIC, and UP interchange traffic over this segment. This track segment is heavily used and usage for passenger operations may be difficult.

Segment B - This is a single-track portion of the CRANDIC's Corridor Track east of the Cedar River crossing used by the CRANDIC, IANR, CCP, and UP for the interchange of freight traffic. There are no longer any rail-served industries located on this segment and the majority of the interchange movements are performed at night. However, since the UP's purchase of the CNW, the UP has approached the CRANDIC about the possibility of using the CRANDIC trackage to provide service to Quaker Oats so that they can eliminate their bridge over the Cedar River just north of the I-380 crossing. If this occurs, usage of this segment for passenger train operations may be restricted.

Segment C - This portion of the Corridor Track and the CRANDIC's First Subdivision is by far the heaviest used section of the CRANDIC under consideration. Virtually all of the CRANDIC's major customers are either located on this segment or receive traffic via this segment. In addition to industrial and yard switching, a portion of the segment is used to gain access to an industrial spur, known as the REA Line, that diverges from the main line at Hawkeye Downs and serves IES Utilities Prairie Creek Power Plant (one of the CRANDIC's largest customers and parent company), and CRANDIC's Third Subdivision a 21.8 mile branch line that diverges at Pinney (MP 2.1) and terminates at Homestead, an Iowa Interstate Railroad (IAIS) interchange point. A portion of this segment would also be used by UP trains to serve Quaker Oats as discussed in the previous segment.

Currently, seven to eight switch crews on weekdays and five on weekends are utilized in this area to keep pace with demand for industrial switching and building trains for interchange with other railroads. Due to the high volume of traffic that is concentrated in this area, the main track is utilized almost continuously during the performance of these tasks. CRANDIC officials have indicated that their ability to accommodate passenger operations over this segment will depend largely on the number and timing of passenger train movements. This segment of track will pose the greatest obstacle to entering the Cedar Rapids CBD.

Segment D - As in the previous segment, this segment too is used to switch industrial customers, primarily Archer Daniels Midland Company (ADM), the CRANDIC's largest customer. However, time spent occupying the main track is less than Segment C. However, recent increases in traffic and a lack of storage track space have greatly diminished capacity. Usage of this segment may require the construction of additional storage tracks to keep the main line open and/or a second main track to improve capacity and minimize freight conflicts.

Segment E - There are only three industries located on this segment. Service is provided by the same train that interchanges traffic with the IAIS at Iowa City. Because this train operates at night, freight service should have little or no impact on contemplated passenger service from an operating standpoint.

Operating Conclusions - Operating characteristics of the CRANDIC have changed significantly since it last operated interurban passenger service. Freight traffic conflicts associated with Segments C and D currently pose the greatest threat to proposed passenger operations within the corridor and greatly impact the scheduling of passenger trains into the Cedar Rapids CBD. However, the addition of UP traffic over segments A, B, and a portion of C would virtually eliminate access to the CBD. To avoid conflicts associated with Segments A, B and C, the northern terminus of passenger service could be located near Hawkeye Downs race track. However, this operating arrangement would require Cedar Rapids transit buses to operate feeder service between the race track and the Cedar Rapids GTC in the CBD in order to provide day base service between downtown Cedar Rapids and Iowa City. Other options could include the use of the UP line between Wilson Avenue and Green Park, or the construction of a new line that runs parallel to the UP from Wilson Avenue to 3rd Avenue Southwest and then follows the alignment that was once used by the interurban passenger trains to what is now the Cedar Rapids GTC located on the east bank of the Cedar River.

Track Inspection

An inspection of the corridor's trackage, as well as the CRANDIC's Third Subdivision, was conducted between January 30th and 31st, 1995. The inspection was accomplished by viewing the trackage from a hyrail vehicle augmented by walking short segments. The purpose of the inspection was to determine the present condition of the trackage, assess its suitability to accommodate joint rail freight and passenger operations based on FRA regulations and track safety standards, and to gather sufficient data to identify needed capital improvements and develop funding requirements. Facility conditions and physical plant layout considerations observed and noted during the inspection included:

- Cross Ties and Switch Ties
  - average number of defective ties per mile
  - number of defective ties per turnout
- Rail
  - pattern weight
  - age
  - jointed or welded
  - condition (bent, battered, wear)
- Joints
  - type
  - wear
  - number of bolts per joint
  - joint tightness
- Tie Plates
  - type (single or double shoulder)
  - wear
- Rail Anchors
  - type
  - number per rail
  - effectiveness
- Grade Crossings
  - number
  - condition
  - type crossing surface
  - type of crossing protection
  - approximate length
- Turnouts
  - size
  - rail pattern weight
  - general condition
- Bridges
  - general conditions
- Surface and Alignment
  - low joints
  - irregular cross level and/or alignment
  - profile deficiencies
- Ballast Section
  - full or lean
  - type ballast (gravel, limestone, granite)
  - condition (clean or fouled)
- Industrial Side Tracks
  - number
  - active or inactive
  - location
- Railroad Company Side Tracks
  - type (storage track or passing track)
  - approximate length
  - condition (ties, rail, other track material, etc.)
  - location
- Connections Between the Various Lines
  - existing
  - required

FRA Track Safety Standards

Minimum safety requirements for railroad track that is part of the general railroad system of transportation have been established by the United States Government and are administered by the FRA. The requirements apply to specific track conditions that may exist and can effect the safety of trains operating over the track.

The standards have established classes of track and the maximum allowable operating speed (in miles per hour) corresponding to each class, as follows:

*	**	***
Class 1 Track	10	15
Class 2 Track	25	30
Class 3 Track	40	60
Class 4 Track	60	80
Class 5 Track	80	90
Class 6 Track	110	110

* Over track that meets all of the requirements prescribed in this part for Class # Track.
** The maximum allowable operating speed for freight trains.
*** The maximum allowable operating speed for passenger trains.

The classes of track vary in the following manner.

Track Geometry

Gage: Gage is measured between the heads (or tops) of the rails at right-angles to the rails in a plane 5/8 of an inch below the top of the rail head. Standard gage is 4 feet 8 ½ inches between rail heads. The tolerance in this measurement varies by class, with Class 1 track 4' 8" to 4' 10" and Class 6 track 4' 8" to 4' 9 ¼".

Alignment: Alignment is a railroad's horizontal location as described by curves and tangents. Alignment may not vary more than a prescribed amount - on tangent track it is 5" in a 62-foot length for Class 1 track and ½ " in a 62-foot length for Class 6 track.

Elevation of Curved Track: If a curve is elevated (or superelevated) with the rail on the outside of the curve higher than the rail on the inside of the curve, the elevation must be provided throughout the curve, unless physical conditions do not permit. Elevation runoff (or return to equal level of both rails) must be at a uniform rate, extend at least the full length of the spiral, and will vary by class of track, with Class 6 track requiring a greater distance than Class 1 track.

Track Surface: In the same manner, deviations in cross level between the two rails making up the track are prescribed by class, with Class 1 track having more tolerance than Class 6 track.

Track Structure

Ballast: Ballast is the material that supports the track on the roadbed and normally consists of crushed rock or similar material which will transmit and distribute the load of the track and railroad rolling equipment to the roadbed. It must provide adequate drainage for the track and maintain proper track crosslevel, surface, and alignment.

Cross Ties: Cross ties are made of a material to which the rails can be fastened and which support the rails on the ballast. Cross ties may be made of wood, concrete, or steel. Each 39 foot segment of rail shall have:

1. A sufficient number of cross ties which in combination provide effective support that will hold the gage within prescribed limits, maintain surface within prescribed limits, and maintain alignment within prescribed limits.

2. The minimum number and type of cross ties specified effectively distributed to support the rail segment.

3. At least one cross tie of the type specified that is located at a rail joint (where two rails are joined together).

The number of cross ties per 39 foot rail segment which must be in good condition varies by class of track, from five cross ties for Class 1 track to 14 cross ties for Class 6 track. In addition, Class 1 and Class 2 track must have one cross tie whose centerline is within 24 inches of the rail joint location, and Classes 3 through 6 shall have one cross tie whose centerline is within 18 inches of the rail joint location.

Rail Joints: Any mismatch of rail ends at rail joints must not be more than ¼" for Classes 1 and 2 track and not more than ⅛" for Classes 4, 5, and 6 track.

If a joint bar (joining the ends of rails at a rail joint) on Classes 3 through 6 track is broken, cracked, or because of wear allows vertical movement of either rail when all bolts are tight, it must be replaced.

In the case of conventional joined track, each rail must be bolted with at least two bolts in Classes 2 through 6 track, and with at least one bolt in Class 1 track.

Track Inspection - All track must be inspected in accordance with schedules prescribed in the Federal track standards. The required frequency of inspection varies by class of track, with a weekly inspection required for Classes 1, 2, and 3 track used for freight service, and twice weekly with at least one day between inspections for Classes 1, 2, and 3 track used for passenger service, plus all Class 4, 5, and 6 track. Each inspection must be made by foot or by riding a vehicle over the track at a speed that allows a person making the inspection to visually inspect the track structure for compliance with the regulations.

Signal System - An additional requirement related to railroad operation by class of track is that Classes 4, 5, and 6 track must have an automatic block signal system or some other form of signal system in place and operable on the railroad.

Railroad Facilities and Conditions

The corridor is comprised of both yard or switching and single track branch line trackage. As such, it is maintained to FRA Class 2 Safety Standards which permits a maximum operating speed of 25 mph for freight and 30 mph for passenger trains. Approximately 27.1 miles in length, corridor trackage is constructed of jointed rail and timber ties both in fair to good condition. There are 31 curves between Cedar Rapids and Iowa City with a variation in curvature of between 1 and 12 degrees. The track profile undulates over the entire route with the steepest gradient being 2.06 percent, although there are also a number of additional locations where the gradient reaches 1.9 percent. Main line at-grade crossings within and between the two communities number 78, including 32 private and 46 public crossings. Twenty-seven of the public crossings are protected by automatic train activated warning devices and the remaining 19 by passive warning devices (crossbucks). The private crossings have no protection. The line's facilities and conditions are summarized in Table 5-1. Key components of the track's structure, geometry, conditions and issues of concern are discussed in more detail in the following paragraphs.

Rail - The track is laid with five different jointed rail weights -- 115-lb., 112-lb., 110-lb., 100-lb., and 90-lb. Rail weight is function of section size and is measured in pounds per yard of rail length. The approximate quantity, location and rolling date of each of the rail sections is presented in Table 5-2. Generally, all of the rail sections would be classified in fair to good condition. However, if passenger service is to be initiated, there are several concerns that should be addressed.

Approximately 18.5 miles, or 68 percent of the route, is laid with rail that was rolled in the 1920's, 1930's and early 1940's prior to the advent of the controlled cooling process used in modern rail production. This process was instituted to eliminate hydrogen pockets that form in the rail during cooling that often results in shatter cracks. Regardless of the operating speed selected, if passenger operations are initiated, all of the rail laid prior to the advent of the controlled cooling process should be replaced for safety reasons.

Secondly, it was noted during the inspection that there are a large number of short rails in the track. It is believed that the majority are the result of broken rails subsequently drilled and spliced. In many cases, broken rails stem from internal rail defects. For some types of defects, drilling and splicing is considered only a temporary repair and the maximum speed over the defective rail must be limited until it is replaced. Due to the age of the rail, it is impossible to know what caused these breaks noted. This issue is of major concern when contemplating passenger service. Therefore, it is suggested that all short rails be removed from the track if passenger operations are initiated.

The condition of the existing rail, while adequate for lower speeds and freight operations, will not provide adequate ride quality at the higher speeds anticipated for passenger operations. In addition, as the speed increases, the level of maintenance required to maintain the track for the desired speed also increases. For example, tolerances in track cross level and alignment become smaller as speeds increase requiring an increase in maintenance to assure not only continued FRA standards compliance, but desired ride quality. Thus, to reduce the level of maintenance and assure adequate ride quality, it would be desirable to replace all or a portion of the jointed rail with continuous welded rail (CWR), depending on the operating speed selected.

Cross Ties - The cross ties on the CRANDIC Railway are treated, mixed hardwoods in fair to good condition. Ties are spaced 21 inches on center resulting in an average of 3,000 ties per mile. Based on data compiled by the CRANDIC in March of 1992 and samples taken during the

Table 5-1
LINE FACILITIES AND CONDITION
Cedar Rapids to Iowa City
UP & CRANDIC Railway

Mileposts	0.28 miles Cedar River Branch (UP) 1.72 miles Corridor Track (CRANDIC's first subdivision) 0.0 to 25.1 CRANDIC Railway
Stations	Cedar Rapids MP 0.0 Crandic MP 0.5 Pinney MP 2.1 Waconia MP 2.6 Konigsmark MP 5.3 Swisher MP 8.3 Mid-River MP 13.3 North Liberty MP 16.7 Oakdale MP 19.4 Coralville MP 22.9 Iowa City MP 25.1
Sidings	Airport MP 6.1 Length 1,417' Swisher MP 8.3 Length 528' Mid-River MP 13.3 Length 2,112' North Liberty MP 16.7 Length 1,050' Great Lakes (Track A) MP 22.3 Length 1,584' (Track B) Length 1,050'
Rail	The corridor is constructed of approximately 27.1 miles of jointed rail. Rail weights and quantities include approximately 3.81 miles of 115-lb. rail, 3.16 miles of 112-lb. rail, 1.65 miles of 110-lb. rail, 12.43 miles of 100-lb. rail, and 6.04 miles of 90-lb. rail. Generally, all of the rail sections are in fair to good, although a number of short rails were noted within the 100-lb. and 90-lb. rail sections that appear to be the result of broken rails. In addition, the majority of the rail was rolled previous to the advent of the controlled cooling process. Controlled cooling of the rail subsequent to rolling eliminates hydrogen pockets and resultant shatter cracks. The joints are generally tight and fully bolted.
Ties	Treated mixed hardwoods in fair to good condition. The majority of the trackage has experienced a tie replacement program within the last eight years and the CRANDIC has a program to install ties in the worst miles in 1995. The average number of defective ties is 800 per mile, based on 3,000 ties per mile spaced 21 inches on center. In general, tie conditions meet or exceed FRA requirements for Class 2 track, which will permit speeds of 25 mph and 30 mph for freight and passenger trains, respectively.
Tie Plates and Rail Anchors	Fully plated with a combination of single and double shouldered tie plates. The majority of the double shoulder tie plates are used with the larger 115-lb. and 112-lb. rail sections. The number of anchors per rail varies between 6 and 16 per 39 foot rail. Sixteen (16) is the standard per 39 foot rail. The lack of sufficient anchors in many areas is allowing the rail to run, slewing ties, which is having impact on the tracks alignment.
Ballast	Generally a full section of hard stone. However, it appears to be fouled where switching movements occur regularly.

Table 5-1 LINE FACILITIES AND CONDITION Cedar Rapids to Iowa City UP & CRANDIC Railway	
Surface/Line	The surface and alignment of the trackage are fair to good, and adequate for current operations. However, to increase speeds and ride quality for passenger train operations, there will need to be some improvements.
Bridges	There are 13 bridge structures on the line of varied construction, primarily steel. CRANDIC officials have indicated that all are currently in good condition. However, it may be necessary to re-examine a number of the structures to evaluate the effect of increased dynamic loading if it is determined that the speed will be increased over these structures.
Roadbed/Drainage	Generally both the roadbed and drainage are adequate. However, several locations were noted where fill settlement is having an impact on both the alignment and surface of the track.
Grade Crossings	There are a total of 78 at-grade crossings within corridor. Five (5) public crossings on UP's portion of the trackage in the CBD of Cedar Rapids are all protected by train activate warning devices. Of the remaining 73 crossings located on the CRANDIC, 32 are private crossings with no protection of any type, including crossbucks. The remaining 42 crossings are public crossings. Of these, 22 are protected by automatic train activated warning devices, 19 by crossbucks, and the remaining crossing is unprotected. Crossing surfaces vary from expense rubber designs to stone filled, the most common.
Vegetation	Both the track and roadbed are free of vegetation.
Timetable Speed	The maximum speed of operation is 20 mph, the maximum permitted for trackage within yard limits.
Speed Restrictions	Speed restrictions on corridor trackage include: 5 mph - UP trackage located in the Cedar Rapids CBD (approximately .28 miles) 10 mph - CRANDIC Corridor Trackage (approximately 1.72 miles) 10 mph - MP 0.0 to MP 3.5 Cedar Rapids 15 mph - Swisher City limits 15 mph - North Liberty City Limits 15 mph - Oakdale City Limits 10 mph - MP 22.3 to MP 25.1 Iowa City
Weight Limit	The maximum gross weight of equipment and lading is 263,000 lbs. per car.
SOURCE: Compiled by Wilbur Smith Associates from data provided by the CRANDIC Railway and the Chicago and North Western Transportation Companies Employee Timetable No. 13 now owned and operated by the Union Pacific Railroad.	

Table 5-2
RAIL CHARACTERISTICS
Cedar Rapids To Iowa City

Railroad	Milepost Beg.	Milepost End	Rail Weight and Length (Track Miles) 115-lb	112-lb	110-lb	100-lb	90-lb	Year Rolled
UP				0.28				
CIC				1.72				
CIC	0.00	0.24				0.24		1944
CIC	0.24	0.51					0.27	1955
CIC	0.51	0.81		0.30				1936
CIC	0.81	1.94	1.13					1992
CIC	1.94	2.34	0.40					1994
CIC	2.34	3.19	0.85					1993
CIC	3.19	3.56	0.37					1992
CIC	3.56	11.11				7.55		1929-1944
CIC	11.11	13.36					2.25	1955-1956
CIC	13.36	14.34				0.98		1929
CIC	14.34	14.60		0.26				1940-1947
CIC	14.60	15.11	0.51					1990
CIC	15.11	15.36				0.25		1929
CIC	15.36	18.63				3.27		1943-1944
CIC	18.63	19.61					0.98	1920-1929
CIC	19.61	20.07	0.46					1990
CIC	20.07	20.68					0.61	1928-1929
CIC	20.68	21.07		0.39				1939-1940
CIC	21.07	22.69					1.62	1929-1955
CIC	22.69	22.90		0.21				1988
CIC	22.90	23.21					0.31	1927-1951
CIC	23.21	24.86			1.65			1927-1931
CIC	24.86	25.00				0.14		1924-1940
CIC	25.00	25.10	0.10					1990
Miles of 115-lb Rail			3.82					
Miles of 112-lb Rail				3.16				
Miles of 110-lb Rail					1.65			
Miles of 100-lb Rail						12.43		
Miles of 90-lb Rail							6.04	

Note: [shaded box] 1995 Replacement Program

Source: Compiled by Wilbur Smith Associates from data provided by the Crandic Railway.

inspection, defective ties average 800 per mile or 27 percent. It is not required by FRA nor necessary that all of the defective ties be replaced for passenger operations. Some new ties, however, will be required to satisfy track standards needed to support higher speed passenger operations. The actual number needed will be determined by the operating speed selected.

Surface and Alignment - The surface and alignment of the CRANDIC trackage are both visibly erratic, but are more than adequate for existing low speed freight operations. However, not suitable for faster speeds needed for passenger train service. These conditions result from a combination of factors -- short rails, weak cross ties, soft roadbed conditions, and a lack of rail anchors to restrain longitudinal rail movement.

The function of rail anchors as a component of the track structure is to restrain longitudinal rail movement that can result from thermal expansion and contraction of the rail, locomotive tractive effort, braking, or a combination thereof. Thus, rail anchors play a significant role in maintaining the alignment and stability of the track. This is essential where a high level of standardization is required for passenger operations. Rail anchors are especially important when the track's profile undulates as in the case of the CRANDIC. The existing number of rail anchors is not sufficient to restrain longitudinal rail movement on this line. This was evident during the inspection. It was noted that the rail is moving some two to three inches at a various locations and virtually every grade crossing is misaligned. When the rail is allowed to move freely, or run as it is called within the railroad industry, it skews ties and the rail may bunch up at fixed structures such as grade crossings and bridges resulting in wide gage and erratic alignment. In the worst case, the track may kick out or buckle beyond the limits that will a train to pass over it safely resulting in a derailment. This condition will have to be addressed prior to the initiation of passenger operations.

Bridges - There are 13 bridges of various types of construction between Cedar Rapids and Iowa City. Table 5-3 provides a listing of the bridges that includes the location, type of construction, type deck, alignment (curve/tangent), and total length. In addition, Table 5-3 presents condition information provided by the CRANDIC from an inspection conducted in 1993 that indicates all but three of the structures are in fair to good condition. The three bridges rated in poor condition must be addressed prior to initiation of passenger operations.

In addition to bridge maintenance, there are two other key issues to be considered. One is the effect of dynamic forces due to an increase in speed and the other is superelevation on bridges located within a curve.

As trains move over railroad bridges, tremendous dynamic forces are generated. These dynamic forces increase as train speeds increase, thus bridges are designed for a specific speed

Table 5–3
BRIDGE INVENTORY AND INSPECTION SUMMARY
(1993)
Cedar Rapids to Iowa City

Milepost Location	Bridge Number	Rating*	Section No.	No.Steel Spans	No.Timber Spans	No.Concrete Spans	Type Deck	Tangent(T) Curve(C)	Total Length(FT)
Corridor Track	I–46	3	1	2			Open	T	110
			2	4			Open	T	632
			3	2			Open	T	51
1.8	1.8	3	1		2		Open	T	28
			2	1			Open	T	50
			3		2		Open	T	29
2.4	2.4	3	1	2			Open	T	175
4.0	4.0	4	1			1	Ballast	C	10
12.0	12.0	4	1	4			Open	T	429
17.5	17.5	2	1		4		Open	T	58
22.2	22.2	2	1		1		Open	C	15
23.3	23.3	3	1	1			Ballast	C	100
23.8	23.8	3	1	1			Open	C	40
24.6	24.6	3	1	3			Open	C	82
24.7	24.7	3	1	4			Open	T	300
24.8	24.8	2	1	5			Open	C	102
24.9	24.9	3	1			3	Ballast	T	63
Total Bridge Length									**2,274**

* Rating Number	Condition	Description
4	Good	No maintenance required in the 5 year plan.
3	Fair	Generally in fair condition. Maintenance will be required in 2 to 3 years.
2	Poor	Maintenance recommended, should be done within 1 year.
1	Emergency	Recommended repairs are required as specified.

Source: Crandic Railway

range. Once an operating speed or speed range is selected, an analysis should be performed to determine if the bridges affected can safely accommodate an increase in speed or if improvements will be required.

Bridges located within curves require superelevation just like the track. Table 5-3 reveals that six of the corridor's thirteen bridges are located in curves. The method of providing superelevation is determined by the type of bridge deck. On a ballast-deck bridge, superelevation is installed by surfacing the track just like a normal track section. Therefore, superelevation can be changed accordingly. However, to install superelevation on an open-deck bridge is more involved. Typically, superelevation is provided on an open-deck bridge by raising timbers under the bridge ties or by cutting or damping of the bridge ties on the low side to a depth equal to the desired superelevation. Depending on the method used, a change in superelevation necessitated by an increase in speed could simply require replacement of the raising timbers or replacement of the entire bridge deck. Table 5-3 also indicates that four of the bridges in curves are open-deck structures.

Grade Crossings - There are seventy-eight at-grade rail-highway crossings between Cedar Rapids and Iowa City. Approximately 50 percent of these crossings are not paved. A listing of the grade crossings, including the number of roadway lanes, type crossing surface, number of trains per day, timetable speed, type of crossing protection and if it is a public or private crossing is presented in Table 5-4. As indicated in Table 5-4, thirty-four crossings do not have passive protection devices.

In most cases, the population who typically use these crossings on a regular basis has become accustomed to current CRANDIC freight operations including train frequency and speeds. However, if speeds are increased and/or the rail traffic levels are increased because of passenger operations, many people could be caught off-guard and the possibility of crossing accidents could increase. If crossing elimination is not possible, some form of warning or protective devices should be installed at every crossing.

Passive Protection - Passive protection devices are the standardized railroad crossing warning signs familiar to all motorists. The majority of grade crossings in the U.S. rail system, given the number of private grade crossings, are protected solely by passive protection devices called crossbucks. The corridor has 19 crossings protected by crossbucks.

Active Warning Devices - Currently, 27 of the corridor's 78 crossings are protected by automatic train activated warning devices. Active warning device systems are automatic systems which use train detection circuits and control logic. The former detects the presence of a train with an electric circuit in the track. The latter controls the protective

Table 5-4
GRADE CROSSING INVENTORY
Cedar Rapids To Iowa City

Railroad	Milepost Location	Roadway Name	Crossing Type(1)	No. of Lanes	Paved (Y/N)	Type Protection(2)	Trains Per Day	Ry Timetable Speed(MPH)	Comments
UP		3rd Ave SE	PUB	6	Y	CFL		5	Rubber
UP		4th Ave SE	PUB	6	Y	CFL		5	Rubber
UP		5th Ave SE	PUB	6	Y	CFL		5	Rubber
UP		6th Ave SE	PUB	2	Y	FL		5	
UP		7th Ave SE	PUB	2	Y	FL		5	
CIC		8th Ave SE	PUB	4	Y	CFL	6	10	Rubber
CIC		3rd Street SE	PUB	4	Y	CFL	6	10	
CIC		2nd Street SE	PUB	2	Y	FL	6	10	
CIC		Alley	PUB	1	Y	XB	6	10	
CIC		1st Street SE	PUB	2	Y	XB	6	10	
CIC		1st Street SW	PUB	2	Y	CFL	24	10	
CIC		2nd Street SW	PUB	2	Y	FL	24	10	
CIC		3rd Street SW	PUB	2	Y	FL	24	10	
CIC		L Street	PUB	2	Y	FL	16	10	
CIC		4th Street SW	PUB	2	Y	FLG	16	10	Rubber
CIC		6th Street SW	PUB	4	Y	CFLG	16	10	Rubber
CIC		9th Street SW	PUB	2	Y	XB	19	10	Rubber
CIC		10th Street SW	PUB	2	Y	XB	19	10	
CIC	0.53	Wilson Ave	PUB	2	Y	FL	20	10	Rubber
CIC	1.94	Ingleside Drive	PVT	2	N	XB	20	10	
CIC	2.12	Private Rd	PVT	1	N	NONE	20	10	
CIC	2.62	Waconia Ave	PUB	2	Y	CFL	22	10	Rubber
CIC	3.13	60th Ave SW	PUB	2	Y	FL	8	10	Rubber
CIC	3.55	66th Ave SW	PUB	2	Y	XB	6	10	
CIC	4.11	Private Rd	PVT	1	N	NONE	2	25	
CIC	4.28	76th Ave SW	PUB	2	N	XB	2	25	
CIC	4.53	Private Rd	PVT	1	N	NONE	2	25	
CIC	5.27	Wright Brothers Blvd	PUB	2	Y	CFL	2	25	Rubber
CIC	5.45	Private Rd	PVT	1	N	NONE	2	25	
CIC	5.91	Private Rd	PVT	1	N	NONE	2	25	
CIC	6.00	Private Rd	PVT	1	N	NONE	2	25	
CIC	6.26	Walford Rd	PUB	2	N	XB	2	25	
CIC	6.99	Private Rd	PVT	1	N	NONE	2	25	
CIC	7.00	Tharp Rd	PUB	2	N	XB	2	25	
CIC	8.22	Division Street	PUB	2	Y	FL	2	15	Rubber
CIC	8.37	2nd Street	PUB	2	Y	FL	2	15	

Table 5-4
GRADE CROSSING INVENTORY
Cedar Rapids To Iowa City

Railroad	Milepost Location	Roadway Name	Crossing Type(1)	No. of Lanes	Paved (Y/N)	Type Protection(2)	Trains Per Day	Ry Timetable Speed(MPH)	Comments
CIC	8.51	Swisher Farm Supply	PVT	2	N	NONE	2	15	
CIC	8.97	Oak Ave	PUB	2	Y	XB	2	15	
CIC	9.27	Public Rd	PUB	2	N	XB	2	25	
CIC	9.57	Private Rd	PVT	1	N	NONE	2	25	
CIC	9.93	Private Rd	PVT	1	N	NONE	2	25	
CIC	10.57	Private Rd	PVT	1	N	NONE	2	25	
CIC	10.74	Private Rd	PVT	1	N	NONE	2	25	
CIC	10.98	Public Rd	PUB	2	Y	FL	2	25	
CIC	13.41	Private Rd	PVT	1	N	NONE	2	25	
CIC	13.79	Private Rd	PVT	1	N	NONE	2	25	
CIC	14.17	Private Rd	PVT	1	N	NONE	2	25	
CIC	14.26	Private Rd	PVT	1	N	NONE	2	25	
CIC	14.29	Private Rd	PVT	1	N	NONE	2	25	
CIC	14.31	Public Rd	PUB	2	Y	XB	2	25	
CIC	14.84	Private Rd	PVT	1	N	NONE	2	25	
CIC	15.16	Private Rd	PVT	1	N	NONE	2	25	
CIC	15.36	Private Rd	PVT	1	N	NONE	2	25	
CIC	15.47	Private Rd	PVT	1	N	NONE	2	25	
CIC	15.78	Scales Bend Rd	PUB	2	N	XB	2	25	
CIC	15.94	Highway 965	PUB	3	Y	CFL	2	15	Rubber
CIC	16.40	Penn Street	PUB	2	Y	FL	2	15	Rubber
CIC	16.85	Private Rd	PVT	1	N	NONE	2	20	
CIC	16.90	Cherry Street	PUB	2	Y	XB	2	20	Rubber
CIC	16.91	W. Zeller Street	PUB	2	Y	FL	2	15	Rubber
CIC	17.81	Private Rd	PVT	1	N	NONE	2	25	
CIC	18.49	Private Rd	PVT	1	N	NONE	2	25	
CIC	18.67	Forever Green Rd	PUB	2	N	XB	2	25	
CIC	19.19	Private Rd	PVT	1	N	NONE	2	25	
CIC	19.36	Oakdale	PUB	2	Y	XB	2	25	
CIC	19.60	Oakdale Institute	PUB	2	Y	XB	2	15	
CIC	19.97	Private Rd	PVT	1	N	NONE	2	25	
CIC	20.31	Private Rd	PVT	1	N	NONE	2	25	
CIC	20.33	12th Ave	PUB	2	Y	FL	2	25	
CIC	20.93	Private Rd	PVT	1	N	NONE	2	25	
CIC	21.85	10th Street	PUB	2	N	XB	2	25	
CIC	22.40	7th Ave	PUB	2	Y	XB	2	10	

Table 5–4
GRADE CROSSING INVENTORY
Cedar Rapids To Iowa City

Railroad	Milepost Location	Roadway Name	Crossing Type(1)	No. of Lanes	Paved (Y/N)	Type Protection(2)	Trains Per Day	Ry Timetable Speed(MPH)	Comments
CIC	22.86	1st Ave	PUB	4	Y	CFL	2	10	Rubber
CIC	22.91	Quarry Rd	PVT	2	N	XB	2	10	
CIC	23.00	5th Street	PUB	2	N	XB	2	10	
CIC	23.13	Private Rd	PVT	1	N	NONE	2	10	
CIC	23.19	Hawkeye Ready Mix	PVT	2	N	NONE	2	10	
CIC	25.00	Burlington Street	PUB	5	Y	CFL	10	10	Rubber

Note: (1) Public – PUB
Private – PVT
(2) Crossbucks – XB
Flashing Lights – FL
Cantilevered Flashing Lights – CFL
Flashing Lights and Gates – FLG
Cantilevered Flashing Lights and Gates – CFLG

SOURCE: IDOT Grade Crossing Inventory, Crandic Railway and Wilbur Smith Associates device, the actuation and duration of operation. Systems of this type typically include flashing lights, warning bells, and gates as the upper limit of grade crossing protection.

There are various active warning device systems that can be used for grade crossing protection. These control systems operate in different ways, but basically differ as to whether or not they recognize and adjust for the speed of the train. Of concern is how long the crossing protection is activated prior to the arrival of the train. Too long a period of time is as dangerous as too short a period. Very often, motorists become impatient with long warning periods and they decide the crossing signals have malfunctioned rather than indicating the presence of an approaching train. This is especially true when trains of differing speeds operate on the same track. Several types of control systems have been developed to combat this problem, the most commonly used are motion sensors that can determine the speed of the trains.

If passenger train operations are to be reintroduced in this corridor, then all unused crossings should be closed, all unpaved crossings should be paved and some sort of grade crossing safety public awareness program should be initiated. At a minimum, crossbucks should be erected at all unprotected private crossings. Secondly, active protection of some type should be installed at all public crossings. The level of protection, such as flashing lights, warning bells, and gates could be based on train speed and on the annual average daily traffic (AADT) or some accident or exposure index that incorporates these values. The Iowa Department of Transportation Rail and Water Division has an extensive database that includes data that could be used for this purpose

Alignment and Superelevation - Thus far, discussions have focused on existing conditions and potential improvements necessary to permit increased speeds, provide adequate ride quality, and ensure both rider and public safety. However, the issue of curvature and maintaining curves for both freight and passenger trains possibly at different speeds has not been addressed. There are 30 curves on the CRANDIC's First Subdivision between Cedar Rapids and Iowa City that vary between 1° and 6°50'. Freight and passenger trains very likely will be operating at different speeds on all or a portion of the curves in the corridor. Table 5-5 provides a listing of the curves by mile post location and other data such as degree of curve, existing superelevation, curve length, orientation (left or right) and other information to be discussed latter.

Curve Negotiation - In general, the highest forces expended by trains on the track structure are experienced during the negotiation of curves. This is because a train is made to change direction by introducing curvature into the track. The rail on the outside of the curve guides the wheel or truck by resisting its tendency to go straight, thus turning the locomotive or car.

Milepost Beg.	Milepost End	Degree of Curvature	Existing Elevation	Curve Length	ilting nology*	Superelevation Required For 79 mph (inchs) Equilibrium	3 inches Unbalanced	Tilting Technology*
0.14	0.43	3.00	1.250	1,525	0.00	13.11	10.11	3.61
0.48	0.65	4.00	1.630	900	0.25	17.47	14.47	7.97
2.04	2.17	3.00	1.250	710	0.00	13.11	10.11	3.61
3.19	3.52	3.00	1.250	1,720	0.00	13.11	10.11	3.61
3.91	4.26	2.50	1.000	1,870	0.00	10.92	7.92	1.42
5.43	5.54	2.33	1.000	600	0.00	10.18	7.18	0.68
7.16	7.25	1.00	0.375	470	0.00	4.37	1.37	0.00
7.55	7.61	1.00	0.375	320	0.00	4.37	1.37	0.00
7.98	8.14	3.00	1.250	830	0.00	13.11	10.11	3.61
9.43	9.63	3.00	1.250	1,040	0.00	13.11	10.11	3.61
10.74	10.84	2.25	0.875	550	0.00	9.83	6.83	0.33
11.11	11.16	2.17	0.875	260	0.00	9.48	6.48	0.00
11.40	11.56	2.17	0.875	850	0.00	9.48	6.48	0.00
11.61	12.00	2.00	0.875	2,080	0.00	8.74	5.74	0.00
12.89	13.05	1.00	0.375	840	0.00	4.37	1.37	0.00
14.22	14.28	1.50	0.625	330	0.00	6.55	3.55	0.00
14.34	14.62	4.00	1.625	1,470	0.25	17.47	14.47	7.97
14.83	15.05	4.00	1.625	1,180	0.25	17.47	14.47	7.97
15.41	15.51	3.00	1.250	510	0.00	13.11	10.11	3.61
16.43	16.71	4.00	1.625	1,490	0.25	17.47	14.47	7.97
19.59	20.05	4.00	1.625	2,430	0.25	17.47	14.47	7.97
20.71	21.06	4.00	1.625	1,850	0.25	17.47	14.47	7.97
21.30	21.49	1.50	0.625	1,000	0.00	6.55	3.55	0.00
21.94	22.22	3.00	1.250	1,480	0.00	13.11	10.11	3.61
22.73	22.92	6.00	2.625	1,010	5.12	26.21	23.21	16.71
23.05	23.09	6.33	2.625	230	5.92	27.65	24.65	18.15
23.20	23.48	2.67	1.125	1,490	0.00	11.66	8.66	2.16
23.71	23.88	2.75	1.125	910	0.00	12.01	9.01	2.51
24.48	24.75	3.75	1.500	1,440	0.00	16.38	13.38	6.88
24.85	24.97	6.83	2.875	680	7.14	29.84	26.84	20.34

*Tilting Technology Permits 9 1/2 Inches Of U

Source: Compiled by Wilbur Smith Associates

This steering action results in centrifugal forces acting outward and directing the weight of the train toward the outside rail. The magnitude of the force generated is a function of curve sharpness, train weight and the speed of operation.

Superelevation - To counteract the effect of centrifugal force, the track can be superelevated so that the combined effect of the centrifugal and vehicle weight forces produces a resultant force which is equally distributed on both rails as illustrated in Exhibit 5-3. When this condition occurs, the curve is described as being balanced and equilibrium speed has been reached. Currently, all of the curves on the CRANDIC's First Subdivision are superelevated for an equilibrium speed of 25 mph as indicated in Table 5-5. Equilibrium speed is calculated using the following equation:

$$V = \sqrt{\frac{E}{.0007D}}$$

Where: E = Superelevation in inches
D = Degree of curvature
V = Velocity in MPH

However, it is not possible to create this situation for all trains if different types of trains (freight and passenger) operate over the same trackage at different speeds. Therefore, a compromise that reduces the amount of actual superelevation required to accommodate the lightest and typically the highest speed train is permitted. The reduction is generally referred to as unbalanced superelevation.

Unbalanced - When trains operate on curves at speeds which are higher (underbalanced) or lower (overbalanced) than the equilibrium speed, the superelevation is "unbalanced."

Underbalanced - When a train rounds a curve at speeds in excess of the equilibrium speed, the resultant of the combined centrifugal and weight forces are directed towards the high rail as shown in Exhibit 5-4. The higher speed increases both the lateral and vertical forces on the high rail and may result in wheel climb or overturning of the high rail. It has been agreed that trains can be comfortably and safely operated at speeds requiring three inches of elevation in excess of equilibrium.[1] There is, however, a general consensus among major

[1] William Hay, Railroad Engineering, Second Edition, John Wiley and Son, New York, New York, 1982, p. 604.

railroads that freight trains should not be operated at the same unbalanced elevation speeds as lighter passenger trains. This policy has evolved as a result of premature high-side curve rail wear, gage widening and derailments. These conditions have been attributed to the increased magnitude of the resultant force exerted by the heavier axle loads and high center of gravity equipment commonly used in the rail freight industry. Exhibit 5-5 provides a graphic illustration of the calculated position of the resultant force for various underbalanced elevations versus equilibrium for speeds over 20 mph. Note that at three inches underbalanced, the force, resulting from a high center of gravity car, such as a 100-ton covered hopper commonly handled on the CRANDIC, is directed at the base of the high rail, a very undesirable condition.

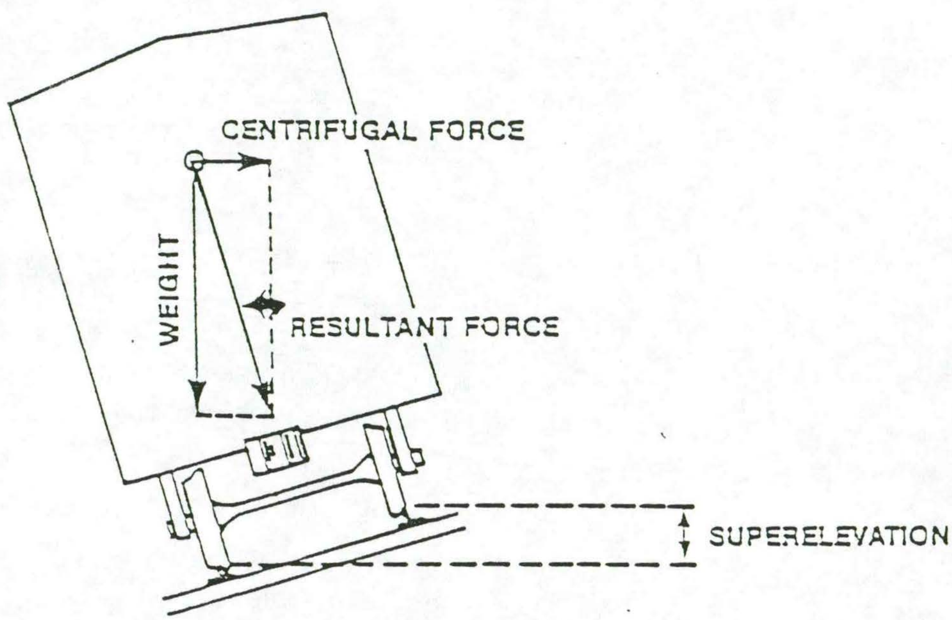
Overbalanced - Conversely, when a train travels at less than the equilibrium speed, the resultant force is directed towards the low rail. As more of the weight is carried by the low rail, there is an unloading of the high rail. From a track maintenance standpoint, the disproportionate loading of the low rail can result in corrugation and crushing of the low rail head, gage widening and surface degradation, all highly undesirable conditions regardless of the type of rail operation.

As a result, the common practice is to establish the actual superelevation on an individual curve basis by determining the train speeds that are likely to occur at that location. Considerations are also given to the frequency with which very slow train operations or stopping due to train meets, grades or switching operations on the curve are likely to occur. The actual superelevation is then established for the slower trains, generally equilibrium but not more than two inches unbalanced. Faster passenger trains are then limited in allowable speed through curves to that permissible for actual elevation plus three inches unbalanced, the maximum permitted by the FRA.

Curvature Conclusions - The maintenance of curves for a difference in freight and passenger operations must be a consideration when selecting the most appropriate speed of operation. In addition, the vast majority of U.S. railroads limit the maximum amount of superelevation on freight lines to between four and five inches. An alternative could be the use of equipment with car body tilting technology. An active body tilting system tilts the car body towards the curve's center by means of hydraulic cylinders positioned on both sides of the coach. This system allows trains to operate at higher speeds without an increase in superelevation. Table 5-5 includes superelevation/speed related data for the curves in the corridor based on the operations discussed.

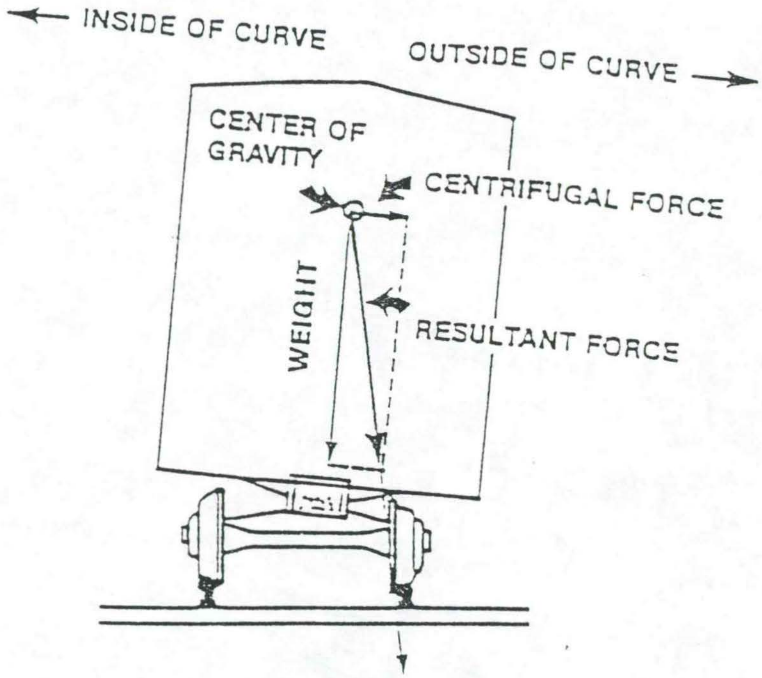
Train Control - As previously discussed, current train operations in the corridor are governed by yard operating rules and controlled by a Yard Manager at CRANDIC Shops. Under FRA guidelines, passenger train operations are restricted to 59 mph without a train control system. With automatic signals or traffic control (TC), permissible speeds can be increased to 79 mph at which

Exhibit 5-3



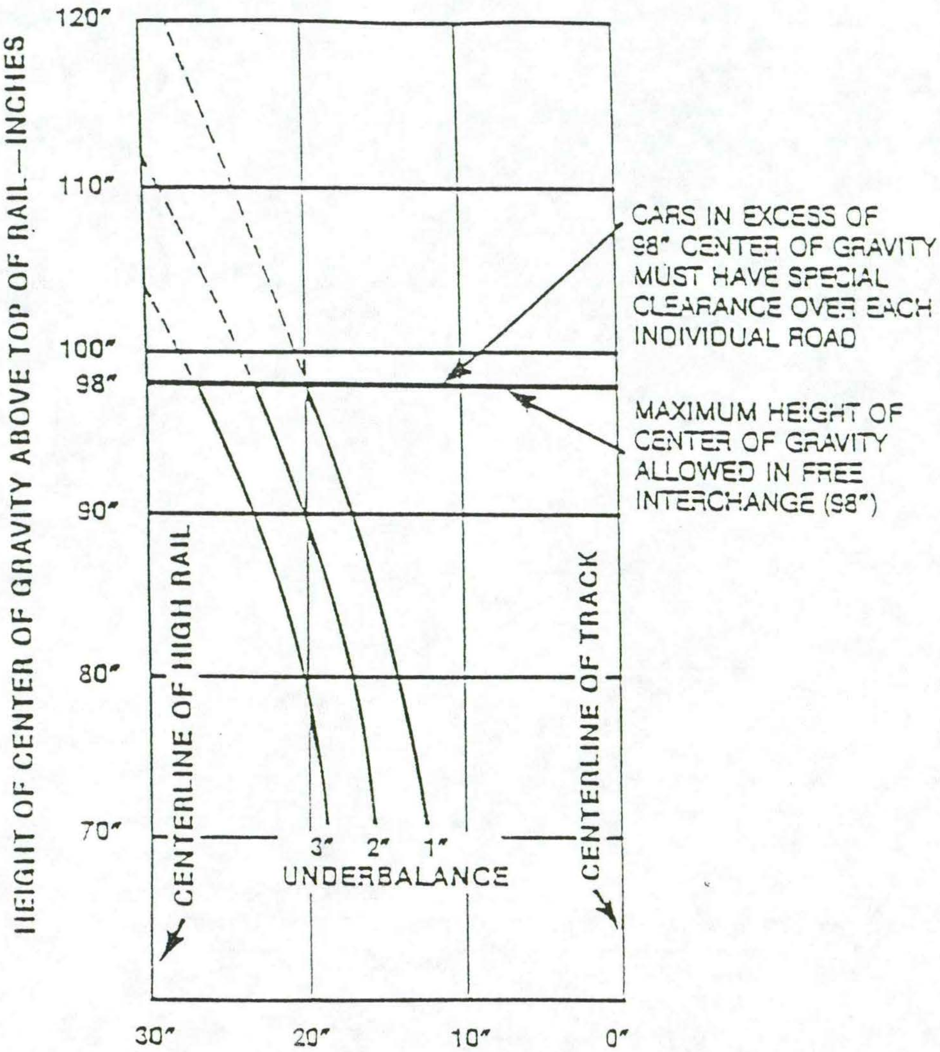
Resultant Force Location
Equilibrium Elevation

Exhibit 5-4



Resultant Force Location
Track Underelevated

Exhibit 5-5



Calculated Position of Resultant Force
For Speeds over 20 mph
in Inches from Centerline of Track (2)

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2 Reference: American Railway Engineering Association, "Special Requirements of Track Construction and Maintenance Due to Operation of Equipment with High Center of Gravity", 1969 Proceedings Volume 70, Page 1029.

TYPICAL CATENARY SYSTEMS

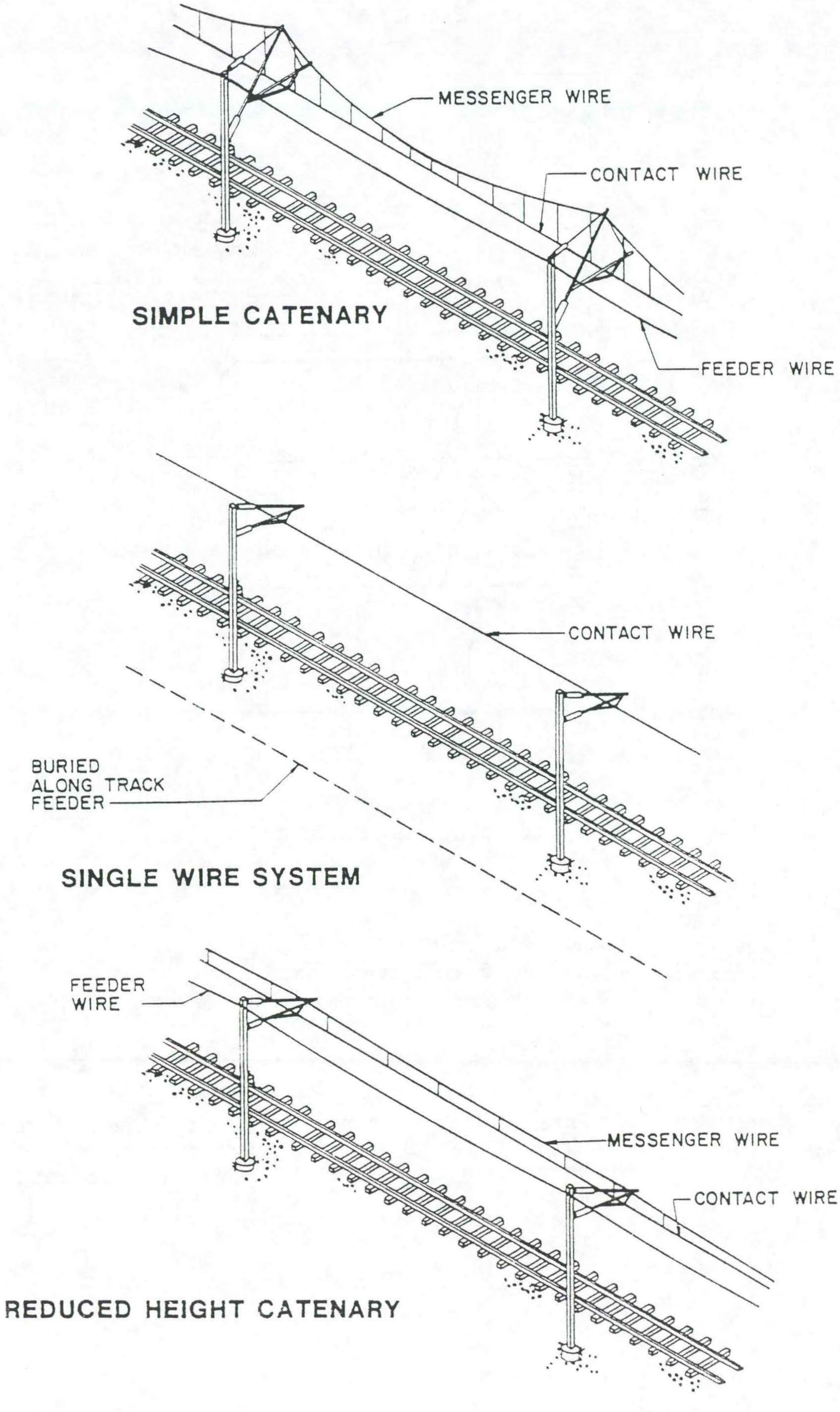


Exhibit 5-6

most conventional passenger services are operated. Speeds in excess of 79 mph require a display of wayside signals in the locomotive's cab, automatic train control or automatic train stop protection. Installation of either system would permit operating speeds up to 90 mph. The only railroads in this country operating speeds in excess of 90 mph are Amtrak, MetroNorth and New Jersey Transit in the Northeast Corridor. Top speeds of 125 mph are permitted by a waiver from FRA.

Electrification- During the years of interurban passenger operations, propulsion power was provided by an overhead catenary system. Since the discontinuance of passenger operations, the CRANDIC has converted to self-contained diesel-electric motive power and the catenary system removed. The CRANDIC has expressed interest in re-electrifying the corridor if passenger trains are reintroduced. The power supply and distribution system that is typically used for light rail vehicles (LRV) consists of two elements that will require capital investment--substations and the catenary or tractive power distribution system which delivers power to the LRV.

Substations are needed to convert and deliver three-phase utility provided power to direct current (DC) for the catenary system. The number and spacing of substations is dependent on elements such as the size of catenary conductors, number of trains, length of trains, efficiency of rolling stock, and utility access. Also of prime importance is the loss of redundancy and degradation of train performance with loss or shutdown (for maintenance) of a substation.

Most modern LRV's require between 600 and 750 V DC which is distributed to the vehicle by means of a sliding contact between the pantograph mounted on the vehicle and the contact wire of a catenary system. A catenary system is comprised of messenger and contact wires, as well as associated feeder cables, supporting structures and foundations. Typical catenary systems, illustrated in Exhibit 5-6 , include three types. All are applicable for the proposed system. Generally the type selected is more a function of aesthetics.

Clearance between the messenger wire or contact wire, depending on the type of catenary system, and any overhead obstruction, such as the bottom of a overhead bridge, or between the contact wire and highest rolling stock is of prime importance. Typical system dimensions and clearances are shown in Table 5-6.

Table 5-6
TYPICAL CATENARY SYSTEM DIMENSIONS AND CLEARANCES

	Jointly Used Track	Exclusive LRV Track	LRV Track in Downtown Streets
Contact Wire Height Above Top of Rail	21' - 6"	15' - 0"	19' - 0"
Lateral Clearance from Center Line of Track	10' - 0"	7' - 0"	7' - 0"

Source: Wilbur Smith Associates

It should be understood, that in addition to the capital cost of constructing an electric tractive power supply and distribution system, there are two other issues to be considered. First, the main track and all potential passing and servicing facility tracks must be electrified. Second, the system will require maintenance.

Conclusions

Based on discussions thus far, there are a number of key issues from an operating and physical plant standpoint that must be addressed if rail passenger operations are to be reintroduced between Cedar Rapids and Iowa City. These issues include Cedar Rapids CBD access due to freight traffic conflicts, train control, operating speed, and curve maintenance issues.

Cedar Rapids CBD Access - Due to existing and potential freight conflicts, access to the Cedar Rapids CBD via corridor Segments A, B and C north of Wilson Avenue will be difficult. Freight conflicts associated with Segment D while not currently as severe, also have the potential to greatly restrict passenger operations. In addition, benefits to be derived from improvements to Segment C could be short lived and future expansions of passenger operations limited if rail freight traffic levels continue to increase or freight customer demands change. Thus, if CBD access is critical to the success of proposed passenger operations, either both railroads will have to modify operations within these segments and major changes will have to be made to the existing physical plant to accommodate joint operations, or a new alignment that avoids the problems associated with these segments will have to be constructed to gain access to the CBD.

While it may be possible to adjust operations to permit joint operations in the short term, potential increases in freight traffic or customer demand could greatly impact passenger operations and the ability to expand operations in the future. The same could be said for improvements or changes in the existing physical plant. Based on these considerations, construction of a new alignment that mitigates potential problems would appear to be the surest means to assure CBD access and realize return on investment over the long term.

Train Control - Passenger safety and operating efficiency are critical to any passenger operation. To assure both, some type of train control system is needed to control the flow of traffic. Throughout the length of the corridor side tracks exist where trains can meet or pass trains operating in the same direction or trains operating in the opposing direction. As there is currently no signal system within the corridor, all train meeting and passing operations are arranged verbally between the CRANDIC's Yard Manager at CRANDIC Shops and the train crew via train radio. If passenger operations are reintroduced within the corridor, however, some type of train control system will be necessary to control the flow of traffic, as well as the meeting and passing of trains.

As previously discussed, a signal system is not needed provided the maximum speed of operation is less than 59 mph under FRA guidelines. An inexpensive system that would be applicable for speeds up to 59 mph is known as Direct Traffic Control (DTC). With a DTC system, the corridor is divided into operating segments or "blocks" and each train is given verbal permission over the radio to operate within a specific block. Generally only one train is allowed within a block at a time, and with block boundaries at passing tracks or yards, train meets can be easily arranged without the danger of head-on collisions on single track rail lines.

The operating or handling of switches at train meeting points is another consideration. While not an issue for existing freight operations, it could be for passenger operations if train frequency and scheduling requires that trains meet between Cedar Rapids and Iowa City. In the past when passenger trains operated on the CRANDIC, trains going south were superior to trains of the same class going north. This meant that when trains from opposing directions met, the northbound trains would enter or take the siding to allow the southbound train to pass on the main line. Such an operation required a crew member from the northbound train to get off and manually throw the switch to permit the northbound train to enter the siding and to throw it again to permit the southbound train to pass. After the southbound train had passed the same procedure had to be repeated before the northbound train could continue.

Proposed passenger service involves vehicles that are typically staffed by a one-man crew. It would be highly undesirable for that crew member to have to detrain and throw switches. With a signalized control system this operation is accomplished using motorized switch machines activated by a dispatcher, which may not be needed for initial start-up or if the maximum operating speed will not exceed 59 mph. In lieu of a signal system specific meeting points can be established, such as Mid-River, a siding located approximately halfway between Cedar Rapids and Iowa City. Spring switches can be installed at both ends which allow trains to make specific moves without having to be thrown. This is accomplished by a large spring activated cylinder which allows trains to move through a switch in the opposite direction for which the switch is aligned, and after the train has passed restores it to its original position.

As in the past, trains traveling in one direction could be superior to trains in the opposite direction. For example, if southbound trains are superior to northbound trains as they were in the days of the interurban passenger trains, the north switch at the Mid-River would be aligned to permit southbound trains to proceed down the main track, the south switch at Mid-River would be aligned to permit the northbound trains to enter the siding. Once the northbound train is in the siding both trains could proceed without throwing switches. After the two trains have moved through the two switches, the spring mechanism would restore the switches to the same position for which they were aligned prior to the arrival of the two trains. Under current operations, the last passenger train in the evening could align the south switch at Mid-River for the evening southbound freight train to proceed down the main track to Iowa City, and when returning north the freight train could restore the south switch at Mid-River to its normal position for passenger train operations the following morning. If train frequency and scheduling dictate that more than one meeting point is needed, a similar arrangement could be established at other locations.

Operating Speeds - Passenger trains could operate within the corridor today, but at a speed that is less than was operated during the days of the interurban passenger trains. According to Cedar Rapids and Iowa City Railway Time Table No. 41 effective July 28, 1952, passenger trains could operate between downtown Cedar Rapids and Iowa City in 50 minutes including 7 station stops. If one assumes two minutes per station stop, the average speed is a little over 44 mph and the average trip speed including station stops is 32 mph. This clearly indicates that the maximum line speed at this time was in excess of 45 mph. As indicated previously, the current maximum permissible operating speed in the corridor is 20 mph and there are several locations where the speed is restricted to 10 and 15 mph.

Since the discontinuance of passenger service in 1953 there have been many changes within the region. Probably the most significant change that will have an impact on potential ridership was the construction of I-380 which has a maximum speed of 65 mph and reduces travel time between Cedar Rapids and Iowa City to under 30 minutes. If a trip time of 50 minutes was not sufficient to maintain ridership in 1953 without the interstate, it is doubtful that it will attract many riders today given the fact trip times by highway are even less than in 1953. While this conclusion may be speculative, it certainly provides an indication that the maximum line speed will have to be greater than in 1953 to permit trip times comparable to those that can be achieved by highway travel.

Curve Maintenance Issues - The majority of the corridor south of Cedar Rapids (MP 3.1) could be upgraded to FRA Class 3 safety standards which would permit maximum freight train speeds of 40 mph and passenger train speeds of 59 mph. To maintain 59 mph over the route however, would require that all 27 of the curves located in this segment of the corridor be modified. Modifications would include an increase in superelevation and lengthening of spirals to accommodate the increase in superelevation. Approximately 50 percent of the curves would require an increase in superelevation in excess of four inches, which is undesirable from a maintenance standpoint. If superelevation is limited to a maximum of four inches, the maximum speed for these curves would be restricted to between 35 and 55 mph depending on the degree of curvature.

A maximum passenger train speed of 59 mph will result in increased curve maintenance unless CRANDIC freight trains can maintain 40 mph. Therefore, if CRANDIC freight trains cannot maintain a maximum speed of 40 mph and a maximum passenger train speed of 59 mph is desired, then either freight traffic should be eliminated on this portion of the corridor or passenger equipment equipped with tilting technology should be considered.

CRANDIC officials have indicated that if potential passenger train speeds over the portions of the corridor south on Pinney were not compatible with freight train speeds, they would entertain the possibility of shifting freight service to their Third Subdivision. To do so would require that this 21.8-mile branch line be upgraded to FRA Class 2 safety standards and a wye track be constructed at Homestead with the IAIS. Currently, the existing switch at Homestead opens to the west. The IAIS's yard is located in Iowa City to the east of the existing junction. A wye track would allow the CRANDIC to access the IAIS's yard in Iowa City direct without a backup move.

Vehicles equipped with the tilting technology could maintain 59 mph over the entire route with the exception of three curves, which would be restricted to between 50 and 55 mph. In addition, the existing superelevation would not have to be modified and the CRANDIC could continue to operate at 25 mph if they so desire without any undesirable maintenance impacts.

Further upgrading of this segment of the corridor to FRA Class 4 track safety standards would permit a maximum speed of 79 mph for passenger trains and 60 mph for freight trains. This would require considerable track and structure improvements, as well as the installation of a signal system. In addition, based on four inches of superelevation and the use of conventional equipment, only five curves could be superelevated to permit an increase in speed up to 79 mph, and over 80 percent of the curves would be restricted to between 35 and 55 mph without major realignment efforts. It is doubtful that the CRANDIC would want to operate freight trains at 60 mph and realignment would require the purchase of additional right-of-way, new track construction, the relocation of existing highways and grade crossings, and new bridge construction. However, if freight traffic were eliminated from this segment, the maximum allowable superelevation increased to six inches (the maximum allowable by the FRA), and vehicles equipped with tilting equipment were utilized, 79 mph could be maintained on all but eight curves in this portion of the corridor. These curves would only be restricted to a maximum speed of between 55 and 70 mph depending on the degree of curvature, which would have little impact on passenger train performance.

OPERATING OPTIONS

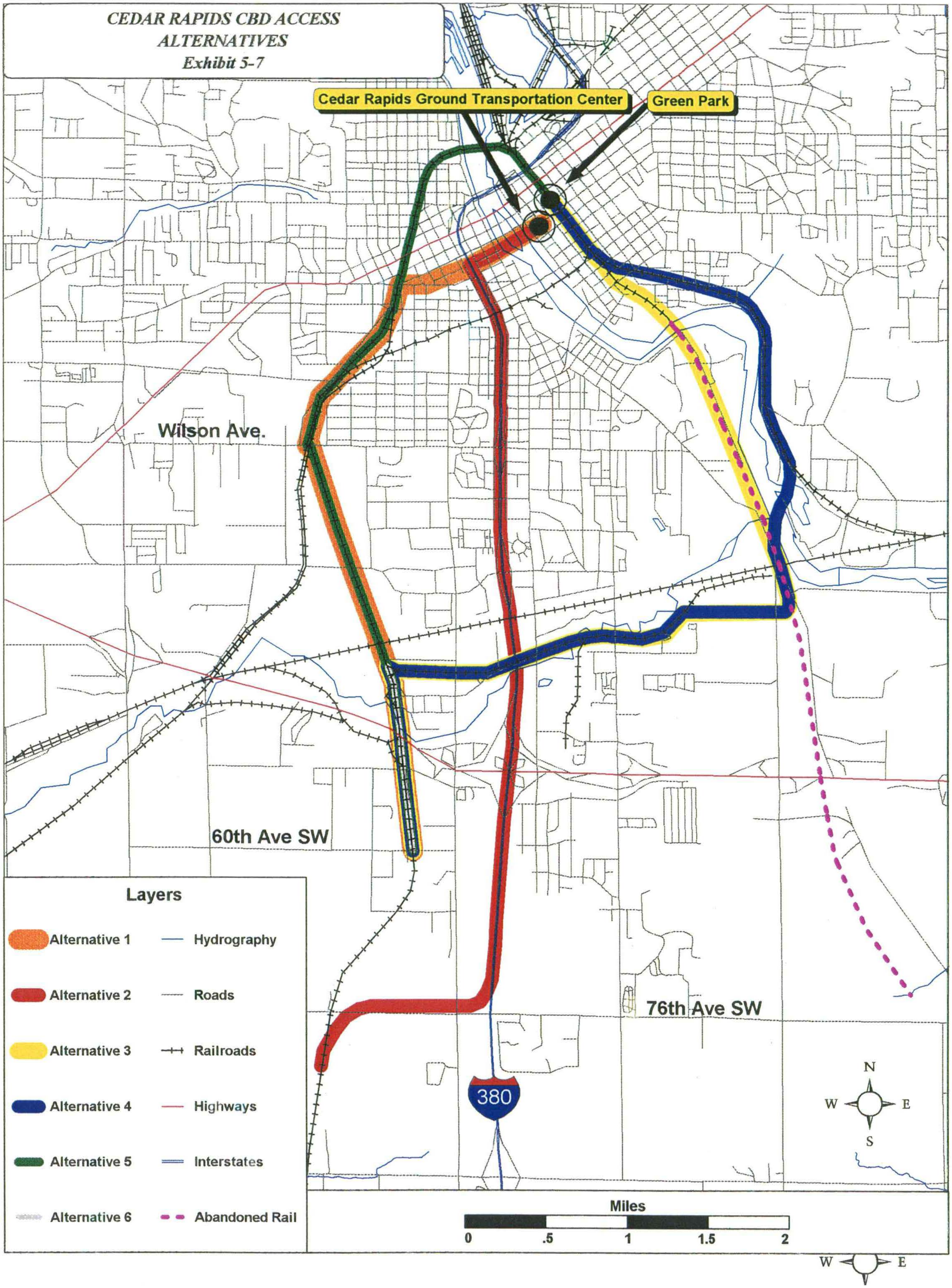
A number of potential options were identified based on issues posed in previous discussions. These options are a combination of alternatives that provide access to the Cedar Rapids CBD and various operating scenarios for Segment E. Each is described in the following paragraphs.

Cedar Rapids CBD Access

Several alternatives were developed to mitigate existing and potential freight conflicts in Segments A, B, C, and D; assure CBD access; and, maximize return on investment. These alternatives, which are illustrated in Exhibit 5-7, are described below. It should be understood, however, that all of the alternatives presented are conceptual in nature.

Alternative No. 1 - This alternative requires that a second main track be constructed parallel to the CRANDIC between 60th Avenue Southwest and Wilson Avenue. At Wilson Avenue the new track would leave the CRANDIC right-of-way and continue north parallel to the UP's Cedar Rapids Branch to 5th Avenue Southwest. It is possible that if the UP shifts their traffic to the CRANDIC, their track could be utilized between Wilson Avenue and 5th Avenue Southwest rather than constructing a new track. At 5th Avenue Southwest, the new alignment would turn east and follow the route once used by the interurban passenger trains to what is now the Cedar Rapids GTC on the east bank of the Cedar River. In the past, the track was located in 5th Avenue Southwest and then shifted to 4th Avenue Southwest, crossed both the Cedar River and the Municipal Island on structure and entered the CBD in 4th Avenue Southeast as depicted in Exhibit 5-8.

The new alignment could be located in one of three streets--3rd, 4th, or 5th Avenue Southwest. Construction along the old alignment (4th Avenue) would require a tunnel or a new bridge at I-380. However, 4th Avenue, primarily a residential side street, is the least traveled of the three. Thus, impacts to vehicular traffic would be the lowest. Unlike 4th Avenue, both 3rd and 5th



CEDAR RAPIDS CBD ACCESS
ALTERNATIVES
Exhibit 5-7
Cedar Rapids Ground Transportation Center
Green Park
Wilson Ave.
60th Ave SW
76th Ave SW
380
Layers
Alternative 1
Alternative 2
Alternative 3
Alternative 4
Alternative 5
Alternative 6
Hydrography
Roads
Railroads
Highways
Interstates
Abandoned Rail
Miles
0
.5
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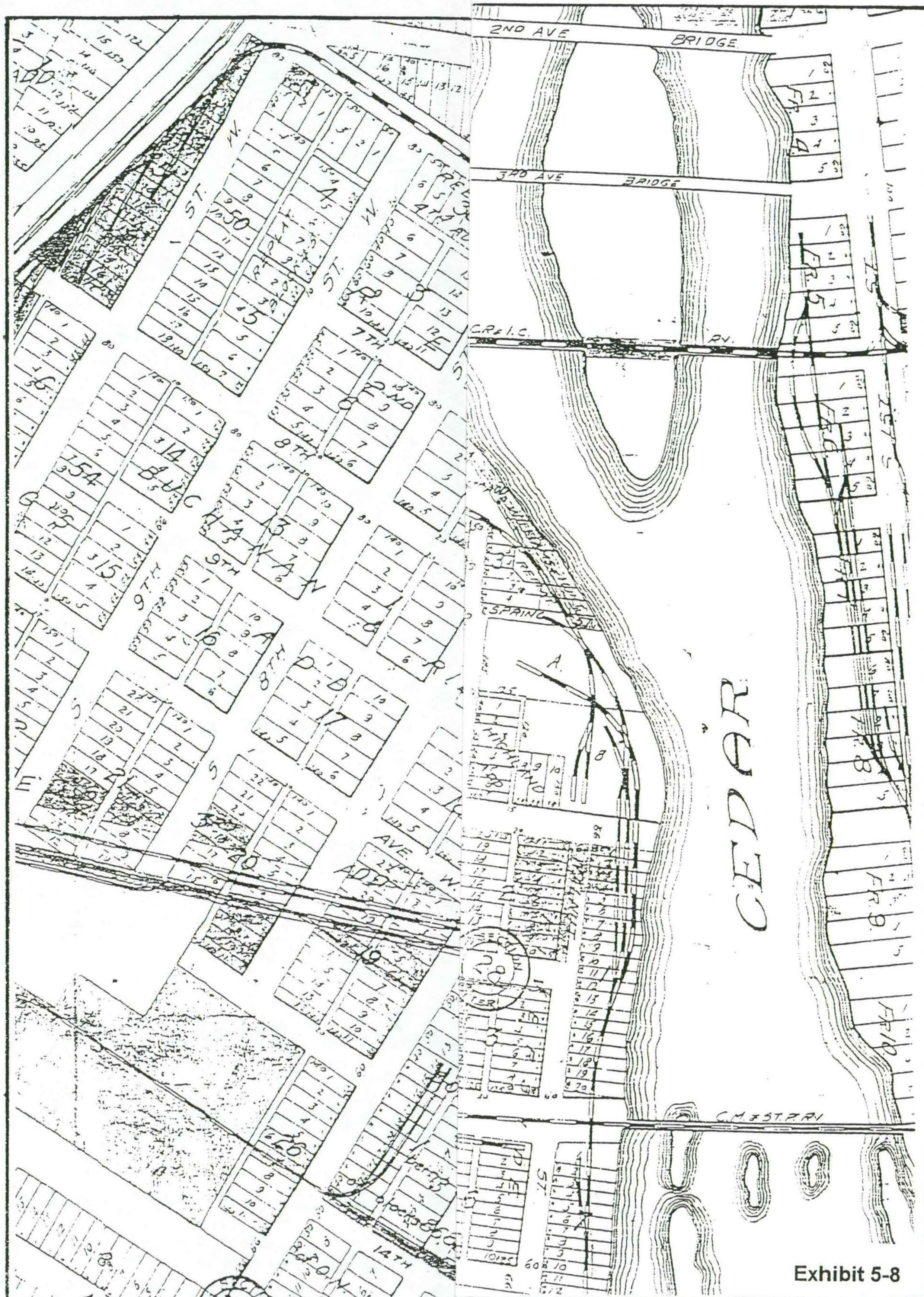

2ND AVE BRIDGE
3RD AVE BRIDGE
C.R.& I.C. RY.
CEDAR
C.M.& ST.P. RY
SPRING
7TH
8TH
9TH
14TH
AVE.

Exhibit 5-8

Avenue Southwest pass under I-380 and both are major east/west corridors. Thus, it is expected that traffic signal preemptions and a large number of grade crossing protection warning devices will be required to permit unrestricted train movement and provide vehicular traffic safety. All three options would require the construction of a new bridge across the Cedar River.

In addition to the track improvements, the Consultant would suggest that the double track portion between 60th Avenue Southwest and Wilson Avenue, approximately 2.65 miles in length, be signalized. Signals could easily be controlled by CRANDIC's yard manager using a micro desk-top computer capable of running applications software, including non-vital logic and graphics functions. The addition of a signalized control system in this area would permit an increase in speed over the current 10 mph and provide operating efficiency and safety for both freight and passenger operations.

Regardless of which street the new alignment follows, the length of the alignment between Wilson Avenue and the GTC is approximately 2.5 miles, which is comparable to the existing CRANDIC corridor. It is expected that the maximum speed of operation would be limited to 25 mph due to instreet running and the residential setting of the proposed route.

Alternative No. 2 - Although more dramatic, like Alternative No. 1, this alternative eliminates potential freight conflicts associated with Segments A, B, C, and D and provides direct access to the CBD at the Ground Transportation Center. To accomplish this, a completely new alignment is proposed that diverges from the CRANDIC right-of-way south of 76th Avenue Southwest and runs east until joining I-380 just north of the 76th Avenue/I-380 interchange. From this point, the new alignment would be located at-grade in the median of I-380 to approximately 8th Avenue Southwest, where it would then descend to ground level and turn east in either 4th or 5th Avenue Southwest, cross the Cedar River and enter the CBD at the GTC.

This 6.25-mile long alternative is approximately 0.4 miles shorter than the existing CRANDIC corridor alignment and will permit speeds which are competitive with I-380 to the point where it descends to ground level at 8th Avenue Southwest. It does have several disadvantages: it will be expensive to construct, 8th Avenue Southwest under I-380 would have to be closed, and a two to three percent grade will be required to avoid conflicts at 5th Avenue Southwest. A gradient this steep could be a problem during icy winter weather conditions, although not insurmountable.

Alternative No. 3 - This alternative like the first would require the construction of a second main track beginning at 60th Avenue Southwest. However, it would only extend as far north as the south leg of the wye at Pinney (MP 2.1). From Pinney passenger trains would utilize the CRANDIC's REA Line to a point just west of IES Utilities Prairie Creek Power Plant, where it would continue east on a new alignment to the abandoned Rock Island Railroad corridor. It would then follow the abandoned Rock Island corridor north across the Cedar River where it would connect with and utilize existing industrial trackage to the UP's Cedar Rapids Branch junction near 9th Avenue Southeast. The remaining six blocks to 3rd Avenue Southeast would utilize the UP's Cedar Rapids Branch. To mitigate potential freight conflicts between 9th and 3rd Avenue Southeast a second track could be constructed between these two points.

This alternative is approximately 1.45 miles longer than its existing CRANDIC corridor counterpart, which would add additional travel time. Due to the connections that would be required and the nature of the existing track that would be utilized (generally branch line and industrial switching trackage) it is expected that the maximum operating speed over this segment would not exceed 25 mph.

Alternative No. 4 - Basically the same as Alternative No. 3, this alternative calls for the connection of the CRANDIC's REA Line with the abandoned Rock Island alignment until across the UP's East Iowa Subdivision. From this point, the new alignment would turn east and cross the Cedar River just north of Sac and Fox Trail City Park and tie into the UP's Cedar Rapids Branch, approximately two miles south of the 9th Avenue Southeast. Passenger trains would then utilize the UP's Cedar Rapids Branch to the CBD. As in the previous alternatives, a second track could be constructed between 9th Avenue and 3rd Avenue Southeast to mitigate potential traffic conflicts.

This alternative is approximately 1.93 miles longer than its existing CRANDIC corridor counterpart. As in the previous alternative, it too would require additional travel time and for the same reasons would result in a maximum operating speed of 25 mph. However, if one views proposed passenger service as a transit system, this alternative with a station stop between Cedar Valley Park and Iroquois Park might generate additional ridership from this area of Cedar Rapids.

Alternative No. 5 - This alternative is based on the assumption that the UP's freight traffic to downtown Cedar Rapids is shifted to the CRANDIC at Wilson Avenue. As in Alternative No. 1, a second track would be constructed parallel to the CRANDIC to Wilson Avenue. Passenger trains would then utilize the UP's Cedar Rapids Branch between Wilson Avenue and 4th Avenue Southeast. To mitigate potential freight conflicts between Quaker Oats and 4th Avenue Southeast, a second track would be constructed on the west side between these two points for passenger train use.

This alternative is approximately 0.9 miles longer than the CRANDIC corridor that terminates at the same point in the CBD. Upgrading of the UP trackage to FRA Class 3 safety standards would permit passenger train speeds up to 59 mph, although something along the lines of 45 mph is more likely, at least to the Cedar River Bridge. The remainder of the route would be restricted to 25 mph or less.

Alternative 6 - Under this alternative, passenger train operations would originate and terminate at a station site near Hawkeye Downs in southwestern Cedar Rapids rather than the CBD. To mitigate freight conflicts and permit an increase in passenger train speeds in Segment D, a second main track would be constructed between 60th Avenue Southwest and the wye at Pinney.

Alternative Conclusions - Given the need to provide trip times that are comparable to the automobile, alternatives 3 and 4 will not be considered further unless additional ridership can be generated due alternative 4. The other four, however, offer benefits that justify consideration in subsequent tasks.

Segment E Operating Scenarios

A number of operating scenarios were developed for Segment E to compliment the four remaining CBD access alternatives, as well as train control, operating speed and maintenance issues previously described. These scenarios focus on mixed traffic versus passenger only service, two speed options of 59 mph and 79 mph, and conventional versus tilt equipment.

Scenario No. 1 - This scenario assumes mixed freight and passenger service, conventional equipment, and a maximum operating speed of 59 and 40 mph for passenger and freight trains, respectively. Superelevation in the curves would be limited to four inches and traffic flow would be governed by a DTC train control system. Curves that would be restricted and the maximum speed for each type of train are presented in Table 5-7.

Scenario No. 2 - This scenario also assumes mixed freight and passenger service, a DTC train control system, and a maximum operating speed of 59 and 40 mph for passenger and freight trains, respectively. However, vehicles equipped with tilting technology would be used for passenger service. The existing superelevation in the curves will not have to be modified except on three curves to permit freight trains to operate at 25 mph and passenger trains at 59 mph. Without modification of superelevation on these curves, passenger trains would be restricted to 45 mph. With superelevation modifications up to four inches, passenger trains would be restricted to between 50 and 55 mph. Only the bridge located at MP 24.8 which is located in a 6.83 degree curve would require modification to change the existing superelevation.

Scenario No. 3 - This scenario assumes that the trackage is upgrade to FRA Class 4 safety standards to permit passenger train speeds up to 79 mph, conventional equipment, and all freight traffic is diverted to the CRANDIC's Third Subdivision. In the absence of freight traffic, the maximum superelevation is increased from four inches to 6 inches and traffic flow is governed by a centralized traffic control system. Curves that would be restricted, their maximum speed and those requiring bridge modifications are presented in Table 5-8.

Scenario No. 4 - Scenario No. 4 is identical to the previous scenario except vehicles equipped with titling technology are used in lieu of conventional equipment. Curves that would be restricted, their maximum speed, and those requiring bridge modifications for this scenario are presented in Table 5-9.

Table 5-7
CURVE SPEED RESTRICTIONS AND MODIFICATIONS
SCENARIO NO. 1

Milepost		Degree of Curvature	Freight Trains Equilibrium (mph)	Passenger Trains 3 inch Unbalanced (mph)	Superelevation & Spiral Mod.	Bridge Mod.
Beg.	End					
3.19	3.52	3.00	-	55	•	
7.98	8.14	3.00	-	55	•	
9.43	9.63	3.00	-	55	•	
14.34	14.62	4.00	35	50	•	
14.83	15.05	4.00	35	50	•	
15.41	15.51	3.00	-	55	•	
16.43	16.71	4.00	35	50	•	
19.59	20.05	4.00	35	50	•	
20.71	21.06	4.00	35	50	•	
21.94	22.22	3.00	-	55	•	•
22.73	22.92	6.00	30	40	•	
23.05	23.09	6.33	30	40	•	
24.48	24.75	3.75	-	50	•	•
24.85	24.97	6.83	25	35	•	•

SOURCE: Wilbur Smith Associates

Table 5 - 8
CURVE SPEED RESTRICTIONS AND MODIFICATIONS
SCENARIO NO. 3

Milepost		Degree of Curvature	Passenger Trains 3 inch Unbalanced (mph)	Bridge Modifications
Beg.	**End**			
3.19	3.52	3.00	65	
7.98	8.14	3.00	65	
9.43	9.63	3.00	65	
14.34	14.62	4.00	55	
14.83	15.05	4.00	55	
15.41	15.51	3.00	65	
16.43	16.71	4.00	55	
19.59	20.05	4.00	55	
20.71	21.06	4.00	55	
21.94	22.22	3.00	65	•
22.73	22.92	6.00	45	
23.05	23.09	6.33	45	
24.48	24.75	3.75	55	•
24.85	24.97	6.83	40	•

Table 5 - 9
CURVE SPEED RESTRICTIONS AND MODIFICATIONS
SCENARIO NO. 4

Milepost		Degree of Curvature	Passenger Trains 3 inch Unbalanced (mph)	Bridge Modifications
Beg.	**End**			
14.34	14.62	4.00	70	
14.83	15.05	4.00	70	
16.43	16.71	4.00	70	
19,59	20.05	4.00	70	
20.71	21.06	4.00	70	
22.73	22.92	6.00	60	
23.05	23.09	6.33	55	
24.48	24.75	3.75	70	•
24.85	24.97	6.83	55	•

SOURCE: Wilbur Smith Associates

Resultant Operating Options

Combining the remaining four Cedar Rapids CBD access alternatives with the four Segment E operating scenarios results in 16 potential operating options. Table 5-10 provides a listing of the potential options and data that describes both the physical and operating characteristics of each. As revealed in Table 5-10, 12 of the options provide access to the Cedar Rapids CBD and vary between 26.7 and 28.0 miles in length. The remaining four options begin at Hawkeye Downs, which results in a length that is almost four miles less than the shortest CBD access option. All terminate at the same point near Burlington Street on the University of Iowa campus in Iowa City. In addition to length, other differences between options include equipment type and maximum operation speed.

Table 5-10
POTENTIAL OPERATING OPTIONS
PHYSICAL AND OPERATING CHARACTERISTICS

Option	CBD Access Alternative	Segment E Scenario	Total Option Length (Mi)	End Points		Max Operating Speed (MPH)	Equipment Type [(2)]
				Beg.[(1)]	End		
1	1	1	27.1	GTC	IC	59	CON
2	1	2	27.1	GTC	IC	59	TILT
3	2	1	26.7	GTC	IC	59	CON
4	2	2	26.7	GTC	IC	59	TILT
5	5	1	28.0	GPK	IC	59	CON
6	5	2	28.0	GPK	IC	59	TILT
7	6	1	22.8	HED	IC	59	CON
8	6	2	22.8	HED	IC	59	TILT
9	1	3	27.1	GTC	IC	79	CON
10	1	4	27.1	GTC	IC	79	TILT
11	2	3	26.7	GTC	IC	79	CON
12	2	4	26.7	GTC	IC	79	TILT
13	5	3	28.0	GPK	IC	79	CON
14	5	4	28.0	GPK	IC	79	TILT
15	6	3	22.8	HED	IC	79	CON
16	6	4	22.8	HED	IC	79	TILT

Note: (1) Beginning end points in Cedar Rapids
GTC - Ground Transportation Center
GPK - Green Park
HED - Hawkeye Downs
(2) Equipment Type
CON - Conventional
TILT - Tilting Technology

SOURCE: Wilbur Smith Associates

CAPITAL IMPROVEMENTS AND ADDITIONS

Based on preceding discussions, capital improvements and additional infrastructure requirements were identified for the operating options, generic (typical) stations, and an equipment servicing facility.

Assumptions

The capital improvements and additions identified for each of the CBD Access Alternatives and Segment E Operating Scenarios described is based on existing facility conditions, FRA requirements, and the operating plan presented in Section 8. Because of the conceptual nature of this effort, a number of assumptions were required.

Cedar Rapids CBD Access - Assumptions for each alternative are outlined below:

Alternative No. 1

- Maximum operating speed between 60 Avenue Southwest and Wilson Avenue - 59 mph between Wilson Avenue and the GTC - 25 mph;

- Construction of a second main track between 60th Avenue Southwest and Wilson Avenue including a set of universal crossovers. Construction to include 115-lb. CWR and new main line timber ties;

- Construction of an additional storage track for the CRANDIC between 60th Avenue Southwest and Waconia Avenue. Construction to include 100-lb. jointed rail and new timber ties;

- Upgrading of the existing main track to FRA Class 3 track safety standards. Improvements to include:

  - Replacement of all rail with new 115-lb. CWR including tie plates, rail anchors and spikes known as (OTM);

  - Installation of 750 new cross ties per mile;

  - Replacement of 20 percent of the switch ties in each turnout;

- Replacement of all turnouts constructed of less than 112-lb. material with 115-lb. new or reconditioned turnouts;

- Surface and align all main line trackage out-of-face (1½ inch raise minimum); and,

- Rework all grade crossings including: ties, flange boards, geotextile fabric and asphalt.

■ Construction of an interlocking at Wilson Avenue that includes two rigid crossings.

■ Construction of two miles of new track between Wilson Avenue and the Ground Transportation in Cedar Rapids. Construction to include 115-lb. CWR, new main timber ties, a new highway bridge at I-380 and 4th Avenue Southwest, and a bridge over the Cedar River;

■ Signalization of both tracks between 60th Avenue Southwest and Wilson Avenue including the new interlocking; and,

■ Grade crossing protection improvements and additions throughout the length of the alternative.

<u>Alternative No. 2</u>

■ Maximum operating speed between the CRANDIC and 8th Avenue Southwest - 79 mph, between 8th Avenue Southwest and the GTC - 25 mph;

■ Construction of a completely new alignment along the route previously described. Construction to include:

- New roadbed and appropriate structures;
- New 115-lb. CWR and timber tie track construction;
- Crashwalls, drainage and fencing on either side of trackage located in the median of I-380; and,
- Automatic train activated warning devices at all major at-grade highway crossings.

■ Construction of a 300-foot passing track between the CRANDIC and I-380. Construction to include:

- New roadbed and appropriate structures;
- New 115-lb. CWR and timber tie track construction; and,
- Two new No. 10 II5-lb. turnouts.

■ NOTE: It was assumed that there would be sufficient horizontal and vertical clearance to permit track construction and rail operations at overhead highway structure locations in the median of I-380.

Alternative No. 5

■ Maximum operating speed between 60th Avenue Southwest and Wilson Avenue - 59 mph, between Wilson Avenue and the bridge over Cedar River - 45 mph and, between the Cedar River Bridge and 4th Avenue Southeast - 25 mph;

■ Improvements and additions between 60th Avenue Southwest and Wilson Avenue are the same as those presented for Alternative No. 1;

■ Between Wilson Avenue and Quaker Oats upgrade the UP's Cedar Rapids Branch to FRA Class 3 track safety standards. Upgrade to include:

- Installations of 750 cross ties per mile;
- Replacement of 20 percent of the switch ties in all turnouts;
- Replacement of broken and missing bolts, joint bars, and tightening of the joints;
- Installation of a sufficient number of anchors to provide a standard anchor pattern;
- Surface and align all main line trackage out-of-face (1½ inch raise minimum);
- Rework all grade crossings. Includes ties, flange boards, geotextile fabric and asphalt; and,
- Install crossbucks at all private crossings; upgrade crossing circuits on crossings with active protection; install automatic warning devices at all public crossings currently unprotected.

- Between Quaker Oats and 4th Avenue Southwest, construct a second track on the west side. Construction to be of 115-lb. CWR and timber cross ties.

<u>Alternative No. 6</u>

- Maximum operating speed between 60th Avenue Southwest and Hawkeye Downs - 59 mph;

- Construction of a second main track on the east side of the existing main track between 60th Avenue Southwest and the south leg of the wye at Pinney (MP 2.1). Construction to include 115-lb. CWR and new timber cross ties; and,

- Construction of an additional storage track for the CRANDIC between 60th Avenue Southwest and Waconia Avenue. Construction to include 100-lb. jointed rail and new timber ties.

Segment E Operating Scenarios - Assumptions for each scenario are outlined below.

Scenario No. 1

- Maximum operating speed for passenger and freight trains - 59 and 40 mph, respectively;

- Upgrading of the main track to FRA Class 3 track safety standards. Improvements to include:

  - Replacement of all rail with new 115-lb. CWR including tie plates, anchors and spikes knows as (OTM);

  - Installation of an average of 500 ties per mile;

  - Replacement of 20 percent of the switch ties in all turnouts;

  - Replacement of all turnouts constructed of less than 112-lb. material with 115-lb. new or reconditioned turnouts;

  - Surface all track out-of-face, increase the superelevation in curves up to four inches and extend the spirals as appropriate;

- Modify bridges for increase in superelevation as appropriate;

- Rework all grade crossings. Includes: ties, flange boards, geotextile fabric and asphalt; and,

- Install cross bucks at all private crossings; upgrade crossing circuits on crossings with active protection; install automatic warning devices at all crossings currently unprotected.

- Upgrading of the sidings at Mid-River and Great Lakes to FRA Class 2 track safety standards. Improvements include:

  - Installation of 400 cross ties;
  - Installation of sufficient anchors to provide a standard anchor pattern;
  - Installation of spring switches;
  - Replacement of broken and missing bolts, joint bars, and tightening of the joints; and,
  - Surface and align the trackage out-of-face (1½ inch raise minimum).

Scenario No. 2. - Assumptions for this scenario are the same as those presented for the previous scenario.

Scenario No. 3

- Maximum operating speed for passenger trains - 79 mph, freight traffic is shifted to the CRANDIC's Third Subdivision;

- Upgrading of the main track to FRA Class 4 track safety standards. Improvements are the same as the previous two scenarios with the following exceptions:

  - Superelevation will be increased to a maximum of six inches;
  - Replacement of an additional 300 ties per mile; and,
  - Installation of a new signalized train control system.

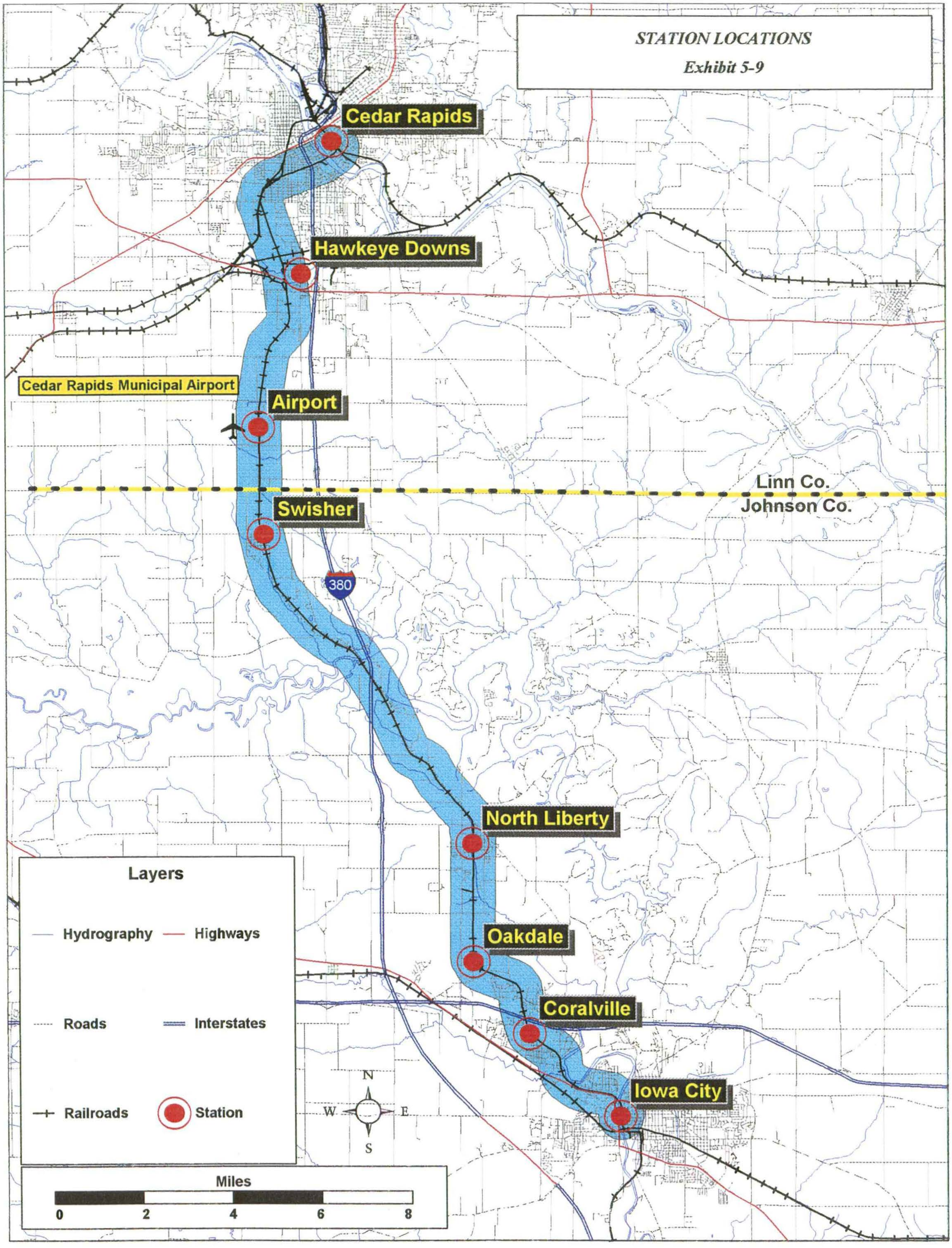
Scenario No. 4 - Assumptions for this scenario are the same as those presented for Scenario No. 3.

CRANDIC's Third Subdivision - Assumptions for this option include:

- A maximum operating speed of 25 mph and construction of a wye track at Homestead;
- Upgrading of the existing track to ensure that it meets FRA Class 2 track safety standards. Improvements include:
  - Replacement of approximately 10 percent of the rail with 115-lb. jointed rail. Replacement includes: joints, bolts, tie plates, anchors, and spikes, all known as other track material (OTM);
  - Replacement of all turnouts constructed of less than 112-lb. material with new or recondition 115-lb. turnouts;
  - Replacement of all turnouts constructed of less than 112-lb. material with new or recondition 115-lb. turnouts;
  - Installation of a sufficient number of anchors to provide a standard anchor pattern;
  - Installation of an average of 500 ties per mile over r the entire length of the route;
  - Replacement of 20 percent in all turnouts;
  - Replacement of broken and missing bolts, joints, and tightening of the joints;
  - Surface and align all main line trackage out-of-face (1½ inch raise minimum);
  - Rework all grade crossings. Includes: ties, flange boards, rail, geotextile fabric and asphalt;
  - Minor bridge improvements throughout the line segment; and,
  - A new wye track that includes two new turnouts, approximately 1,500 feet of new 115# welded rail track and a 200 foot ballast-deck bridge.

Stations

Eight stations are proposed for passenger operations. The general location of the proposed stations is indicated on Exhibit 5-9. The number and location of potential stations is preliminary in



STATION LOCATIONS
Exhibit 5-9
Cedar Rapids
Hawkeye Downs
Cedar Rapids Municipal Airport
Airport
Swisher
Linn Co.
Johnson Co.
380
North Liberty
Oakdale
Coralville
Iowa City
Layers
Hydrography
Highways
Roads
Interstates
Railroads
Station
N
W
E
S
Miles
0
2
4
6
8

nature, and subsequent efforts may conclude that changes in the number and location are warranted.

Generally, the stations are of a simple design that includes a single 150-foot poured in-place concrete platform covered by a canopy, and a train annunciator system to warn waiting passengers of approaching trains. Final platform design should adhere to recommendations of the American Railway Engineering Association (AREA) and requirements of the American Disabilities Act (ADA).

At all stations, with the exception of the Swisher and North Liberty, there appears to be adequate parking nearby that could be used by potential park and ride patrons. Therefore, it was assumed that parking for one hundred cars would be provided at these two stations.

Equipment Storage and Servicing Facilities

Generally, train storage and maintenance facilities consist of tracks for train storage located relatively close to end of line terminal stations and at a site close to downtown. There appears to be sufficient trackage available at both CRANDIC's shops in Cedar Rapids and in Iowa City to provide storage for passenger equipment. In addition, routine fueling, cleaning and maintenance could be performed at CRANDIC's shop in Cedar Rapids. This option should be explored before constructing a new facility, especially since recent estimates value a new facility at approximately $5 million.

CAPITAL COST ESTIMATES

In order to plan for implementation of the additions proposed, an estimate of the cost is necessary. Capital estimates are typically prepared in a series of stages, each based on a more detailed level of analysis -- and hence more reliable -- than the previous estimate. These progressive stages are defined as follows:

- Reconnaissance - Based on brief field investigation and review of existing mapping.
- Conceptual or Planning - Design configuration developed from initial engineering analysis, existing large-scale mapping and limited site verification without detailed surveys.
- Preliminary Engineering - Basic dimensions and design features established, based on project-specific surveys and mapping.

- Final Design - Complete design, ready for construction. The cost estimate is usually referred to as an Engineer's Estimate.

Estimates prepared for this Study could best be characterized as reconnaissance level. Because numerous details necessary for construction are not identifiable at this stage of the planning process, a contingency percentage is added to the estimates. Based on experience, a contingency of 30 percent has been selected for these estimates.

Unit Costs

Unit price descriptions, presented in Appendix A, were prepared for all identifiable work elements. Actual unit costs were developed from information provided by the following sources and recent Consultant experience for similar work.

- Track and civil work elements - CRANDIC and IDOT
- Signal work elements - USS

Administrative Costs

Added to each estimate are administrative costs as follows:

- Design @ 7%
- Construction Management @ 8%
- Project Management @ 3%

No costs have been included for right-of-way acquisitions or utility adjustment unless indicated.

Estimates

Order-of-magnitude estimates were prepared for all system elements discussed in this report section.

CBD Access Alternatives and Segment E Operating Scenarios - An estimate of the cost for the improvements and additions identified and discussed was prepared for each CBD access alternative and Segment E Operating Scenario presented. In addition, separate estimates for each Segment E Operating Scenario were prepared to compliment CBD Access Alternative No. 2. These estimates were given an "A" designation. A summary of improvement and construction costs for each is provided in Table 5-11 and detailed estimates are provided in Appendix B.

Electrification

Estimates were prepared to construct an electric tractive power and distribution system for each of the operating options presented. The estimated unit cost of the system is $997,100 per mile for single track sections and $1,764,000 per mile for double track sections based on a construction cost of $650,000 and $1,150,000 plus contingencies and administrative costs. In addition to the main track, train passing tracks, equipment storage tracks and servicing facilities will require electrification.

Table 5-11
CBD ACCESS ALTERNATIVE AND SEGMENT E OPERATING SCENARIOS
CAPITAL COST SUMMARY

OPTIONS	ESTIMATED COST ($Millions)
CBD Access Alternatives	
Alternative No. 1	$29.2
Alternative No. 2	62.9
Alternative No .5	18.4
Alternative No. 6	4.5
Segment E Operating Scenarios	
Scenario No. 1	13.1
Scenario No. 1A	12.1
Scenario No. 2	13.0
Scenario No. 2A	11.5
Scenario No. 3	22.8
Scenario No. 3A	21.4
Scenario No. 4	22.8
Scenario No. 4A	21.8
CRANDICS Third Subdivision	3.4

Source: Wilbur Smith Associates

For estimating purposes, it was assumed that the sidings at both Mid-River and Great Lakes (a total of 0.7 miles), two storage tracks one at each end of the line (each 0.2 miles in length), and 0.5 miles in CRANDIC shops for equipment servicing would also be electrified. A summary of the costs for each option is presented in Table 5-12. It should be understood that it was assumed that all existing overhead structures have sufficient vertical clearance to permit installation of the power distribution system. Thus, estimates do not include potential modifications to existing overhead structures.

Stations - As previously discussed, eight stations are proposed. The estimated cost of each station, excluding land purchase, is $398,840 based on a construction cost of $260,000 plus contingencies and administrative costs. It should be noted that for CBD access Alternatives No's. 2 and 6 there are only seven stations, since Alternative No. 2 bypasses Hawkeye Downs and Alternative No. 6 does not access the Cedar Rapids CBD. The estimated cost of parking facilities for the stations at Swisher and North Liberty is $306,800, excluding land cost, for each site based on a construction cost of $200,000. This cost includes parking for 100 cars, landscaping and lighting.

Equipment Storage and Servicing Facilities - Based on previous discussions, there were no costs developed for storage tracks. The estimated cost of a servicing facility is $7.7 million based on a construction cost of $5 million plus contingencies and administrative costs.

Infrastructure Cost - Table 5-13 provides a summary of the estimated funding required to provide for infrastructure improvements and additions presented for each of the operating options. As revealed in Table 5-13, funding requirements using diesel powered equipment varies from $28.60 million for Option 8 to $99.20 million for Option 12. Using electric powered equipment, funding requirements range between $52.80 million and $127.53 million for the same two options. It should be noted that all four of the options are based on the use of tilt equipment. The additional cost of tilt vs. non-tilting equipment is not included in these estimates.

Table 5-12
ELECTRIC POWER AND DISTRIBUTION SYSTEM
COST SUMMARY

OPTION	MAIN TRACK LENGTH (Miles)	DOUBLE TRACK LENGTH (Miles)	CAPITAL COST ($Millions)
CBD Access			
Alternative No. 1	2.0	2.65	6.67
Alternative No. 2	6.15	0.10	6.31
Alternative No. 5	2.90		7.57
Alternative No. 6	1.00	2.65	0.98
Segment E Options			
Scenario No. 1			21.94
Scenario No. 1A			20.43
Scenario No. 2			21.94
Scenario No. 2A			20.43
Scenario No. 3			21.94
Scenario No. 3A			20.43
Scenario No. 4			21.94
Scenario No. 4A			20.43
Passing Track	0.7		.70
Storage Tracks	0.4		.39
Servicing Tracks	0.5		.50

Source: Wilbur Smith Associates

SUMPTION

Options	Max Oper Speed (Mph)	Cost of CBD Alternatives($			Total Cost Non-Elec. ($Millions)	Electric Cost ($Millions)	Total Cost Electric ($Millions)
		1	2				
1	59	29.20			53.80	30.20	84.00
2	59	29.20			53.70	30.20	83.90
3	59		62.90		86.10	28.33	114.43
4	59		62.90		85.50	28.33	113.83
5	59				43.00	31.10	74.10
6	59				42.90	31.10	74.00
7	59				28.70	24.20	52.90
8	59				28.60	24.20	52.80
9	79	29.20			66.90	30.20	97.10
10	79	29.20			66.90	30.20	97.10
11	79		62.90		98.80	28.33	127.13
12	79		62.90		99.20	28.33	127.53
13	79				56.10	31.10	87.20
14	79				56.10	31.10	87.20
15	79				41.80	24.20	66.00
16	79				41.80	24.20	66.00

Source: Wilbur Smith Associates

Section 6

TECHNOLOGY OPTIONS

Section 6
TECHNOLOGY OPTIONS

Technology options available for regional rail passenger systems in the United States have been limited. Since 1980, the commuter railroads have had to rely on diesel-electric and electric locomotive hauled passenger coaches or electric multiple unit (EMU) commuter cars. Recently, there has been renewed interest in examining diesel multiple unit and railbus technology. This interest has grown from a need to expand suburban passenger rail services with minimum capital costs.

The purpose of this chapter is to examine the technology options available for the Cedar Rapids and Iowa City regional rail service and to determine the optimum technology for planning purposes. The CRANDIC was an electrified interurban railway when it last operated passenger service on May 30, 1953. After rail passenger service was abandoned, the line was de-electrified in October of 1953 in order to save approximately $100,000 in annual operating expenses. The CRANDIC has expressed interest in the electrification of the rail passenger service line. Therefore, the balance of this report will examine the suitability and availability of various diesel and electric technology options.

There are two basic categories of train. Traditional diesel-electric or electric locomotives pulling passenger coaches and diesel or electric multiple unit (DMU or EMU) trainsets. This Chapter is organized by technology option:

- The first section of this Chapter outlines the history and characteristics of various diesel-electric locomotives developed in North America for passenger rail service over the past 25 years. This review includes the suitability and availability of remanufactured locomotives to pull passenger coaches on the CRANDIC.

- The second section describes the history and characteristics of various passenger railcars suitable for regional rail operations. The availability and costs of the refurbishment of Amtrak Heritage equipment is discussed.

- The third section describes the advancements in the development of diesel multiple unit technology in North America, Europe and Japan over the same time frame.

- The fourth section reviews the electric technology options in terms of the unique operating characteristics and profile of the CRANDIC rail system.

- The last section examines the array of technology options found suitable for the CRANDIC and provides a recommendation based on the review.

The CRANDIC represents an important part of American history. The building of electric interurban railways affected economic development at the turn of the century much in the same way highways have affected development patterns today. There may be merit in examining the feasibility of operating the CRANDIC as it was - an electric interurban railway.

DIESEL-ELECTRIC LOCOMOTIVE OPTIONS

The choice of diesel-electric motive power also has been limited. There were several suppliers of passenger diesels after the Second World War, including the Electro-Motive Division of the General Motors Corporation (EMD), the American Locomotive Company (Alco), Fairbanks-Morse, Baldwin and General Electric (GE).

EMD pioneered the introduction and advancement of diesel-electric motive technology in North America in the 1930's with the advent of the streamlined *Zephyrs*. Consequently, EMD produced twice as many diesel-electric locomotives as its competitors. The most popular passenger diesel ever built exclusively for passenger train service was the E series locomotive produced by EMD. Today, only EMD and GE build diesel-electric locomotives in the United States.

Exhibit 6-1 Chicago,Burlington & Quincy *Zephyr*

Most of the passenger diesels in operation by Class I and commuter railroads before the creation of Amtrak were purchased after the end of the Second World War. However, not many new locomotives were purchased for passenger train service after 1960. Among the last new diesel-electric locomotives built specifically for passenger rail service were the FP45 built by EMD and the U28CG and U30CH built by General Electric (GE). The FP45 was built for both the Atchison, Topeka & Santa Fe Railway Company and Milwaukee Road. The GE locomotives were built for the Santa Fe and New Jersey Transit. These locomotives were delivered in the mid-1960's. The Santa Fe used these locomotives to power their *Super Chief* and other long distance trains operating between Chicago and Los Angeles. New Jersey Transit used the U30CHI for commuter train service.

The National Railroad Passenger Corporation (Amtrak) began operations in May, 1971 with 286 diesel-electric locomotives inherited from the freight railroads. These heritage fleet locomotives were generally F and E series passenger locomotives built by EMD in the late 1940's and 1950's. These venerable work horses proved to be very unreliable for a variety of reasons and needed to be overhauled or replaced. Commuter railroads in New England, New York, New Jersey and Chicago also continued to rely on older E and F series EMD locomotives. These engines also needed to be replaced.

The following paragraphs discuss the various new passenger locomotives acquired by Amtrak and several commuter railroads over the past 20 years to replace this heritage equipment.

Electro-Motive Division (EMD) series SDP40F

In 1973, Amtrak ordered SDP40F locomotives from EMD to replace the antiquated passenger locomotives inherited from the freight railroads. The SDP40F design was based on the SD40 freight locomotive and was an adaptation of the Santa Fe FP45. The SDP40F was a six-axle, 3,000 horsepower diesel-electric weighing over 396,000 pounds.

In late 1975, these locomotives were involved in several derailments while operating at higher speeds on curved track. Subsequent investigations revealed that the cause of the accidents could be traced to the design of the locomotive's wheel sets. Lateral forces exerted by the wheel sets on curved track at high speed caused the tracks to spread apart precipitating the derailment. The SDP40F locomotives were speed restricted on curves nationwide and were eventually removed from service. Amtrak no longer operates any SDP40F locomotives. Many of the SDP40F locomotives were traded in to EMD for newer F40PH locomotives because their diesel engines and electrical equipment could be dropped into the newer four-axle units.

General Electric (GE) series P30CH

Amtrak placed an order with GE in 1974 for twenty-five P30CH diesels. The P30CH were 3,000 horsepower diesel-electric locomotives weighing 386,000 pounds. These second generation Amtrak diesels were freight locomotives modified for passenger operations. GE had modified the design of its U30C freight locomotive to include a more streamlined front end cowl to reduce wind resistance and additional space for diesel-driven generators for head end power. Amtrak was modernizing its passenger coach fleet and was standardizing on electric power instead of steam for heating and air-conditioning. The twin diesel generator sets installed in the locomotive for head end power on this series of locomotive was unreliable. The generators failed frequently. After correcting generator failures, the P30CH became a reliable piece of motive power.

Exhibit 6-2 Amtrak P30CH

When the SDP40F started having derailment problems in the mid-1970's, Amtrak became suspicious of all six-axle locomotives. The P30CH locomotives were assigned to short distance trains as needed. Amtrak leased five P30CH locomotives to the Southern Pacific in 1978 to alleviate an equipment shortage on the San Francisco - San Jose commuter rail line. These engines worked extremely well in the commuter rail environment logging thousands of hours without major incidents. Amtrak's operating department gained more confidence in the reliability of this locomotive and assigned it to the *AutoTrain* and the *Sunset Limited.* By late 1992, all the P30CH locomotives were replaced by newer locomotives.

Electro-Motive Division (EMD) series F40PH

Reliable motive power was desperately needed for Amtrak in the mid-1970's. The SDP40F was prone to derailing at high speeds on curves and the P30CH had recurring generator problems. Both locomotives were modified six-axle heavy weight freight engines. Beginning in 1976, Amtrak wrote its own specifications for a four-axle, light weight, 3,000 horsepower diesel-electric locomotive with head end power.

Exhibit 6-3 Amtrak F40PH Locomotive

EMD developed a locomotive satisfying the Amtrak specifications utilizing major components from the SDP40F. In fact many of the SDP40F engines traded-in by Amtrak were converted to F40PHR series engines.

Between 1976 and 1987, Amtrak purchased a total of 210 F40PH units from EMD. This engine has proven to be reliable with good operating characteristics.

Several commuter railroads purchased modified F40PH series locomotives new for regional passenger rail service. Metra in Chicago ordered 85 of these units between 1977 and 1989. A new order for these units in 1991-92 resulted in design changes that affected the exterior appearance of the front cab. All F40PH units resemble their more utilitarian freight locomotive cousins with a squared off front end. However, these Metra units have a more aerodynamic front end design. These Metra units have been designated as the F40PHM-2. Many of the older Amtrak F40PH engines have been retired from service and are candidates for remanufacturing into commuter rail locomotives.

General Electric (GE) series P32BH

In 1991, Amtrak acquired twenty new locomotives from GE. These 3,200 horsepower, four-axle locomotives weigh 269,000 pounds and were designated as the P32BH. These newer locomotives began replacing older F40PH locomotives on long distance trains.

General Electric (GE) Genesis series AMD-103

In April, 1993, Amtrak acquired a completely new series of locomotive designed and built specifically for passenger service. The GE Genesis series passenger diesel has a unique design that features sleek styling, a high strength, lightweight monocoque carbody, integral head end power, reduced emissions and extensive internal diagnostic systems. Amtrak ordered forty-four diesel-electric units rated at 4,000 horsepower. These units weigh 262,800 pounds.

Exhibit 6-4 Amtrak *Genesis* AMD-103 Locomotive

An additional ten 3,200 horsepower dual mode versions of the AMD-103 have been ordered to replace 1950 vintage EMD FL-9 locomotives. The dual mode locomotive allows diesel-electric trains to operate in electrified territory, such as in the Grand Central Terminal and Penn Station region, without having to change engines. This reduces operating expenses and the need for an additional fleet of electric locomotives. The dual mode version relies on AC traction power while the diesel-electric version uses traditional and time tested DC traction power. The AMD-103 is capable of operating at speeds of 103 to 110 mph. One important new feature of the Genesis series locomotive is the bolsterless truck design. Unlike its freight railroad ancestors, this truck design is based on European design concepts in operation in high speed rail passenger service. This truck is able to maintain tolerances and gauge until overhaul. This advanced truck design minimizes wheel wear and other wheel/track dynamics. Propulsion power is micro-processor controlled. The diesel engine improvements include a complete micro-processor driven electronic fuel injection system for reduced emissions while maintaining the fuel efficiency advantage of the GE four stroke cycle design.

Electro-Motive Division (EMD) series F59

Exhibit 6-5 Metrolink F59PHI Locomotive

In 1988, EMD introduced a 3,000 horsepower diesel-electric locomotive specifically design-ed for commuter rail applications. The locomotive, designated as the F59PH was designed to provide the enhanced acceleration, deceleration and braking characteristics needed for commuter rail operations. This was accomplished by adding separate head end power diesel generator sets allowing all the horsepower developed by the main diesel to be available for propulsion power and by utilizing fully blended dynamic and friction braking. A single F59PH can handle a ten car bi-level train consist weighing up to 700 tons. GoTransit in Toronto ordered 42 units between 1988 and 1990. The Southern California Commuter Rail Authority (Metrolink), the new start commuter railroad in the Los Angeles metropolitan region, purchased 23 F59PH units.

EMD also developed a completely new intercity rail passenger diesel. In September, 1994 the General Motors Locomotive Group and the California Department of Transportation unveiled this new generation diesel-electric locomotive developed specifically for the intercity rail passenger industry. The F59PHI is very sleek. The outer shell is made of high strength light weight composite materials originally developed for military aircraft. The aerodynamic locomotive weighs 270,000 pounds fully loaded. The 3,000 horsepower diesel engine with electronic fuel injection and micro-processor control affords smoother operation, greater fuel economy over conventional EMD diesels and includes advanced engine diagnostics. Propulsion power is augmented by AC traction motors for reduced maintenance expenses. A separate 600 kW head-end power unit is included in the standard unit. The maximum speed of this new generation passenger diesel is 110 mph.

CalTrans has ordered 9 of these new units for its *Capitols*. The Long Island Railroad has ordered 23 F59PHI units while BC Transit has ordered 5 F59PHI units for commuter service.

Remanufactured Locomotives

During this same period of time, many older commuter railroads began upgrading their diesel-electric locomotive fleets and new start commuter rail operations were attempting to commence operations with tight capital budgets. Freight railroads were purchasing newer, more powerful, fuel efficient locomotives and downsizing their equipment fleet. The combination of the purchase of newer engines and the downsizing of railroad operations due to merger and line abandonment resulted in a supply of well maintained surplus freight locomotives. This permitted several remanufacturers to develop a market niche in the locomotive rebuilding business supplying remanufactured surplus locomotives to the short line and commuter railroad market.

A new start commuter railroad can achieve significant start-up capital cost savings by purchasing rebuilt locomotives. Because of the economics associated with rebuilding locomotives, many short line and commuter railroads can purchase rebuilt units at prices nearly half the cost of a new engine. However, added operating costs over the life-cycle of the rebuilt unit may not be the most economical purchase. The rebuilt main diesel engine does not have the same life expectancy of a new diesel engine. In addition, fuel consumption and other on-going maintenance expenses associated with older engines can add operating expenses that could counter initial capital cost savings over the remaining useful life of the engine. Life-cycle benefit/cost analysis should be considered when deciding whether to buy new or used equipment.

Typically, remanufacturing a diesel-electric freight locomotive for passenger train service includes rebuilding the main diesel engine, overhauling the bolster and trucks, installing either new or rebuilt traction motors and adding new power control units. Other major components are either rebuilt or changed to new. Most of the rebuilt freight units delivered for passenger service have been delivered with head end power auxiliary diesel-generator sets.

There are several suppliers of remanufactured locomotives. MK Rail has become a major supplier of rebuilt locomotives for the commuter rail industry. Other suppliers of rebuilt locomotives include AMF, Chrome Locomotive, Republic and Conrail. National Railway Equipment in Illinois operates a large brokerage for used locomotives. The rebuilt locomotives used by commuter railroads are mostly used EMD GP40 freight locomotives converted for commuter rail passenger service or surplus Amtrak EMD E series or F40PH units.

The GP40WH locomotives delivered to New Jersey Transit and the Maryland Rail Commuter Service (MARC) were remanufactured by MK Rail from EMD GP40 freight locomotives and are representative of this type of rebuilt unit. The North Carolina Department of Transportation (NCDOT) purchased two rebuilt GP40 locomotives from AMF for the 403(b) *Piedmont*, scheduled to commence operating on May 25, 1995. These locomotives have been designated as the GP40H-2 series. There is a sufficient supply of surplus GP40 locomotives and a great deal of expertise in the remanufacturing of these units to passenger service specifications.

In addition, surplus used Amtrak F40PH units are excellent units for the commuter rail market. There is expertise in the remanufacturing of these units to commuter service specifications. The F40PHM-2C locomotives remanufactured by MK Rail for Tri-Rail and the North County Transit District (Coaster) are surplus Amtrak F40PH passenger locomotives.

The most popular passenger diesel ever built was the E series locomotive built by EMD in the 1940' through late 1950's. There are 11 used EMD series E8A and 4 used E9A passenger locomotives available for purchase from National Railway Equipment Company in Dixmoor, Illinois. The E8 locomotives were operated by the Burlington Northern Railroad for its Metra commuter rail service. These locomotives were rewired by MK Rail in the late 1970's. The E9 locomotives were operated and maintained by Metra staff and were leased to Amtrak for intercity passenger service. The E9 locomotives are cab signal equipped. All these locomotives are equipped with diesel-generator sets for head end auxiliary power. The head end power diesels are Cummins engines that develop 425 kW electrical power. All these locomotives were retired from revenue service in operating condition.

Estimated Cost of New and Rebuilt Locomotives

The cost of a new or rebuilt locomotive varies according to the specification requirements of the purchasing railroad. Each locomotive is unique. Table 6-1 illustrates the initial purchase prices of new and rebuilt diesel-electric locomotives as delivered to Amtrak or commuter railroad customers over the last several years. The price is the average contract price per unit. The original purchase price has been inflated to 1995 dollars using CPI cost indices for transportation equipment.

Caution must be exercised in using these price comparisons because of the variances in specifications and level of overhaul utilized in the rebuild process. However, the comparisons are useful for general planning purposes and capital budgeting analysis.

Table 6-1
Diesel-Electric Passenger Locomotives
Price Comparisons

Type		Supplier	Customer	Year	Contract Price US$	Present Value 1995 US$
SDP40F	N	EMD	Amtrak	1973	453,000	1,436,010
P30CH	N	GE	Amtrak	1974	480,000	1,368,000
F40PH	N	EMD	Amtrak	1976	413,000	1,037,539
F40PH-2	R	MK	Tri-Rail	1987	941,555	1,224,022
F59PH	N	EMD	GOTransit	1988	1,875,000	2,231,250
RP39-2	R	MK	VRE	1991	590,000	684,400
F59PH	N	EMD	Metrolink	1991	2,200,000	2,508,000
P32BH	N	GE	Amtrak	1991	1,750,000	1,995,000
GP40H-2	R	AMF	NCDOT	1992	985,000	1,122,900
F40PHM-2	N	EMD	Metra	1992	2,060,000	2,245,400
P40BH (AMD-103)	N	GE	Amtrak	1993	2,300,000	2,507,000
GP40WH-2	R	MK	MARC	1993	1,210,500	1,283,130
F40PHM-2C	R	MK	Coaster	1994	1,500,000	1,545,000
F59PHI	N	EMD	BCTransit	1995	2,250,000	2,250,000
F59PHI	N	EMD	LIRR	1995	2,752,175	2,752,175
E8A and E9A	used	EMD	Metra	1954	as is	60 to 90,000
F40PH	used	EMD	Amtrak	1976	as is	400 to 500,000

Sources: Amtrak, NCDOT, Metra and other sources as compiled by Wilbur Smith Associates

Note: N = purchased new; R = purchased as a rebuilt unit

Although Amtrak does not advertise the sale of used F40 locomotives, they can be made available for sale to commuter rail operators. The general asking price for a surplus Amtrak F40 unit is approximately $ 500,000 as is. Amtrak is willing to negotiate a complete overhaul package. The level of effort required for the overhaul is dependent on the purchaser's specifications and the condition of the locomotive available for sale.

The prices of the former Metra and Amtrak E8A and E9A locomotives range between $60,000 and $90,000 in as-is condition. It is estimated that these locomotives can be rebuilt at an estimated cost of between $600,000 to $700,000 depending on the level of rebuild and body restoration needed and desired.

The market for locomotives is extremely competitive and a new start commuter railroad has a wide variety of used and new equipment to choose from. The selection of equipment and whether to buy new or used equipment is a capital budgeting problem that requires competent analysis.

PASSENGER COACHES

Traditional passenger trains pulled (or pushed) by locomotives require passenger coaches. During the first 75 years of the 20th Century, passenger coaches were manufactured in the United States primarily by American Car & Foundry, the Budd Company, Pullman-Standard and the St. Louis Car Company. Today, there are no domestic carbuilders. There are numerous reasons for the disappearance of these carbuilders. The most significant reason for their disappearance can be traced to the disinvestment in passenger railroads. Since the end of World War II, the United States was made significant investments in airport and highway infrastructure. As intercity travel demand shifted from passenger rail service to private automobile and air carrier services, passenger railroad ridership and revenues declined precipitously. There were no new orders for passenger railcars of any significance after the mid-1960's until Amtrak placed orders in 1973.

Since the mid-1980's, foreign carbuilders from Canada, Japan and Europe have delivered most of the new railcars ordered by the commuter railroads and Amtrak. Between 1986 and 1987, Bombardier Inc., a Canadian company headquartered in Saint-Bruno, Québec, acquired the designs for all Pullman and Budd built passenger railcars and merged with UTDC, another Canadian carbuilder. Bombardier has established a car assembly plant in Barre, Vermont. MK Rail, of Boise, Idaho has attempted to resurrect domestic carbuilding capability. Although MK designs new railcars, it relies on foreign manufacturers for the carbodies. These carbodies often come from Mafersa in Brazil, Sorefame in Portugal or Japanese carbuilders. Final assembly occurs in the United States. In deference to local political requirements, final assembly of the railcars often occurs in the destination city.

Other carbuilders that have delivered new railcars to passenger railroads in the United States include Japanese carbuilders Nippon Sharyo, Kawasaki and Tokyu Car Corp. Messerschmitt-Bolkow-Blohm (MBB) of Germany delivered 67 new commuter railcars to the MBTA in Boston between 1987 and 1988. Breda Costruzione Ferroviarie, the Italian carbuilder noted for its Cleveland LRV, low-floor San Francisco MUNI LRV, WMATA and Los Angeles subway cars has shown interest in building commuter and intercity passenger railcars for the US market. Mafersa supplied new cars to the Virginia Railway Express (VRE).

Many of the newer fleets of commuter railcars also include cab control equipment for push-pull operation. Push-pull service reduces the operating expenses of turning trains and eliminates the need to construct costly wyes to turn the trains around.

The remainder of this section will describe the types of passenger equipment in operation, the availability of such equipment and estimated costs of new and remanufactured passenger rolling stock suitable for commuter rail operations. There are two basic types of passenger cars suitable for regional rail passenger operations, the single deck and double-deck design. The following paragraphs describe the design development of these two carbody styles.

Single Deck Passenger Cars

There are two basic carbody designs for passenger railroad applications. Traditional single-level cars and large capacity bi-level cars. The following railcar types are single level designs suitable for both intercity and regional rail passenger service. Design concepts for these cars date back to the 1930's. The Amtrak Heritage fleet is of special noteworthy importance because many of the carshells are stainless steel and could be easily refurbished for commuter rail service at minimum expense. Several of these cars are now available for sale by Amtrak.

Amtrak Heritage Fleet - Amtrak and the commuter railroads inherited an antiquated fleet of passenger equipment. The average age of the fleet Amtrak acquired from the freight railroads was over 20 years old with some equipment being over 30 years old. Each railroad that had been operating passenger trains purchased rolling stock suited for the unique operating characteristics, profile and passenger market the railroad served. Often, railroads would purchase new equipment as a complete train set for their named trains. Consequently, there were no standardized designs for passenger train equipment as there were for freight cars.

The individuality of passenger equipment created significant operating problems for Amtrak when it commenced operations in 1971. The only standardized feature of the inherited passenger equipment was its reliance on steam heating. This was a carry-over from the 1950's when railroads were converting from steam to diesel-electric motive power. Steam heat was a by-product of the steam generated by the engine for propulsion power. Even after all the steam engines had long been retired from active service, passenger trains pulled by modern diesel-electric locomotives required steam generator equipment.

Eventually, Amtrak phased out steam heated passenger cars by 1982 and standardized on all-electric operation of its passenger car fleet. This also necessitated the purchase of locomotives equipped with diesel-generator head end power to power the heating, air-conditioning and other auxiliary systems on-board passenger cars.

Amtrak began a major refurbishment of the inherited fleet of passenger equipment and began standardizing other major subsystems required on passenger cars as well as phasing out steam heating. Many of these rebuilt cars are still in service today. However, as Amtrak continues its modernization program, many high quality Heritage cars are being retired and stored at the Amtrak shops in Beech Grove, Indiana.

Among the equipment recently retired from service and available for sale are the cars listed in Table 6-2. Specifications for this equipment can be found in Appendix D.

The Budd Company stainless steel cars were originally manufactured between 1948 and 1954. The coaches built by St. Louis Car Company are aluminum with painted exteriors and were manufactured between 1960 and 1964. Amtrak overhauled all of this equipment between 1987 and 1992. The 4000 series coaches have been modified to comply with ADA requirements. The cost for these cars is subject to a bid and auction disposal process. Amtrak will auction the bid price with those bidders whose bid price is within 50 percent of the top bid.

Table 6-2 Amtrak Heritage Fleet					
Quantity					
Total	**For Sale**	**Series**	**Type of Car**	**Carbuilder**	**Cost as is Estimated**
2	2	9400	dome car	Budd Co	$ 250,000
9	2	3100	lounge car	Budd Co	$ 125,000
20	7	4700	coach	Budd Co	$ 100,000
21	7	4600	coach	St. Louis	$ 75,000
4	4	4000	coach ADA compliant	Budd Co	$ 125,000

Source: Amtrak, estimated costs compiled by Wilbur Smith Associates

Amfleet - The Budd Company pioneered the design development and manufacturing process for high buff strength, light weight stainless steel cars that came to symbolize modern streamlined passenger car design. This design development began in 1934 with the Zephyrs of the Chicago, Burlington and Quincy and ended with the Amfleet II cars purchased by Amtrak in 1980.

The Budd Company also produced the original Metroliner equipment for the Penn Central Railroad for its high speed electric service between New York and Washington, DC in 1969. These electric multiple unit trains had a unique car shell design that had a more tubular design than the conventional passenger car equipment manufactured between 1940 and the late 1950's. This sleek design conveyed the modern image of passenger rail service that Amtrak was seeking.

Amtrak placed its first order for new passenger cars in 1973 with the Budd Company for 492 cars in various configurations. The design of these cars was based upon the Metroliner car design favored by Amtrak executives. These new cars were equipped with modern all-electric heating and air-conditioning systems and other auxiliary systems powered by the AC electricity generated by the diesel-electric locomotive. An additional order of 150 stainless steel cars was placed with the Budd Company in 1980. This second generation of Amfleet equipment had larger windows, more comfortable seating arrangements and other improvements in operating systems. Today, Bombardier owns the designs of the Budd Amfleet equipment and can produce new coaches that feature the distinctive, sleek design of these cars.

Horizon Cars - In 1989, Amtrak ordered 104 new passenger railcars from Bombardier. These cars were intended for short distance trains and utilize a design similar to cars designed and built for commuter railroads by the Pullman-Standard Company in the early 1970's. The cars are aluminum with a squarish design that blends in well with the older designs of the Heritage fleet. Bombardier has utilized this design for commuter railcars purchased by New Jersey Transit and others.

Other New Single Deck Cars - Nippon Sharyo, a Japanese carbuilder, designed a new series of stainless steel EMU commuter cars for the Northern Indiana Commuter Transportation District (NICTD), the successor to the Chicago, South Shore and South Bend Railroad. These cars were assembled in Cleveland by the General Electric Service Shop from 1982-83. Nippon Sharyo modified this carbody design for traditional locomotive pulled single deck commuter cars and supplied 64 cars to the Maryland Rail Commuter Service (MARC). Both cab and trailer cars were designed for MARC and delivered in lots between 1985 and 1993.

The Virginia Railway Express acquired 38 new stainless steel cars from Mafersa, a Brazilian carbuilder with a reputation for high quality. Mafersa was a licensee of the Budd Company stainless steel carbuilding processes and techniques.

Messerschmitt-Bolkow-Blohm (MBB) produced 34 push-pull railcars for MBTA in 1987-88. These cars are Americanized versions of a traditional European regional railroad design.

Double Deck Passenger Railcars

Commuter railroads typically require high capacity, easy entry railcars that minimize train length. Reducing train length minimizes capital investment in longer passenger platforms. High capacity cars reduce maintenance expenditures for running gear and auxiliary systems and minimizes capital investment in additional coaches.

There are two basic varieties of double deck car, Gallery cars and Bi-level cars. The Gallery cars utilize a suspended seating principle developed by St. Louis Car in the mid-1950's. The Bi-level cars have two full passenger decks with intermediate end decks over the trucks, an arrangement that permits a higher ceiling and more comfortable seating arrangements and more efficient stairway and door positioning.

Gallery Cars - Bi-level "Gallery" cars were developed by the St. Louis Car Company for the Chicago & North Western in 1955. These 85-foot cars seated as many 169 passengers. The Gallery cars have proven themselves in revenue service since their introduction and have evolved over time. Pullman-Standard and the Budd Company continued to develop this design concept and delivered additional fleets of cars to Chicago's commuter railroads between 1957 and 1980. The Illinois Central ordered 129 electric multiple unit (EMU) bi-level cars produced by the St. Louis Car Company between 1971-72 for service on its electrified suburban division.

Metra, the commuter railroad in Chicago organized under the Regional Transportation Authority, has standardized its fleet based on this carbody design and operates 880 Gallery cars on its 8 commuter rail lines. Bombardier delivered 36 new EMU Gallery cars for the Illinois Central Division of Metra between 1978-79. In 1992, Metra ordered 173 new Gallery cars. These new Gallery cars will be wheelchair accessible in compliance with Americans with Disabilities Act (ADA) requirements. The new Metra Gallery car is being produced by a cooperative design and assembly

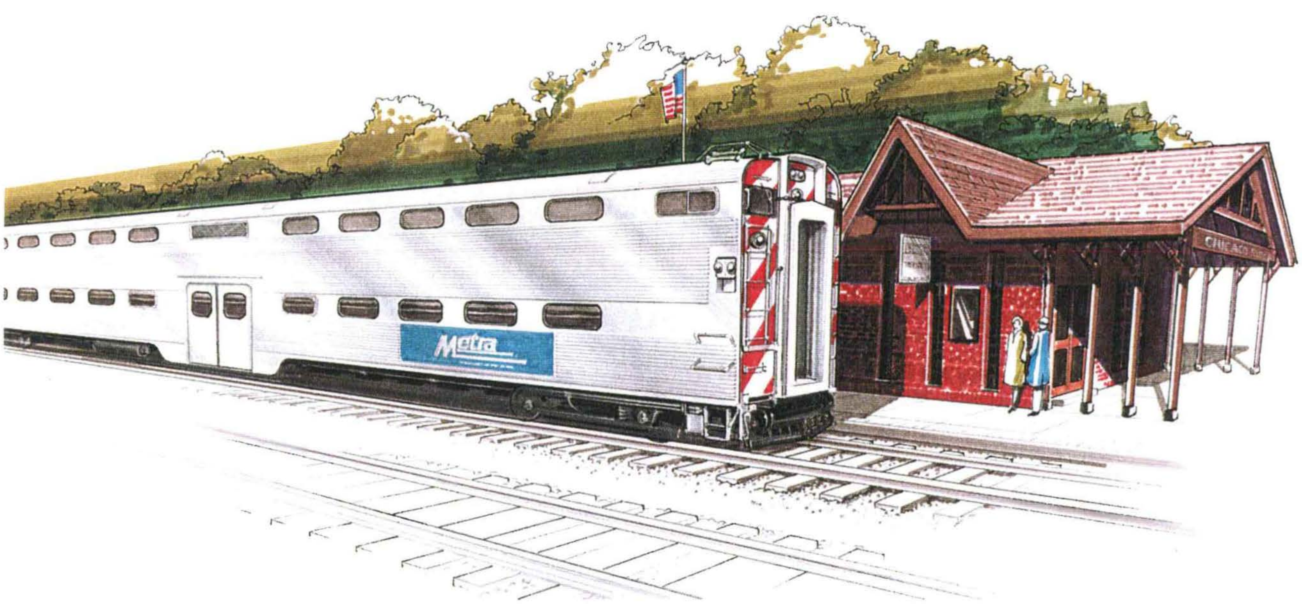


Exhibit 6-6 Metra Gallery car

effort of MK Rail and Nippon Sharyo of Japan. The trailer cars can seat up to 148 passengers reduced to 141 passengers when the 3 wheelchair positions are occupied. The cab cars seat 138 passengers reduced to 131 when the three wheelchair positions are occupied. Maximum operating speed of the car is 79 mph with a design speed of 100 mph.

The Southern Pacific purchased Gallery cars for its Peninsula Commuter service operating between San Francisco and San Jose. The original Gallery cars built in the 1950's for the Southern Pacific were replaced by new stainless steel cars built by Nippon Sharyo. These new cars were ordered by CalTrans in 1984 and were delivered between 1985-87. The former Southern Pacific Peninsula commuter service is now operated by a Joint Powers Board formed by the City and County of San Francisco and San Mateo and Santa Clara counties.

Bombardier Bi-Level Commuter Cars - Several new start commuter railroads commenced operations during this period. Railcar design choices were limited to the products supplied by the Budd Company, Pullman-Standard and St. Louis Car. Although the Gallery car had proven itself in revenue service, the Government of Ontario was interested in developing a new car design for its highly successful GOTransit commuter service in Toronto. In 1977, the Government of Ontario purchased an original design bi-level car from a predecessor company to Bombardier for the GOTransit commuter rail service.

Exhibit 6-7 Metrolink Bombardier Bi-Level Cab Control Car

This design features "pinched" car ends giving it a very distinctive appearance. The carbody is constructed of aluminum alloy and is painted to conform to the graphic standards of the purchasing railroad. The Bi-Level cars have two full passenger decks and four low level platform doors located approximately at the quarter points of the carbody. This low level loading at platform level allows a full carload of passengers on or off the coach within 90 seconds thereby minimizing platform congestion and speeding up train operations. These cars are fully accessible for passengers with physical disabilities and meet all the requirements of ADA. Other new start commuter railroads have selected the Bombardier-built Bi-Level cars as standard equipment because of these features. These railroads include Tri-Rail, Metrolink, Coaster and the soon to be started West Coast Express in Vancouver, BC.

Kawasaki Doubledeck Commuter Cars - The Massachusetts Bay Transportation Authority (MBTA) in Boston operates 11 commuter rail lines serving an annual ridership of over 22.3 million. Growth in commuter rail ridership prompted MBTA to acquire more railcars to provide additional capacity. MBTA concluded that the optimum way to achieve more capacity was to utilize doubledeck equipment. This would minimize train length and maximize seated capacity of each train. However, because of restrictive clearances in Boston, the MBTA was required to solicit bids for a new doubledeck car design.

Kawasaki, a Japanese carbuilder, was awarded a contract by MBTA for 75 new bi-level cars in 1989. The new design cars were delivered in 1991. The Kawasaki bi-level car has a stainless steel superstructure with traditional vestibules at each car end with wide sliding doors and conventionally operated traps. This design arrangement allows passengers to board and alight from the train at either high or low platform stations. As passengers enter the car, they can choose to

Exhibit 6-8 Prototype Double Deck Commuter for Long Island Railroad Built By Tokyu Car Corp

be seated either at standard floor height at the car ends over the trucks or the upper or lower level decks located in the car center by using the stairways. The cars feature large picture windows. With 3-2 seating, these 85 foot cars seat up to 189 passengers.

In 1994, Kawasaki received an order from the Maryland Rail Commuter Service (MARC) for the supply of 50 doubledeck cars. Kawasaki has recently won an order from the Long Island Railroad to supply 114 doubledeck cars of similar design characteristics for commuter service into New York City. These new cars are based on specifications developed by the LIRR from testing conducted with 10 prototype doubledeck cars designed and built by Tokyu Car Corp. of Yokohama, Japan. New Jersey Transit and Virginia Railway Express also are considering doubledeck cars of similar design.

California Cars - The California Department of Transportation (CalTrans) was directed to develop specifications and purchase new standardized passenger railcars to be used in intercity and commuter rail service throughout the State. This activity was in response to Proposition 116 funding for rail passenger improvements in California. In 1992, MK Rail was awarded a contract to design the California Car. The initial contract was for 66 intercity versions of the design which included 14 cab control cars, 32 coaches, 6 baggage cars and 14 food service cars. Additional orders were placed with MK Rail by Metrolink for a bi-level commuter rail version of the car.

Exhibit 6-9 California Cars as built by MK-Rail

The California Car advances older technology cars serving North American rail passenger railroads. Passenger amenities specified include individual reading lights, enclosed overhead storage compartments, 5-channel personal audio system, bike racks and two washrooms (one ADA compliant), ac electrical outlet provisions for portable computers and telephone and fax communication capabilities. The car was designed to promote rail ridership as an attractive alternative to automobile and air carrier service in California's congested travel corridors.

The carbody of the California Car is of stainless steel construction manufactured in Brazil by Mafersa. The commuter coach version of the California Car weighs between 142,000 and 146,000 pounds empty for trailers and cab control cars respectively. The car is designed for incremental high speed rail service with a maximum design operating speed of 125 mph.

Superliners - Superliners delivered to Amtrak are designed specifically for long distance travel and generally would not be appropriate for commuter rail systems. Superliners were developed for Amtrak by Pullman-Standard in 1975. Bombardier owns the designs for Superliner equipment and received an order from Amtrak in 1993 to develop the next generation of Superliner rolling stock. Delivery prices for Superliners are included in Table 6-3 for informational purposes only.

Estimated Cost of Commuter Railcars - The following table illustrates the initial purchase prices of new passenger railcars as delivered to Amtrak or commuter railroad customers. The contract price is per unit. The bi-level railcars cost significantly more than a single level car. Cab control cars for commuter equipment generally costs 10 to 25 percent more than the trailer car.

The total contract price, including spare parts, was averaged among the total units ordered. Individual car prices are listed if they were known.

Table 6-3
Passenger Railcars
Initial Purchase Price Comparisons

Type	Supplier	Customer	Year	Contract Price US$	Present Value 1995 US$
Amfleet I	Budd	Amtrak	1973	541,000	1,747,430
Superliners	Pullman	Amtrak	1975	848,000	2,255,680
Amfleet II	Budd	Amtrak	1980	766,000	1,248,580
Bi-Level	Bombardier	Tri-Rail	1986	975,000	1,296,750
Horizon	Bombardier	Amtrak	1988	1,000,000	1,260,000
Bi-Level	Bombardier	Metrolink	1990	1,300,000	1,482,000
California Car	MK Rail	Caltrans	1992	1,806,475	1,969,058
Single level	Mafersa	VRE	1992	650,000	708,500
Superliners	Bombardier	Amtrak	1993	2,000,000	2,120,000
California Car	MK Rail	Caltrans	1993	2,180,000	2,310,800
Doubledeck	Kawasaki	MARC	1994	1,600,000	1,648,000
Bi-Level	Bombardier	BC Transit	1994	1,464,000	1,507,920
Single level	Bombardier	Metro North	1994	1,299,890	1,338,887
Comet IV	Bombardier	NJ Transit	1995	1,168,420	1,168,420
Doubledeck	Kawasaki	LIRR	1995	1,574,560	1,574,560

Sources: Amtrak, Tri-Rail, VRE, MARC, and other sources as compiled by Wilbur Smith Associates

The California and Superliner cars have a variety of configurations each having a separate price based on the optional equipment installed. These cars were designed primarily for the intercity

Exhibit 6-10 Amtrak Superliner as built by Bombardier

rail passenger market and are considered to be more luxurious than is required for typical commuter train operation.

Caution must be exercised in using these price comparisons because of the variances in specifications. However, the comparisons are useful for general planning purposes and capital budgeting analysis.

Amtrak is selling surplus Heritage fleet cars. It has been reported that Amtrak will make these cars available to public transit agencies for approximately $ 100,000 each as is, where is. Amtrak also will negotiate to refurbish these cars in accordance with purchaser specifications. The Fort Worth Transportation Authority is currently negotiating with Amtrak for several Budd Company built stainless steel Heritage cars completely refurbished for an estimated cost of $ 475,000 each. Delivery cost is $ 1.60 per mile per car plus switching costs.

DIESEL MULTIPLE UNIT (DMU) TECHNOLOGY OPTIONS

Even during the golden era of passenger railroading, the railroads needed a less expensive alternative to traditional train consists for branch line operations. The concept of a self-propelled railcar was an attractive design option. Operated in one or two-car trains for branch line services, the railroads had hoped to achieve operating economies in capital costs, fuel and crew costs over those of more conventional train consists. They experimented with various self-propelled passenger railcar technologies between World War I and the 1940's to provide the operating economies they believed were necessary to continue passenger service on lightly used branch lines.

Design Development

These technologies included a variety of gasoline and diesel engines driving a variety of power transmissions or electric motors. Hall-Scott Motor Car Co., Strang Gas-Electric Car Co., McKeen Motor Car Co and the J. G. Brill Co supplied large numbers of self-propelled motor cars with either electric or mechanical transmissions. EMD and GE also produced gas-electric and diesel-electric versions of self-propelled rail passenger cars. These railcars did enjoy early commercial success for branch line passenger service operations. However, not many new orders for self-propelled railcars came after the mid-1930s until the Budd Company introduced the rail diesel car in 1949. The rail diesel car (RDC) enjoyed considerable commercial success with over 400 units being sold. With the abandonment of passenger service by Class I railroads nearly ending rail passenger service in the United States, not many new passenger railcars of any type were purchased after the mid-1960's. With the enactment of the Urban Mass Transportation Act of 1964, as amended, there was a renewed interest in the development of commuter rail and regional rail passenger services in the United States. By the mid-1970's, carbuilders were again delivering new railcars for commuter railroads and the Budd Company was developing a replacement for the RDC.

Elsewhere in the world, the development of self-propelled railcar designs was continuing. The Japanese, who had licensed Budd Company technology and designs were building improved versions of the RDC. In Europe, "railbus" technology was operating on secondary lines. Recently, the German Public Transport Operators Association (VDV) invited rolling stock manufacturers to draft new concepts for rail vehicles for short-haul, suburban operation or lightly used branch lines. The manufacturers were asked to see how far LRV and bus design standards, principles and components could be adapted with the goal of achieving vehicle standardization and system commonality. It is believed that this would provide economies in operation and reduced capital cost.

Design Standards

In the United States, the Federal Railroad Administration developed buff strength standards for "multiple unit locomotives." The body structure of multiple unit trains having a total empty weight of 600,000 pounds or more must be designed to meet or exceed certain minimum specifications. These design requirements include a body structure designed to resist a minimum static end load (buff strength) of 800,000 pounds at the rear draft stops ahead of the bolster on the center line of the draft, without developing any permanent deformation in any member of the carbody structure.

Through past practice and precedent, this standard has been applied to all new passenger railcars operating on Class I or commuter railroads that are required to comply with FRA safety requirements. Transit authority rapid transit trains are not required to comply with this standard, but many do because of liability considerations in the event of accidents. It is widely believed that the FRA will not waive these crash worthiness requirements for diesel multiple unit equipment despite the waivers granted for the demonstration of the British Leyland railbus in the early 1980's. The Budd Company RDC and certain other diesel cars satisfy the requirements of the FRA regulation.

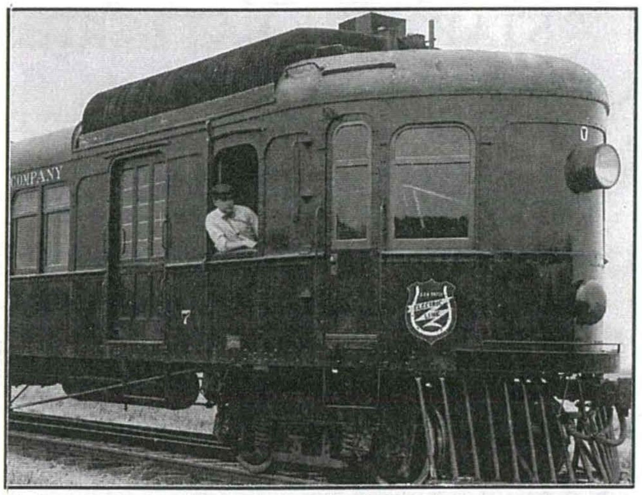


Exhibit 6-11 Gas Operated RDC

Most current design European diesel railcars do not satisfy this very strict standard. What is significant in the latest European designs is the recognition that the "Eurorailbus" must satisfy some minimum buff strength standards for safety reasons. The German Federal Transport Ministry is currently developing regulations covering the construction and operation of innovative lightweight diesel multiple unit railcars. The new Eurorailbus design specification does not want to sacrifice the strength inherent to railcar designs. Therefore, it differs significantly from previous "railbus" designs that relied on bus bodies mounted on railcar frames.

The following paragraphs describe the design development of self-propelled railcars in the United States, Japan and in Europe. To the extent that such determinations could be made, the buff strength and other relevant characteristics pertinent to new start commuter railroads in the United States are discussed.

North American Self-Propelled Rail Passenger Cars

In North America, the passenger railroad business was declining from the end of World War II through to the creation of Amtrak in 1971. During this period of transition in the rail passenger business, Class I railroads and many commuter railroads began to consider technologies that allowed more economical operation of rail passenger service. The rail diesel car and "railbus" were two technologies that were advanced during this period of railcar development. The following paragraphs portray the design development of self-propelled rail passenger cars from the late 1940's through today in the United States.

<u>The Budd Company Rail Diesel Car (RDC)</u> - In 1949, the Budd Company developed the rail diesel car (RDC) to satisfy this emergent market. The Budd Company manufactured nearly 400 RDC units between 1949 and 1962. These self-propelled passenger cars were configured in 4 different body styles conforming to the differing needs of the railroads who purchased them. The original cars were built with two 275 horsepower Detroit Diesel engines and Allison hydraulic torque converter transmissions. Later versions of the RDC were delivered with Cummins engines and Twin Disc transmissions. North American operating experience with this technology has been mixed.

Most of the RDC's produced were used for suburban and branch line passenger rail service by the Boston & Maine (MBTA), Central of New Jersey (NJ Transit), New Haven (ConnDOT), and Baltimore & Ohio (MARC) railroads. The New York Central operated RDC units in intercity rail passenger service between Cleveland and Columbus, Ohio. Other railroads in the Western United States also operated RDC equipment for lightly used intercity passenger services. The last RDC's in daily revenue service were recently retired by VIA Rail in Canada and MARC. The Dallas Area Rapid Transit Authority (DART) has purchased 13 ex-Via Rail RDC's and will remanufacture the cars for its emergent commuter rail line between Dallas and Fort Worth, Texas. Other VIA Rail RDC equipment is still available for sale. Many of the existing Budd RDC cars still in service in the United States have been remanufactured and modified into cab control cars for push-pull commuter train operations. The stainless steel bodies of these Budd cars, with some caring restoration, can be made to look like new equipment.

Exhibit 6-12 Rail Diesel Car (RDC) as built by the Budd Company

<u>SPV 2000</u> - In 1978, the Budd Company decided to develop a new self-propelled vehicle utilizing the Metroliner and Amfleet carbody style. The SPV 2000, as it was designated, was a modernized self-propelled diesel car designed to replace the aging fleet of RDC's still in operation. It also was designed to provide transit authorities with an optional technology for quickly expanding rail service to more distant suburbs. The SPV2000 was powered by two 360 horsepower Detroit Diesel series 92 engines and Allison hydraulic transmissions. The SPV 2000 could operate in 12 car multiple unit trains at speeds up to 120 mph. An overhead cooling and ventilation system provided a complete air change in the car every six minutes. Modern air-coil suspension systems provided a smooth ride.

The SPV 2000 was designed for maximum passenger appeal to attract the attention of those transit systems needing newer equipment. Unfortunately, the mechanical systems of the SPV 2000 proved to be unreliable in revenue service. Consequently, not many SPV 2000 vehicles were purchased by the commuter railroads despite an aggressive marketing campaign that included a national tour. The Budd Company delivered a total of only 29 cars to the Kingdom of Morocco, State of Connecticut and the New York Metropolitan Transportation Authority (MTA). An additional 13 carbodies were built and never fitted with interiors and mechanical systems. These carshells are still available at the Red Lion Plant of the former Budd Company and could be purchased and converted to regional rail passenger cars. The retrofitting of the carshells with modern propulsion and control systems could be an attractive alternative to purchasing new equipment. Kinki Sharyo, in joint venture with Delaware Car Co., have expressed interest in outfitting the existing SPV 2000 carbody shells. The former Budd Company demonstrators also are available for sale through Kinki Sharyo.

General Motors/Fairmont Motor Car "RailBus" - There was some interest in developing a unique hybrid vehicle that could operate on both railway and highway. In 1967, the Red Arrow Division of the Philadelphia Suburban Transportation Company acquired a new General Motors Corporation (GMC) "Modernaire" transit bus and equipped it with Fairmont Motor Car hy-rail equipment. The GMC new look bus was a suburban model equipped with air-conditioning, reclining seats and two sets of non-powered, retractable 12 inch steel wheels. This hy-rail equipment permitted the bus to operate normally on highways and to operate on the Norristown Division of the

Exhibit 6-13 Red Arrow "railbus"

Red Arrow System in suburban Philadelphia. Two of the rubber tires also rode the rails and provided the necessary propulsion power directly from the diesel-hydraulic propulsion system of the bus.

Only two such vehicles were produced for the Red Arrow. Bus 409 was delivered in 1967 and 410 in 1968. Demonstrations were provided in Washington, DC on the Baltimore & Ohio Railroad and in Indianapolis on the Monon Railroad. The demonstrations and revenue service performance of the GMC/Fairmont railbus was not successful. Ride quality of the vehicle on the railway was terrible. Bus suspension systems rely on the pneumatic tires for much of their lateral stability. While operating on railway track, the 12 inch steel wheel did not have much lateral stability. Vertical ride quality was dampened by the air suspension system of the bus to some extent, but vibration from the steel wheel/rail interface was especially noisy and uncomfortable. Tractive effort was noticeably reduced during winter weather when the rubber tires of the bus continued to spin on the slippery wet rail. Continued experimentation with the railbus was discontinued in 1969.

Japanese Rail Diesel Cars

Japan has an extensive passenger railroad network made famous by the Shinkansen "Bullet Train." In addition to the Shinkansen, Japan's railroads operate an extensive regional rail passenger service that includes many branch lines that are not electrified. The railroad supply industry has responded with self-propelled rail diesel car equipment satisfying this market.

Tokyu Car Corporation - Tokyu Car Corporation (TCC) of Yokohama, Japan was a licensee of the Budd Company technology. As such, TCC had access to Budd Company designs and manufacturing processes. TCC has had a successful record of accomplishment in the North American railcar market. TCC built 60 stainless steel heavy rail rapid transit cars for the Greater Cleveland Regional Transit Authority, 33 carbon steel light rail vehicles for the Niagara Frontier Transportation Authority in Buffalo, New York and the M-4 cars for the Metro-North Commuter Railroad in New York City. TCC also designed and built 10 stainless steel prototype double deck commuter railcars for the Long Island Railroad.

TCC has designed and built rail diesel cars for the Japanese domestic and the export market. Stainless steel RDC's were built for the Taiwan Railway Administration and for the State Railways of Thailand. Each of these trains evolved from the Budd Company designs and resemble its Budd Company ancestor. However, the TCC model RDC cars have proven to be more reliable than the original Budd Company designs mainly because of differences in choice of propulsion engines and transmissions. These cars are very sleek in design and satisfy Federal Railroad Administration (FRA) buff strength loading requirements.

TCC has also delivered carbon steel RDC designs to the Philippine National Railways and Ferrocarril del Pacifico de Nicaragua. These carbodies do not satisfy FRA requirements.

<u>Nippon Sharyo</u> - As described previously, Nippon Sharyo has built new stainless steel EMU commuter railcars for the Northern Indiana Commuter Transportation District (NICTD) operating on the Chicago, South Shore and South Bend Railroad, stainless steel Gallery cars delivered for CalTrain service on the former Southern Pacific San Francisco Peninsula Commuter service and single level stainless steel commuter cars for MARC.

Exhibit 6-14 Diesel Rail Car as proposed by Nippon Sharyo

Recently, Nippon Sharyo announced its interest in building diesel multiple unit trainsets for the emergent regional rail market in the United States. The design of the proposed diesel rail car would utilize a carbody evolved from the successful NICTD EMU and MARC push pull cars. The advantage of utilizing this evolved carbody design is that it satisfies FRA/AAR requirements for buff strength. The proposed DMU has acceleration and deceleration specifications equivalent to EMU equipment. The design concept requires the car to be powered by twin 345 horsepower Cummins NTA855-R1 diesel engines with electronic fuel injection. Each engine drives the inner axle of one truck through a Twin Disc or Voith hydraulic transmission. Maximum operating speed is 80 mph utilizing a bolsterless truck design. Electrical systems are powered by an auxiliary diesel generator set providing 50kVA, 480 VAC, 3 phase electrical power. Seating capacity of each car is 87 passengers. HVAC includes hot water heating and 12.3 tons AC cooling capacity. Braking is pneumatic friction.

Kinki Sharyo - Kinki Sharyo is noted for the development of the Boston No. 7 LRV and the new Dallas LRV. During the recent procurement of ex-VIA Rail rail diesel cars by DART, Kinki Sharyo submitted a proposal for the completion of the unfinished SPV 2000 stainless steel carbody shells in joint venture with Delaware Car, a railcar rebuilder. It is estimated that the price for outfitting the carbodies with interiors and equipping them with properly sized propulsion power and auxiliary systems would be approximately $2.1 million each FOB shipping point.

European Diesel Multiple Units

While the rail diesel car was being phased out in North America and more fully developed in Japan, new self-propelled railcar designs were being advanced in Europe. These DMU's have established remarkable performance marks in revenue service for reliability and operating economy. In Great Britain, for example, British Rail operates more than 2,000 diesel multiple unit cars. Equipment availability has been better than 90 percent for some of the newer designed fleet and has achieved average fuel efficiency of 3.8 miles per gallon with light-weight class DMU cars. This is only about ⅓ as much fuel as an equivalent locomotive-hauled train.

The current European designs do not satisfy FRA buff strength requirements. Some of the carbuilders are interested in developing a lightweight DMU for the United States rail passenger market that would fall below the total empty 600,000 pound train weight threshold. The following paragraphs describe representative DMU trainset types developed by various European carbuilders. The later designed equipment is considered only in the context of carbuilders expressions of interest in supplying such vehicles to the United States transit industry.

British Leyland Railbus - The British and Germans developed their own version of the railbus. These units were generally two-axle four wheel units designed with railcar under frames and lightweight bodies. One such unit demonstrated in the United States was designed and built by Leyland Industries. The significant difference between the GMC/Fairmont railbus and that of the British vehicle consisted of the underframe design. While the American railbus was a bus with hy-rail equipment, the British railbus was a true hybrid vehicle consisting of a bus shell mounted on a modified European freight wagon underframe.

The British Leyland Railbus was 39 feet long and was capable of speeds up to 70 mph. It was powered by a 190 horsepower diesel engine coupled to an automatic four-speed gear box and an axle-mounted reversing flash final drive gearbox. Braking was provided by conventional bus pneumatic systems. Suspension was provided by two-axle flexicoil suspension.

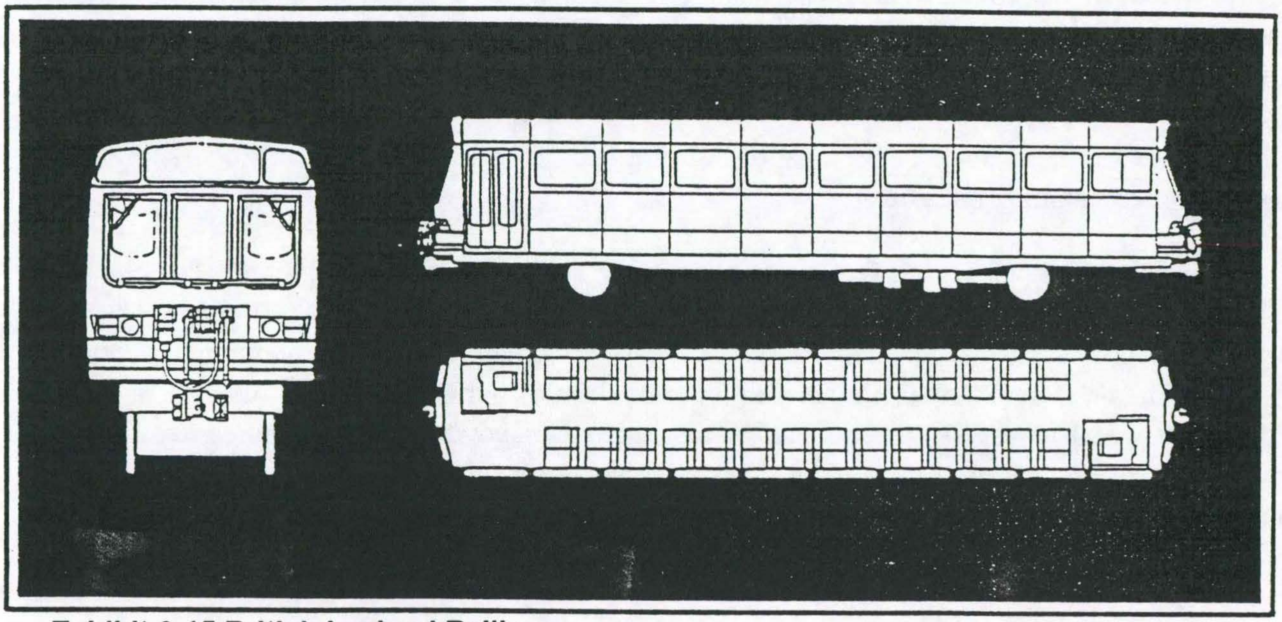


Exhibit 6-15 British Leyland Railbus

In 1980, the State of New Hampshire received a $1.25 million FRA grant to operate the railbus on a Boston & Maine commuter rail line between Concord, NH and Lowell, MA. FRA was interested in the prototype vehicle because it was fuel efficient, inexpensive and boasted of a suspension system that could negotiate relatively poor track. The British Leyland Railbus also was tested in a 5-week commuter rail demonstration in Cleveland, Ohio. The demonstration route operated from Mentor to downtown Cleveland on Norfolk Southern and Greater Cleveland Regional Transit Authority rapid transit track into the Cleveland Union Terminal light rail station. The train was also operated as part of a commuter rail feasibility demonstration study in Youngstown, Ohio.

During revenue service demonstration programs, the railbus displayed mechanical unreliability in the North American transit and railroad environment. Cleveland transit officials were required to dispatch a regular transit bus to provide daily backup service in case of mechanical failures during the service demonstation. Other operating problems involved the failure of the two-axle vehicle to shunt track circuits, crossing gates and railroad signalling systems properly. In addition, the two-axle design showed a tendency to derail over sharp turnouts found in rapid transit system track layouts.

Although the railbus was not a commercial success in the United States, it did demonstrate the willingness of the FRA to consider this technology option for the emergent regional rail market including allowing a lightweight vehicle of bus body construction and buff strength to operate on freight railroad right-of-way. The railbus demonstrations also illustrated the potential for operating such vehicles in mixed freight corridors with the cooperation of participating Class I railroads. During the entire period of the demonstrations, there were no reportable accidents involving the railbus and other vehicles.

ABB Transportation - ABB Transportation has supplied several types of DMU equipment to British Rail, the State Railways of Thailand and for the State Railway Authority of New South Wales in Australia. ABB is noted for the overhaul and retrofitting of 10 FL-9AC dual mode locomotives for MetroNorth.

Class 158 "Express" - ABB supplies several versions of the Class 158 DMU. In Great Britain, ABB has supplied over 360 of this class of DMU to British Rail. Twenty (20) similar vehicles have been delivered to the State Railways of Thailand.

The Class 158 is constructed of lightweight welded aluminum alloy extrusions. Each DMU is powered by a single Cummins NTA855R1 or Perkins 2006-DWU underfloor main diesel rated at 390 horsepower and is fitted with a Voith T211 hydrodynamic transmission and Gmeinder final drive. The Class 158 is capable of a maximum speed of 90 mph. This lightweight equipment has allowed British Rail to achieve train weights per passenger 45 percent below traditional locomotive hauled equipment resulting in substantial fuel economies.

Although, the aluminum alloy body structure does not comply with FRA requirements, it is likely that a stainless steel body structure could be designed to be compliant. The added weight from the stainless steel design could require a different power plant and some of the fuel efficiencies would be lost to pushing the extra weight.

Class 158 "Xplorer" - The "Xplorer" series DMU produced by ABB is similar in appearance to the Class 158 "Express" series. However, the Explorer has a stainless steel carbody with aerodynamically shaped glass reinforced plastic front ends. The DMU weighs approximately 100,000 pounds empty. ABB has delivered 16 Explorer series DMU trainsets to the State Railway Authority of New South Wales and has expressed interest in supplying this type of DMU to the United States. Each Explorer DMU is powered by a single Cummins KTA19R underfloor main diesel rated at over 400 horsepower driving through a Voith T311 hydraulic transmission to tandem Voith V19 final drive gearboxes on both axles of one truck. The Explorer is designed to be a high speed luxury diesel railcarfor long-distance travel in New South Wales and is capable of a maximum speed of 100 mph.

Exhibit 6-16 DMU Type Xplorer for New South Wales State Rail Authority as built by ABB Transportation

Flexliner Class IC3D - In 1992, the Swedish State Railways placed into service the Flexliner Class IC3D DMU. The IC3D is designed to operate in 3-car DMU trainset and is tailored to operate intercity services. The carbody is aluminum mounted on articulated trucks and is

Exhibit 6-17 Type IC3D Flexliner as built by ABB Skandia

capable of 100 mph operating speeds. The carbody does not satisfy FRA buff strength requirements. However, ABB has expressed interest in modifying the IC3D design for the US market.

Flexliner RL2D - The RL2D, designed for the Swedish State Railways, is a 2-car DMU trainset intended for regional and commuter rail services. The train can seat 135 passengers and operate at speeds up to 90 mph and is similar in appearance to the IC3D.

Siemens Duewag - Siemens Transportation Systems Group, a German manufacturer of rail passenger equipment, has been actively involved in the North American transit market. Siemens Duewag has supplied light rail vehicles to a number of North American cities including Calgary, Denver, Edmonton, Pittsburgh, Sacramento, San Diego, and St. Louis. Siemens is building new diesel multiple unit trainsets for German Rail and has expressed considerable interest in designing and building new DMU equipment for the North American market. These DMU trainsets are designed for several different travel markets.

Siemens Type 628 - The type 628.4 series DMU is designed for short distance intercity rail service and was designed over twenty years ago. There are over 400 of these trains in operation in Germany. Variations of this design are operating in Denmark, Netherlands, Norway and Switzerland.

The two-car married pair trainset is powered by a single 635 horsepower Daimler diesel engine mounted underfloor. The Daimler diesel supplies propulsion power through a Voith hydraulic transmission and has a maximum operating speed of 75 mph. The type 628 is

Exhibit 6-18 Type 628 as built by Siemens Duewag

constructed of lightweight low alloy high tensile strength steel for the underframe and sidewall supports. The sidewall and cab exterior uses a specific steel type to provide additional strength. The roof is made of type 301 corrugated stainless steel alloy. However, the carbody does not satisfy FRA buff strength requirements. Siemens has indicated that a DMU for the United States market would likely be a variation of the type 628. However, because of the additional weight of the carbody to satisfy buff strength requirements, the US design would need more horsepower.

Siemens Type VT610 - The type VT610 is a newer design DMU developed by a consortium of carbuilders including Siemens Duewag, ABB Henschel and AEG. The unique characteristic of this train is the introduction of tilt train technology developed by Fiat Ferroviarie for the Pendolino class high speed train. The tilt technology permits the VT610 train to travel at speeds of up to 100 mph. The VT610 will lean into curves at higher speeds that normal operating practice would allow for conventional trains enabling shorter travel times. Superelevation of the curve, lateral acceleration and velocity is measured by means of gyroscopes, accelerometers and velocimeters with signals controlled by the microprocessor control system.

Exhibit 6-19 Type VT610 as built by Siemens Duewag

The power for the DMU is supplied by twin MTU 12 cylinder 183 series diesel engines. The twin 650 horsepower diesels generate electrical power through a directly coupled brushless single-bearing three-phase synchronous alternator. Energy developed through the electrical generator flows through uncontrolled rectifiers, and GTO-impulse DC-AC converted with integrated braking controller to the 3-phase traction motors.

Vehicle control is realized by microprocessors. This train is designed for high speed intercity operations. The interior of the train is high quality with sound absorbing materials built into several layers of carbody material design. This train type would be suitable for long distance commuter and short distance intercity train service such as Richmond to Washington and the Amtrak *San Diegans*.

Breda Costruzione Ferroviarie, SPA - Breda is noted for its Cleveland LRV, WMATA and Los Angeles rapid transit cars, the new San Francisco MUNI low-floor LRV and the Seattle dual-mode trolley bus. Breda has built diesel multiple unit trainsets for the Sardinian Franchised Railways. The DMU is equipped with two Fiat 8217.32.038 S type diesel engines. The engines are fuel efficient four stroke, supercharged with direct injection and supply propulsion to dc traction motors through a diesel generator set. The engines develop 280 horsepower. Braking is dynamic with blended pneumatic friction braking assistance. Breda has expressed some interest in developing a regional rail vehicle for the United States market.

New Developments in European Regional Railcar Designs

Since 1992, the German Public Transport Operators Association (VDV) has undertaken a coordinating role in defining requirements for new regional rail vehicles. It has been the intent of the VDV to develop a light weight vehicle that is both inexpensive to purchase and economical to operate. The VDV asked carbuilders to design a DMU that has similar components to other public transport equipment currently in operation. New designs are being developed by no less than 7 European manufacturing consortiums. Nearly all of these new DMU trainsets share technology with light rail vehicles and buses.

Siemens Duewag Type RVT 4 N - The first of the new vehicles designed in accordance with the VDV standards for regional rail systems is the type RVT4N by Siemens Duewag introduced in February 1995. It is a completely new design DMU for the Dürener Kreisebahn (DKB), a regional railroad in Germany. The 78-foot articulated DMU vehicle resembles a modern light rail vehicle (LRV). The type RVT is assembled from readily available bus, LRV and DMU components. The RVT carbody structure is built of self-supporting light weight aluminum alloy, welded underframe and bolted sidewalls. The advanced design front section is made of sandwiched glass-fiber reinforced plastic. The roof is made of sandwiched aluminum alloy.

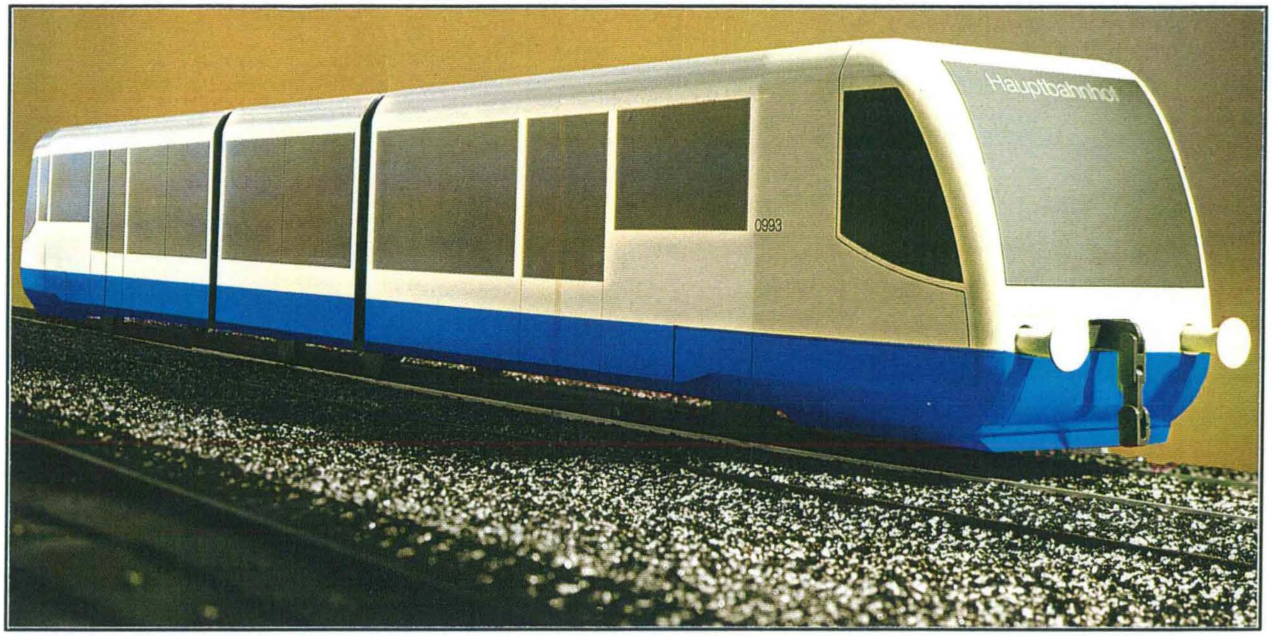


Exhibit 6-20 Type RVT4N as proposed by Siemens Duewag

The RVT has performance characteristics similar to many LRV. The RVT will accelerate at roughly 2.5 mphps and brake at 2.25 mphps with an emergency brake rate of 8.5 mphps. Top speed of the RVT is about 55 mph. The RVT is powered by two self-sufficient water-cooled 5-cylinder diesel engines connected to 5-speed automatic hydrodynamic transmissions with integral retarder. Primary deceleration of the RVT is accomplished by means of the hydrodynamic retarders and electrically controlled pneumatic disc brakes. Electromagnetic track brakes are also provided. This vehicle permits the design of regional rail systems with the same flexibility and operating characteristics as a light rail system without the expense of electrification.

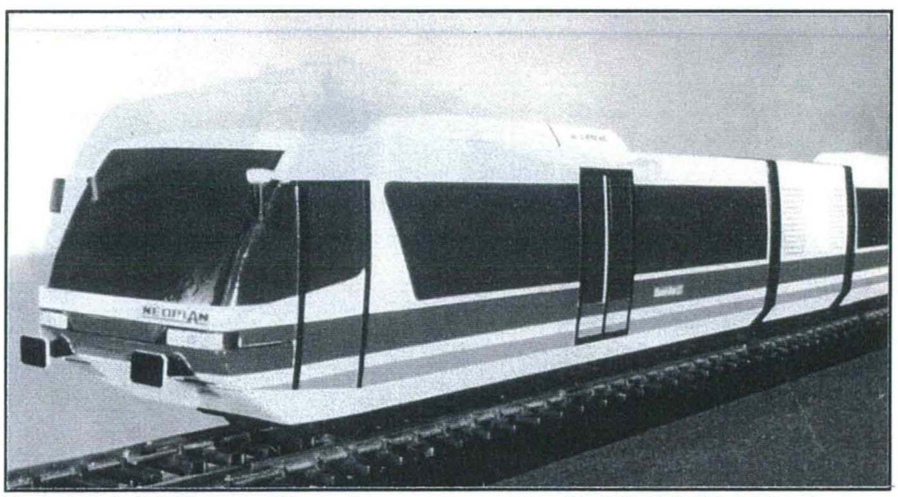


Exhibit 6-21 Eurorailbus as proposed by De Dictrich and Neoplan

Eurorailbus - The Eurorailbus is being jointly developed by the French railcar builder De Dietrich, the German bus builder Neoplan and a regional bus operator. The design concept of this new version of the railbus is based on double articulated LRV designs. The propulsion engine will be housed in the central module that also divides the two passenger sections of the vehicle. This basic version provides seated capacity for 96 people in a 2+3 configuration or 76 in a more comfortable 2+2 seating arrangement. The basic design concept is still in development. A prototype vehicle is in production.

Type GTW 2/6 - This new DMU is being jointly developed by a consortium that includes AEG, Alusuisse, DWA, SLM and Stadler. The vehicle design is essentially an electric double articulated LRV developed for Switzerland by Stadler, with trucks by SLM and traction equipment by ABB. The LRV design will be modified to house a 540kW diesel engine in the central module powering an electric generator for power transmission to two dc traction motors mounted in the center truck. Seating capacity will be 104 for 2+2 and 142 for 2+3 seating arrangements.

The truck design will be of the type developed specifically for articulated railcars. The power truck is a frameless radial self-steering design. The unpowered trucks also radial self-steering units, will incorporate a torsionally elastic truck frame. These trucks are especially suited for poor track conditions and lines with a lot of curves. The self-steering trucks should result in minimized wheel and rail wear and the elimination of squealing around curves. A diesel electric prototype of this design is currently in production and could be available for testing by late 1995.

AEG-Regioliner - The Regioliner has a sleek futuristic appearance that is very appealing which could induce potential ridership. Three prototypes of this design are being developed by AEG. The design concept includes two versions, a single car unit and a two-car articulated unit.

Exhibit 6-22 Regioliner as proposed by AEG

In each design, the diesel engine would be mounted beneath the drivers cabs. Type 183 diesels from MTU have been selected for main propulsion power. Hydraulic transmissions, either Voith or Twin Disc, will drive the leading axle of one truck through a cardan shaft. Hydrodynamic braking and magnetic track brakes will be featured in the design.

The design continues to rely on light rail and bus technology for major components. This permits greater flexibility in maintenance management by optimizing spare parts inventories for large urban transit systems.

Costs of Self-Propelled Rail Diesel Cars

Because no new self-propelled rail diesel cars have been purchased by any North American railroads or transit systems since the late-1970's and early 1980's, it is difficult to determine the costs for such equipment. The European equipment currently in production or in design do not satisfy FRA buff strength requirements. Other design considerations, including passenger amenities such as heating, ventilation and air conditioning system requirements necessary for the North American environment also differ significantly from current European design practice. Hence, using the "as delivered" prices for European DMU equipment would artificially understate the cost of equipment for the United States market. The foreign exchange and transportation cost alone would add substantially to the delivered price of such vehicles.

Recently, the Dallas Area Rapid Transit Authority (DART) purchased 13 former VIA Rail Budd Company RDC's for a cost of $1.7 million. These cars are going to be completely rebuilt for an additional $ 20.5 million making the unit price of the rebuilt RDC's $1.7 million each. During the DART bidding for rebuilding the RDC's, several optional bids for new and other rebuilt equipment were submitted by several carbuilders. Siemens Duewag bid a price of $2.3 million for the type 628 modified for North American operations. Kinki Sharyo submitted a proposal for outfitting the SPV 2000 carshells with rebuilt RDC engines and Twin Disc transmissions. Because the DART procurement was a negotiated procurement, the Kinki Sharyo price was not made public.

However, in subsequent discussions with representatives from Kinki Sharyo, it was revealed that the price for outfitting the SPV 2000 carshells with new engines and transmissions could cost between $1.9 and $2.1 million. In discussions with other manufacturers, a budget price of $2.5 million for a new DMU seating 148 passengers seems reasonable. These prices are subject to some degree of variation based upon the individual specification of the purchaser and the cost of subcomponent systems such as engines and transmissions. Table 6-4 illustrates the prices as quoted or indicated by potential suppliers.

Table 6-4
Costs of Diesel Multiple Unit Railcars

Type		Supplier	Customer	Purchase Price $	Price 1995 $
SPV 2000	N	Budd Company	ConnDOT 1981	1,000,000	1,630,000
Budd RDC	R	VIA Rail/ AMF	DART 1995	1,710,000	1,710,000
Type 628 modified	N	Siemens Duewag	DART		2,300,000
SPV 2000	N	Kinki Sharyo	budget estimate		2,100,000
ABB IC3	N	ABB	budget estimate		2,500,000
CSS&SB modified	N	Nippon Sharyo	budget estimate		2,500,000

Source: DART, Nippon Sharyo, Kinki Sharyo, ABB, Siemens as compiled by Wilbur Smith Associates

ELECTRIC MOTIVE POWER OPTIONS

The choice of electric motive power for rail passenger service on the CRANDIC is limited by the track profile and operating environment. The electric locomotives in use in the United States today are either too heavy or are designed for high speed rail service on the Northeast Corridor for Amtrak. These technology options are categorically dismissed from further consideration. However, the choice of EMU options has greatly expanded since the 1980's when many cities throughout North America began developing or renovating existing light rail systems. For the CRANDIC, a modern light rail vehicle would be the direct descendent of the interurban railway cars that once served the Cedar Rapids to Iowa City corridor. Therefore, only light rail vehicle options were researched for the CRANDIC.

At the turn of the century there were dozens of electric railway equipment suppliers in North America including American Car and Foundry, J.G. Brill Company, Canadian Car and Foundry Company, Cincinnati Car Company, Jewett Car Company, G. C. Kuhlman Car Company, Pullman-Standard Car Mfg. Company, and the St. Louis Car Company. Most of the interurban car builders went out of business about the same time as the interurban railways in the 1930's. Others survived until the 1970's.

The Boeing Company entered the railcar building market in the early 1970's as an attempt to diversify its aerospace and defense contracting manufacturing base to include public transportation vehicles. The federal government was encouraging such diversification during this period. Grumman and Rohr, other defense contractors, also began manufacturing transit vehicles. Boeing produced standard light rail vehicles (SLRV) for Boston and San Francisco in the late 1970's with disastrous results. It was apparent that aircraft design standards could not withstand the rigorous transit environment. The SLRV was noted for being unreliable. Boeing no longer manufactures rail cars.

St. Louis Car and Pullman-Standard abandoned rail car manufacturing in the late 1970's after the Europeans began winning car orders. The Canadian Car and Foundry Company was acquired by Bombardier in the 1980's. Bombardier is the only remaining North American producer of light rail vehicles. All other light rail vehicles are designed and manufactured in Japan and Europe.

Several different European and Japanese suppliers of light rail vehicles have delivered railcars to American cities. These suppliers include ABB, Bombardier, Breda, Kawasaki, Kinki Sharyo, Nippon Sharyo, Siemens-Duewag, and Tokyu Car Corp. The car types and specifications vary with the requirements of the cities the cars operate in. However, for purposes of illustration several cars suitable for the CRANDIC are presented.

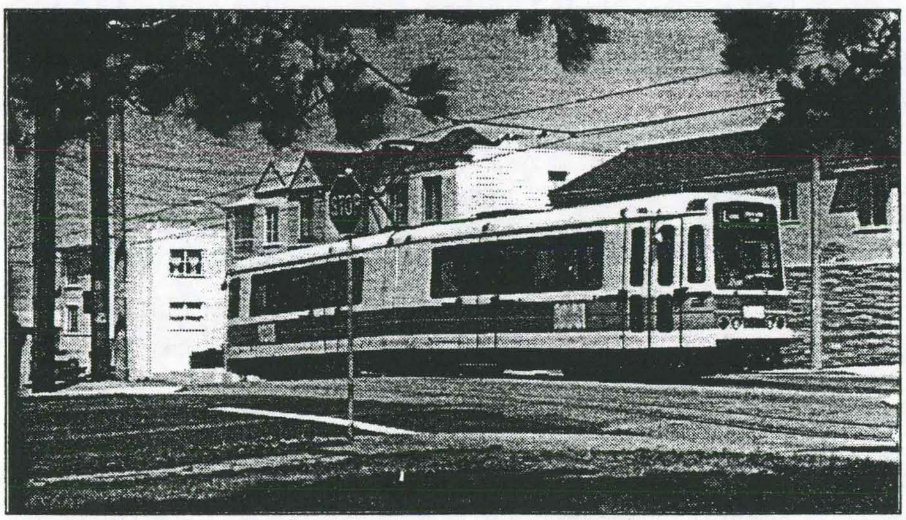


Exhibit 6-23 Boeing-Vertol LRV built for Muni in San Francisco

ABB Transportation

ABB has supplied light rail vehicles to Baltimore and for the SEPTA Norristown Line in suburban Philadelphia. The new N-5 cars being supplied to SEPTA are the replacement cars for the famed "Bullet" cars of the former Philadelphia & Western suburban railway. These new cars are among the most advanced cars in the United States featuring three phase a.c propulsion and micro-processor controlled GTO thyristor inverters.

Exhibit 6-24 ABB Transportation's N-5 highspeed cars built for Septa's Norristown Line

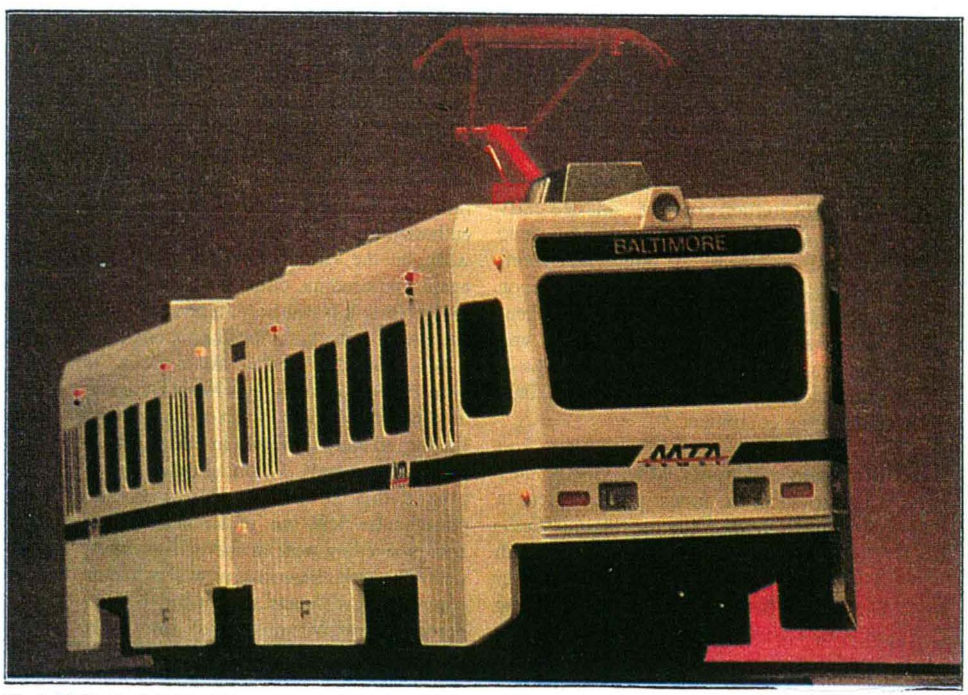


Exhibit 6-25 Baltimore LRV built by ABB Transportation

Bombardier

Bombardier has built light rail vehicles for Portland and San Jose in the United States and advanced light rail vehicles for Vancouver and Toronto.

Exhibit 6-26 Portland's LRV built by Bombardier

Exhibit 6-27 San Jose LRV built by Bombardier

Exhibit 6-28 Vancouver ART built by Bombardier

Exhibit 6-29 Toronto ART built by Bombardier

<u>Breda Costruzione Ferroviarie</u>

Breda built 48 light rail vehicles for the Greater Cleveland Regional Transit Authority (GCRTA) and is currently delivering new low floor light rail vehicles for the San Francisco Municipal Railway (MUNI). The GCRTA cars were delivered between 1980 and 1982 and were state-of-art at the time they were delivered. The Cleveland LRV utilizes full chopper controlled traction propulsion equipment capable of an acceleration rate of 3.15 mphps. The Cleveland LRV is an articulated car that seats 84 people with a crush load of 270 people. The MUNI vehicle is currently the most advanced light rail vehicle in the United States combining low floor design with 3 phase a.c drive with microprocessor controlled GTO thyristor inverters. The MUNI car has an acceleration rate of 3.15 mphps and a maximum service brake deceleration rate of 4.0 mphps. The MUNI cars are articulated and seat 60 people. The low floor design is a compromise between very low floor car designs developed by Breda for Lille, France and the need for a high floor car capable of operating in the MUNI subway along Market Street. All the passenger doors are equipped with movable steps in order to accommodate both high platform and street level boarding.

Exhibit 6-30 Cleveland LRV built by Breda Costruzione Ferroviarie

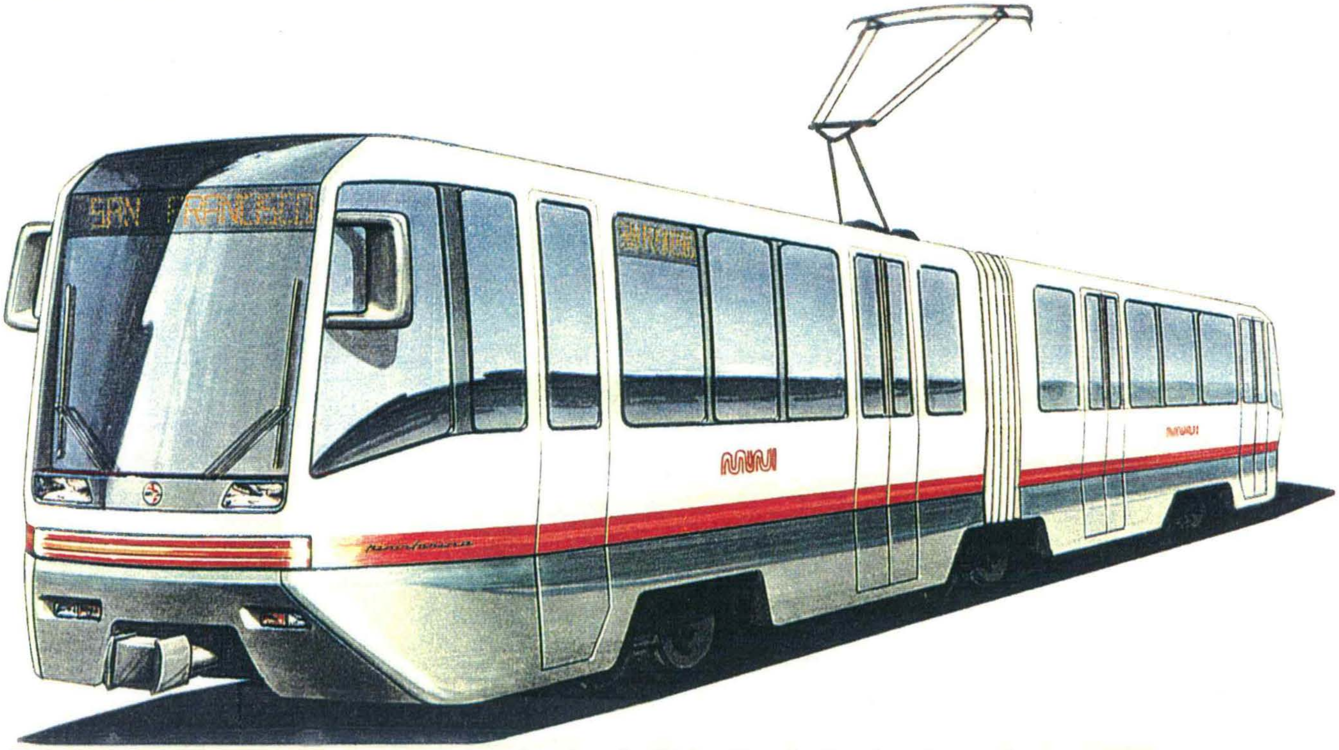


Exhibit 6-31 New advanced Muni LRV being built by Breda Costruzione Ferroviarie

Kawaski

Kawaski delivered light rail cars to SEPTA in the mid-1980's. These cars are non-articulated and utilize chopper control.

Kinki Sharyo

The MBTA in Boston experienced reliability problems with the fleet of Boeing-built light rail vehicles delivered in the late 1970's. By 1985 it was apparent that a new fleet of light rail cars was needed to replace both aging PCC cars and Boeing SLRV. Kinki Sharyo, a Japanese supplier, delivered new LRV designated No. 7 cars in the mid-1980's. The cars are articulated and chopper controlled.

Nippon Sharyo

Nippon Sharyo delivered articulated light rail cars to the Los Angeles MTA for operation on the Blue Line from Long Beach to downtown Los Angeles. The cars are articulated and are chopper controlled and were delivered in the mid-1980's.

Exhibit 6-32 Boston's LRV built by Kinki Sharyo


Exhibit 6-33 Proposed Dallas LRV being built by Kinki Sharyo

Exhibit 6-34 Los Angeles LRV built by Nippon Sharyo

Siemens-Duewag

Siemens Duewag enjoys the largest market share of new light rail cars delivered to transit systems in the United States. The first cars were delivered to San Diego for the San Diego Trolley. Since then, cars of similar design have been delivered to Calgary, Denver, Edmonton, Sacramento, St. Louis, and Pittsburgh. The San Diego car derives its design from the U2 cars operating successfully in Germany and throughout Europe.

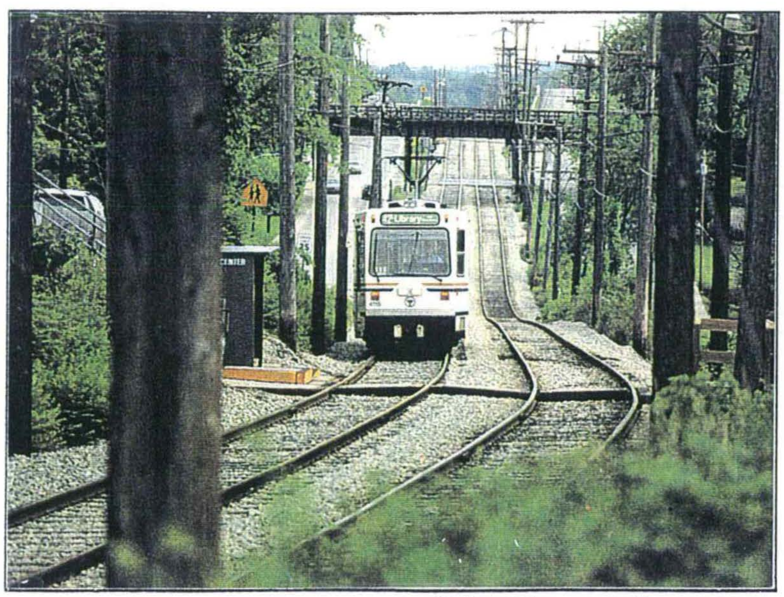


Exhibit 6-35 Pittsburgh LRV built by Siemens-Duewag

Exhibit 6-36 St. Louis LRV built by Siemens-Duewag

Exhibit 6-37 Denver LRV built by Siemens-Duewag

Exhibit 6-38 Sacremento LRV built by Siemens-Duewag

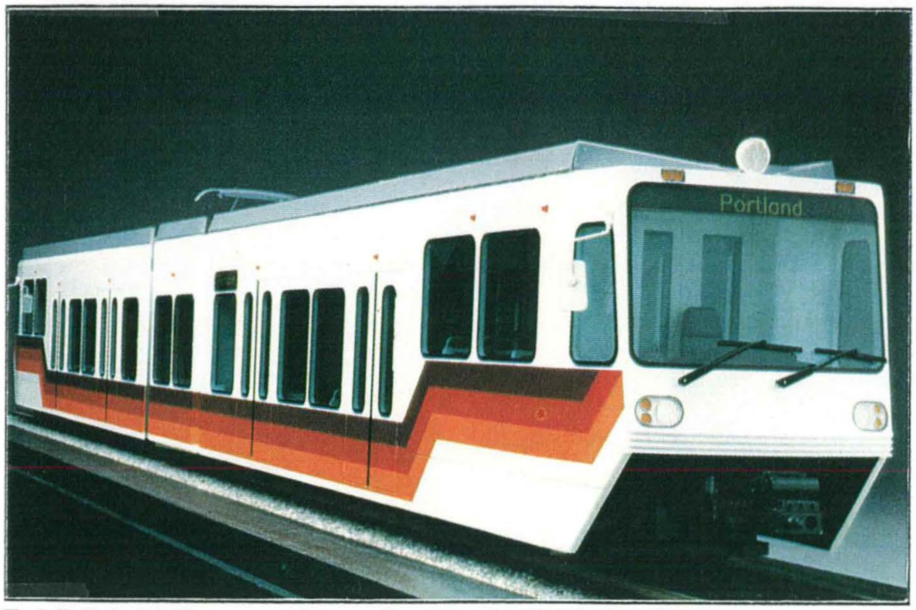


Exhibit 6-39 Proposed new Portland LRV being built by Siemens Duewag

Tokyu Car Corp.

The light rail system in Buffalo, New York utilizes street level and high platform loading. Tokyu Car Corp of Yokohama, Japan delivered non-articulated light rail vehicles to the Niagara Frontier Transportation Authority in 1983. The cars are equipped with folding steps to permit loading from high platforms and street level. The cars are equipped with full chopper control.

Exhibit 6-40 Buffalo LRV built by Tokyu Car Corp.

Costs of Electric Multiple Unit Cars

The following table illustrates the costs of light rail cars purchased new over the last 20 years. For purposes of comparison, the original prices paid by the CRANDIC for its passenger cars are inflated to 1995 dollars.

Table 6-5
Interurban and Light Rail Vehicles
Initial Purchase Price Comparisons

Type	Supplier	Customer	Year	Contract Price US$	Present Value 1995 US$
Interurban	Cincinnati Car	C & LE RR	1930	35,000	286,550
SLRV	Boeing	MBTA/MUNI	1976	500,000	1,510,500
LRV 6[1]	Breda	GCRTA	1977	634,583	1,486,574
LRV 4	Kawasaki	SEPTA	1979	409,497	803,024
LRV 4	Tokyu	NFTA	1981	1,053,955	1,564,069
LRV 6	Siemens	PATransit	1982	977,500	1,388,441
LRV 6	Siemens	Sacramento	1984	936,538	1,250,840
LRV 6	Breda	MUNI	1993	2,541,666	2,694,166
LRV 6	Siemens	Tri-Met	1993	2,326,086	2,465,651
LRV 6	Siemens	LAMTA	1994	2,847,222	2,932,639
LRV 6	Kinki Sharyo	Dallas	1994	2,625,000	2,703,750
LRV 6	Bombardier	Cologne	1994	2,325,000	2,394,750
LRV 8	Bombardier	Sarre, Germany	1995	3,066,667	3,066,667
LRV 6	Kinki Sharyo	MBTA	1995	2,430,000	2,430,000
LRV 6	LHB Siemens	Hannover	1995	2,350,000	2,350,000

Source: Wilbur Smith Associates

1 The number following the car type designates the number of axles the car has. A 4 means a rigid carbody, 6 means a single articulated car, and an 8 means a double articulated car.

It is apparent that the sophistication and complexity of the cars being specified and delivered to transit agencies throughout the world today has added considerable cost to the price of a new car. The simple design of the former CRANDIC "Comets" pales in comparison to the cars being built today. Since 1984, the cost of these added features has allowed carbuilders to raise prices at double the rate of inflation. For planning purposes, it can be estimated that a new LRV built to specifications for the CRANDIC could cost between $ 2.4 and $ 3 million. A capital budget figure of $ 2.75 million each is realistic.

Determination and Findings

The CRANDIC operating plan is very likely to be similar to the operating characteristics of several light rail systems in North America. With train frequencies of 20 minutes in the peak hours and continuing service throughout the rest of the day, the proposed CRANDIC operation has more in common with the Cleveland Green Line and SEPTA Norristown Line than with most new start commuter railroads in California or Southeast Florida. This is particularly true if the rail passenger service is designed to provide urban rail service in short segments of the corridor between the Oakdale Campus and Main Campus of the University of Iowa near downtown Iowa City.

Although no ridership forecast has been generated at this point in the study effort, it is anticipated that ridership will more likely follow the demand patterns of light rail systems. This ridership pattern requires considerable flexibility in the consist of trains. Trains must be able to provide sufficient passenger capacity in the morning and evening rush hours to accommodate peak hour loading and less capacity during day base and late evening service hours. This type of peaked passenger volume demands greater flexibility in train consist to optimize seated capacity and to reduce operating expenses. There are two approaches that can be taken to satisfy this requirement:

- locomotive hauled passenger coaches, and
- DMU or EMU equipment.

Conventional trains with locomotives and passenger coaches require a great deal of switching and consist changes throughout the day to match seated capacity with likely passenger demand. This type of operation is expensive and time consuming requiring extra train and yard crews to accomplish the tasks of making and breaking trains. This could result in considerable additional operating expense.

A train during the late evening and mid-day could consist of one locomotive pulling one passenger coach. This is a very inefficient operation. In addition, the manual coupling and uncoupling of cars in a train is still a very hazardous part of railroading. The expense associated with this type of operation is quite high and is the reason most railroads attempt to utilize DMU or EMU equipment for transit type operations. The DMU offers the same flexibility of automatic coupling and uncoupling as EMU trains.

The DMU and EMU requires fewer train crew members to operate than conventional locomotive hauled trains. For typical high capacity commuter rail operations, the capital cost per passenger seat would be minimized if conventional trains were purchased and operated for peak hour demand requirements. This cost is even further minimized if high capacity doubledeck cars or used equipment is considered. However, DMU and EMU technology can achieve better operating cost ratios because of the savings that result from decreased labor and energy costs.

Cedar Rapids and Iowa City Rail Passenger Equipment Needs

As indicated previously, the CRANDIC will not operate in accordance with standard commuter rail or light rail operating practices. The interurban service contemplated must compete with the auto travel times in the corridor. The running time between Cedar Rapids and Iowa City for Greyhound Lines and Burlington Trailways is 35 minutes. This is the target for the CRANDIC rail passenger service. Train performance simulations were conducted utilizing a variety of equipment operating over several alignments. The 35-minute threshold was achieved by EMU and DMU technology options on the Class 4 track improvements.

By examining the cost differentials between EMU and DMU, it is recommended that DMU technology utilizing tilt equipment be considered. The Siemens VT 610 is suggested.

Section 7

RIDERSHIP FORECASTS

Section 7
RIDERSHIP FORECASTS

INTRODUCTION

This Section documents the procedures used to estimate ridership that would be attracted to restored passenger rail service in the Cedar Rapids - Iowa City Transportation Corridor, and the ridership forecasts and related conclusions that resulted from the application of these procedures. The forecasting procedures were designed to make the most effective use of available project resources in meeting the following demand estimation objectives:

1. Identify potential rail markets in the corridor;
2. Quantify the major market magnitudes;
3. Determine primary factors influencing each market's selection of mode of travel;
4. Estimate rail ridership for alternative service and forecast year scenarios;
5. Estimate range of uncertainty in forecasts; and,
6. Identify conditions required to support rail passenger service financial and economic feasibility.

The material presented in this Section is organized into five major sections: (1) Data Assembly, (2) Forecast Methodology, (3) Forecast Results, (4) Sensitivity Analysis and (5) Conclusions.

DATA ASSEMBLY

To support study forecasting procedures and justify findings, it is essential that a reliable data base be assembled. The contents of this data base include :

- Existing travel characteristics and magnitudes;
- Transport system characteristics;
- Socioeconomic growth indicators; and,

- Information indicating how travelers would change their behavior in response to the provision of rail passenger service.

This information is required to develop relationships linking the present and future demand for transport services with the underlying factors influencing travel decisions.

Potential Data Sources

Investigations carried out as part of the project identified the following potential sources of information:

- **Census Data** - 1990 population characteristics including age, income and vehicle ownership distribution and intercounty work commuting patterns.

- **Urban Area Transportation Planning Data Bases** - Cedar Rapids and Iowa City computerized transport networks and socioeconomic/demographic data and trip tables for base and future years.

- **University of Iowa, Kirkwood Community College Student Residence Records** - Residential location for students living off campus and commuting to school.

- **Cedar Rapids Municipal Airport Data** - Historic and projected future enplanements and a survey of airport users containing local trip origin or destination.

- **Corridor Highway Roadside Origin-Destination Surveys** - Travel origin-destination data for the corridor was last collected in the mid-1960's.

- **Public Transport System Ridership Records** - Organizations providing public transport services within Iowa City (Coralville Transit, Iowa City Transit and CAMBUS) and Cedar Rapids (Five Seasons Transportation) records of current and past ridership.

- **Intercity Bus Ridership Records** - Greyhound, Burlington Trailways and Jefferson Lines Bus Companies records of current and past ridership.

- **Roadway Traffic Counts** - Past and current vehicle traffic counts from state and county data bases for roads linking Cedar Rapids and Iowa City and within each urban area.

- **Fixed Guideway and Other Public Transport Ridership Experience in Other Cities** - Past and current ridership data for other, comparable fixed guideway services operating in environments similar to the Cedar Rapids - Iowa City Corridor.

- **Market Research Behavioral Surveys Conducted in Other Cities** - Other cities in the U.S. have examined the implications of introducing or restoring rail passenger services. In some cases, market research surveys have been undertaken to determine how existing trip makers would react to the availability of the new mode.

- **Survey of Corridor Major Employers** - The consultant identified and contacted major employers within 0.5 miles of the Crandic Rail Line to determine their approximate number of employees.

- **Survey of Corridor Special Event Venues** - Facilities hosting special events with unusual travel demands were contacted to determine seating capacities and annual number of events and patrons.

Review of Available Data

Information available from the potential sources listed above were reviewed to determine the extent to which they satisfy the needs of this project. Findings of this review are presented below.

Existing Travel Characteristics and Magnitudes - Data were reviewed with respect to the ability to isolate and quantify trips (of various types) for which the proposed rail service would be a realistic alternative. In approximate order of importance, it was found that:

- The number of **workers commuting** between the two counties can be determined from available census journey to work data. Employment location and worker residence location (and ultimately proximity to proposed rail stations) can also be determined to the traffic analysis zone level within the two urbanized areas from the census data.

- The number of **students commuting** between Cedar Rapids and the University of Iowa and between Iowa City and Kirkwood Community College can be determined from school student residence records.

- **Travel within the two urban areas** along proposed rail alignments can be obtained from the urban travel model output available for each city. This information would be supplemented by bus ridership data for routes paralleling the proposed rail service (for example, the shuttle service operated by the University of Iowa between the main and Oakdale campuses).

- Travel demands to the **Cedar Rapids Airport** can be determined from data provided by the Cedar Rapids Municipal Airport Authority.

- **Resident non-work oriented travel (shopping/personal business) between Cedar Rapids and Iowa City** is not directly represented in any of the available data sources. Intercity bus data is incomplete (Greyhound does not provide ridership information) and, in any event, represents a very small proportion of the total market. The latest road origin-destination survey for the corridor was conducted thirty years ago and would, therefore, be unsuitable for use today. Traffic count data is available for the major road linking the two urban areas (I-380). These counts, in combination with work and school commuter information, truck counts and assumptions regarding the proportion of through traffic on the interstate, could be used to infer the road traffic representing this category of travel. It should be noted, however, that these types of trips would have a low probability of diverting to rail because of the costs involved (these are often trips where several family members travel together by car -- each of whom would pay a fare on rail) and because of the desire to have a car available to stop at several locations at the non-home end of the trip.

- **Special event travel** demands can be estimated from information provided by the event venues.

Transport System Characteristics - Data derived from the computerized transport networks for Cedar Rapids and Iowa City are suitable to estimate access times to proposed rail stations and competing auto travel times within the urban areas. It can be supplemented with data describing travel times and distances for the roads linking the two cities to obtain inter-county travel times. The networks and urban models may also be used to determine the level of congestion that currently exists within the urban areas and how it may change in the future.

Socioeconomic Growth Indicators - Population and employment data at the traffic analysis zone level are compiled and forecast as part of the urban planning function for Cedar Rapids and Iowa City (Cedar Rapids has forecast data available through year 2020, Iowa City through year 2010). These data are sufficient to estimate growth in intercity travel demand and to quantify the development characteristics within primary (within walking distance) and secondary (within acceptable motorized access time) rail station service areas.

Behavioral Change in Response to Rail Data - No rail service currently exists or has recently been provided within the corridor. Therefore, no observed rail usage information for corridor residents is available. Market research surveys have been conducted in other cities in the U.S. to determine probable traveler response to new rail service. These data were then used to develop and calibrate mode choice models estimating the share of work commuter and non-work trips captured by rail under different operating and fare assumptions. After review of available studies, the survey and model developed for the Burlington-Charlotte, Vermont Corridor appears to be suitable for use on this project. A comparison of this corridor and the Cedar Rapids - Iowa City Corridor's socioeconomic characteristics is provided in Appendix C of this report. The discussion also includes a description of the survey procedures employed and the model developed from the survey data.

Change in behavior for other special purpose travel (to the airport and special events) can be derived from the experience of other rail systems serving these types of special generators.

Data Needs Conclusions

Based on the above comparison of data needs and information available it was determined that the most effective use of the resources allocated for survey data collection would be a survey designed to better define the characteristics of total travel between the two cities at either end of the rail corridor. When the original proposal was prepared it was assumed that reasonably current origin-destination survey data was available for travel along the I-380 Corridor. It was subsequently found that the information available was collected in the mid 1960's. The 30-year time difference between then and now (and probable changes in travel characteristics in the corridor over this period) would make it impossible to use the data to develop or support project findings. Secondary sources exist that can be used to help define the work and school commute markets in the corridor (census journey to work data and university student residence information). However, it is believed that confirmation (or information providing a sound basis for revision) of data from these sources is necessary to provide credibility to the demand estimation work.

The original study proposal suggested undertaking a market research survey designed to measure how existing travelers in the corridor would react to the provision of rail service. The review of available data has found that information meeting this need is available from a prior rail feasibility study in a corridor with similar transportation system and demographic/economic development characteristics to the Cedar Rapids - Iowa City Corridor. Consequently, it was decided that the resources set aside for the market research (stated preference) survey would be reallocated to a survey intended to quantify the number of trips occurring in the corridor (that are potentially served by the proposed rail service) by major market segment.

The revised data collection program was designed to obtain information describing the characteristics of vehicle and person travel along I-380. People traveling by auto would be surveyed to determine trip origin/destination, trip purpose and frequency. Information would also be obtained recording vehicle occupancy and time of day the trip was taken.

Two alternatives were considered for obtaining the necessary person travel information. The first was to conduct a standard roadside survey on I-380 (possibly diverting vehicles through the roadside rest area to carry out the survey). Vehicles would be screened (to eliminate trucks and private vehicles not registered within the corridor) and then drivers of the remaining corridor registered automobiles would be questioned to obtain the desired origin/destination, trip purpose and frequency information.

The second alternative involved recording vehicle license plate numbers for Iowa registered automobiles. These plate numbers would then be matched to registration addresses by the Iowa Department of Transportation and a survey form mailed to the owner for completion and return. Again, addresses would be screened to select only automobiles registered within this corridor.

For either alternative, the survey would be carried out over a single weekday during daylight hours. Both alternatives have advantages and disadvantages. The traditional roadside survey would produce information in a shorter period of time and non-response bias would be limited to the small number of potential respondents who might refuse to be surveyed. However, potential problems exist related to interrupting traffic flow on a relatively high volume interstate highway and the coincidental safety issues.

The license plate/mailback approach would eliminate the safety issue (no interference with road traffic would occur). However, non-response bias could pose a larger potential problem. This type of survey would also require a longer time period to obtain usable information as allowance must be made for address matching and the eventual return of the survey forms by respondents. Additionally, some people consider license plate surveillance and eventual contact by a government agency an infringement of their privacy.

After weighing the alternative advantages and disadvantages, and considering prior experience with both types of surveys, the license plate/mailback approach was recommended to and approved by the project Steering Committee. It was believed that safety should be the overriding consideration. To supplement data from the survey, classified traffic counts would also be taken on I-380 to determine total traffic proportions of trucks, private automobiles registered in Iowa and those registered out of state. If feasible, Iowa registered private vehicles would be further stratified by vehicles registered inside and outside the two counties making up the corridor (county of registration is indicated on Iowa license plates, but may or may not be readable by classified count survey personnel). The results of the survey and traffic counts are summarized and discussed later in this chapter.

Travel Survey Administration and Findings

In order to obtain updated origin-destination data in the corridor, Wilbur Smith Associates (WSA) conducted a travel pattern survey in August of 1995. The objectives of the survey were to determine the proportion of total travel in the corridor by Linn/Johnson County residents, to find out the purposes for this travel and to obtain origin-destination (O/D) data to provide an up-to-date picture of travel patterns and characteristics for private vehicle traffic between Cedar Rapids and Iowa City. The results of the survey would provide a basis for estimating the potential intercounty market for rail service.

Survey Procedures - The license plate survey was performed at milepost 10 on I-380 (close to Shueyville Road exit). This site was chosen because its location would intercept the majority of traffic between Cedar Rapids and Iowa City. The survey of southbound vehicles was carried out on Tuesday, August 7, while northbound vehicles were surveyed on Wednesday, August 8. WSA staff were on-site during daylight hours (6:00 am - 8:30 pm).

License plates were manually observed by trained WSA field staff. The three person teams had a spotter, a recorder, and a counter. Realizing that the proposed rail system is primarily for commuters, all vehicles having out-of-state license plates, as well as all commercial vehicles, were excluded from the survey. The spotter used a pair of binoculars to observe traffic and recite the license plate numbers of private, in-state vehicles. The recorder wrote these down for entry into a database, while the counter conducted a classification count of all passing traffic.

Mailing Procedures - The daily lists of license plates compiled were matched against the Iowa DOT Office of Vehicle Registration master vehicle database. This information was then used to generate labels addressed to the registered owners of the vehicle. Surveys were sent only to owners of vehicles registered in Linn or Johnson Counties (as these travelers were considered potential rail users).

The response time for the day the vehicle was observed until the driver received a questionnaire is of utmost importance for insuring a high response rate and accurate information. The objective was to process the plate numbers and generate mailing labels within one business day, so that the questionnaire was received within three business days (Friday and Saturday). It was important that this survey be seen as a government survey to help improve the response rate. News releases and positive media attention also contributed to improving the response rate.

Survey Form - The survey questionnaire (shown in Exhibit 7-1) provided the respondent with the location, direction of travel and date the vehicle was observed. The respondent was then asked to provide information about that particular trip or to pass the questionnaire to the operator of the vehicle.

The basic information requested in the questionnaire included:

- Origin and Destination of the trip
- Trip Purpose
- Trip Frequency
- Vehicle Occupancy

A time/date code was printed on each survey form for use in the expansion factoring of returned surveys.

Traffic Classified Counts - Vehicle classification count data were obtained by staff at the survey site. These were used to provide control information for the O/D survey and allow for the expansion of returns. The classification counts used four vehicle categories: In-state passenger vehicles, out-of-state passenger vehicles, single-unit trucks, and multiple-unit trucks. Passenger vehicles include motorcycles, vans, and light trucks. Counts were recorded in 30-minute increments for the entire time the survey was taken.

Survey Data Editing and Expansion - As survey forms were returned they were reviewed for completeness and their responses entered into a computer data base. Reported origins and destinations were geocoded; first, using computer address matching techniques to assign latitude/longitude and, then, manual techniques to code addresses rejected by the computerized process. Coded longtitude/latitudes were subsequently used to code trip ends to standard urban area traffic analysis zones (TAZ's) and the rail service shed areas defined for this project.

Table 7-1 contains a summary of the classified vehicle traffic count data collected during the survey period. About 67 percent of the vehicles observed were Iowa registered passenger vehicles. About 21 percent were trucks.

The East Central Iowa Council of Governments is conducting a survey to determine travel characteristics in the I-380 Corridor. Information collected will be used to evaluate proposed improvements to the transportation system between Cedar Rapids and Iowa City.

Your participation, by completing and returning the enclosed questionnaire, would be greatly appreciated. Your answers will be used only in combination with those from other people. **Nothing will be retained from the survey identifying you or your family members.**

To encourage your prompt response, survey forms will be entered in a lucky draw. A survey will be randomly selected from those returned by August 31 and the winner awarded $100. If you wish to participate in the lucky draw, please provide your name and address below (this information is not part of the survey and will only be used to contact the winning entry).

1 THE SURVEY: If you were traveling on the journey described below, please answer the following questions about your trip. If you did not personally make this trip, please give this form to another person in your household who may have made this trip.

2 The Trip: Northbound on I-380 on August 9, 1995

3 Where did you begin this trip?

____
Street Address or major intersection or other identification

______________ ______________
City State

4 Was this location your?

- ☐ Home
- ☐ Place of Work
- ☐ School
- ☐ Other ____________

5 Where did this trip end?

____
Street Address or major intersection or other identification

______________ ______________
City State

6 Was this location your?

- ☐ Home
- ☐ Place of Work
- ☐ School
- ☐ Other ____________

7 How often each week to you make the same kind of trip, in this direction?

- ☐ Less than 1
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ More than 5

8 How many people were in the vehicle for this trip, including yourself?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ More than 5

Thank you for helping us. If you wish to be included in the lucky draw, please provide your name and address below:

____
Name Address City State Zip Code

To return the survey, simply insert in the envelope provided and mail. Postage has been attached.

Thanks again!

Exhibit 7-1
1995 TRAVEL SURVEY QUESTIONNAIRE

Table 7-1
Classified Traffic Counts
I380 At Milepost 10 (Shueyville Road Exit)
6:00 AM - 8:30 PM August 7-8, 1995

Vehicle Type	Northbound	Southbound	Total
Iowa Passenger Vehicles	8,784	8,428	17,212
Out Of State Passenger Vehicles	1,378	1,571	2,949
Single Unit Trucks	976	1,105	2,081
Multi Unit Trucks	1,591	1,756	3,347
Total Vehicles	12,729	12,860	25,589

Source: 1995 Traffic Survey

Tables 7-2 and 7-3 show the detailed (by half hour) data used to calculate survey expansion factors for each direction of travel. The first two columns contain Iowa registered passenger vehicle counts and the number of license plates recorded for each period. The spotters were able to read and record about 45 percent of all Iowa plates passing the survey location.

The third column contains the number of Linn/Johnson County addresses returned from registration records. When compared to the number of plates recorded, this column indicates the percentage of Linn/Johnson County vehicles in the vehicle mix (shown in the fourth column). When this percentage is applied to the total Iowa passenger vehicles (Column 1) the control total for Linn/Johnson County passenger vehicles (shown in Column 7) is obtained. The survey found that, in total, about 64 percent of Iowa registered passenger vehicles using I-380 at this location were based in Linn or Johnson County.

The fifth column shows the number of usable surveys returned for each time period. An overall response rate of about 35 percent was achieved (1293 surveys). The survey expansion factors were derived by dividing the number of returned surveys into the estimated Linn/Johnson

Table 7-2
Traffic Survey Expansion Factors
Northbound Traffic

Survey Period	Iowa Passenger Cars	License Plates Recorded	Bicounty Addresses (Surveyed)	Percent Bicounty Psgr Cars	Surveys Returned	Percent Surveys Returned	Estimated Bicounty Psgr Cars	Survey Expansion Factor
600 - 630	143	96	59	61.5%	21	35.6%	88	4.185
630 - 700	242	120	61	50.8%	21	34.4%	123	5.858
700 - 730	328	198	96	48.5%	41	42.7%	159	3.879
730 - 800	642	242	128	52.9%	61	47.7%	340	5.567
800 - 830	367	141	63	44.7%	26	41.3%	164	6.307
830 - 900	257	156	66	42.3%	22	33.3%	109	4.942
900 - 930	228	123	33	26.8%	10	30.3%	61	6.117
930 - 1000	246	155	72	46.5%	26	36.1%	114	4.395
1000 - 1030	203	116	57	49.1%	21	36.8%	100	4.750
1030 - 1100	307	161	76	47.2%	28	36.8%	145	5.176
1100 - 1130	257	122	46	37.7%	18	39.1%	97	5.383
1130 - 1200	274	123	49	39.8%	17	34.7%	109	6.421
1200 - 1230	286	142	75	52.8%	24	32.0%	151	6.294
1230 - 1300	252	112	69	61.6%	29	42.0%	155	5.353
1300 - 1330	263	151	73	48.3%	28	38.4%	127	4.541
1330 - 1400	232	112	43	38.4%	12	27.9%	89	7.423
1400 - 1430	262	132	61	46.2%	19	31.1%	121	6.372
1430 - 1500	298	165	68	41.2%	20	29.4%	123	6.141
1500 - 1530	298	167	88	52.7%	29	33.0%	157	5.415
1530 - 1600	362	138	50	36.2%	22	44.0%	131	5.962
1600 - 1630	430	186	119	64.0%	39	32.8%	275	7.054
1630 - 1700	416	130	53	40.8%	21	39.6%	170	8.076
1700 - 1730	589	192	124	64.6%	50	40.3%	380	7.608
1730 - 1800	483	137	70	51.1%	18	25.7%	247	13.710
1800 - 1830	278	134	76	56.7%	26	34.2%	158	6.064
1830 - 1900	315	132	87	65.9%	31	35.6%	208	6.697
1900 - 1930	206	90	60	66.7%	19	31.7%	137	7.228
1930 - 2000	192	109	51	46.8%	14	27.5%	90	6.417
2000 - 2030	128	97	39	40.2%	11	28.2%	51	4.679
Total	8,784	4,079	2,012	49.8%	724	36.0%	4,379	6.048

Source: 1995 Traffic Survey and Consultant Calculations

Table 7-3
Traffic Survey Expansion Factors
Southbound Traffic

Survey Period	Iowa Passenger Cars	License Plates Recorded	Bicounty Addresses (Surveyed)	Percent Bicounty Psgr Cars	Surveys Returned	Percent Surveys Returned	Estimated Bicounty Psgr Cars	Survey Expansion Factor
600 - 630	195	82	37	45.1%	7	18.9%	88	12.570
630 - 700	337	104	46	44.2%	14	30.4%	149	10.647
700 - 730	511	107	66	61.7%	30	45.5%	315	10.507
730 - 800	345	108	59	54.6%	20	33.9%	188	9.424
800 - 830	283	96	50	52.1%	20	40.0%	147	7.370
830 - 900	325	152	70	46.1%	21	30.0%	150	7.127
900 - 930	257	134	67	50.0%	18	26.9%	129	7.139
930 - 1000	231	130	62	47.7%	23	37.1%	110	4.790
1000 - 1030	162	119	37	31.1%	7	18.9%	50	7.196
1030 - 1100	269	132	70	53.0%	23	32.9%	143	6.202
1100 - 1130	249	130	54	41.5%	19	35.2%	103	5.444
1130 - 1200	208	101	45	44.6%	14	31.1%	93	6.620
1200 - 1230	294	161	61	37.9%	22	36.1%	111	5.063
1230 - 1300	249	140	74	52.9%	27	36.5%	132	4.875
1300 - 1330	335	134	45	33.6%	10	22.2%	113	11.250
1330 - 1400	336	135	61	45.2%	17	27.9%	152	8.931
1400 - 1430	275	136	50	36.8%	12	24.0%	101	8.425
1430 - 1500	293	79	40	50.6%	12	30.0%	148	12.363
1500 - 1530	261	117	60	51.3%	21	35.0%	134	6.374
1530 - 1600	330	152	64	42.1%	27	42.2%	139	5.146
1600 - 1630	333	151	74	49.0%	24	32.4%	163	6.800
1630 - 1700	361	104	41	39.4%	17	41.5%	142	8.372
1700 - 1730	459	200	98	49.0%	40	40.8%	225	5.623
1730 - 1800	478	196	96	49.0%	31	32.3%	234	7.552
1800 - 1830	305	144	75	52.1%	27	36.0%	159	5.883
1830 - 1900	248	83	48	57.8%	18	37.5%	143	7.968
1900 - 1930	189	96	51	53.1%	18	35.3%	100	5.578
1930 - 2000	192	117	85	72.6%	26	30.6%	139	5.365
2000 - 2030	118	43	20	46.5%	4	20.0%	55	13.721
Total	8,428	3,583	1,706	48.1%	569	33.4%	4,057	7.130

Source: 1995 Traffic Survey and Consultant Calculations

County passenger cars. Expansion factors ranged, by time period, from less than four to over thirteen. The average expansion factor for the entire survey was 6.52.

The survey was intended to measure traveler characteristics over a period (6:00 am to 8:30 pm) when most travel with a potential for using the proposed rail service was occurring. Therefore, no further expansion covering periods when the rail service would not, for the most part, be operating was attempted.

Survey Findings - Tables 7-4 through 7-6 show expanded vehicle and person trips and average vehicle occupancies cross classified by trip purpose and trip frequency. About 44 percent of all surveyed trips were for work commuting or work related purposes. A similar proportion (about 43 percent) were for shopping, personal business or recreational purposes.

School trips (to/from colleges/universities) reported in the survey reflect summer period attendance patterns and, therefore, understate demands when schools are in full session. However, student address records were used to provide the primary basis for estimating the magnitude of this rail market segment.

Tables 7-7 through 7-10 show the origin-destination patterns reported for work/work related and other trip purposes. The locations used reflect rail primary (walk-in) and secondary (car/bus-in) service areas. Survey prepared trip origins and destinations have been translated to production district (home location) and attraction district (work or other non-home location) for these tables.

FORECAST METHODOLOGY

To oversimplify, the process of estimating likely ridership on a new (or for that matter existing) transport service consists of (1) determining the number of trips that might potentially use the service, and (2) estimating the share of that total market that would be captured by the service in question given the costs and other service attributes of it and competing modes. In practice, the process is more complex because the total travel market is composed of a series of submarkets or market segments that (because of differences in characteristics of trip makers and/or the trips being made) can be expected to react differently to the availability of a new transportation alternative (in this case passenger rail).

Table 7-4
Expanded Vehicle Trips

Trip Purpose	Trip Frequency < One	One	Two	Three	Four	Five	Five +	Unknown	Total
Home Based Work	76	40	108	136	255	2,565	814	7	4,000
Home Based School	71	16	43	19	71	105	25	0	349
Home Based Other	1,562	407	300	179	66	53	81	27	2,676
Work Related	225	136	124	73	88	113	102	0	860
School Related	0	0	0	5	0	0	0	0	5
Other	262	51	29	36	11	20	46	5	461
Unknown	30	0	19	7	0	6	0	24	87
Total	2,226	649	623	455	491	2,861	1,067	63	8,436

Source: 1995 Travel Survey

Table 7-5
Expanded Person Trips

Trip Purpose	Trip Frequency < One	One	Two	Three	Four	Five	Five +	Unknown	Total
Home Based Work	102	40	149	169	280	3,142	941	7	4,831
Home Based School	101	27	75	25	84	116	25	0	452
Home Based Other	3,493	886	538	355	143	97	212	119	5,841
Work Related	305	185	132	73	88	176	154	0	1,114
School Related	0	0	0	5	0	0	0	0	5
Other	594	88	49	63	49	26	65	11	946
Unknown	107	0	30	7	0	6	0	218	368
Total	4,703	1,226	973	697	643	3,563	1,397	354	13,557

Source: 1995 Travel Survey

Table 7-6
Average Vehicle Occupancy

Trip Purpose	Trip Frequency < One	One	Two	Three	Four	Five	Five +	Unknown	Total
Home Based Work	1.35	1.00	1.38	1.25	1.10	1.23	1.16	1.00	1.21
Home Based School	1.43	1.71	1.75	1.33	1.17	1.11	1.00		1.30
Home Based Other	2.24	2.18	1.79	1.98	2.16	1.83	2.60	4.37	2.18
Work Related	1.36	1.36	1.07	1.00	1.00	1.56	1.52		1.30
School Related				1.00					1.00
Other	2.27	1.72	1.69	1.75	4.50	1.31	1.41	2.00	2.05
Unknown	3.51		1.60	1.00		1.00		9.00	4.24
Total	2.11	1.89	1.56	1.53	1.31	1.25	1.31	5.58	1.61

Source: 1995 Travel Survey

Table 7-7
Work Purpose Vehicle Trips

Production District	Attraction District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1 - Cedar Rapids - Walk						5	19	51				7		5		20	6		5	8	126
2 - Hawkeye Downs - Walk																8					8
3 - Airport - Walk	7								6							8			6		28
4 - Swisher - Walk	16															6	11				34
5 - North Liberty - Walk	57	6	18					4	72	39						13	49			17	276
6 - Oakdale - Walk	14		7						23	7	9						18				78
7 - Coralville - Walk	86	7	5						99	81							69		8		356
8 - Iowa City - Walk	69		17						39	31							63	5	25	7	256
9 - Cedar Rapids - Ride	4		14		73	37	117	365	65	25					34	174	39	18	61	49	1,075
10 - Hawkeye Downs - Ride	6				30	15	7	91	5	17				11	12	80		16	6	11	308
11 - Airport - Ride								6													6
12 - Swisher - Ride						11															11
13 - North Liberty - Ride	6																				6
14 - Oakdale - Ride	9								6								15			14	44
15 - Coralville - Ride	42								24	6	6						47		5	4	133
16 - Iowa City - Ride	203	20	17		17				158	81	6						140		36	21	699
17 - Linn County - No Rail	99				61	93	114	280	18	42	7			14	18	155	46	14	38	28	1,029
18 - Johnson County - No Rail	28	6			6				35	19						17	17	16			144
19 - External To Bicounty Area	32	5							12	26									5		81
20 - Unknown	12						19	15	22	18					13	14	6		11	34	163
Total	691	44	79	0	188	160	276	812	584	392	28	7	0	31	77	496	525	68	207	193	4,859

Source: 1995 Travel Survey

Table 7-8
Work Purpose Person Trips

Production District	Attraction District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1 - Cedar Rapids - Walk						10	19	112				37		5		20	6		9	15	234
2 - Hawkeye Downs - Walk																17					17
3 - Airport - Walk	7								6							8			6		28
4 - Swisher - Walk	16															6	19				41
5 - North Liberty - Walk	70	6	18					4	89	39						13	49			23	311
6 - Oakdale - Walk	14		7						29	13	9						18				91
7 - Coralville - Walk	106	7	5						119	81							75		8		401
8 - Iowa City - Walk	69		23						59	31							100	5	34	13	334
9 - Cedar Rapids - Ride	4		14		92	47	117	467	65	25					86	237	39	18	166	63	1,441
10 - Hawkeye Downs - Ride	6				30	23	7	158	5	17				11	20	90		16	19	11	413
11 - Airport - Ride								13													13
12 - Swisher - Ride						11															11
13 - North Liberty - Ride	6																				6
14 - Oakdale - Ride	13								6								15			14	48
15 - Coralville - Ride	49								29	6	12						57		11	4	168
16 - Iowa City - Ride	220	20	17		29				183	103	6						148		46	21	794
17 - Linn County - No Rail	99				69	100	128	302	22	52	7			14	18	216	46	14	49	34	1,169
18 - Johnson County - No Rail	32	6			6				46	19						17	17	21			164
19 - External To Bicounty Area	32	5							12	34									5		89
20 - Unknown	12						24	15	22	22					13	14	6		11	34	173
Total	758	44	84	0	227	190	295	1,071	694	442	34	37	0	31	136	639	593	73	363	233	5,945

Source: 1995 Travel Survey

Table 7-9
Other Purpose Vehicle Trips

	Attraction District																				
Production District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1 - Cedar Rapids - Walk	6				6			5	12										6		36
2 - Hawkeye Downs - Walk								18								8					26
3 - Airport - Walk								15												14	29
4 - Swisher - Walk																5	6				12
5 - North Liberty - Walk	14	7	6						17	19						7	63		16	16	166
6 - Oakdale - Walk			5														7			6	18
7 - Coralville - Walk			11				8		30	35						5	47			5	139
8 - Iowa City - Walk	5		47						40	6							25		64		188
9 - Cedar Rapids - Ride	5		22		5	7	23	136	47	5					11	96	15		231	41	643
10 - Hawkeye Downs - Ride							6	28		22				8	13	21	20		33	7	158
11 - Airport - Ride										5						5					11
12 - Swisher - Ride																					0
13 - North Liberty - Ride																					0
14 - Oakdale - Ride									5								13			6	25
15 - Coralville - Ride			32						7	5					9		11			16	81
16 - Iowa City - Ride	52	7	120						103	76						23	143		75	71	670
17 - Linn County - No Rail	45				19		22	166	17	18				13	12	45	32	6	252	35	682
18 - Johnson County - No Rail	5		20					6	10	16							15	12			84
19 - External To Bicounty Area		6	8					5	18	8		6				10	22		43	33	158
20 - Unknown						6	13			12						11	14		22	20	97
Total	131	20	271	0	30	13	72	380	306	227	0	6	0	21	44	236	433	18	744	270	3,223

Source: 1995 Travel Survey

Table 7-10
Other Purpose Person Trips

	Attraction District																				
Production District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1 - Cedar Rapids - Walk	12				6			11	18										25		72
2 - Hawkeye Downs - Walk								44								8					52
3 - Airport - Walk								30												14	43
4 - Swisher - Walk																22	13				34
5 - North Liberty - Walk	27	7	12						30	39						20	138		27	62	363
6 - Oakdale - Walk			5														14			6	25
7 - Coralville - Walk			59				16		51	58						20	108			5	317
8 - Iowa City - Walk	11		91						52	6							37		130		328
9 - Cedar Rapids - Ride	19		29		20	7	44	266	110	5					16	190	41		521	92	1,358
10 - Hawkeye Downs - Ride							12	93		49				8	20	35	40		76	21	354
11 - Airport - Ride										22						11					32
12 - Swisher - Ride																					0
13 - North Liberty - Ride																					0
14 - Oakdale - Ride									16								34			12	62
15 - Coralville - Ride			79						7	5					9		30			27	157
16 - Iowa City - Ride	111	7	250						217	171						48	362		133	179	1,478
17 - Linn County - No Rail	84				37		70	289	35	43				13	36	76	81	11	690	105	1,570
18 - Johnson County - No Rail	14		28					11	25	42							25	17			163
19 - External To Bicounty Area		6	30					10	32	8		6				21	68		294	76	551
20 - Unknown						12	13			24						17	14		74	40	194
Total	278	20	584	0	63	19	155	753	593	472	0	6	0	21	80	468	1,003	29	1,971	640	7,155

Source: 1995 Travel Survey

Travel Market Segments

The first step in forecasting rail travel demand is the identification of the specific market segments that will be evaluated individually. Based on the information collected in the data assembly task, the following travel market segments were recommended by WSA and approved by the Project Steering Committee:

- Inter-County Work Commuters
- Inter-County School Commuters
- Inter-County Other Purpose Trips
- Airport Passenger Trips
- University of Iowa Main Campus - Oakdale Campus Trips
- Intra-Urban Area Trips Along Rail Alignment
- Special Event Trips

The process then moves on to quantifying the number of trips within each market segment, the service characteristics of rail and competing modes, the share captured by rail and how each of these will change in the future. The specific procedures employed within each of these market segments are presented below.

Inter-County Work Commuters - Numbers of work commuters extracted from the 1995 survey and the 1990 census data were compared and allocated to traffic analysis zone origins and destinations (within urban areas) and county sector (outside urban areas) based on zone coding provided in the survey and census data and zonal/county sector estimates of base year population and employment. The employer survey data (for employers within one-half mile of the rail line) was used to check and refine these allocations. Future year estimates of population and employment growth by county and within the major urban areas were used to forecast increases in work commute travel for years 2000 and 2010.

For each rail alternative (and set of station locations) examined, work commute trips were organized into the groups represented in the classification matrix shown below:

	EMPLOYMENT TRIP END	
HOME TRIP END	WALK ACCESS	SHORT RIDE ACCESS
WALK ACCESS		
SHORT RIDE ACCESS		
LONG RIDE ACCESS		

Travel times and costs for rail and the other available transport alternatives (primarily auto) were derived from the urban area transport networks supplemented with data describing the operating characteristics of the test rail alternative and the road network linking the two major urban areas. The work trip mode choice model transferred from the Burlington-Charlotte, Vermont Corridor was then used to estimate the share of total trips captured by rail for each major origin-destination movement.

Inter-County School Commuters - The number of school commuters that might potentially use the proposed rail service was derived from University of Iowa and Kirkwood Community College student records. Their home locations were estimated using information provided by the schools supplemented by zonal estimates of population from the urban area data bases. Future growth within this travel market was based on population projections for the urban areas and counties within the corridor and on projected growth of university attendance.

School commute trips were classified similarly to work commute trips (based on access mode) and alternative mode travel times and costs were compiled for each rail service alternative. The Vermont Corridor work mode choice model (with adjustments to reflect lower student time values) will be used to estimate the share attracted to rail.

Inter-County Other Purpose Trips - The 1995 travel survey provided the basis for the magnitude and origin/destination pattern for trips in this travel market. Future year estimates of the growth were related to growth in corridor population and employment.

The mode specific travel times and costs derived from the transport networks and test rail service schemes were used to solve the Vermont Corridor non-work mode choice model to estimate rail shares and trips for major movements.

Airport Trips - Survey data describing the distribution of trip origins/destinations to/from the airport were used to determine the number of airport trips potentially served by the proposed rail system. Airport growth trends and future enplanement forecasts were used to estimate levels of future air travel from the corridor.

Experience of other airports with rail access was reviewed to determine the likely range of market share that rail might be expected to capture. Based on this review and the comparisons of rail to other mode travel times/costs, estimates of rail trips to the airport were prepared.

University of Iowa Main Campus - Oakdale Campus Trips - The University operates shuttle bus service serving park and ride facility users and other inter-campus travel demands. Ridership records from the University were used to determine total usage of these services. University development plans were reviewed to determine the change that can be expected within this travel market in the future. The proposed rail service was assumed to completely replace the existing bus shuttle service.

Intra-Urban Area Trips Along Rail Alignment - Other relatively short segments of the proposed rail service may serve local travel demands similar to the inter-campus shuttle demand. Public transport ridership records, census journey-to-work data and off-campus student resident information were used to identify where these markets exist.

Each of these identified situations were examined to determine the size of the potential market, and the ability of rail to serve these traveler's needs (in terms of access requirements, service frequency and service periods). In the case of public transport segments paralleling proposed rail segments an assessment was made of rail's suitability to replace or supplement the existing service. An estimate was then made of the numbers of trips diverted or transferred to rail within each of these segments.

Special Event Trips - Trying to serve large special event traffic with rail service can be a "double edged sword." On the one hand, large demands for transport exist at such events and even a relatively small share attracted to rail can produce large ridership and revenue numbers. However, such demands are typically infrequent and have very strong peaking characteristics. The costs of obtaining additional equipment to fully meet the demand cannot usually be justified (as it would be under utilized during periods when special events are not occurring).

Data from the special event operators in the corridor was assessed to determine the number of potential rail trips associated with typical events and the frequency at which such events are scheduled.

Rail system capacity (assuming equipment is available to meet the average daily operating schedule of the rail alternative) was calculated and compared to potential rail demand. In cases where potential demand is found to greatly exceed capacity (for example, University of Iowa football games) the trains were assumed to operate at capacity. For other events, where the peaking is less pronounced or the overall demand magnitudes are smaller, estimates of rail ridership were based on judgement and the experience observed on other existing rail services.

Mode Choice Model Structure and Coefficients

WSA recommended and the Project Steering Committee approved use of mode choice models originally developed from information collected in the Burlington-Charlotte, Vermont Corridor for estimating work commute, school commute and routine non-work travel diversion to rail shares for the Cedar Rapids - Iowa City Corridor.

The survey and modeling work undertaken in the Vermont Corridor are recent and were commissioned for the express purpose of determining how travelers would react to a new rail service. The two corridors are similar in terms of size, existing transport service characteristics, economic development and "special" travel generators.

The surveys undertaken in Vermont represent the current state of the art with respect to determining how people will react when confronted with a new travel mode. The survey process was computerized to minimize respondent bias and/or tendencies to "please" human surveyors. They also was designed to identify and exclude inconsistent or overly enthusiastic responses. The models developed from the data collected were calibrated using generally accepted statistical procedures and have been tested for reasonableness and used to forecast rail demand in the Vermont Corridor.

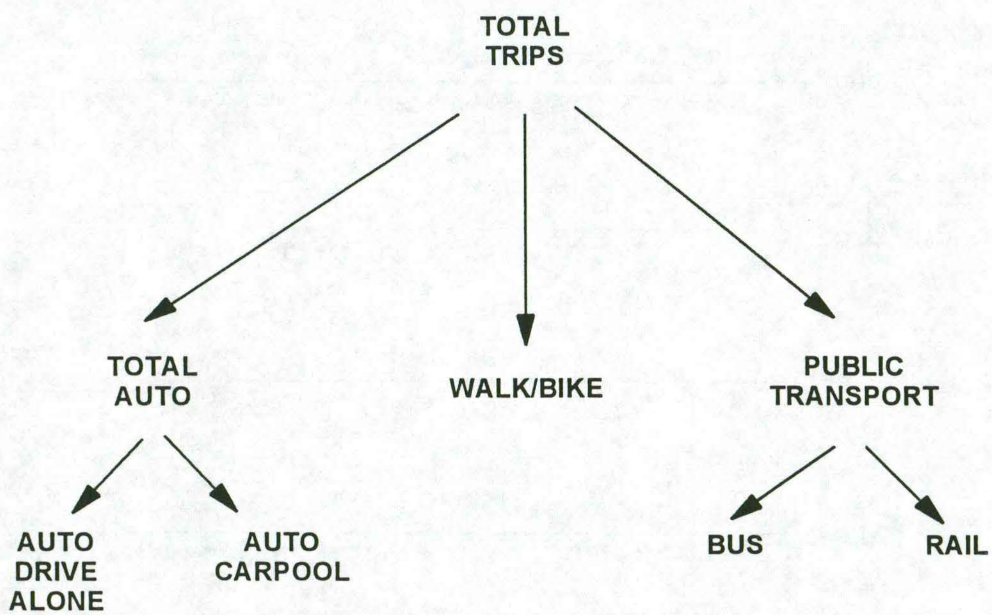
The model structure and coefficients developed from the survey data is presented below. A comparison of the two corridors and a description of the data collection activities used in the market research exercise is presented in Appendix C.

The models developed for Vermont and used in the Cedar Rapids - Iowa City are known as Nested Logit Models. They may be used to estimate the split among five modes:

- Auto Drive Alone
- Auto Carpool
- Walk/Bike
- Bus
- Rail

The "nested logit" model structure splits travel, first, between major travel modes (private vehicles, public transport and non-motorized transport). The process then looks at the characteristics of subalternatives within major modes (drive alone/car pool for private vehicles, bus/rail for public transport) and performs a secondary split within major travel mode.

The branching or nesting structure of the work model is shown below.



The mathematical formulae used to apply the model are as follows:

$$p(auto) = \frac{e^{\theta_A \ln(e^{Vauto}+e^{Vpool})}}{e^{\theta_A \ln(e^{Vauto}+e^{Vpool})}+e^{Vwb}+e^{\theta_B \ln(e^{Vbus}+e^{Vrail})}} x \frac{e^{Vauto}}{e^{Vauto}+e^{Vpool}}$$

$$p(pool) = \frac{e^{\theta_A \ln(e^{Vauto}+e^{Vpool})}}{e^{\theta_A \ln(e^{Vauto}+e^{Vpool})}+e^{Vwb}+e^{\theta_B \ln(e^{Vbus}+e^{Vrail})}} x \frac{e^{Vpool}}{e^{Vauto}+e^{Vpool}}$$

$$p(walk/bike) = \frac{e^{Vwb}}{e^{\theta_A \ln(e^{Vauto}+e^{Vpool})}+e^{Vwb}+e^{\theta_B \ln(e^{Vbus}+e^{Vrail})}}$$

$$p(bus) = \frac{e^{\theta_B \ln(e^{Vbus}+e^{Vrail})}}{e^{\theta_A \ln(e^{Vauto}+e^{Vpool})}+e^{Vwb}+e^{\theta_B \ln(e^{Vbus}+e^{Vrail})}} x \frac{e^{Vbus}}{e^{Vbus}+e^{Vrail}}$$

$$p(rail) = \frac{e^{\theta_B \ln(e^{Vbus}+e^{Vrail})}}{e^{\theta_A \ln(e^{Vauto}+e^{Vpool})}+e^{Vwb}+e^{\theta_B \ln(e^{Vbus}+e^{Vrail})}} x \frac{e^{Vrail}}{e^{Vbus}+e^{Vrail}}$$

Where:

p( ) =	Probability of using the indicated mode.
V ( ) =	Utility function for the indicated mode.
e =	Base for natural logarithms (2.71828)
ln =	Natural logarithms function
θ_A =	Nested model structural parameter for auto/carpool
θ_B =	Nested model structural parameter for bus/rail

The utility functions ($V_{()}$) are used to weight travel time, cost and other factors associated with making a trip using a given mode. The factors included in these functions are:

Variable	Units	Description
Time	Minutes	Total in-vehicle travel time
Headway	Minutes	Transit vehicle headway
Cost	¢/1000$	Out of picket travel costs (cents) divided by the natural logarithm of trip maker household income in thousands of dollars per year

The work and non-work trip purpose utility functions and calibrated constants and coefficients are shown below:

Work Trips

V_{auto}	=	-0.0638 x Time - 0.0112 x Cost
V_{pool}	=	-1.500 - 0.0638 x Time - 0.0112 x Cost
V_{wb}	=	-2.0966 - 0.0638 x Time
V_{bus}	=	-4.3569 - 0.0638 x Time - 0.0112 x Cost - 0.0305 x Headway
V_{rail}	=	-4.3569 - 0.0638 x Time - 0.0112 x Cost - 0.0305 x Headway
Θ_A	=	0.5831
Θ_B	=	0.5789

Non-Work Trips

V_{auto}	=	-0.0224 x Time - 0.0023 x Cost
V_{pool}	=	-1.0000 - 0.0224 x Time - 0.0023 x Cost
V_{wb}	=	-0.2310 - 0.0606 x Time
V_{bus}	=	-3.8988 - 0.0224 x Time - 0.0023 x Cost - 0.0139 x Headway
V_{rail}	=	-3.8988 - 0.0224 x Time - 0.0023 x Cost - 0.0139 x Headway
Θ_A	=	0.7080
Θ_B	=	N.A. (Nonwork trips have no public transport nest)

Sensitivity Analyses

As indicated in the above description of forecasting methodology, assumptions must be made in several areas affecting the rail ridership forecasts. It is important to gain an understanding of how the assumptions made affect the forecasts and how different assumptions might change these estimates. With this knowledge, decision makers may better understand the range of uncertainty involved in this, or any, attempt to predict what will happen in the future.

For the above reasons, a series of sensitivity tests were carried out concurrently with the base or "most likely" forecasts. Assumptions will be varied within the sensitivity tests to determine their impact on forecast rail ridership. Sensitivity tests include:

- Road User Costs
- Road Congestion Levels
- Rail Fare Structure
- School Commute Value of Time
- Population and Employment Growth Estimates
- Rail Station Service Area Definition (walk versus ride access)

FORECAST RESULTS

Rail Travel Demand Market Areas

To analyze and summarize rail travel demand and the various factors which affect demand, Linn and Johnson Counties were divided into 24 geographic rail station areas (RSAs) reflecting accessibility to the proposed rail stations. There are eight proposed rail stations. In defining the RSAs, the area surrounding each rail station was subdivided into one of three station access categories: (1) within walking distance of the rail station (0-0.5 miles); (2) within short motorized access distance (0.5-3.0 miles); or (3) within long motorized access distance (more than 3.0 miles). The RSAs used for this study are shown in Exhibit 7-2 and numbered as follows:

Table 7-11
Rail Station Area (RSA) Numbers

Rail Station	0-0.5 Miles (Walking Distance)	0.5-3.0 Miles (Short Motorized Access Distance)	> 3.0 Miles (Long Motorized Access Distance)
Cedar Rapids GTC	11	12	13
Hawkeye Downs	21	22	23
Airport	31	32	33
Swisher	41	42	43
North Liberty	51	52	53
Oakdale	61	62	63
Coralville	71	72	73
Iowa City	81	82	83

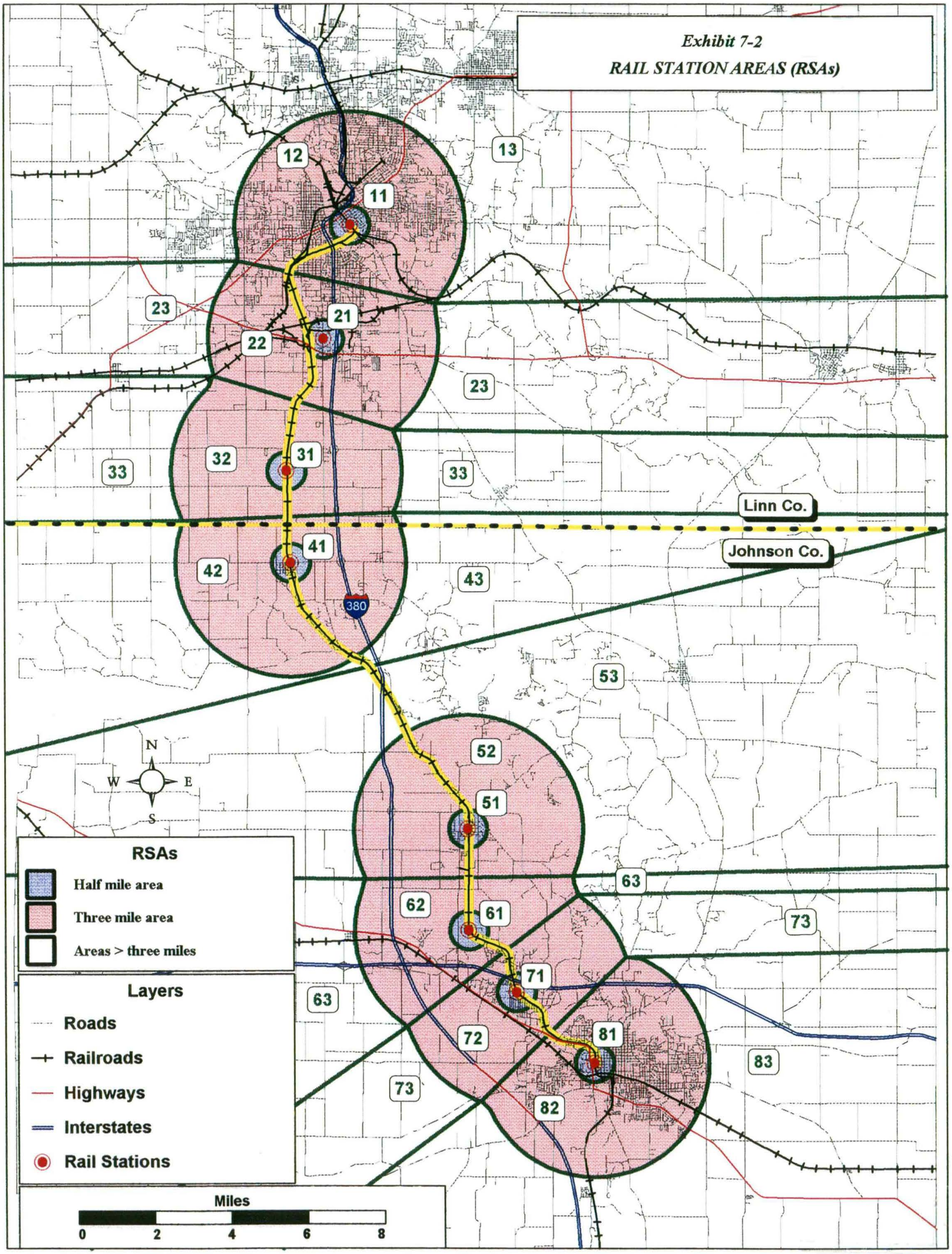


Exhibit 7-2
RAIL STATION AREAS (RSAs)

Assumed Development Characteristics

The base forecasts contained in this section were developed using data covering a range of years. Census journey to work data were from 1990. The travel survey was conducted in 1995. Urban area population and employment data were available for 1989,1990,2000,2010 and 2020. Airport and special event data were from 1994. Student address lists reflected the 1994/1995 school year. Past public transport utilization data were from the period 1990-1994. Judgement and reasonable adjustments were used to consolidate the available information into a base forecast. With these factors in mind the base forecasts may be assumed to be representative of 1995 conditions. A separate section of the report addresses how these base estimates may change over time.

Assumed Road and Rail Service Characteristics

The process of estimating the share of total travel attracted to competing travel modes requires that assumptions be made about the characteristics of the alternatives available. These assumptions relate to the travel times and costs that will exist on each alternative and that are considered by trip makers as they make their travel choices. For this study, the two available travel modes are private vehicle and rail. To estimate total travel time and cost values the overall trip was broken down into its mainline and access components. For private vehicle trips, the mainline component has been defined as the portion of the trip spent on I-380 or other expressways. The access component is the portion spent traveling on local roads and parking at one's destination. For rail trips, the mainline component is train travel. The access component includes times and costs associated with getting from or to rail stations.

All costs are expressed in terms of a one way person trip. Therefore, for private vehicle travel costs, adjustments must be made to translate vehicle trip related costs to person trip costs. These adjustments recognize that vehicles may carry more than one occupant and that, in our trip definition, parking costs should be allocated or split over two trips (for example, the trips to and from work where parking costs are incurred only at the destination end).

Road Service Characteristics - Private vehicles were assumed to travel at 60 MPH on interstate and other expressway facilities. Speeds ranging from 20-40 MPH were assumed on local roads. Table 7-12 contains assumptions for road access times and costs. Table 7-13 contains road mainline travel times. Perceived (considered by trip makers in making travel decisions) vehicle operating costs were assumed to include fuel costs and taxes, tires and maintenance (vehicle depreciation, insurance and registration fees were not included). These assumptions produced an average cost per vehicle mile of 11.5 cents. Later tables for individual market segments show

Table 7-12
Road Alternative - Access Times And Costs
Interstate To Rail Service Areas

Station	Access Distance (Miles)	Average Speed (MPH)	Access Time (Minutes)	Access Cost ($)	Parking Costs Per Hour ($)	Parking Costs Per Day ($)	Parking Costs Per Month ($)
Primary Service Areas							
Cedar Rapids	0.3	20	1	0.03	1.50	5.00	50.00
Hawkeye Downs	0.3	20	1	0.03			
Airport	1.5	40	2	0.17	1.50	4-6.00	--
Swisher	1.2	40	2	0.14			
North Liberty	2.0	40	3	0.23			
Oakdale	2.0	40	3	0.23			
Coralville	0.3	30	1	0.03	2.50	8.00	75.00
Iowa City	2.0	20	6	0.23	2.50	8.00	75.00
Secondary Service Areas							
Cedar Rapids	1.5	20	5	0.17	1.50	5.00	50.00
Hawkeye Downs	1.5	20	5	0.17			
Airport	2.0	40	3	0.23	1.50	4-6.00	--
Swisher	2.0	40	3	0.23			
North Liberty	2.0	40	3	0.23			
Oakdale	3.0	40	5	0.35			
Coralville	1.5	30	3	0.17	2.50	8.00	75.00
Iowa City	3.0	20	9	0.35	2.50	8.00	75.00

Source: Consultant Estimates

Table 7-13
Station To Station Travel Times (Minutes)
Rail Versus Road
(Excluding Access Time)

		To Station							
From Station	Mode	Cedar Rapids	Hawkeye Downs	Airport	Swisher	North Liberty	Oakdale	Coralville	Iowa City
Cedar Rapids	Rail	--	10	15	19	28	32	36	40
	Road	--	4	7	9	18	21	24	26
Hawkeye Downs	Rail	--	--	5	9	18	22	26	30
	Road	--	--	3	5	14	17	20	22
Airport	Rail	--	--	--	4	13	17	21	25
	Road	--	--	--	2	11	14	17	19
Swisher	Rail	--	--	--	--	9	13	17	21
	Road	--	--	--	--	9	12	15	19
North Liberty	Rail	--	--	--	--	--	4	8	12
	Road	--	--	--	--	--	4	8	13
Oakdale	Rail	--	--	--	--	--	--	4	8
	Road	--	--	--	--	--	--	4	9
Coralville	Rail	--	--	--	--	--	--	--	4
	Road	--	--	--	--	--	--	--	5
Iowa City	Rail	--	--	--	--	--	--	--	--
	Road	--	--	--	--	--	--	--	--

Source: Consultant Estimates

mainline, access and total travel costs for major origin-destination pairs taking into account vehicle occupancy and vehicle parking charge adjustments.

Rail Service Characteristics - The base forecasts presented in this report assume a 40 minute travel time between Cedar Rapids and Iowa City rail line termini. Table 7-13 also shows travel times between individual stations. Table 7-14 shows other fare and time operating assumptions used in the base forecasts. The rail service area was assumed to include trips with origins and destinations within the walk and short ride (3 miles or less) access areas. Trips originating or terminating outside these areas were considered to be very unlikely rail users and were excluded from the ridership analyses.

Table 7-14
Rail Alternative - Access Times And Costs

Access Variable	Value
Fares	
Intracounty	$ 0.50
Intercounty	$ 1.50
Service Headway	
Peak Periods	20 Minutes
Off Peak Periods	30 Minutes
Access Time	
Primary Service Area	4 Minutes (Walk)
Secondary Service Area	8 Minutes (Ride)
Access Costs	
Primary Service Area	$ 0.00
Secondary Service Area	$ 0.50

Source: Consultant Estimates

Intercounty Work Commuter

The best available source of information on current home-to-work travel demand is the journey-to-work information collected as part of the 1990 Census. This Census data quantifies home-to-work travel by locally defined traffic analysis zones (TAZ) and/or Census place codes. 1990 journey-to-work data is available on a TAZ-TAZ basis for persons living and working within each county, and on a TAZ-Place basis for persons living in one county and working in the other. For the purposes of this study, the Census county-to-county journey-to-work data reported by place code were allocated to TAZs based on TAZ employment.

It is important to recognize that the Census journey-to-work data tends to overestimate actual weekday home-to-work travel by 10-15 percent. The Census data reports a "work trip" for every employed person. However, not every employed person makes a work trip on every weekday. The average number of actual weekday home-to-work trips is less than the journey-to-work trips reported by the Census because of vacations, illness, part-time and weekend workers.

The Census journey-to-work data, and the summaries of this data presented in this Section, represent one-way travel from home to work. The work commute travel demand market that would be served by the proposed passenger rail service must also include travel from work to home. In general it can be assumed that there is one work-to-home trip for each home-to-work trip. In the real world, there are somewhat fewer direct work-to-home trips than there are direct home-to-work trips. Work commuters are more likely to make nonwork related side trips (for shopping, meals, recreation, etc) as part of work-to-home travel than they are for home-to-work travel.

The 1990 Census journey-to-work data reports approximately 129,000 one-way home-to-work trips within Linn and Johnson Counties. Table 7-15 shows the distribution of these trips from, to and within each of the 24 RSAs. Some, but not all, of this travel market could be served by the proposed passenger rail system. Analysis of this data provides important insights into the location and magnitude of work commute trips that could be served by the proposed rail passenger service.

This 1990 Census data indicates:

- More than 50% of all home-to-work trips within the two county region originate within the three RSAs surrounding the Cedar Rapids GTC station (11, 12 and 13), and more than 25% of all home-to-work trips originate within the three RSAs surrounding the Iowa City station (81, 82 and 83). Together, almost 80% of all home-to-work trips originate within these six RSAs.

Table 7-15
1990 Journey-To-Work Trips By Rail Station Area (RSA)

Origin RSA		Destination Rail Station Area (RSA)																									
		Cedar Rapids GTC			Hawkeye Downs			Airport			Swisher			North Liberty			Oakdale			Coralville			Iowa City				
Station		1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	Total	Pct
	Area	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
1	1	176	143	91	5	34	3	0	2	0	0	0	0	0	0	0	0	1	1	0	1	0	4	9	0	472	0.4%
1	2	6,685	11,290	6,955	264	4,183	508	6	141	42	1	0	8	1	6	11	14	42	29	11	64	1	239	496	20	31,017	24.0%
1	3	6,284	9,633	16,775	200	4,107	414	15	283	74	1	0	15	1	5	10	13	39	27	10	59	1	221	457	18	38,663	29.9%
2	1	4	3	3	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0.0%
2	2	1,032	1,459	970	35	1,692	107	2	69	12	0	0	2	0	1	3	3	10	7	3	16	0	59	123	5	5,613	4.3%
2	3	298	515	614	24	421	448	2	42	256	0	1	52	0	1	2	3	9	6	2	14	0	52	108	4	2,875	2.2%
3	1	2	5	4		4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0.0%
3	2	11	8	23	1	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	81	0.1%
3	3	140	205	298	11	218	255	2	27	163	0	1	33	0	1	2	2	7	5	2	11	0	39	82	3	1,506	1.2%
4	1	32	51	56	1	24	4	0	1	1	7	4	0	0	0	2	1	5	7	1	2	0	5	18	0	223	0.2%
4	2	95	150	171	4	72	12	0	4	4	9	6	1	1	4	17	1	16	28	3	7	0	13	56	4	679	0.5%
4	3	110	171	204	5	102	62	0	8	36	5	4	10	1	4	42	5	26	48	5	14	1	54	137	6	1,060	0.8%
5	1	3	5	5	0	2	0	0	0	0	0	0	0	2	11	2	7	29	11	3	20	0	50	95	5	252	0.2%
5	2	25	40	44	1	18	3	0	1	1	0	0	0	12	54	14	34	147	81	17	116	1	299	574	25	1,507	1.2%
5	3	94	149	165	3	69	11	0	3	3	1	1	1	2	13	285	26	109	183	24	93	4	336	770	31	2,377	1.8%
6	1	4	6	7	0	3	0	0	0	0	0	0	0	0	0	0	7	16	8	5	20	0	36	111	4	228	0.2%
6	2	17	28	31	1	13	2	0	1	1	0	0	0	5	25	9	44	166	84	38	158	1	273	727	18	1,640	1.3%
6	3	6	9	10	0	4	1	0	0	0	0	0	0	4	19	43	21	84	145	22	78	2	162	416	13	1,039	0.8%
7	1	10	16	18	0	8	1	0	0	0	0	0	0	1	3	3	42	96	35	41	148	0	196	499	12	1,129	0.9%
7	2	51	82	90	2	38	6	0	2	2	0	0	0	6	30	17	151	376	140	149	705	6	1,199	2,630	40	5,723	4.4%
7	3	6	9	10	0	4	1	0	0	0	0	0	0	0	2	18	10	42	70	5	35	6	122	310	16	668	0.5%
8	1	22	35	39	1	16	3	0	1	1	0	0	0	2	8	9	39	89	36	32	167	1	1,219	1,523	23	3,264	2.5%
8	2	146	233	258	5	107	18	0	5	5	0	0	0	14	64	58	278	646	240	200	1,419	8	7,035	14,767	427	25,933	20.0%
8	3	12	19	21	0	9	1	0	0	0	0	0	0	3	21	35	41	188	293	25	149	5	687	1,624	314	3,447	2.7%
Total		15,266	24,265	26,862	566	11,188	1,862	29	592	603	25	18	122	54	273	584	743	2,141	1,482	599	3,295	36	12,303	25,532	988	129,426	100.0%
Pct		11.8%	18.7%	20.8%	0.4%	8.6%	1.4%	0.0%	0.5%	0.5%	0.0%	0.0%	0.1%	0.0%	0.2%	0.5%	0.6%	1.7%	1.1%	0.5%	2.5%	0.0%	9.5%	19.7%	0.8%	100.0%	

Source: 1990 Census CTTP Data For Johnson And Linn Counties

- More than 50% of all home-to-work trips within the two county region have their destination within the three RSA surrounding the Cedar Rapids GTC station (11, 12 and 13), and more than 30% of all home-to-work trips have a destination within the three RSAs surrounding the Iowa City station (81, 82 and 83). Together, more than 80% of all home-to-work trips have destinations within these six RSAs.

Approximately 91,000 or 70% of total home-to-work trips within the two county region have both their origins and destinations within the three Cedar Rapids GTC RSAs, within the three Iowa City RSAs, or within the three RSAs surrounding each of the other six stations. Because these trips have their origins and destinations totally within the service area of a single rail station, these trips cannot logically be made by rail. Table 7-16 shows the pattern of the remaining 39,000 1990 home-to-work trips within the two county region when the 91,000 home-to-work trips having both their origins and destinations within the service area of a single rail station are eliminated.

These 39,000 trips can be categorized as "intercity" or "intracity" trips. For the purposes of this study, intercity trips involve home-to-work travel between any of the twelve RSAs in the Cedar Rapids area (11-44) and any of the twelve RSAs in the Iowa City area (51-88). Intracity trips involve home-to-work travel within the twelve RSAs in the Cedar Rapids area or within the 12 RSAs in the Iowa City area. Because of the station access and wait times associated with rail travel, work commuters having longer intercity trips are more likely to choose rail than are commuters having shorter intracity trips. Of the 39,000 home-to-work trips in 1990, approximately 5,000 (13%) are intercity and 34,000 (87%) are intracity. Table 7-17 and Table 7-18 show the origins and destinations of the intercity and intracity trips, respectively.

Exhibit 7-3 shows graphically the breakdown of total commuters in the two county area by rail ridership potential. About 70 percent commute within individual station service areas and are, therefore, not potential rail users. A further 24 percent are unlikely rail users because of rail access requirements. This leaves about 6 percent of all commuters as potential to rail.

Table 7-19 contains and compares intercounty work commute trips extracted from the 1995 travel survey and the 1990 census data. Census reported trips have been multiplied by two (to reflect a trip in each direction). The trips shown in the table have been categorized by rail access modes that would be required to make the trip.

Table 7-16
1990 Journey-To-Work Trips Excluding Intra Rail Station Area Trips

		Destination Rail Station Area (RSA)																									
Origin RSA		Cedar Rapids GTC			Hawkeye Downs			Airport			Swisher			North Liberty			Oakdale			Coralville			Iowa City				
Station		1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8		
	Area	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	Total	Pct
1	1				5	34	3	0	2	0	0	0	0	0	0	0	0	1	1	0	1	0	4	9	0	62	0.2%
1	2				264	4,183	508	6	141	42	1	0	8	1	6	11	14	42	29	11	64	1	239	496	20	6,087	15.7%
1	3				200	4,107	414	15	283	74	1	0	15	1	5	10	13	39	27	10	59	1	221	457	18	5,972	15.4%
2	1	4	3	3				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.0%
2	2	1,032	1,459	970				2	69	12	0	0	2	0	1	3	3	10	7	3	16	0	59	123	5	3,779	9.8%
2	3	298	515	614				2	42	256	0	1	52	0	1	2	3	9	6	2	14	0	52	108	4	1,982	5.1%
3	1	2	5	4	0	4	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0.0%
3	2	11	8	23	1	36	0				0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	81	0.2%
3	3	140	205	298	11	218	255				0	1	33	0	1	2	2	7	5	2	11	0	39	82	3	1,315	3.4%
4	1	32	51	56	1	24	4	0	1	1				0	0	2	1	5	7	1	2	0	5	18	0	212	0.5%
4	2	95	150	171	4	72	12	0	4	4				1	4	17	1	16	28	3	7	0	13	56	4	663	1.7%
4	3	110	171	204	5	102	62	0	8	36				1	4	42	5	26	48	5	14	1	54	137	6	1,040	2.7%
5	1	3	5	5	0	2	0	0	0	0	0	0	0				7	29	11	3	20	0	50	95	5	237	0.6%
5	2	25	40	44	1	18	3	0	1	1	0	0	0				34	147	81	17	116	1	299	574	25	1,427	3.7%
5	3	94	149	165	3	69	11	0	3	3	1	1	1				26	109	183	24	93	4	336	770	31	2,077	5.4%
6	1	4	6	7	0	3	0	0	0	0	0	0	0	0	0	0				5	20	0	36	111	4	197	0.5%
6	2	17	28	31	1	13	2	0	1	1	0	0	0	5	25	9				38	158	1	273	727	18	1,346	3.5%
6	3	6	9	10	0	4	1	0	0	0	0	0	0	4	19	43				22	78	2	162	416	13	789	2.0%
7	1	10	16	18	0	8	1	0	0	0	0	0	0	1	3	3	42	96	35				196	499	12	941	2.4%
7	2	51	82	90	2	38	6	0	2	2	0	0	0	6	30	17	151	376	140				1,199	2,630	40	4,863	12.6%
7	3	6	9	10	0	4	1	0	0	0	0	0	0	0	2	18	10	42	70				122	310	16	622	1.6%
8	1	22	35	39	1	16	3	0	1	1	0	0	0	2	8	9	39	89	36	32	167	1				498	1.3%
8	2	146	233	258	5	107	18	0	5	5	0	0	0	14	64	58	278	646	240	200	1,419	8				3,704	9.6%
8	3	12	19	21	0	9	1	0	0	0	0	0	0	3	21	35	41	188	293	25	149	5				823	2.1%
Total		2,120	3,198	3,041	506	9,072	1,306	27	565	440	4	3	111	37	195	283	671	1,875	1,245	404	2,408	25	3,362	7,618	224	38,741	100.0%
Pct		5.5%	8.3%	7.9%	1.3%	23.4%	3.4%	0.1%	1.5%	1.1%	0.0%	0.0%	0.3%	0.1%	0.5%	0.7%	1.7%	4.8%	3.2%	1.0%	6.2%	0.1%	8.7%	19.7%	0.6%	100.0%	

Source: 1990 Census CTTP Data For Johnson And Linn Counties

Table 7-17
1990 Intercity Journey-To-Work Trips

Origin RSA		Destination Rail Station Area (RSA)																									
		Cedar Rapids GTC			Hawkeye Downs			Airport			Swisher			North Liberty			Oakdale			Coralville			Iowa City				
Station		1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8		
	Area	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	Total	Pct
1	1													0	0	0	0	1	1	0	1	0	4	9	0	17	0.3%
1	2													1	6	11	14	42	29	11	64	1	239	496	20	934	18.5%
1	3													1	5	10	13	39	27	10	59	1	221	457	18	861	17.1%
2	1													0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
2	2													0	1	3	3	10	7	3	16	0	59	123	5	232	4.6%
2	3													0	1	2	3	9	6	2	14	0	52	108	4	203	4.0%
3	1													0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
3	2													0	0	0	0	0	0	0	0	0	0	1	0	2	0.0%
3	3													0	1	2	2	7	5	2	11	0	39	82	3	154	3.0%
4	1													0	0	2	1	5	7	1	2	0	5	18	0	41	0.8%
4	2													1	4	17	1	16	28	3	7	0	13	56	4	151	3.0%
4	3													1	4	42	5	26	48	5	14	1	54	137	6	342	6.8%
5	1	3	5	5	0	2	0	0	0	0	0	0	0													16	0.3%
5	2	25	40	44	1	18	3	0	1	1	0	0	0													134	2.7%
5	3	94	149	165	3	69	11	0	3	3	1	1	1													501	9.9%
6	1	4	6	7	0	3	0	0	0	0	0	0	0													20	0.4%
6	2	17	28	31	1	13	2	0	1	1	0	0	0													93	1.8%
6	3	6	9	10	0	4	1	0	0	0	0	0	0													30	0.6%
7	1	10	16	18	0	8	1	0	0	0	0	0	0													55	1.1%
7	2	51	82	90	2	38	6	0	2	2	0	0	0													273	5.4%
7	3	6	9	10	0	4	1	0	0	0	0	0	0													30	0.6%
8	1	22	35	39	1	16	3	0	1	1	0	0	0													118	2.3%
8	2	146	233	258	5	107	18	0	5	5	0	0	0													778	15.4%
8	3	12	19	21	0	9	1	0	0	0	0	0	0													64	1.3%
Total		397	631	698	15	291	49	0	15	15	1	1	1	4	22	90	42	155	157	38	189	3	687	1,486	61	5,048	100.0%
Pct		7.9%	12.5%	13.8%	0.3%	5.8%	1.0%	0.0%	0.3%	0.3%	0.0%	0.0%	0.0%	0.1%	0.4%	1.8%	0.8%	3.1%	3.1%	0.8%	3.7%	0.1%	13.6%	29.4%	1.2%	100.0%	

Source: 1990 Census CTTP Data For Johnson And Linn Counties

Table 7-18
1990 Intracity Journey-To-Work Trips

Origin RSA Station	Area	Cedar Rapids GTC 1-1	Cedar Rapids GTC 1-2	Cedar Rapids GTC 1-3	Hawkeye Downs 2-1	Hawkeye Downs 2-2	Hawkeye Downs 2-3	Airport 3-1	Airport 3-2	Airport 3-3	Swisher 4-1	Swisher 4-2	Swisher 4-3	North Liberty 5-1	North Liberty 5-2	North Liberty 5-3	Oakdale 6-1	Oakdale 6-2	Oakdale 6-3	Coralville 7-1	Coralville 7-2	Coralville 7-3	Iowa City 8-1	Iowa City 8-2	Iowa City 8-3	Total	Pct
1	1				5	34	3	0	2	0	0	0	0													45	0.1%
1	2				264	4,183	508	6	141	42	1	0	8													5,153	15.3%
1	3				200	4,107	414	15	283	74	1	0	15													5,110	15.2%
2	1	4	3	3				0	0	0	0	0	0													10	0.0%
2	2	1,032	1,459	970				2	69	12	0	0	2													3,547	10.5%
2	3	298	515	614				2	42	256	0	1	52													1,779	5.3%
3	1	2	5	4	0	4	0				0	0	0													15	0.0%
3	2	11	8	23	1	36	0				0	0	0													79	0.2%
3	3	140	205	298	11	218	255				0	1	33													1,161	3.4%
4	1	32	51	56	1	24	4	0	1	1																170	0.5%
4	2	95	150	171	4	72	12	0	4	4																512	1.5%
4	3	110	171	204	5	102	62	0	8	36																699	2.1%
5	1																7	29	11	3	20	0	50	95	5	221	0.7%
5	2																34	147	81	17	116	1	299	574	25	1,293	3.8%
5	3																26	109	183	24	93	4	336	770	31	1,576	4.7%
6	1													0	0	0				5	20	0	36	111	4	177	0.5%
6	2													5	25	9				38	158	1	273	727	18	1,253	3.7%
6	3													4	19	43				22	78	2	162	416	13	759	2.3%
7	1													1	3	3	42	96	35				196	499	12	886	2.6%
7	2													6	30	17	151	376	140				1,199	2,630	40	4,590	13.6%
7	3													0	2	18	10	42	70				122	310	16	592	1.8%
8	1													2	8	9	39	89	36	32	167	1				380	1.1%
8	2													14	64	58	278	646	240	200	1,419	8				2,925	8.7%
8	3													3	21	35	41	188	293	25	149	5				759	2.3%
Total		1,724	2,567	2,343	491	8,781	1,258	27	550	425	2	2	110	34	173	193	628	1,720	1,088	366	2,219	21	2,674	6,132	163	33,692	100.0%
Pct		5.1%	7.6%	7.0%	1.5%	26.1%	3.7%	0.1%	1.6%	1.3%	0.0%	0.0%	0.3%	0.1%	0.5%	0.6%	1.9%	5.1%	3.2%	1.1%	6.6%	0.1%	7.9%	18.2%	0.5%	100.0%	

Destination Rail Station Area (RSA)

Source: 1990 Census CTTP Data For Johnson And Linn Counties

WORK COMMUTER RIDERSHIP POTENTIAL

Linn - Johnson Counties

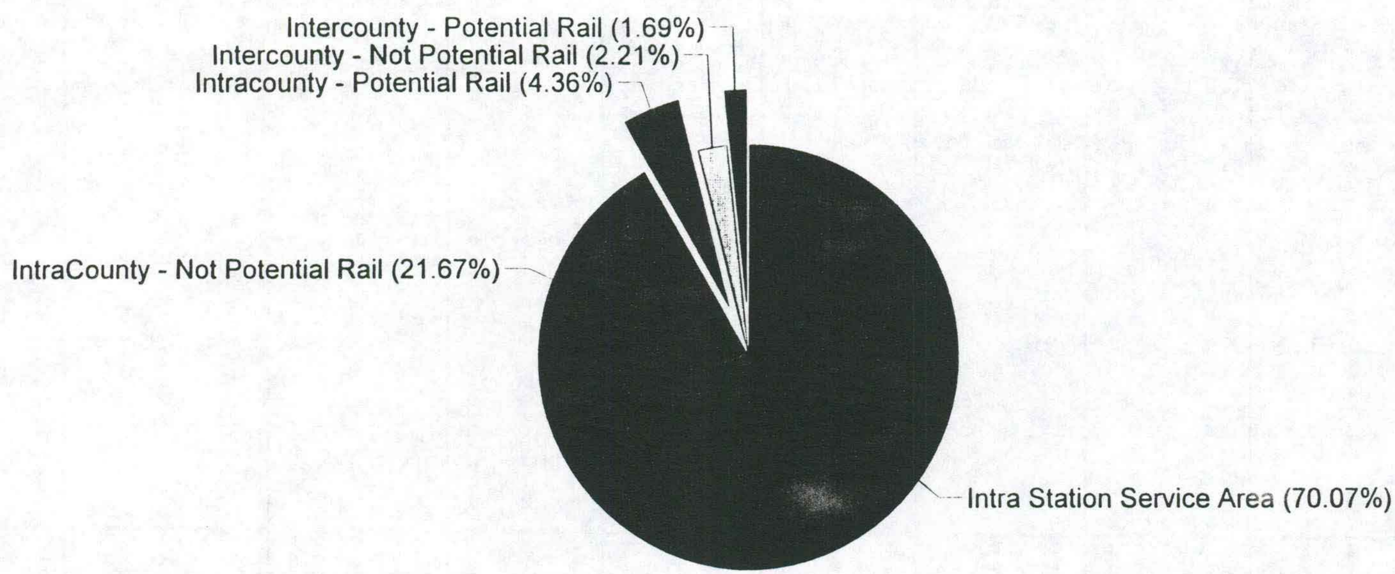


EXHIBIT 7-3

Table 7-19
Intercounty Work Commute Trips
Survey Versus Census

Access Combination	Survey Trips	Census Trips	Likely Trips
Walk-Walk	466	102	500
Ride-Walk	1,290	1,192	1,400
Walk-Ride	525	256	600
Ride-Ride	789	2,820	900
Total	3,070	4,370	3,400

Sources: 1995 Travel Survey, 1990 Census Journey To Work Data and Consultant Estimates

Comparing survey and census derived trips one finds some degree of agreement between the two. In comparing the data one should take into consideration several characteristics of the different work trip estimates:

1. Census data tends to overstate average weekday trips because it does not account for vacation/illness work absences or work schedules that do not require that all work trips be made over five weekdays.

2. Work place destinations for census data trips were allocated based on the employment distribution by Traffic Analysis Zone within a County (census data does not include detailed work place identification for intercounty trips). It is possible that this process may tend to understate commuter travel to higher paying jobs in city central areas which are close to rail stations (it may be hypothesized that workers are more likely to accept a relatively long commute to a higher paying job than a lower paying one. It would seem that a comparable low paying job could be found close to one's residence, eliminating the need to commute to another city).

3. The survey data was collected in August, a period when a higher than average number of workers could be expected to be taking vacation leave. The survey data may, therefore, understate average weekday commuter travel.

Taking the above into consideration, a third column is shown in Table 7-19 containing the consultant's estimate of average weekday work commuter trips in each rail access combination category. In total, 3,400 work commuter trips were considered to be potential users of the proposed rail service.

Table 7-20 contains the mode service characteristic assumptions and results from applying the work mode choice models. An average annual income of $35,000 was assumed in applying the model. An average private vehicle occupancy of 1.2 was assumed to calculate road user trip costs.

Table 7-20
Intercounty Work Commuter Trips
Mode Service Assumptions And Estimated Rail Trips

Access Combination	Mode	Access Time	Access Cost ($)	Mainline Time	Mainline Cost ($)	Total Time	Total Cost ($)	Total Trips	Share (%)	Trips By Mode
Walk-Walk	Rail	8	0.00	40	1.50	48	1.50		95.1%	475
	Road	7	1.35	26	2.50	33	3.85	500	4.9%	25
Ride-Walk	Rail	12	0.50	40	1.50	52	2.00		95.6%	1,338
	Road	10	1.45	26	2.50	36	3.95	1,400	4.4%	62
Walk-Ride	Rail	12	0.50	40	1.50	52	2.00		95.6%	573
	Road	10	1.45	26	2.50	36	3.95	600	4.4%	27
Ride-Ride	Rail	16	1.00	40	1.50	56	2.50		96.0%	864
	Road	14	1.55	26	2.50	40	4.05	900	4.0%	36
Total	Rail								95.6%	3,251
	Road							3,400	4.4%	149

Source: Consultant Estimates

The model application suggests that about 4.4 percent of the potential trips could be attracted to the rail service. This percentage translates to about 150 one way, work commuter trips on an average weekday.

Intercounty School Commuter

There are two major educational institutions, Iowa University and Kirkwood Community College, that could be served by the proposed CRANDIC passenger rail service. Mount Mercy College was not included because of its location relative to the proposed rail service. The University of Iowa's main campus is located within walking distance of the Iowa City rail station, and its Oakdale campus is located within walking distance of the Oakdale rail station. Kirkwood Community College is located near the Hawkeye Downs rail station. Both institutions provided addresses for students residing off-campus (e.g., student commuters). This data was geocoded to both traffic analysis zone (TAZ) and rail station area (RSA).

Table 7-21 summarizes the number of University of Iowa student commuters by RSA of residence. Total student enrollment at the university is approximately 27,000. The Oakdale campus, located in RSA 61, serves about 600 students and faculty. Consequently, it can be assumed that the vast majority of the 5,800 University of Iowa student commuters travel to the main campus in downtown Iowa City, which is located in RSA 81. Analysis of this data shows:

- Almost 2,700 (47%) of the student commuters travel from one of the three RSAs surrounding the Iowa City rail station (81-83), and would not be served by the proposed passenger rail system.

- Almost 1,900 (32%) travel from the adjacent Coralville RSAs. Of these, 170 live within walking distance of the Coralville rail station, and the remainder live within three miles of the rail station.

- About 900 (15%) can be classified as intercounty commuters. Of these, almost 800 come from RSAs served by the Cedar Rapids GTC.

Table 7-21
1994 University of Iowa Student Commuters
By Rail Station Area (RSA) Of Residence

Rail Station		Area			Total	
		< 0.5 Miles	>0.5 & <3.0 Mi	> 3.0 Miles		
		1	2	3		
Cedar Rapids GTC	1	1	473	319	793	13.7%
Hawkeye Downs	2	0	67	17	84	1.4%
Airport	3	0	5	0	5	0.0%
Swisher	4	26	3	0	29	0.5%
North Liberty	5	149	77	0	226	3.9%
Oakdale	6	0	100	0	100	1.7%
Coralville	7	172	1,698	0	1,870	32.2%
Iowa City	8	360	2,327	9	2,696	46.5%
Total		708	4,750	345	5,803	100.0%

Source: University of Iowa

Table 7-22 summarizes the number of Kirkwood Community College student commuters by RSA of residence. Kirkwood Community College is located in RSA 22 and would be served by feeder bus service to and from the Hawkeye Downs rail station. Analysis of this data shows:

- More than 700 (16%) of the 4,600 student commuters travel from one of the three RSAs surrounding the Hawkeye Downs station (21-23), and would not be served by the proposed passenger rail system.

- More than 2,600 (57%) travel from the adjacent Cedar Rapids GTC RSAs. Of these, 34 live within walking distance of the Cedar Rapids GTC rail station; 1,655 live within three miles of the rail station; and the remaining 900 reside more than three miles from the station.

- About 1,250 (27%) can be classified as intercounty commuters, and most of these come from RSAs served by the Iowa City station.

Table 7-22
1994 Kirkwood Community College Student Commuters
By Rail Station Area (RSA) Of Residence

Rail Station		Area			Total	
		< 0.5 Miles	>0.5 & <3.0 Mi	> 3.0 Miles		
		1	2	3		
Cedar Rapids GTC	1	34	1,655	924	2,613	56.6%
Hawkeye Downs	2	2	647	67	716	15.5%
Airport	3	0	9	0	9	0.2%
Swisher	4	2	3	0	5	0.1%
North Liberty	5	0	0	0	0	0.0%
Oakdale	6	0	0	0	0	0.0%
Coralville	7	0	32	1	33	0.7%
Iowa City	8	73	1,141	23	1,237	26.8%
Total		111	3,487	1,015	4,613	100.0%

Source: Kirkwood Community College

Tables 7-23 and 7-24 contain the mode service assumptions used to estimate the share that could be attracted to rail from University of Iowa and Kirkwood Community College commuters. Road user costs were calculated assuming an average vehicle occupancy of 1.3 persons. Kirkwood access cost assumptions include a free shuttle from the station to the campus and free parking for auto users. At the University it was assumed that commuters from Cedar Rapids could obtain an on campus parking pass at a cost of about $50 per month. For model application, an average student income of $10,000 per year was assumed.

Table 7-23
Intercounty School Commuter Trips - University Of Iowa
Mode Service Assumptions And Estimated Rail Trips

Access Combination	Mode	Access		Mainline		Total		Total		Trips
		Time	Cost ($)	Time	Cost ($)	Time	Cost ($)	Trips	Share (%)	By Mode
Walk-Walk	Rail	8	0.00	30	1.50	38	1.50		92.6%	50
	Road	11	1.30	22	2.05	33	3.35	54	7.4%	4
Ride-Walk	Rail	12	0.50	30	1.50	42	2.00		94.4%	1,034
	Road	11	1.30	22	2.05	33	3.35	1,096	5.6%	62
Total	Rail								94.3%	1,084
	Road							1,150	5.7%	66

Source: Consultant Estimates

Table 7-24
Intercounty School Commuter Trips - Kirkwood Community College
Mode Service Assumptions And Estimated Rail Trips

Access Combination	Mode	Access		Mainline		Total		Total		Trips
		Time	Cost ($)	Time	Cost ($)	Time	Cost ($)	Trips	Share (%)	By Mode
Walk-Ride	Rail	9	0.00	30	1.50	39	1.50		93.3%	140
	Road	14	0.55	22	2.05	36	2.60	150	6.7%	10
Ride-Ride	Rail	14	0.50	30	1.50	44	2.00		95.1%	2,235
	Road	14	0.55	22	2.05	36	2.60	2,350	4.9%	115
Total	Rail								95.0%	2,375
	Road							2,500	5.0%	125

Source: Consultant Estimates

The total potential trips shown in the table were estimated assuming that students made two one-way trips per day and attended class five days per week. Only students living within the short ride (3 mile) rail service area were considered to be potential rail users.

The model solutions indicate that the rail service would attract 5-6 percent of the total school commute market (about 190 one way trips per day). The shares calculated for Kirkwood Community College are slightly lower than for the University reflecting the different assumptions related to access requirements at the schools.

Intercounty Other Purpose Trips

Table 7-25 contains the road and rail mode service assumptions used to estimate rail share from the intercounty non work/school commute market. Road user cost was calculated assuming an average private vehicle occupancy of 2.1 persons per car. The potential rail trips shown were extracted from the road travel survey results for this trip purpose (previously reported in Table 7-10). Potential trips include only those with origin and destination within the walk and short ride rail service areas (3 miles around stations).

Table 7-25
Intercounty Other Purpose Trips
Mode Service Assumptions And Estimated Rail Trips

Access		Access		Mainline		Total		Total		Trips
Combination	Mode	Time	Cost ($)	Time	Cost ($)	Time	Cost ($)	Trips	Share (%)	By Mode
Walk-Walk	Rail	8	0.00	40	1.50	48	1.50		99.3%	301
	Road	7	1.05	26	1.40	33	2.45	303	0.8%	2
Ride-Walk	Rail	12	0.50	40	1.50	52	2.00		99.4%	883
	Road	10	1.10	26	1.40	36	2.50	889	0.7%	6
Walk-Ride	Rail	12	0.50	40	1.50	52	2.00		99.4%	264
	Road	10	1.10	26	1.40	36	2.50	266	0.7%	2
Ride-Ride	Rail	16	1.00	40	1.50	56	2.50		99.4%	692
	Road	14	1.20	26	1.40	40	2.60	696	0.6%	4
Total	Rail								99.4%	2,140
	Road							2,154	0.6%	14

Source: Consultant Estimates

The mode choice models predict a very low share to rail (less than 1 percent - about 14 one way trips per weekday). For most origin destination combinations, travel costs are similar for private auto and rail (due to the sharing of private vehicle costs over 2+ occupants) and rail requires about a 15 minute increase in travel time. Other purpose trips also often have multiple destinations and include the transport of purchased goods making them less likely to be diverted to the rail mode.

Airport Trips

Airport users were assumed to fall into two categories; area residents and visitors. Residents were assumed to travel to the airport from their homes while visitors were assumed to travel to employment or residential locations depending on their purpose for visiting the area (business or nonbusiness). Table 7-26 contains population and employment for 1990 within the primary rail service areas in the two counties. The percentages shown in this table were used to allocate air travelers to non-airport locations in the travel corridor.

Table 7-26
Percent Of Population And Employment
Served By Rail - 1990

	Rail	1990 Population		1990 Employment	
Area	Proximity	Number	Percent	Number	Percent
Cedar Rapids	Walk	1,600	0.6%	17,900	11.9%
	Ride	77,600	29.3%	40,200	26.6%
	Total	79,200	29.9%	58,100	38.5%
Iowa City	Walk	9,500	3.6%	15,100	10.0%
	Ride	63,200	23.9%	36,900	24.5%
	Total	72,700	27.4%	52,000	34.5%
Two County	Total	264,900	100.0%	150,900	100.0%

Note: Iowa City includes Coralville and Oakdale
Source: 1990 Census and Consultant Estimates

Airport potential rail trips were estimated using the chain of calculations shown in Table 7-27. Total Enplanements/Deplanements (EDs) for 1994 were 789,000. Each ED (plane boarding or alighting passenger) could potentially generate one person trip to or from the airport. Total EDs were converted to average daily trips (divided by 365) and then adjusted to allow for some (20 percent) passengers transferring to other flights and, therefore, not requiring a trip to or from the airport. This produced an average daily number of person trips to the airport of 1,729. It was further assumed that all these trips traveled to locations within Linn and Johnson Counties (Some trips to the airport probably originate outside the two County area. License plate data from airport parking facilities were

Table 7-27
Airport Potential Rail Trips

Annual Enplanements/Deplanements (ED's) (1994)	789,000
Daily ED's (365 Days)	2,162
Percent Connecting ED's	20%
Daily Person Trips To/From Airport	1,729
Area Visitor Trips (45 Percent)	**778**
Business Related (65 Percent)	506
Cedar Rapids - Rail Walk (11.9 Percent)	60
Cedar Rapids - Rail Ride (26.6 Percent)	135
Cedar Rapids - Rail Total (38.5 Percent)	195
Iowa City - Rail Walk (10.0 Percent)	51
Iowa City - Rail Ride (24.5 Percent)	124
Iowa City - Rail Total (34.5 Percent)	175
Non-Business Related (35 Percent)	272
Cedar Rapids - Rail Walk (0.6 Percent)	2
Cedar Rapids - Rail Ride (29.3 Percent)	80
Cedar Rapids - Rail Total (29.9 Percent)	81
Iowa City - Rail Walk (3.6 Percent)	10
Iowa City - Rail Ride (23.9 Percent)	65
Iowa City - Rail Total (27.4 Percent)	75
Area Resident Trips (55 Percent)	**951**
Cedar Rapids - Rail Walk (0.6 Percent)	6
Cedar Rapids - Rail Ride (29.3 Percent)	279
Cedar Rapids - Rail Total (29.9 Percent)	284
Iowa City - Rail Walk (3.6 Percent)	34
Iowa City - Rail Ride (23.9 Percent)	227
Iowa City - Rail Total (27.4 Percent)	262

Source: Cedar Rapids Municipal Airport and Consultant Estimates reviewed to try to estimate the proportion of airport utilization by local area residents. However, it was noted that university students, with cars registered outside Linn and Johnson Counties, were probably significant users of air travel and their license plate data would skew the findings from the parking lot information). This assumption was adopted to produce an optimistic estimate of potential rail trips.

Daily trips to the airport were split into visitor (45 percent) and area resident (55 percent) categories. Visitor trips were further segregated into business (65 percent) and nonbusiness (35 percent) groupings. Person trips in each of these major groupings were then allocated to rail service areas (by rail access requirement) according to the population or employment percentages shown in Table 7-26.

The process resulted in the identification of 1,072 daily trips to or from the airport that were candidates for diversion to rail. As shown in Table 7-28, about 160 of these were traveling to locations within walking distance of a rail station. The remainder, about 910 trips, would require some kind of motorized access at the non-airport end of their trip. Table 7-28 also shows the assumed share to rail for each category of trip and the rail trips estimated using these shares.

Business travelers, to locations within walking distance of rail stations, were assumed to have the highest probability for rail diversion (20-25 percent). Business travelers and area residents whose trips would require motorized access were assumed to use rail at a rate of about 5 percent. Area residents, within walking distance of rail stations, were assumed to have a 10-15 percent probability of using rail. Visitors, whose trip by rail would require a motorized access component, were assumed have the lowest rail share (about 2.5 percent). All other things equal, travelers to Cedar Rapids were assumed to have a lower diversion rate to rail than to Iowa City reflecting a lower probability of using rail for a shorter trip. All of these assumed shares are intended to produce somewhat optimistic estimates of rail utilization (observed rail shares at U.S. airports with rail service range from 5-15 percent; Philadelphia and Chicago-O'Hare - 5 percent; Boston Logan - 6 percent; Atlanta Hartsfield - 9 percent; Washington National - 15 percent. Source: TR News 181, November - December, 1995).

Application of the shares noted above to potential rail trips to the airport produced a ridership estimate of 73 passengers per day. This represents an overall rail share (of potential trips) of 6.8 percent.

Table 7-28
Airport Estimated Rail Trips

Trip Category	Potential Rail Trips	Assumed Rail Share	Estimated Rail Trips
Area Visitor Trips			
Business Related			
Cedar Rapids - Rail Walk	60	20.0%	12
Cedar Rapids - Rail Ride	135	5.0%	7
Cedar Rapids - Rail Total	195	9.6%	19
Iowa City - Rail Walk	51	25.0%	13
Iowa City - Rail Ride	124	5.0%	6
Iowa City - Rail Total	175	10.8%	19
Non-Business Related			
Cedar Rapids - Rail Walk	2	5.0%	0
Cedar Rapids - Rail Ride	80	2.5%	2
Cedar Rapids - Rail Total	81	2.6%	2
Iowa City - Rail Walk	10	10.0%	1
Iowa City - Rail Ride	65	2.5%	2
Iowa City - Rail Total	75	3.5%	3
Area Resident Trips			
Cedar Rapids - Rail Walk	6	10.0%	1
Cedar Rapids - Rail Ride	279	5.0%	14
Cedar Rapids - Rail Total	284	5.1%	15
Iowa City - Rail Walk	34	15.0%	5
Iowa City - Rail Ride	227	5.0%	11
Iowa City - Rail Total	262	6.3%	17
Total Trips			
Cedar Rapids - Rail Walk	68	18.8%	13
Cedar Rapids - Rail Ride	493	4.6%	23
Cedar Rapids - Rail Total	561	6.3%	35
Iowa City - Rail Walk	95	19.8%	19
Iowa City - Rail Ride	416	4.6%	19
Iowa City - Rail Total	511	7.4%	38
Total	1,072	6.8%	73

Source: Consultant Estimates

University of Iowa Main Campus - Oakdale Campus Trips

CAMBUS ridership records for the Oakdale route show, for 1994, 235 riders per day. All of these trips were assumed to make use of the new rail service as it was assumed that the bus service would be replaced by the rail.

Intraurban Trips

Work and school commuter travel was assumed to be the primary potential market for rail diversion within the two urban areas in the corridor. Other purpose travel was not considered to be a significant market because of its short average trip length, nonrepetitive nature and other characteristics that work against rail usage.

The intracounty census journey to work data (shown in detail in Table 7-18) is summarized in Table 7-29. This table shows potential rail trips within each of the major urban areas by rail access requirement. Tables 7-30 and 7-31 show mode service assumptions, model estimated rail shares and rail trips for work commute travel within Linn and Johnson Counties. The estimated shares are in the range 4-7 percent for trips that can be made with a walk access link at one or both ends of the rail trip. The model was also used to estimate a rail share for trips requiring motorized access at both ends. However, on review it seemed unlikely that a significant proportion of travelers would accept two transfers for a relatively short trip within these two urban areas (and the models do not directly represent the reluctance of travelers to choose options that include multiple transfers). Therefore, the model estimated shares were set to zero for this trip category.

Table 7-29
Intracounty Work Commute Trips
Within Rail Service Areas

Access Combination	Linn County	Johnson County	Total
Walk-Walk	88	826	914
Ride-Walk	2,832	5,028	7,860
Walk-Ride	248	2,274	2,522
Ride-Ride	12,156	13,824	25,980
Total	15,324	21,952	37,276

Source: 1990 Census Journey To Work Data

Table 7-30
Intracounty Work Commuter Trips - Linn County
Mode Service Assumptions And Estimated Rail Trips

Access Combination	Mode	Access Time	Access Cost ($)	Mainline Time	Mainline Cost ($)	Total Time	Total Cost ($)	Total Trips	Share (%)	Trips By Mode
Walk-Walk	Rail	8	0.00	10	0.50	18	0.50		95.8%	84
	Road	2	1.00	3	0.30	5	1.30	88	4.2%	4
Ride-Walk	Rail	12	0.50	10	0.50	22	1.00		96.1%	2,722
	Road	6	1.10	3	0.30	9	1.40	2,832	3.9%	110
Walk-Ride	Rail	12	0.50	10	0.50	22	1.00		96.1%	238
	Road	6	1.10	3	0.30	9	1.40	248	3.9%	10
Ride-Ride	Rail	16	1.00	10	0.50	26	1.50		100.0%	12,156
	Road	10	1.25	3	0.30	13	1.55	12,156	0.0%	0
Total	Rail								99.2%	15,201
	Road							15,324	0.8%	123

Source: Consultant Estimates

Table 7-31
Intracounty Work Commuter Trips - Johnson County
Mode Service Assumptions And Estimated Rail Trips

Access Combination	Mode	Access Time	Access Cost ($)	Mainline Time	Mainline Cost ($)	Total Time	Total Cost ($)	Total Trips	Share (%)	Trips By Mode
Walk-Walk	Rail	8	0.00	4	0.50	12	0.50		93.2%	770
	Road	5	1.40	6	0.30	11	1.70	826	6.8%	56
Ride-Walk	Rail	12	0.50	4	0.50	16	1.00		94.1%	4,732
	Road	5	1.40	8	0.40	13	1.80	5,028	5.9%	296
Walk-Ride	Rail	12	0.50	4	0.50	16	1.00		94.1%	2,140
	Road	5	1.40	8	0.40	13	1.80	2,274	5.9%	134
Ride-Ride	Rail	16	1.00	4	0.50	20	1.50		100.0%	13,824
	Road	5	1.40	10	0.50	15	1.90	13,824	0.0%	0
Total	Rail								97.8%	21,466
	Road							21,952	2.2%	486

Source: Consultant Estimates

The models and assumptions noted above produced rail ridership estimates of 123 and 486 one way trips per weekday within Linn and Johnson Counties, respectively.

Tables 7-32 and 7-33 contain similar calculations for intracounty school commute trips to the University of Iowa and Kirkwood Community College. Potential rail trips were derived from student address locations shown earlier in Tables 7-21 and 7-22 . Estimated rail shares range from 3.4 to 7.5 percent depending on the access mode combinations required to make the trip by rail. Other assumptions are similar to those used in estimating intercounty school commuter trips.

The rail service is estimated to attract 227 trips per weekday to the University and 116 to the Community College.

Special Event Trips

Table 7-34 contains a summary of the special event venues and activities that would be served by the new rail service. The first three venues (Hancher Auditorium, Carver-Hawkeye Arena and Kinnick Stadium) are closely associated with the University of Iowa and can be expected to draw most of their patrons from the student population (or, in the case of the football stadium, from a large area well outside the rail corridor). Therefore, it was assumed that only about 10 percent of the annual admissions to these facilities would be traveling from Linn County and be potential rail users. The other three venues (Five Seasons Center, Hawkeye Downs and Veteran's Memorial Baseball Park) are located in Linn County and would appeal to a broad cross section of the two county population. Potential rail users to these facilities would be traveling from Johnson County. The proportion of two county population, in Johnson County and within the rail primary service areas was, therefore, used to estimate annual potential rail trips to these locations.

Rail shares ranging from zero (at Veteran's Memorial - this facility is not within walking distance of a rail station) to 10 percent were assumed for each facility. The shares assumed were intended to represent an optimistic level of rail usage. The assumed shares produced an estimate of about 54,000 trips per year to special events. These were then converted to trips per event and compared to estimates of rail system capacity for serving an event (capacity was estimated as five trains, the total equipment available, serving the event within one hour before and after starting and ending times. The capacity per train was taken to be 120 passengers - 600 for 5 trains. Therefore, capacity per event would be 1,200 one way person trips). All event rail usage estimates were within this capacity constraint.

Table 7-32
Intracounty School Commuter Trips - University Of Iowa
Mode Service Assumptions And Estimated Rail Trips

Access Combination	Mode	Access Time	Access Cost ($)	Mainline Time	Mainline Cost ($)	Total Time	Total Cost ($)	Total Trips	Share (%)	Trips By Mode
Walk-Walk	Rail	8	0.00	4	0.50	12	0.50		92.6%	594
	Road	5	1.40	6	0.30	11	1.70	642	7.5%	48
Ride-Walk	Rail	12	0.50	4	0.50	16	1.00		93.8%	3,516
	Road	5	1.40	8	0.40	13	1.80	3,750	6.3%	234
Total	Rail								93.6%	4,110
	Road							4,392	6.4%	282

Source: Consultant Estimates

Table 7-33
Intracounty School Commuter Trips - Kirkwood Community College
Mode Service Assumptions And Estimated Rail Trips

Access Combination	Mode	Access Time	Access Cost ($)	Mainline Time	Mainline Cost ($)	Total Time	Total Cost ($)	Total Trips	Share (%)	Trips By Mode
Walk-Ride	Rail	9	0.00	10	0.50	19	0.50		96.1%	69
	Road	6	0.05	3	0.30	9	0.35	72	3.9%	3
Ride-Ride	Rail	14	0.50	10	0.50	24	1.00		96.6%	3,220
	Road	10	0.20	3	0.30	13	0.50	3,334	3.4%	114
Total	Rail								96.6%	3,289
	Road							3,406	3.4%	117

Source: Consultant Estimates

Table 7-34
Special Event Rail Ridership Estimates

Facility	Activities	Seating Capacity	Events Per Year	Annual Admissions	Average Per Event	Rail Access	Primary Rail Service Area		Potential Rail Trips (Patrons*2)	Assumed Rail Share	Estimated Rail Trips	Rail Trips Per Event
							County	% Of Patrons				
Hancher Auditorium	Student Concerts/Activities	2,533	61	92,700	1,520	Walk	Linn	10%	18,540	5%	927	15
Carver-Hawkeye	Basketball/Volleyball	15,500	40	314,000	7,850	Walk	Linn	10%	62,800	5%	3,140	79
Kinnick Stadium	Football	70,000	6	420,000	70,000	Walk	Linn	10%	84,000	5%	4,200	700
Five Seasons Center	Performing Arts	10,000	108	274,300	2,540	Walk	Johnson	27%	150,316	5%	7,516	70
Hawkeye Downs	Racing/Fair/Trade Shows	7,500	94	700,000	7,447	Walk	Johnson	27%	383,600	10%	38,360	408
Veteran's Memorial	Baseball	6,000	85	147,000	1,729	Ride	Johnson	27%	80,556	0%	0	0
Total			394	1,948,000					779,812	7%	54,143	

Source: Telephone Survey Of Facility Managers and Consultant Estimates

Summary of Total Rail Ridership

Table 7-35 contains a summary of base (1995) rail ridership from all major markets. It was estimated that about 1,670 one way trips would be made by rail on an average weekday (393,000 per year). An additional 54,000 trips per year could be expected from patrons of special events served by the rail system. Of the daily riders, only about 420 (26 percent) would be traveling from one county to another (intercounty travel markets and airport travel). The large majority (74 percent)of the forecast rail riders would be local (intracounty travelers).

Table 7-35
Rail Ridership Summary - 1995
Average Weekday And Annual Travel - Person Trips

Trip Category	Potential Trips	Rail Share	Weekday Rail Trips	Annual Factor	Annual Trips
Intercounty Work Commuter	3,400	4.4%	149	260	38,740
Intercounty School Commuter	3,650	5.2%	191	175	33,425
Intercounty Other Purposes	2,154	0.6%	14	365	5,110
Airport	1,072	6.8%	73	365	26,645
Univ. Of Iowa - Oakdale Campus	235	100.0%	235	260	61,100
Intracounty Work Commuter	11,296	5.4%	609	260	158,340
Intracounty School Commuter	7,798	5.1%	399	175	69,825
Special Event Travel	N.A.	6.9%	N.A.	N.A.	54,143
Total	29,605	5.6%	1,670	N.A.	447,328

Source: Consultant Estimates

Sensitivity Tests

Table 7-36 shows estimated change in rail ridership in response to changes in the major assumptions used to prepare the base forecasts. An increase in rail travel time (say, from the 80-minute round trip time assumed in the base forecasts to 110 minutes, an alternative service scenario considered in this report) would result in a 15-20 percent reduction in rail usage. On the other hand, an increase in private vehicle user costs of 25 percent would result in an increase of rail ridership of about 10-15 percent.

Forecasts of population and employment growth for the corridor were reviewed and are reported in some detail in Section 3 of this report. The corridor population is expected to grow at a relatively moderate rate (about 1 percent per year) over the next 20-25 years. Growth in Johnson County is expected to be somewhat higher than Linn County. When this growth rate is compounded over the 1995-2000, 1995-2010 and 1995-2020 periods growth factors of 1.05, 1.16 and 1.28 are obtained. The base rail ridership forecast can be expected to grow at approximately these same rates over these time periods.

Table 7-36
Rail Share Sensitivity To Travel Time and Cost Assumptions

	Percent Change In Rail Share			
	Cost Variable		Time Variable	
Trip Type	Road + 25%	Rail + 25%	Road + 25%	Rail + 25%
Work Commute Trips				
Intercounty	+ 16.5%	- 8.4%	+ 37.3%	- 27.1%
Intracounty	+ 7.3%	- 4.2%	+ 11.0%	- 13.1%
School Commute Trips				
Intercounty	+ 20.9%	- 12.6%	+ 32.1%	- 12.6%
Intracounty	+ 10.1%	- 6.4%	+ 11.0%	- 13.0%

Source: Consultant Estimates

Section 8

ALTERNATE TRANSIT SERVICE PLANS

Section 8
ALTERNATE TRANSIT SERVICE PLANS

The CRANDIC corridor runs parallel to I-380. Transit service improvements in the corridor must provide trip times that are competitive with automobile travel times. Regional rail or express bus service must be designed to encourage people to leave their cars at home or parked at convenient park-and-ride lots located strategically in the corridor. The service must be safe, fast, frequent, comfortable, convenient and easy to use. This service should be better than the last rail passenger timetable effective July 28, 1952, which shows 6 passenger trains operating in each direction with an average headway of 190 minutes (3 hours 10 minutes) with running times averaging 55 minutes between Cedar Rapids and Iowa City. The CRANDIC Bus Timetable No. 3 effective June 1, 1953, shows 9 bus trips operating in each direction with an average headway of 126 minutes (2 hours 6 minutes) with running times of 1 hour and 10 minutes. These schedules reflect the declining patronage of the CRANDIC and would not be conducive to encouraging ridership in today's market.

There are two basic operating plans to consider. One plan is to examine the optimum rail passenger schedule. The second plan is to consider an express bus service operating between Cedar Rapids and Iowa City.

REGIONAL RAIL SERVICE PLAN

The regional rail passenger service plan developed is based upon an evaluation of the various rail alignments presented in Section 5 of this report. Some of the alternatives presented are capable of competing with the automobile. Others are not and were discarded from further consideration. This section compares and contrasts the alternatives that were found to be competitive with the automobile.

Alternatives Analysis

The various alternatives were analyzed by using computerized train performance simulations to determine the operating speeds and resultant trip times utilizing various types of passenger equipment. For purposes of analysis, the train performance simulations compared diesel multiple unit to electric multiple unit technology and conventional to tilt train technology. The reason for utilizing tilt train technology is to achieve higher operating speeds with minimum reconstruction costs. This logic is discussed in more detail in Section 5.

All of the alternatives discussed in Section 5 that did not provide service to downtown Cedar Rapids were eliminated from the analysis. The Five Season's Transit System in Cedar Rapids operates frequent bus service from its central transfer point at the GTC. This level of service expands the market area for a regional rail or commuter bus operation by providing excellent feeder bus service. This expanded service area is an important component of building ridership. Operating from the GTC also eliminates the need for a second transfer if rail service was truncated either at Hawkeye Downs or at the Airport station. The three alternative alignments subjected to further analysis are defined as follows:

CRANDIC via Quaker Oats - This alignment follows the UP's Cedar Rapids Branch north from the former Green Park passenger depot to Quaker Oats, turns west across UP's existing bridge over the Cedar River and then south over UP trackage to Wilson Avenue, where it joins the CRANDIC corridor. The major advantage of this alignment is the existence of a bridge across the Cedar River. The disadvantage is the circuitous route through Quaker Oats.

CRANDIC via Ground Transportation Center - This alignment begins at the Cedar Rapids Ground Transportation Center (GTC) and proceeds west on a new bridge over the Cedar River and continues along 4th Avenue SW to the UP right-of-way. From this point, the alignment turns south parallel to the UP's line to the CRANDIC corridor near Wilson Avenue, by-passing the CRANDIC's freight yards. The major advantage of this alignment is its direct route to the GTC. The disadvantage is the extra cost required to construct a new bridge and boulevard trackage in 4th Avenue SW.

Interstate Alignment - This alignment also begins at the Cedar Rapids GTC and proceeds west on a new bridge constructed over the Cedar River, continues in 4th Avenue SW to I-380, turns southbound and rises to run at grade in the median of I-380 to 76th Avenue SW, where it turns westbound to rejoin the CRANDIC corridor just south of 76th Avenue SW. This alignment provides dramatic reductions in running time. Its major disadvantage is the cost to construct new track in the median of the highway.

Table 8-1 provides a summary of the train performance simulations over the three alignments considered at two different speed limit classifications. The fastest running time was achieved by trains running at maximum speed of 79 mph on the interstate alignment using equipment with tilt technology. The slowest running time was achieved by trains operating on the Quaker Oats alignment with a maximum operating speed of using conventional equipment at 59 mph.

Table 8-1

CRANDIC Regional Rail Service

Train Requirements

ROUTE (Option)	One Way Mileage	Round Trip Mileage	Scheduled Speed (MPH)	Running Time (min)	Recovery Time (min)	Peak Hour Headway (min.)	Peak Trains Required
CRANDIC via Quaker Oats (5)	28.0	56.0	34.6	97.1	12.9	20	6
CRANDIC via Quaker Oats (14)	28.0	56.0	48.7	69.0	11.0	20	4
CRANDIC via GTC (1)	27.1	54.2	34.6	94.0	6.0	20	5
CRANDIC via GTC (10)	27.1	54.2	50.0	65.0	15.0	20	4
Interstate Alignment (3)	26.7	53.5	40.0	80.2	9.8	20	5
Interstate Alignment (12)	26.7	53.5	57.0	56.3	13.7	20	4
Minimum Trains Required							4

Trains Required for Peak Service	4
Spare Ratio 20 %	1
Total Trainsets Required	5
Estimated Cost per Trainset	$3.5 Million
Total Estimated Cost	$17.5 Million

Further analysis revealed, that by holding recovery time to less than four minutes (2 minutes average dwell time at each end terminal point), the 79 mph interstate alignment option could be operated every 20 minutes with as few as three train sets. However, because recovery time is an important element of maintaining schedule reliability, some additional time should be added to the schedule. Adding just one minute extra to the recovery time requires an extra train to be added to the schedule. This adds considerable dead time and eliminates the advantages of the running time improvement. Also, the interstate alignment adds over $ 60 million to the construction cost of the regional rail passenger system without a significant improvement in ridership or potential operating cost savings. The next fastest schedule is the 79 mph speed option operated over the CRANDIC via the GTC alignment. This running time, with 15 minutes of recovery time added (7½ minutes at each end terminal point), provides an 80 minute run time requiring four trains for peak hour service. Thus, this alignment and speed option will be the primary rail alternative.

Service Plan

The most important design elements of an operating plan are those dealing with the quality, type and level of service contemplated. As a result of considerable interaction between the consulting team and local public officials, the frequency of service on the proposed regional rail line has been designed to provide peak hour service at 20-minute intervals (headways). During the off-peak travel hours, the Cedar Rapids to Iowa City line would operate with a minimum policy headway of 40 minutes. More frequent service could be operated between North Liberty and Iowa City, and between Cedar Rapids and the Airport. Proposed headway sheets are provided for planning purposes. See Exhibits 8-1 and 8-2 for the weekday and weekend headways. These headway sheets provide the framework for building a public timetable that provides both frequent service and easy to remember departure times. Service frequencies can be adjusted by the operating railroad in response to customer demands. The proposed schedule assumes operating the fast schedule along a new alignment identified as the primary rail alternative. This contemplated fast schedule also minimizes direct labor costs and the number of trains required for the service.

Service is planned to operate from 6:00 A.M. to 10:00 P.M. Monday through Thursday. This schedule coincides with peak flight operations at the Cedar Rapids Municipal Airport and peak travel patterns on I-380. There would be service every 40 minutes from 6:00 A.M. to 10:00 P.M. on Saturdays, Sundays and Holidays. Additional late night "owl service" would be provided for people wanting to enjoy entertainment facilities in downtown Cedar Rapids or Iowa City on Friday and Saturday. "Owl Service" trains would depart for their last trips from Iowa City at midnight and from downtown Cedar Rapids at 12:40 A.M. The "owl service" is depicted by the shaded areas of the headway sheets in Exhibits 8-1 and 8-2. Additional trains could be added to the schedule when special events are held. The special trains would serve the travel demand of major sporting events and festivals. Exhibit 8-3 provides a graphic illustration (known as a stringline diagram)of the proposed weekday operating schedule. Points where lines cross indicate locations where trains will meet and pass.

The fare structure should be calculated on the basis of a premium service. Because of the regional context of the service, it may be appropriate to consider distance based fares as contrasted to the flat fare structures of the bus systems operating in the region. The distance based fare system was originally used by the CRANDIC interurban rail passenger service. In those days, conductors collected fares. The fare collection media today should utilize modern automated fare collection equipment supplemented by an honor fare system. To reduce operating expenses, there should be no conductors on-board trains. The rail operation should employ service inspectors circulating throughout the system who have multiple responsibilities. One of the responsibilities could be to check fare tickets and issue warrants to fare violators.

Equipment Needs

Section 6 of this report described the technology options available for CRANDIC regional rail system. Total revenue equipment needed to provide passenger service is related to customer demand, service frequency and running times. It follows that the more people you have to transport, the more equipment you need. It is well established that peak hour travel demand governs the amount of equipment needed. It is also well established that faster schedules require less equipment than slow schedules. Because we have determined that more people are likely to ride

Exhibit 8-1

East Central Iowa Regional Rail System

Weekday Headway Sheet

Depart: Cedar Rapids	Airport	Oakdale	Arrive: Iowa City	Train No.
06:00	06:11	06:28	06:35	
06:40	06:51	07:08	07:15	
07:00	07:11	07:28	07:35	
07:20	07:31	07:48	07:55	
07:40	07:51	08:08	08:15	
08:00	08:11	08:28	08:35	
08:20	08:31	08:48	08:55	
08:40	08:51	09:08	09:15	
09:00	09:11	09:28	09:35	
09:20	09:31	09:48	09:55	
09:40	09:51	10:08	10:15	
10:00	10:11	10:28	10:35	
10:40	10:51	11:08	11:15	
11:20	11:31	11:48	11:55	
12:00	12:11	12:28	12:35	
12:40	12:51	13:08	13:15	
13:20	13:31	13:48	13:55	
14:00	14:11	14:28	14:35	
14:20	14:31	14:48	14:55	
14:40	14:51	15:08	15:15	
15:00	15:11	15:28	15:35	
15:20	15:31	15:48	15:55	
15:40	15:51	16:08	16:15	
16:00	16:11	16:28	16:35	
16:20	16:31	16:48	16:55	
16:40	16:51	17:08	17:15	
17:00	17:11	17:28	17:35	
17:20	17:31	17:48	17:55	
17:40	17:51	18:08	18:15	
18:00	18:11	18:28	18:35	
18:40	18:51	19:08	19:15	
19:20	19:31	19:48	19:55	
20:00	20:11	20:28	20:35	
20:40	20:51	21:08	21:15	
21:20	21:31	21:48	21:55	
22:00	22:11	22:28	22:35	
22:40	22:51	23:08	23:15	
23:20	23:31	23:48	23:55	
00:00	00:11	00:28	00:35	
00:40	00:51	01:08	01:15	

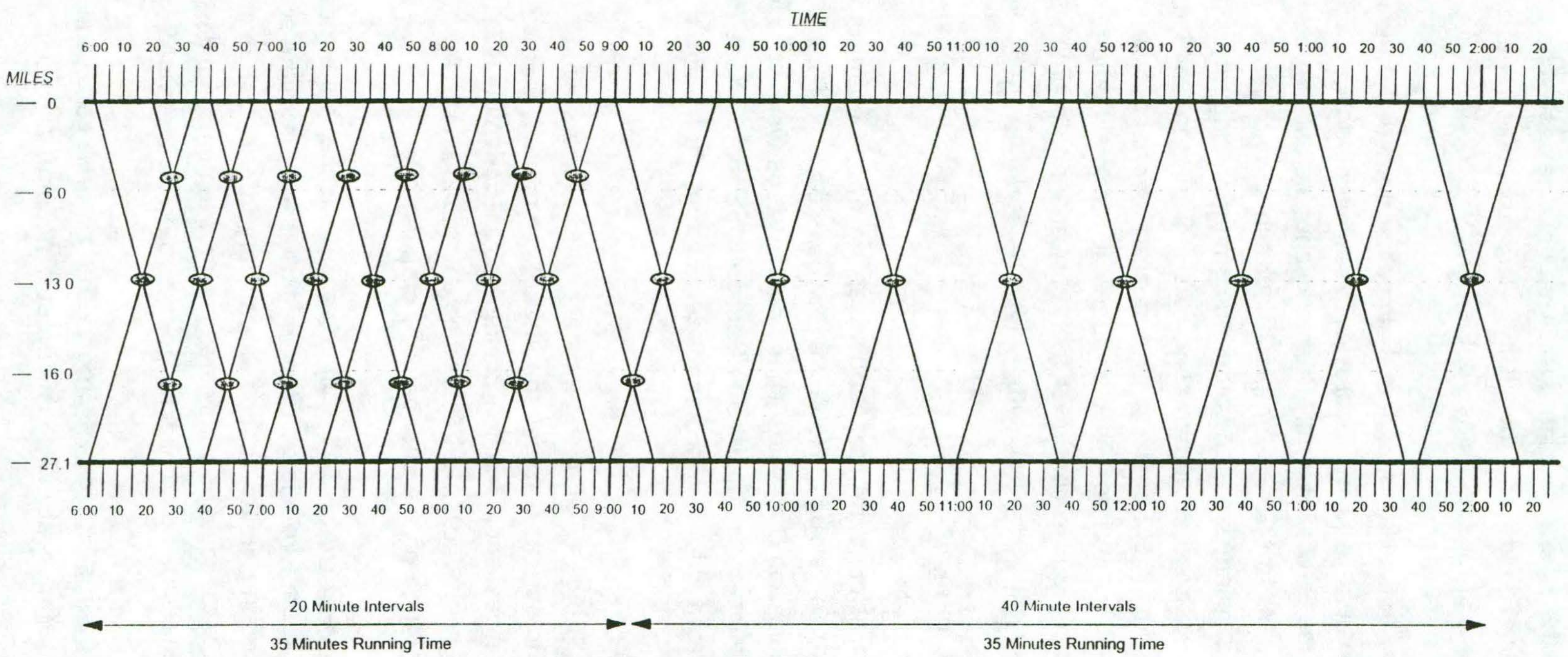
Depart: Iowa City	Oakdale	Airport	Arrive: Cedar Rapids	Next Trip
06:00	06:07	06:23	06:35	06:40
06:40	06:47	07:03	07:15	07:20
07:00	07:07	07:23	07:35	07:40
07:20	07:27	07:43	07:55	08:00
07:40	07:47	08:03	08:15	08:20
08:00	08:07	08:23	08:35	08:40
08:20	08:27	08:43	08:55	09:00
08:40	08:47	09:03	09:15	09:20
09:00	09:07	09:23	09:35	09:40
09:20	09:27	09:43	09:55	10:00
09:40	09:47	10:03	10:15	10:20
10:00	10:07	10:23	10:35	10:40
10:20	10:27	10:43	10:55	11:00
10:40	10:47	11:03	11:15	11:20
11:20	11:27	11:43	11:55	12:00
12:00	12:07	12:23	12:35	12:40
12:40	12:47	13:03	13:15	13:20
13:20	13:27	13:43	13:55	14:00
14:00	14:07	14:23	14:35	14:40
14:40	14:47	15:03	15:15	15:20
15:00	15:07	15:23	15:35	15:40
15:20	15:27	15:43	15:55	16:00
15:40	15:47	16:03	16:15	16:20
16:00	16:07	16:23	16:35	16:40
16:20	16:27	16:43	16:55	17:00
16:40	16:47	17:03	17:15	17:20
17:00	17:07	17:23	17:35	17:40
17:20	17:27	17:43	17:55	18:00
17:40	17:47	18:03	18:15	
18:00	18:07	18:23	18:35	18:40
18:20	18:27	18:43	18:55	
18:40	18:47	19:03	19:15	19:20
19:20	19:27	19:43	19:55	20:00
20:00	20:07	20:23	20:35	20:40
20:40	20:47	21:03	21:15	21:20
21:20	21:27	21:43	21:55	22:00
22:00	22:07	22:23	22:35	22:40
22:40	22:47	23:03	23:15	23:20
23:20	23:27	23:43	23:55	00:00
00:00	00:07	00:23	00:35	00:40

Exhibit 8-2

East Central Iowa Regional Rail System
Saturday, Sunday and Holiday Headway Sheet

Depart: Cedar Rapids	Airport	Oakdale	Arrive: Iowa City	Train No.	Depart: Iowa City	Oakdale	Airport	Arrive: Cedar Rapids	Next Trip
					06:00	06:07	06:23	06:35	06:40
06:00	06:11	06:28	06:35		06:40	06:47	07:03	07:15	07:20
06:40	06:51	07:08	07:15		07:20	07:27	07:43	07:55	08:00
07:20	07:31	07:48	07:55		08:00	08:07	08:23	08:35	08:40
08:00	08:11	08:28	08:35		08:40	08:47	09:03	09:15	09:20
08:40	08:51	09:08	09:15		09:20	09:27	09:43	09:55	10:00
09:20	09:31	09:48	09:55		10:00	10:07	10:23	10:35	10:40
10:00	10:11	10:28	10:35		10:40	10:47	11:03	11:15	11:20
10:40	10:51	11:08	11:15		11:20	11:27	11:43	11:55	12:00
11:20	11:31	11:48	11:55		12:00	12:07	12:23	12:35	12:40
12:00	12:11	12:28	12:35		12:40	12:47	13:03	13:15	13:20
12:40	12:51	13:08	13:15		13:20	13:27	13:43	13:55	14:00
13:20	13:31	13:48	13:55		14:00	14:07	14:23	14:35	14:40
14:00	14:11	14:28	14:35		14:40	14:47	15:03	15:15	15:20
14:40	14:51	15:08	15:15		15:20	15:27	15:43	15:55	16:00
15:20	15:31	15:48	15:55		16:00	16:07	16:23	16:35	16:40
16:00	16:11	16:28	16:35		16:40	16:47	17:03	17:15	17:20
16:40	16:51	17:08	17:15		17:20	17:27	17:43	17:55	18:00
17:20	17:31	17:48	17:55		18:00	18:07	18:23	18:35	18:40
18:00	18:11	18:28	18:35		18:40	18:47	19:03	19:15	19:20
18:40	18:51	19:08	19:15		19:20	19:27	19:43	19:55	20:00
19:20	19:31	19:48	19:55		20:00	20:07	20:23	20:35	20:40
20:00	20:11	20:28	20:35		20:40	20:47	21:03	21:15	21:20
20:40	20:51	21:08	21:15		21:20	21:27	21:43	21:55	22:00
21:20	21:31	21:48	21:55		22:00	22:07	22:23	22:35	22:40
22:00	22:11	22:28	22:35		22:40	22:47	23:03	23:15	23:20
22:40	22:51	23:08	23:15		23:20	23:27	23:43	23:55	00:00
23:20	23:31	23:48	23:55		00:00	00:07	00:23	00:35	00:40
00:00	00:11	00:28	00:35						
00:40	00:51	01:08	01:15						

CRANDIC OPERATING SCHEDULE
Daily Train Movements
Time Distance Stringline Diagram



faster trains, the operating plan is built around the fast schedule with 32 minutes running time between Cedar Rapids and Iowa City. This schedule requires the use of new DMU tilt train technology from Europe, such as the Siemens VT610.

Table 8-1 also illustrates that 4 single car trainsets would be the minimum number of trains with tilt equipment required to provide peak hour service assuming the fast schedule on the CRANDIC via the GTC alignment. The slow schedule utilizing conventional DMU technology would require 6 trainsets to operate the peak hour schedule. With a 20 percent spare ratio needed for routine planned maintenance and other equipment contingencies, between 5 and 7 trainsets would be needed for service implementation. As indicated in Section 6, the estimated cost of a new conventional DMU is $ 2.5 million. The cost differential between tilt and conventional DMU trains is approximately $ 1 million. This would result in a total equipment cost of $ 17.5 million for either option. This is $ 3.5 million lower than conventional locomotive hauled passenger trains. The trainsets will be equipped to accommodate people with wheelchairs and bicycles.

Passenger Stations

The envisioned rail passenger service from Cedar Rapids to Iowa City would include intermediate station stops at Hawkeye Downs, the Cedar Rapids Municipal Airport, North Liberty, Swisher, Oakdale, and Coralville. These station stops were selected based upon the demographic analysis of station areas outlined in Section 3. Each of these intermediate stations represent a specific target market for rail passenger service that should add to the overall attractiveness of the service.

Cedar Rapids - The main terminal of the rail line should be an attractive, adaptive reuse of existing building structure across the street from the Cedar Rapids Ground Transportation Center (GTC). The rail passenger terminal could be connected to the GTC by aerial pedestrian bridge. The adaptive reuse of historic structure could be developed in such a way as to add to the redevelopment of the riverfront area on the east bank by creating a more festive ambiance.

Hawkeye Downs - This station would be close to the race track and should be located in such a way as to capture a large park-and-ride market from the southwest side of Cedar Rapids in addition to serving as a destination station for special events. An additional multimodal transportation center could be considered for the site near the intersection of the CRANDIC and the UP. The UP line is being considered for future Amtrak service.

Cedar Rapids Municipal Airport - The airport is considering future terminal expansion. The rail passenger station at this location could become a ground transportation terminal featuring connections to local shuttle bus service, airport limousine service and the CRANDIC. The ground transportation terminal could be connected to the main terminal building by covered walkway or be designed to complement future main terminal expansion. This expanded terminal could become the focal point for future regional public transportation services.

North Liberty, Swisher and Oakdale - These station sites were selected based upon population and employment densities within walking distance of the rail line. The station design concepts are relatively simple platforms with shelters or canopies and small park-and-ride lots to accommodate expected patronage. Typical station design is depicted in Exhibit 8-4.

Coralville - The Coralville station could be more ornate than the other stations and should be designed to permit easy transfer from Coralville Transit buses.

Iowa City - The terminus in Iowa City should utilize a renovated historic structure. Although the existing CRANDIC freight station that is contemplated as the Iowa City terminus is only 2½ blocks from the Iowa City transit mall, however the uphill walk could be considered by many to be inconvenient. It may be appropriate to consider constructing a future intermodal public transportation center in Iowa City that would serve as a joint terminal for regional rail passenger trains, intercity and local transit buses. Similar to the multi-use facility constructed in Cedar Rapids at the GTC, this intermodal terminal could become an adjunct university library, medical office or other university administration building that would serve as a major destination for students and residents.

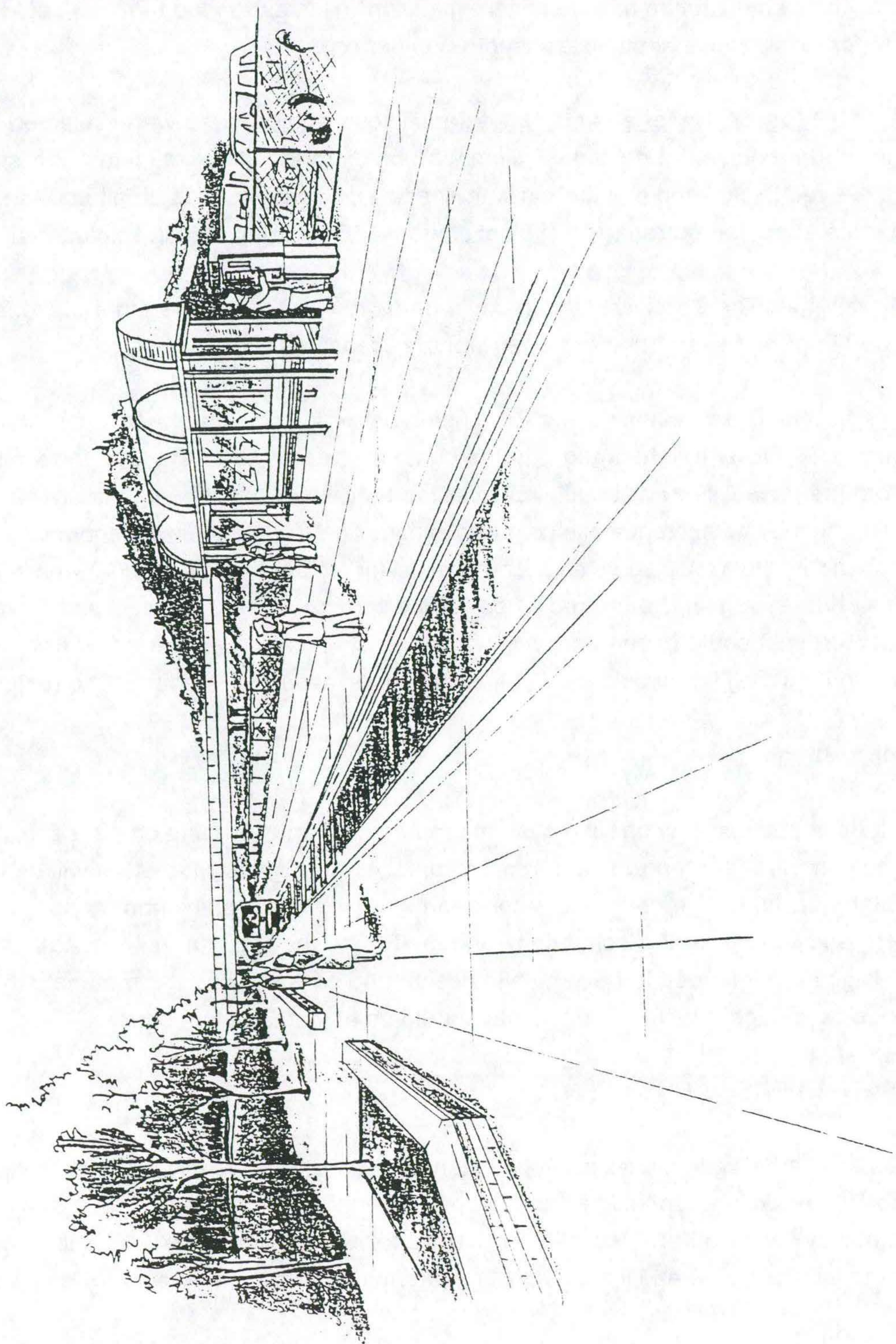
Passenger Amenities

Modern public transportation systems must place an emphasis on passenger amenities if they are to compete for market share in an automobile dominated market. It will be necessary to develop high quality, user friendly, ADA compliant, directional graphics and maps to assist regular customers and visitors to the community on how to use the regional rail system. Although the station designs are intended to be simple in design and construction, the materials to be used are assumed to be of high quality. Parking lots should be lighted and landscaped.

ALTERNATE EXPRESS BUS SERVICE

As an alternative to the rail passenger service discussed up to this point, express bus service seems to be the only reasonable alternative to consider. Other technologies, such as monorail, guided busways, and other fixed guideway transit systems, are likely to result in costs that fall between the rail alternative and the express bus alternative. Some may actually cost more than the

Exhibit 8-4
TYPICAL RAIL STATION



most expensive rail alternative. This part of the report will examine operating an express bus as an alternative to the restoration of rail passenger service on the CRANDIC rail line.

Primary Alternative

When the CRANDIC ceased rail passenger operations on May 30, 1953, substitute motor bus service was provided. The initial schedule effective June 1, 1953, provided for 9 trips in each direction daily except Sunday. The Sunday schedule provided 6 buses in each direction. The running time for these bus trips averaged 65 minutes. Buses travelled on Iowa 965 which paralleled the rail line and served all of the cities listed on the rail passenger timetables.

By 1965, Missouri Transit Lines, Inc. was operating daily service between Cedar Rapids and Iowa City. Service frequencies remained at 9 round trips daily except Sundays and Holidays. The running time between Cedar Rapids and Iowa City had decreased to 40 minutes on some schedules operating as express service. The 1965 schedule indicates Continental Trailways operated two round trip "Silver Eagle" express buses. Local buses continuing to serve North Liberty, Oakdale and Coralville operated on 55 minute schedules.

Today, Burlington Trailways and Greyhound Lines operate the bus service between Cedar Rapids and Iowa City. With the completion of the interstate, the running time for buses operating between Cedar Rapids and Iowa City was reduced to 35 minutes. Neither Greyhound Lines nor Burlington Trailways provides local service connecting Cedar Rapids with Swisher, North Liberty or Oakdale. To achieve running time competitive with the automobile, the primary alternative would be the express bus route as operated by Burlington Trailways and Greyhound Lines.

Service Plan

The frequency of express bus service should be the same as the proposed regional rail line for the sake of comparison. The bus service also needs to be designed to serve commuters and others who are in need of public transportation alternatives. As indicated in Section 4 of the report, current intercity bus schedules are not conducive to building local ridership between Cedar Rapids and Iowa City. Express bus service has been designed to have 20 minute intervals (headways) during the peak hours. During the off-peak travel hours, the Cedar Rapids to Iowa City express bus would operate with a minimum policy headway of 40 minutes. More frequent service could be operated between Oakdale and Iowa City by Cambus and between Cedar Rapids and the Airport by Five Seasons Transit. Local service to Coralville would continue to be operated by Coralville Transit.

The Proposed headway sheets for the express bus service are literally the same as the rail option. However, the express bus would not have any intermediate station stops and would operate non-stop between the Cedar Rapids GTC and Iowa City. The express bus running time of 35 minutes with 5 minutes for layover is equivalent to the round trip running time of 80 minutes for the fast schedule on the CRANDIC via the GTC rail alternative. (Refer to Exhibits 8-1 and 8-2 for the weekday and weekend headways.)

As with the rail schedules, the express bus service is planned to operate from 6:00 A.M. to 10:00 P.M. Monday through Thursday. There would be service every 40 minutes from 6:00 A.M. to 10:00 P.M on Saturdays, Sundays and Holidays. Additional late night "owl service" would be provided for people wanting to enjoy entertainment facilities in downtown Cedar Rapids or Iowa City on Friday and Saturday. "Owl Service" buses would depart for their last trips from Iowa City at midnight and from downtown Cedar Rapids at 12:40 A.M. The "owl service" is depicted by the shaded areas of the headway sheets in Exhibit 8-1. Additional buses could be added to the schedule when special events are held. The special buses could operate directly to the major sporting events and festivals and park in specially designated areas close to the entrances of the events. An alternate route could include an intermediate stop at the airport. However, this would add an extra 8-10 minutes of running time to the schedule requiring additional buses to maintain 20 minute service during peak hours.

Equipment Needs

As with the rail service, bus equipment needed to provide passenger service is related to customer demand, service frequency and running times. Modern motorcoaches are capable of operating the contemplated schedule. However, buses designed for local transit use would have to be modified to operate the higher speeds required to satisfy the demanding 35 minute schedule.

Table 8-2 illustrates that 4 buses would be required to operate the peak hour schedules. Modern, lift-equipped motorcoaches cost approximately $335,000 each new.

Table 8-2

CRANDIC Express Bus Service

Bus Equipment Requirements

ROUTE	One Way Mileage	Round Trip Mileage	Scheduled Speed (MPH)	Running Time (min)	Recovery Time (min)	Peak Hour Headway (min.)	Peak Buses Required
Iowa 965 Local	33.4	66.8	33.4	120.0	10.0	20	7
Interstate 380 Express	26.0	52.0	44.6	70.0	10.0	20	4
Express via Airport	27.5	55.0	42.0	78.6	11.4	20	5
Minimum Buses Required							4

Buses Required for Peak Service	4
Spare Ratio 20 %	1
Total Buses Required	5
Estimated Cost per Bus	$335,000
Total Estimated Cost	$1,675,000

Section 9

FINANCIAL ASSESSMENT

Section 9
FINANCIAL ASSESSMENT

This section of the report presents the preliminary financial feasibility of restoring rail passenger service in the CRANDIC corridor. Order-of-magnitude capital, operating and maintenance expenses for rail passenger and comparable express bus alternatives are developed and analyzed. The costs developed are then used to evaluate the reasonableness of the various alternatives when compared to projected ridership. The financial implications of both the primary rail and express bus alternatives and funding options are also examined.

CAPITAL COST ESTIMATES

Capital costs for both the rail and bus alternatives were prepared based on generally accepted planning level cost estimating methodologies and procedures developed for transit system service planning. Costs include varying contingencies depending on the nature of the improvement. Costs also include factors for project management, design, construction management and system testing.

Rail Passenger Alternatives

Preliminary infrastructure capital cost estimates in 1995 dollars were based largely on information provided in Section 5 of this report. Section 5 outlined the minimum general facility needs of the proposed regional rail system. As the system matures and grows, larger parking lots, longer platforms, more double tracking and more equipment could be needed. It is not the intended purpose of this study to anticipate the long range capital needs of the proposed system. The information provided is intended to highlight the immediate needs to begin the service. The essential characteristics of the system as envisioned would include the major improvements and facilities outlined in Table 9-1. Table 9-1 also provides a summary of the resulting cost estimates grouped by line improvements, station improvements, maintenance and storage facilities, rolling stock and other related capital costs for the primary and secondary rail passenger alternatives.

In addition to the detailed description of the improvements outlined in Section 5, the following are key assumptions underlying the capital costs of the primary alternative:

- Track improvements include a new second track between Wilson Avenue and 60th Avenue SW, upgrading all existing main line track South of 60th Avenue SW to 79 mph standards, upgrading side tracks at Mid-River and Great Lakes, and installing a crossover near Wilson Avenue. Construction of a new bridge over the Cedar River west of the Ground

Transportation Center and laying of new track in 4th Avenue SW to the UP and up to Wilson Avenue.

- Grade crossing improvements include the provision for gates and active warning devices as well as traffic signal preemption in critical areas, and the lengthening of existing train detection circuits in the vicinity of currently protected grade crossings to allow higher train speeds.

- Signal system installation consistent with FRA requirements to include the provision of CTC to allow higher train speeds.

- Station improvements including park-and-ride facilities, station platforms with canopies, passenger information systems and landscaping.

Table 9-1
Rail Passenger Alternatives
Capital Cost Estimates

Item	Primary	Secondary
Line Improvements		
Main Line Track Improvements	$ 13,604,795	13,100,000
CRANDIC Third Subdivision	3,400,000	0
GTC Access	23,438,705	14,650,000
Signal System	14,956,500	3,750,000
Subtotal	55,400,000	31,500,000
Stations		
Ground Transportation Center	$ 398,840	$ 319,072
Hawkeye Downs	398,840	319,072
Airport	398,840	319,072
Swisher	705,640	319,072
North Liberty	705,640	319,072
Oakdale	398,840	319,072
Coralville	398,840	319,072
Iowa City	398,840	319,072
Subtotal	3,804,320	2,552,576
Maintenance and Storage Facility	$ 7,700,000	0
Rolling Stock	$ 17,500,000	$ 17,500,000
Project Total	84,404,320	51,552,576

As summarized in Table 9-1, the capital cost of implementing the primary rail alternative is approximately $ 84.4 million. The secondary alternative is a less costly option that can be considered. This less costly alternative is $32 million cheaper to construct than the primary rail alternative. This option operates over UP trackage through Quaker Oats to a junction with the CRANDIC at Wilson Avenue. Conventional DMU equipment is utilized and the maximum operating speed is limited to 59 mph. The running time for this less costly option is 48 minutes as compared to the preferred 35 minute running time of the more expensive option. Both options will be subjected to tests of reasonableness.

Express Bus Alternative

The capital costs for an express bus alternative are limited. There are no tracks to improve or construct, no stations to build, no signalling system to install, no grade crossing protection to improve and no bridges to build. The people of Iowa have already invested in the highway infrastructure necessary to support express bus service between Cedar Rapids and Iowa City. The express bus route would follow the existing Burlington Trailways and Greyhound Lines route as outlined in Section 8. This would achieve the 35 minute running time deemed desirable. The total capital cost of this alternative is summarized in Table 9-2. Several assumptions were made for the capital cost estimation:

- To improve safety, traffic signal preemption at the Iowa City and Cedar Rapids bus terminals would be installed;
- The service would be operated by an existing carrier eliminating the need for a maintenance facility; and,
- The proposed timetable would require 4 buses to operate peak hour service with one spare bus needed for maintenance and operating contingencies. These five buses should be modern motorcoaches equipped with reclining seats for express bus service. The buses are required to be ADA compliant and should be powered by natural gas or other clean fuel engines. Buses have an economic life of 12 years. To compare the rail alternative with the express bus alternative the differences in economic life cycles must be accounted for. The capital cost includes the present value of equipment purchases in years 1, 12 and 24. Rail cars are assumed to have a 30 year life.

Table 9-2 Express Bus Alternative Capital Cost Estimate	
Item	**Cost**
Line Improvements	
Traffic Signal Preemption System	$ 500,000
Stations	
Ground Transportation Center	$ 0
Iowa City	0
Rolling Stock	$ 2,772,056
Project Total	$3,272,056

The total estimated capital cost of the express bus alternative is approximately $ 3.3 million.

OPERATING COSTS

Operating and maintenance costs (O&M) were developed for the primary rail and express bus alternatives. These O&M costs represent the annual cost of operating the service. Costs are in 1995 dollars. The costs were developed by utilizing the operating plan outlined in Section 8 and the patronage forecasts discussed in Section 7. The basic methodologies used are documented.

Rail Passenger Alternatives

The East Central Iowa regional rail system should be classified as an interurban rail service. As such, this classification falls somewhere between traditional commuter rail and LRT system operating categories. Only one interurban railway system still operates in the United States. The Northern Indiana Commuter Transit District (NICTD) operates the former Chicago, South Shore and South Bend Railroad. NICTD operates electric multiple unit equipment. There are no commuter rail systems operating in the United States with DMU type equipment as recommended for initial service implementation in the CRANDIC corridor. Therefore, certain cost assumptions must be made.

By examining operating cost data from the Federal Transit Administration *Transit Profiles: Section 15 Report Year 1993* for several LRT and commuter rail systems, an average unit cost for the two types of operations can be calculated. Caution must be exercised in utilizing this data. The methods for collecting and reporting data for Section 15 Report purposes vary widely among transit and commuter rail systems. Differences in the operating environment also contribute greatly to variances in costs. However, as a benchmark for planning purposes, Section 15 data can be helpful. Table 9-3 illustrates the cost comparisons and average unit costs for typical LRT system operation. None of these operations are similar to the contemplated rail passenger service between Cedar Rapids and Iowa City. Therefore, commuter rail service costs were also compared. LRT costs include track maintenance.

Table 9-3

Cost Comparison and Average Unit Cost for Light Rail Transit

Characteristic	GCRTA Cleveland	SRTD Sacramento	SDMTD San Diego	SCCTC Santa Clara	TOTAL
System Type	LRT	LRT	LRT	LRT	
Total Operating Cost	$10,837,793	$15,550,646	$19,911,414	$19,602,424	$65,902,277
Total Revenue Hours	43,822	80,615	233,774	120,646	478,857
Total Revenue Miles	970,694	1,670,570	4,432,911	1,724,040	8,798,215
Cost per Hour	$247.31	$192.90	$85.17	$162.48	$137.62
Cost per Mile	$11.16	$9.31	$4.49	$11.37	$7.49
Average Cost per Hour	**$137.62**				
Average Cost per Mile	**$7.49**				

Table 9-4 illustrates the cost comparisons and average unit costs for commuter rail including NICTD. Most of these costs include lease costs for trackage rights and liability insurance premiums.

Table 9-4

Cost Comparison and Average Unit Cost for Commuter Rail

Characteristic	Tri-Rail Ft. Lauderdale	NICTD South Shore	SP - Commute San Mateo	VRE Washington, DC	TOTAL
System Type	RRT	RRT	RRT	RRT	
Total Operating Cost	$19,700,756	$22,243,478	$34,573,641	$11,772,991	$88,290,866
Total Revenue Hours	57,032	57,236	110,984	26,519	251,771
Total Revenue Miles	2,295,135	2,011,135	3,445,358	933,581	8,685,209
Cost per Hour	$345.43	$388.63	$311.52	$443.95	$350.68
Cost per Mile	$8.58	$11.06	$10.03	$12.61	$10.17
Average Cost per Hour	**$350.68**				
Average Cost per Mile	**$10.17**				

Average Unit Costs for Regional Rail - By averaging the costs of both the LRT and commuter rail systems, a hybrid unit cost for regional rail transit can be derived. For planning purposes, the unit costs for the East Central Iowa regional rail system would be:

- $ 211.04 average cost per revenue hour, and
- $ 8.82 average cost per vehicle mile.

In discussions with Siemens Duewag sales representatives, actual operating experience in Germany reveals that the direct expense of operating the Type 628 DMU is approximately 47 cents per mile. Direct expense is fuel and operators wages and running maintenance. What this indicates is that the average of the costs to operate LRT and commuter rail may tend to overstate the operating expense of regional rail transit systems utilizing DMU equipment. It can be argued that regional rail systems operating DMU vehicles with single person operating crews could be less expensive to operate than an LRT system with considerable power distribution and catenary system maintenance expense. What is certain, as revealed in Section 6, is that DMU does provide lower cost of operation than conventional trains for light travel demand rail lines.

Operating Statistics - The development of estimated annual operating and maintenance (O&M) costs for the East Central Iowa regional rail system is based on the unit costs identified previously. To apply unit costs, certain operating statistics must be derived from the service plan. O&M costs for the proposed system were generated using the following procedures:

1. Build a generalized headway sheet for the rail line based upon the system service plan. The generalized schedule of train service is outlined in Section 8. Headway sheets are designed to provide generalized information regarding train schedules and operations. Caution must be exercised in interpreting the headway sheet. The headway sheet included is not intended to be a detailed public timetable or operating schedule. Considerable "tinkering" with the headway sheet must be done before it can become an operating schedule. For example, terminal departure times can be adjusted to provide positive train separation and more even spacing of trains operating on single track sections of the route alignment. Some trains could operate more frequently between intermediate stations such as operating every 20 minutes between Cedar Rapids and the Airport and Oakdale and Iowa City with through trains between Iowa City and Cedar Rapids operating on a 40 minute schedule. These issues can be resolved during preliminary engineering and detailed operations planning.

2. Determine round trip distances and trip times for the rail lines.

3. Calculate weekday and weekend train miles and platform hours from headway sheets and convert to annual figures.

4. Multiply unit costs by train miles and platform hours and average the two resulting products. The reason for averaging the two products is to eliminate bias in the estimating process. The use of cost per train mile measurements as the basis for estimating total annual costs could understate operating costs if train speeds are relatively higher than normal. With most costs of operating rail service fixed, the more miles operated in a given amount of time would result in a lower cost per train mile. The use of revenue hours as the only measurement of unit cost tends to overstate the costs for the same reason. If operating hours are fixed by time schedules, then the fixed costs are evenly distributed over time. This method does not factor in the efficiencies of speed. More service can be provided over the same fixed time period. Therefore, averaging the resultant products of these unit costs tends to "smooth" out the cost estimates.

Tables 9-5.1 and 9-5.2 compute the average annual costs for both the fast and slow schedules for the sake of comparison. The estimated annual O&M costs range between $ 6.4 million for the fast schedule and $ 7.8 million for the slow schedule. The $ 1.4 million difference in average annual costs can be accounted for by increased direct costs of operating trains with slower scheduled speeds. It takes more trains in service to maintain the recommended headways. In year 15, a mid-life rail equipment overhaul must be completed.

Table 9-6 illustrates the estimated operating statistics and annual O&M costs for CRANDIC rail passenger service and then compares these data to Section 15 Report data from other LRT and commuter rail systems. The CRANDIC data compares favorably.

Table 9-5.1

East Central Iowa Regional Rail System
Estimated Average Annual Operating Costs
Fast Schedule

Schedule	Northbound Trips	Southbound Trips	Daily Trips	Daily Mileage	Days Per Year	Annual Mileage
Sunday	25	25	50	1,355.0	51	69,105.0
Weekday	37	36	73	1,978.3	203	401,594.9
Friday	40	40	80	2,168.0	52	112,736.0
Saturday	28	29	57	1,544.7	52	80,324.4
Holiday	25	25	50	1,355.0	7	9,485.0

Route Miles 27.1 **Total** 673,245.3

Schedule	Northbound Trips	Southbound Trips	Total Trips	Daily Hours	Days Per Year	Annual Hours
Sunday	25	25	50	66.7	51	3,400.0
Weekday	37	36	73	97.3	203	19,758.7
Friday	40	40	80	106.7	52	5,546.7
Saturday	28	29	57	76.0	52	3,952.0
Holiday	25	25	50	66.7	7	466.7

Trip Time 80 minutes **Total** 33,124.0

Average Annual Operating Cost			
Cost Type	Units	Unit Costs	Total Cost
Mileage	673,245.3	$8.82	$5,938,024
Hours	33,124.0	$211.04	$6,990,489

Average Annual Operating Cost $6,464,256

Table 9-5.2

East Central Iowa Regional Rail System
Estimated Average Annual Operating Costs
Slow Schedule

Schedule	Northbound Trips	Southbound Trips	Daily Trips	Daily Mileage	Days Per Year	Annual Mileage
Sunday	25	25	50	1,400.0	51	71,400.0
Weekday	37	36	73	2,044.0	203	414,932.0
Friday	40	40	80	2,240.0	52	116,480.0
Saturday	28	29	57	1,596.0	52	82,992.0
Holiday	25	25	50	1,400.0	7	9,800.0

Route Miles 28 **Total** 695,604.0

Schedule	Northbound Trips	Southbound Trips	Total Trips	Daily Hours	Days Per Year	Annual Hours
Sunday	25	25	50	91.7	51	4,675.0
Weekday	37	36	73	133.8	203	27,168.2
Friday	40	40	80	146.7	52	7,626.7
Saturday	28	29	57	104.5	52	5,434.0
Holiday	25	25	50	91.7	7	641.7

Trip Time 110 minutes **Total** 45,545.5

Average Annual Operating Cost			
Cost Type	Units	Unit Costs	Total Cost
Mileage	695,604.0	$8.82	$6,137,314
Hours	45,545.5	$211.04	$9,611,922

Average Annual Operating Cost $7,874,618

Table 9-6

Comparison of Annual Operating Statistics and Costs

East Central Iowa Regional Rail System with LRT and Commuter Rail Systems

Operating Statistics	Rail Lines						
	CRANDIC	Cleveland	Sacramento	Santa Clara	Tri-Rail	South Shore	VRE
Annual Operating Cost	$6,464,256	$10,837,793	$15,550,646	$19,602,424	$19,700,756	$22,243,478	$11,772,991
Annual Revenue Train Hours	33,124	43,822	80,615	120,646	57,032	57,236	26,519
Annual Train Miles	673,245	970,694	1,670,570	1,724,040	2,295,135	2,011,135	933,581
Cost per Train Hour	$195.15	$247.31	$192.90	$162.48	$345.43	$388.63	$443.95
Cost per Train Mile	$9.60	$11.16	$9.31	$11.37	$8.58	$11.06	$12.61
Peak Hour Trains	4	24	32	38	5	15	5
Average System Speed (mph)	50.0	22.2	20.7	14.3	40.2	35.1	35.2
Directional route miles	54.2	26.7	36.2	39.0	132.8	138.4	161.8

Express Bus Alternative

The operating cost estimation methodology used for estimating bus operating costs is essentially the same as determining O&M costs for the primary rail alternative. The estimate uses an average cost to operate an interurban bus service. The costs of operating regular route buses by the Five Season's Transit System in Cedar Rapids, the Coralville Transit, Iowa City Transit System's and the cost of operating a Greyhound Lines bus were used in the estimation process. Cambus operated by the University of Iowa has an unusually low cost structure reflecting the use of student labor. Because of the special nature of this service and its unique cost structure, the Cambus costs were not used to obtain an average operating cost for use in the estimation process.

By utilizing a simple average of the costs, the average cost will be heavily skewed by the cost structure of the local transit systems. By utilizing a weighted average, the greater operating efficiencies gained by express bus service will receive more emphasis. The weighted average was used. Table 9-7 presents the summary of costs and the weighted average used in the cost estimations process. The weighted average costs used in the cost estimation model are:

- $ 30.11 average cost per revenue vehicle hour, and
- $ 2.80 average cost per revenue vehicle mile.

Table 9-7

Cost Comparison
and
Average Unit Cost for Bus Operations

Characteristic	Greyhound	Cedar Rapids	Iowa City	Coralville	TOTAL
System Type	Intercity Bus	Motor Bus	Motor Bus	Motor Bus	
Total Operating Cost	$657,487,000	$3,516,053	$2,390,498	$599,370	$663,992,921
Total Revenue Hours	21,916,233	77,718	49,840	11,373	22,055,164
Total Revenue Miles	235,000,000	1,047,692	613,605	164,330	236,825,627
Cost per Hour	$30.00	$45.24	$47.96	$52.70	$30.11
Cost per Mile	$2.80	$3.36	$3.90	$3.65	$2.80
Average Cost per Hour	$30.11				
Average Cost per Mile	$2.80				

By multiplying the average unit costs by the units of service as indicated by the headway sheets, the total cost of the service can be estimated. Table 9-8 presents the calculations and the summary of costs. The average annual operating cost of providing express bus service between Cedar Rapids and Iowa City is approximately $ 1.4 million.

Table 9-9 illustrates operating performance characteristic comparisons among the existing bus service providers and the contemplated express service. The low cost per mile is indicative of the efficiencies gained through express operation. The cost per hour falls outside the range of the existing services but is within 6 percent of the lowest cost operator in the region, Five Season's Transit.

Table 9-8

East Central Iowa Regional Transit System
Estimated Average Annual Operating Costs
Express Bus Schedule

Schedule	Northbound Trips	Southbound Trips	Daily Trips	Daily Mileage	Days Per Year	Annual Mileage
Sunday	25	25	50	1,300.0	51	66,300.0
Weekday	37	36	73	1,898.0	203	385,294.0
Friday	40	40	80	2,080.0	52	108,160.0
Saturday	28	29	57	1,482.0	52	77,064.0
Holiday	25	25	50	1,300.0	7	9,100.0

Route Miles 26 **Total** 645,918.0

Schedule	Northbound Trips	Southbound Trips	Total Trips	Daily Hours	Days Per Year	Annual Hours
Sunday	25	25	50	66.7	51	3,400.0
Weekday	37	36	73	97.3	203	19,758.7
Friday	40	40	80	106.7	52	5,546.7
Saturday	28	29	57	76.0	52	3,952.0
Holiday	25	25	50	66.7	7	466.7

Trip Time 80 minutes **Total** 33,124.0

Average Annual Operating Cost			
Cost Type	Units	Unit Costs	Total Cost
Mileage	645,918.0	$2.80	$1,808,570
Hours	33,124.0	$30.11	$997,364

Average Annual Operating Cost $1,402,967

Table 9-9

Operating Performance Indicators Comparison

CRANDIC Bus Operations

Characteristic	CRANDIC	Cedar Rapids	Iowa City	Coralville
System Type	Interurban	Motor Bus	Motor Bus	Motor Bus
Total Operating Cost	$1,402,967	$3,516,053	$2,390,498	$599,370
Total Revenue Hours	33,124	77,718	49,840	11,373
Total Revenue Miles	645,918	1,047,692	613,605	164,330
Cost per Hour	$42.35	$45.24	$47.96	$52.70
Cost per Mile	$2.17	$3.36	$3.90	$3.65

ECONOMIC REASONABLENESS

The capital and O&M costs developed for the primary rail and express bus alternatives must be subjected to an analysis of economic reasonableness. Economic reasonableness measures the cost effectiveness of transit investments. A review of relevant literature and practice suggests that cost effectiveness is measured by the incremental cost per new transit rider and the incremental cost per new transit passenger mile. Total annualized costs of the proposed investment, both capital and O&M costs, are first discounted by the "social cost of capital" and then compared to the number of new transit riders attracted to the new service. Because the costs associated with providing transit service vary by trip type and distance, the total annualized costs also are compared to the incremental passenger-miles of service provided by the new transit system. The CRANDIC alternatives are compared to other transit system indices of cost effectiveness.

Annualized Costs and Ridership

Capital costs generally occur in the early years of project development prior to commencement of service. Operating and maintenance expenses continue throughout the life of the transit investment. Costs accruing in different years have different levels of importance on the viability of projects. The timing of costs must be leveled to a discounted annual equivalent. Leveling the costs and the effectiveness of the project are derived by calculating a uniform annual cost over the life of the project that results in a net present annual cost. This net present annual cost is equivalent to the discounted costs of the actual expected cost streams over the expected life cycle of the project producing an average year cost.

Ridership varies over time. In the early years of project development ridership is likely to be lower than forecasted as people learn about the new service and slowly begin to change commuting travel patterns and habits. Growth in ridership during the first several years are likely to average in the 8 to 10 percent annual growth range based upon empirical evidence from other new start systems. Ridership will level off and grow (or decline) in concert with normal growth patterns in the community. For purposes of evaluation, a normal or average year must be used to compare with the average annual costs. Therefore, the stream of expected annual ridership over the economic life of the project must be leveled. Leveled ridership is simply the uniform annual ridership that results after computing a present value of ridership equivalent to the discounted value of the actual expected ridership over the life of the project. This present value method of discounting expected annual ridership results in ridership in an average year.

Annualized Costs - Table 9-10 provides a summary of the calculations utilized to derive the annualized capital and O&M costs. The primary and secondary rail passenger and express bus

Table 9-10

Annualized Costs

Capital Costs	Year	Alternatives: Primary	Alternatives: Secondary	Alternatives: Express Bus
Line Improvements	1	$55,400,000	$31,500,000	$500,000
Station Improvements	1	3,804,320	2,552,576	0
Maintenance Facilities	1	7,700,000	0	0
Rolling Stock Purchased Year:	1	17,500,000	17,500,000	1,675,000
Present Value	12			743,720
Present Value	24			353,336
Total Capital Cost		$84,404,320	$51,552,576	$3,272,056
Operating Costs		**Primary**	**Secondary**	**Express Bus**
Year	1	6,464,256	7,874,618	1,402,967
Year	2	6,464,256	7,874,618	1,402,967
Year	3	6,464,256	7,874,618	1,402,967
Year	4	6,464,256	7,874,618	1,402,967
Year	5	6,464,256	7,874,618	1,402,967
Year	6	6,464,256	7,874,618	1,902,967
Year	7	6,464,256	7,874,618	1,402,967
Year	8	6,464,256	7,874,618	1,402,967
Year	9	6,464,256	7,874,618	1,402,967
Year	10	6,464,256	7,874,618	1,402,967
Year	11	6,464,256	7,874,618	1,402,967
Year	12	6,464,256	7,874,618	1,402,967
Year	13	6,464,256	7,874,618	1,402,967
Year	14	6,464,256	7,874,618	1,402,967
Year	15	6,464,256	7,874,618	1,402,967
Year	16	6,464,256	7,874,618	1,402,967
Year	17	6,464,256	7,874,618	1,402,967
Year	18	6,464,256	7,874,618	2,002,967
Year	19	6,464,256	7,874,618	1,402,967
Year	20	6,464,256	7,874,618	1,402,967
Year	21	6,464,256	7,874,618	1,402,967
Year	22	6,464,256	7,874,618	1,402,967
Year	23	6,464,256	7,874,618	1,402,967
Year	24	6,464,256	7,874,618	1,402,967
Year	25	6,464,256	7,874,618	1,402,967
Year	26	6,464,256	7,874,618	1,402,967
Year	27	6,464,256	7,874,618	1,402,967
Year	28	6,464,256	7,874,618	1,402,967
Year	29	6,464,256	7,874,618	1,402,967
Year	30	6,464,256	7,874,618	2,102,967
Annualized O&M Costs		6,464,256	7,874,618	1,451,532
Annualized Capital Costs		6,801,841	4,154,437	411,958
Total Annualized Costs		$13,266,097	$12,029,055	$1,863,490

alternatives are compared on the basis of the annualized costs. The primary rail alternative is $ 32.8 million more expensive to construct than the secondary rail alternative. However, the annualized O&M expense of the secondary alternative is $ 1.5 million greater than the primary alternative. The net effect is to cause the primary alternative to be $ 1.2 million more expensive on an annualized basis than the secondary alternative. However, the greater running time of the less costly rail alternative is not considered to be an attractive travel option when compared to the primary and express bus alternatives as discussed in Section 7.

Annualized Ridership - Research has shown that transit projects typically generate about 80 percent of "stable" ridership in the first year of operation, 90 percent in the second year, and 100 percent in the third year. After that ridership tends to grow on a secular basis with regional growth in population and employment, typically 1 to 2 percent per year. Using this pattern, together with a typical year forecast as provided in Section 7, produces a consistent year by year ridership pattern for calculation of discounted, leveled ridership. Because the synthetic ridership forecast is constructed from a matrix of stations, annualized passenger miles can be calculated in a similar manner. The annualized ridership is 472,088 for the primary rail option, 377,670 for the secondary rail option, and 26,590 for the express bus option. Table 9-11 on the following page tabulates the annualized ridership data.

Cost Effectiveness Summary

Table 9-12 summarizes the results of the cost effectiveness analysis. The primary and secondary rail and express bus alternatives were examined because of the ability to compare and contrast two competing rail alternatives with an express bus alternative. The primary alternative provides service utilizing 4 trains during the peak period operating on a fast schedule with 35 minutes running time. The secondary alternative provides service with 6 trains during the peak period operating on a slower schedule requiring 48 minutes of running time from Cedar Rapids to Iowa City. The express bus operates on I-380 and requires 35 minutes to complete a run from the GTC in Cedar Rapids to the bus depot in Iowa City

In 1984, the Federal Transit Administration established threshold values for the cost per new rider index that would need to be met for a proposed project to continue receiving federal financial support through the various stages of the federally mandated planning process. To progress from systems level planning to the "alternatives analysis or major investment study" phase, the preliminary estimate of the cost per new rider was $ 10; to move from alternatives analysis to preliminary engineering, the estimated cost per new rider could not exceed $6. Factored for inflation since 1984, these thresholds would be $ 14.85 and $ 8.92 respectively in 1995 dollars.

Table 9-11

Annualized Ridership

Annual Ridership		Alternatives		
		Primary	Secondary	Express Bus
	Year 1	334,000	267,200	20,000
	Year 2	375,750	300,600	22,500
	Year 3	447,328	357,862	25,000
	Year 4	451,801	361,441	25,250
	Year 5	456,319	365,055	25,503
	Year 6	460,882	368,706	25,758
	Year 7	465,491	372,393	26,015
	Year 8	470,146	376,117	26,275
	Year 9	474,848	379,878	26,538
	Year 10	479,596	383,677	26,803
	Year 11	484,392	387,513	27,071
	Year 12	489,236	391,388	27,342
	Year 13	494,128	395,302	27,616
	Year 14	499,070	399,255	27,892
	Year 15	504,060	403,248	28,171
	Year 16	509,101	407,280	28,452
	Year 17	514,192	411,353	28,737
	Year 18	519,334	415,467	29,024
	Year 19	524,527	419,621	29,314
	Year 20	529,773	423,818	29,608
	Year 21	535,070	428,056	29,904
	Year 22	540,421	432,336	30,203
	Year 23	545,825	436,660	30,505
	Year 24	551,283	441,026	30,810
	Year 25	556,796	445,437	31,118
	Year 26	562,364	449,891	31,429
	Year 27	567,988	454,390	31,743
	Year 28	573,668	458,934	32,061
	Year 29	579,404	463,523	32,381
	Year 30	585,198	468,158	32,705
Annualized Ridership		472,088	377,670	26,590

Because all of the riders are new riders, the cost per rider index for the rail passenger and express bus alternatives measure the cost per new rider. None of the alternatives examined satisfies the cost-effectiveness criteria established by the Federal Transit Administration for project justification. The cost per new rider for the primary rail alternative is $28.10 which is nearly 3 times higher than the cost-per-rider index used by FTA to evaluate the cost-effectiveness of new start rail programs.

Figure 9-1 illustrates the extend to which the cost-per-rider for each alternative exceeds the FTA cost-effectiveness index established by the FTA. Although the Intermodal Surface Transportation Efficiency Act (ISTEA) establishes broader project evaluation criteria, the cost-per-rider index is a good measure to use for feasibility screening.

Figure 9-1
Cost Effectiveness Index

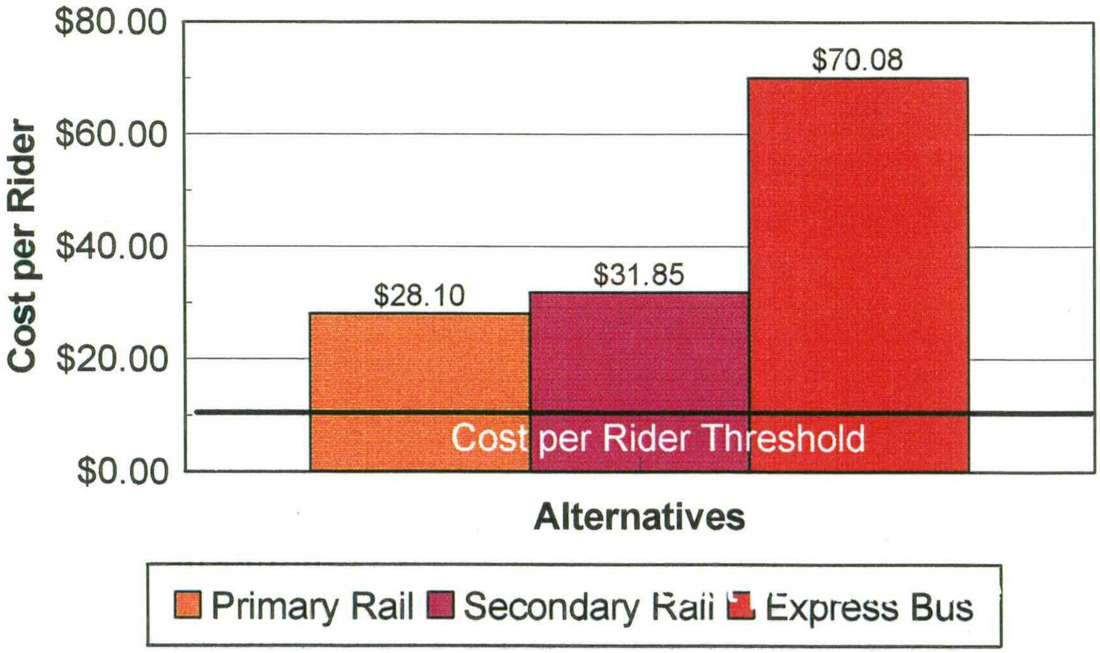


Table 9-12

Cost Effectiveness Summary

Item	Alternatives		
	Primary Rail	Secondary Rail	Express Bus
Daily Riders	1,670	1,336	100
Annual Riders	472,088	377,670	26,590
Annual Passenger-Miles	3,900,694	3,120,555	850,874
Total Capital Cost	$84,404,320	$51,552,576	$3,272,056
Annualized Capital Cost	$6,801,841	$4,154,437	$411,958
O&M Costs	$6,464,256	$7,874,618	$1,451,532
Total Annual Costs	$13,266,097	$12,029,055	$1,863,490
Total Cost per Rider	$28.10	$31.85	$70.08
Total Cost per Passenger-Mile	$3.40	$3.85	$2.19
Operating Cost per Rider	$13.69	$20.85	$54.59

COST EFFICIENCY

The traditional measures of cost efficiency examine the differences between a base case and the new investment. However, in studying the Cedar Rapids to Iowa City corridor there is no viable base case. The only public transportation in the corridor is provided by the intercity bus carriers and LIFTS. As was shown in Section 4, the intercity bus schedules are inconvenient for local commutation travel and the LIFTS program is limited to client groups. Therefore, the measures of cost effectiveness, such as cost per rider and operating ratio, are compared to other transit systems. The systems selected for comparison are two commuter railroads that operate interurban service, Tri-Rail and the Northern Indiana Commuter Transportation District (NICTD) and Greyhound Lines. Tri-Rail and NICTD are publicly supported operations. Greyhound Lines is an investor owned company. The measurement of particular interest for Greyhound Lines is the cost per passenger-mile.

Table 9-13 summarizes and compares the cost efficiency measures for the rail and express bus alternatives with other transit systems. The rail alternatives do not compare favorably with other commuter rail systems. The express bus option compares more favorably with the cost per passenger-mile of Greyhound, but is still outside the range of what is considered to be a reasonable cost threshold for cost efficiency.

Table 9-13

Cost Efficiency Indicators

Item	CRANDIC Alternatives		
	Primary Rail	Secondary Rail	Express Bus
Daily Riders	1,670	1,336	100
Annual Riders	472,088	377,670	26,590
Annual Passenger-Miles	3,900,694	3,120,555	850,874
Total Annual O&M Costs	$6,464,256	$7,874,618	$1,451,532
Operating Cost per Passenger Mile	$1.66	$2.52	$1.71
Operating Cost per Rider	$13.69	$20.85	$54.59
Passenger Fares	$339,968	$271,974	$132,949
Operating Ratio	0.05	0.03	0.09

Item	Other Transit Systems		
	Tri-Rail	NICTD	Greyhound
Daily Riders	9,133	9,079	41,729
Annual Riders	2,697,456	2,531,169	15,230,947
Annual Passenger-Miles	88,615,547	70,811,478	5,967,000,000
Total Annual O&M Costs	$19,700,756	$22,243,478	$657,487,000
Total Cost per Passenger-Mile	$0.2223	$0.3141	$0.1102
Operating Cost per Rider	$7.30	$8.79	$43.17
Passenger Fares	$4,606,436	$10,247,529	$666,496,000
Operating Ratio	0.23	0.46	1.01

The operating cost per passenger-mile is $1.66 for the primary rail alternative and compares favorably to the other alternatives considered. However, when compared to peer group costs, the primary rail alternative's cost-per-passenger-mile is over 7 ½ times greater than TriRail and 5 times greater than NICTD.

Fare recovery ratios are very poor in comparison to the peer group. Only 5 percent of the operating costs are covered by fare revenue requiring public subsidies to account for 95 percent of the operating costs. Tri-Rail covers 23 percent of its operating costs from the fare box.

None of the alternatives examined are cost efficient.

FINANCIAL IMPLICATIONS

Based on this preliminary feasibility study, the restoration of rail passenger service on the CRANDIC Railway will cost between $ 84.4 to $ 51.5 million to construct and add between $ 6.4 to $ 7.9 million in additional operating expenses to existing regional transit service budgets. This has serious and far reaching implications for transit service providers in the region. An assessment of the financial feasibility of expanding transit service in the region by restoring rail passenger service in the CRANDIC corridor or by instituting express bus service between Cedar Rapids and Iowa City must begin with an evaluation of current operations and funding sources. The assessment also must consider a projection of broad financial trends under present policies.

Analysis of Current Transit Funding in the Region

The regional transit network consists of several general public service and specialized transit service providers operating in Johnson and Linn Counties. These providers include Iowa City Transit, Coralville Transit, Cambus and SEATS in Johnson County; and, Five Season's Transit and LIFTS in Linn County. SEATS and LIFTS are specialized transit service providers serving the needs of the elderly and handicapped. Section 4 outlines in greater detail the characteristics and service area of these providers.

During Fiscal Year 1994, the fixed route general public service providers operated approximately 89 peak-hour vehicles, delivered 2.7 million vehicle-miles of service and carried over 7 million riders. Table 9-14 summarizes financial data for the transit providers in the region.

Table 9-14

Regional Transit Providers Financial Data

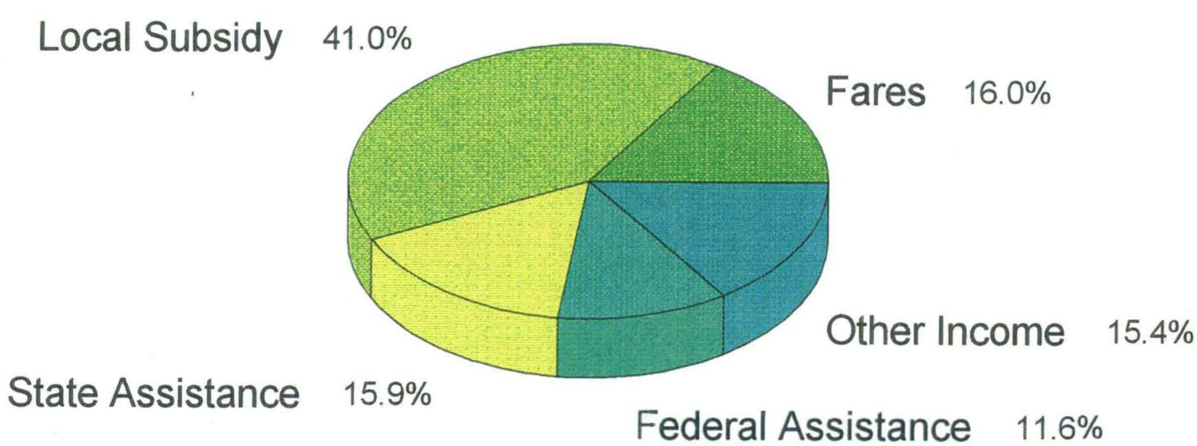
Item	Johnson County				Linn County		Regional Total
	Iowa City	Coralville	CamBus	SEATS	Five Season's	LIFTS	
Service Consumed							
Daily Riders (System Total)	5,835	1,532	15,400	97	3,712	350	26,926
Annual Riders	1,542,023	453,187	3,957,368	24,278	1,077,362	87,596	7,141,814
Annual Passenger-Miles	3,077,932	1,440,205	4,016,562	145,668	6,317,428	525,576	15,523,371
Service Supplied							
Annual Vehicle Miles	778,769	193,757	591,083		1,144,182		2,707,791
Peak Vehicles Operated	25	8	18		38		89
Cost of Service Provided							
Total Annual O&M Costs	$2,579,502	$648,256	$1,133,633	$309,516	$3,516,053	$538,080	$8,725,040
Cost per Passenger-Mile	$0.8381	$0.4501	$0.2822	$2.1248	$0.5566	$1.0238	$0.5621
Cost per Rider	$1.67	$1.43	$0.29	$12.75	$3.26	$6.14	$1.22
Cost per Mile	$3.31	$3.35	$1.92	ERR	$3.07	ERR	$3.22
Income							
Passenger Fares	$665,532	$193,413	$31,189	$11,393	$420,125	$17,703	$1,339,355
Local Subsidy	$1,446,933	$272,353	$0	$122,183	$1,340,904	$246,429	$3,428,802
Other Local Income			$718,197	$123,919	$323,264	$162,200	$1,327,580
State Assistance	$197,558	$101,402	$297,223	$33,923	$256,034	$84,536	$970,676
Federal Assistance	$250,279	$66,972	$87,024	$18,098	$837,386	$27,212	$1,286,971
Fare Recovery Ratio	25.8%	29.8%	66.1%	43.7%	21.1%	33.4%	30.6%
Percent Local Subsidy	56.1%	42.0%	0.0%	39.5%	38.1%	45.8%	39.3%
Percent State Subsidy	7.7%	15.6%	26.2%	11.0%	7.3%	15.7%	11.1%
Percent Federal Subsidy	9.7%	10.3%	7.7%	5.8%	23.8%	5.1%	14.8%

Public transportation services generally do not recover sufficient revenues to cover operating expenses. The transit systems in East Central Iowa fall within this category. Public transportation is considered a government service like roads, police and fire protection, parks, schools and libraries. Funds to finance the daily operations of regional transit comes from a variety of local, state and federal sources as illustrated in Table 9-14.

Operating costs for the 6 public transportation systems in East Central Iowa totaled $ 8.7 million in FY 1994. This is $ 1.22 per passenger. Over 31 percent of the operating cost was recovered by fare box receipts and other user fees with 50 percent of this revenue coming from passenger fares. The balance of income generated directly by transit operations comes from contract services (student fees, specialized transit services) and advertisement. Fare box revenues are charges to the passenger and display considerable consistency within the region. Individual fixed route basic fares are $.50. Many systems sell weekly or monthly passes which offer discounted rides as both a means to attract riders and to reduce fare collection costs. All systems offer discounts to senior citizens and handicapped persons. Some also offer child and student discounts. An additional 40 percent of the cost of providing the service is subsidized by local communities. All of the systems are heavily dependent on local funds. The degree of dependency and the basis of that local funding varies among the operators.

The remaining 30 percent of funds needed to balance costs come from state and federal sources. Within the East Central Iowa region, approximately 11.1 percent of operating revenue is from state sources and 14.8 percent from the federal government. The breakdown of revenue sources for the region can be seen in Exhibit 9-2.

Figure 9-2
Sources of Transit Operating Funds
East Central Iowa



Source: FTA Section 15 Reports

State and Federal Roles in Public Transportation

The IDOT has had an increasing role in public transportation since 1973. IDOT offers financial, technical, and administrative assistance to public transportation operators and to local governments in Iowa for planning new or expanded services. IDOT also administers federal financial assistance programs. Federal assistance is made available from the Federal Transit Administration (FTA) on a formula and discretionary basis.

Iowa Grant Programs - IDOT provides assistance to transit systems throughout Iowa through the State Transit Assistance (STA) and Capital Match Loan Bank Programs. STA may provide full or partial funding of the local match for selected capital projects, although this is not a high priority for the STA program. The STA program primarily funds maintenance of service.

FTA Section 9 Formula Grant Program - The Federal Transit Administration (FTA) is responsible for the implementation of the Section 9 program at the national level. Section 9 FTA funds provide operating and capital assistance to urban transportation operations in cities over 50,000 population. For cities of over 200,000 federal funds flow directly to the transit operator. There are no cities in the region in this category. For those between 50,000 and 200,000 federal funds are administered by IDOT. Iowa receives an annual allocation of Section 9 funds based on population and density factors. IDOT has the discretion to allocate these funds to urban and rural systems. Those cities of over 50,000 population receive a formula allocation from FTA annually for operating and capital assistance. Federal funds may provide up to 50 percent of the operating cost. Planning and capital funds may provide up to eighty percent of costs.

FTA Section 18 Rural and Small Urban Grant Program - The Federal Surface Transportation Act of 1978 amended Section 18 of the Urban Mass Transportation Act of 1964 to provide for both capital and operating assistance to public transportation systems in non-urbanized areas. This program passes Federal dollars through the State to designated eligible recipients -- counties, cities, villages, county transit boards, and regional transit authorities. The Section 18 program provides for the reimbursement of costs incurred in providing public transportation in rural and small urban areas of less than 50,000 population. Small urban areas of under 50,000 and rural areas receive assistance from FTA's Section 18 program. This program is also administered by IDOT. Federal funds may be used for up to 50 percent of the operating deficit. For capital costs of purchasing buses, vans, equipment, and facilities, federal funds currently may be used for up to 80 percent.

FTA Section 16 Special Equipment for Elderly and Handicapped Transportation Program (Section 16(b)(2) - Section 16 of the Urban Mass Transportation Act of 1964 was specifically written to provide specialized transportation services for the elderly and handicapped in areas where existing transportation services are unavailable, insufficient, or inappropriate. IDOT administers the Section 16 capital grant program for the Federal Transit Administration (FTA). Under this program, Federal funds are provided to cover 80 percent of the purchase of small buses and vans by private, non-profit corporations.

FTA Section 3 Grants - Nearly $1 billion is available nationwide annually for capital assistance on a competitive, discretionary basis. This money is allocated in three general categories: bus systems, rail modernization and "new start" fixed guideways systems. In recent years annual appropriations passed by Congress specify the new starts to be funded but the bus and rail modernization funds are allocated by FTA. Section 3 funds can be used to fund up to 80 percent of the cost of restoring rail passenger service to the CRANDIC Railway. In theory, funding for new start rail systems are authorized based on the results of technical analysis. As pointed out in the preceding paragraphs, the CRANDIC project does not satisfy federal thresholds for consideration of federal funding support. However, the Congress can appropriate and earmark funds for the project. In fact, most of the new start rail systems were initially funded by Congressionally earmarked funds.

FTA Section 6 Grants - This section provides money for studies and special demonstration projects intended to improve mass transportation. The federal share varies and awards are made on a discretionary basis.

FTA Section 10 Grants - Under this program, federal assistance is available for training activities at the state, local government and transit agency level. Again, the amounts and match ratios vary and awards are competitive.

ISTEA Flexibility - Provisions in the Intermodal Surface Transportation Efficiency Act (ISTEA), which authorizes federal highway and public transportation assistance through 1997, allow for considerable flexibility in transferring of funds between highway and transit projects. Prior to passage of ISTEA in 1991, only limited transfers of highway funds for transit use were permitted. IDOT could reallocate highway improvement funds to the construction of the improvements necessary to support restoration of rail passenger service in the CRANDIC corridor. Some other special provisions of ISTEA "flexible" funding are outlined in the following paragraphs:

> **Title 23 Interstate Substitute Transit Program** - A total of $45 million was appropriated in FY 1995 for transit projects that have been substituted for cancelled interstate highway segments. The funds are allocated by a formula that reflects the remaining cost to complete each substitute transit project. In addition to these funds which are directly appropriated for interstate substitute transit projects, substitute highway funds allocated to Iowa may be transferred from the FHWA to support transit improvement projects. The Interstate Maintenance Program provides funds to states for improvement and maintenance of Interstate Highways segments in the State. IDOT could suballocate FHWA funds to ECICOG in recognition of CRANDIC's planned goal of alleviating congestion on I-380, which is parallel to the rail corridor. Funds appropriated and allocated for I-380 improvements can be used to upgrade rail infrastructure in the CRANDIC corridor.

Surface Transportation Program - Surface Transportation Funds (STP) programmed for transit projects must result from the local and state planning process and must be contained in an approved State Transportation Improvement Program (STIP) before funds can be transferred from FHWA to FTA program accounts. The funds may be used for any non-operating purpose eligible under FTA programs. ISTEA specifically outlined transportation enhancement programs that included projects for pedestrian access, landscaping and historic preservation. Eligible projects could include building pedestrian bridges for safety purposes, landscaping station areas, renovation of historic transportation buildings, and preservation of railway corridors. This fund could be used to purchase the right-of-way from the CRANDIC to guarantee preservation of the right-of-way for future public transportation use. The right-of-way has a very high intrinsic value that should be preserved.

Congestion Management and Air Quality Funds - Congestion Management and Air Quality Funds (CMAQ) may be designated for use on transit projects. CMAQ funds programmed for transit projects must be contained in an approved State Transportation Improvement Program (STIP) before funds can be transferred from FHWA to FTA program accounts. The funds may be used for any non-operating purpose eligible under FTA programs. ISTEA requires that the project or program contribute to the attainment of a national ambient air quality standard. No CMAQ funds can be allocated for projects that result in new capacity for single occupant vehicles (SOV). ECICOG's goal of reducing SOV miles traveled on I-380 is a prime candidate for CMAQ funding. Based on prior grants under CMAQ authorizations, the CRANDIC project would be eligible for funding the procurement of rail equipment construction of parking facilities and right-of-way acquisition.

Analysis of Future Transit Funding in the Region

Under current conditions and governmental policies, the transit operators in the region all face increasing pressure to find additional sources of revenue to fund current and future operations. Recent federal legislative initiatives threaten continuation of federal operating subsidies for local transit systems. This will have a larger impact on Cedar Rapids than the other systems in the region.

Local Funding - The significant capital expenditure contemplated and any increase in operating expenses associated with restoration of regional rail passenger service on the CRANDIC will require substantial increases in local funding support. This would require a combination of increases in bus fares and local taxes to generate the income needed to subsidize the rail service. Given the political climate throughout the country, the prospect of substantially raising taxes earmarked specifically for rail passenger service with marginal benefits is nil. Local tax initiatives for rail passenger service with marginal benefits recently failed in Seattle, WA and Columbus, OH.

In Cleveland, OH public officials have refused to approve spending Congressionally earmarked funds for preliminary engineering to relocate an existing rapid transit line that was perceived to be only marginally beneficial to the community. In an era of increasing demands on diminishing financial resources, communities and elected public officials are extremely reluctant to fund projects with marginal returns on investment.

State Funding Sources - IDOT has a backlog of unfunded highway projects that have higher economic benefits than the restoration of rail passenger service in the CRANDIC corridor. Without specific direction from the Iowa legislature, it is unlikely that the IDOT will fund any capital costs associated with improving the CRANDIC corridor for rail passenger service.

Federal Funding Sources - The Department of Transportation and Related Agencies Appropriations Act of 1995 (Act) provided a funding level of $4.6 billion for transit programs in FY 1995. This is a 0.7 percent increase over the appropriation in FY 1994. The funding was significantly decreased in the area of operating assistance. The operating assistance was reduced nearly 12 percent to $710 million. The Clinton Administration in its FY 1995 budget recommendation considered completely eliminating operating assistance to urbanized areas under the Urbanized Area Formula Apportionments (Section 9) programs. The transit industry's overall formula program was increased 3.5 percent despite the cut in operating assistance. This allows transit capital improvement spending to increase over FY 1994 levels. During the past summer of 1995 when the new Congress began deliberations on the FY 1996 Budget, it expressed a strong desire to eliminate all federal operating assistance to local transit systems as a part of its plan to reduce the federal deficit. The House of Representatives on July 25 approved the Fiscal Year 1996 Transportation and related Agencies Appropriations Act that largely reflects the bill proposed by the Appropriations Committee. The Bill cuts operating assistance 44 percent, from $710 million in FY 1995 to $400 million in FY 1996. It is estimated that by FY 2000, there will be no further operating assistance available from federal sources.

FUNDING OPTIONS

The ongoing need for development of local funding strategies for public transportation maintenance and expansion has led to broad agreement among public finance specialists on which constitute the best funding options for transit. The major objectives of local funding sources must consider the effectiveness in delivering revenue (yield), the economic impact of the taxes to be imposed (fairness) and the legal and political feasibility of imposing the taxes (precedent).

The most important consideration in evaluating funding options is the yield. How much revenue can be derived and will it be sufficient to fully fund the annualized capital and operating expenses. Another important consideration in examining the imposition of tax adjustments is the need for fiscal rationality. Taxes should neither constitute an excessive burden on taxpayers nor result in private sector resource allocation behavioral changes or distort consumptive patterns in ways that are contrary to public policy. Tax changes should not alter the satisfaction-motivated behavior of consumers and the profit-motivated behavior of businesses in the market segment of the regional economy. In other words, taxes should be relatively neutral. The taxes should reflect the relationship between costs of the service extensions and service improvement programs and the direct and indirect beneficiaries of the CRANDIC rail passenger service. These fiscal rationality criteria should be expanded to include the following relevant criteria:

- All functional areas of economic activity - allocation of resources, income distribution, stabilization of employment and utilization of capital, and economic growth; and,
- Recognition that certain distortions and behavioral responses may be either beneficial or harmful to a regional economy depending on public policy initiatives and goals.

If such changes in behavior and allocational effects do occur, *nonneutrality* is said to exist. In this context, *neutrality* is deemed desirable. Therefore, any changes in taxes and tax rates should attempt to be neutral with respect to the fiscal rationality criteria. In examining funding options for the restoration of rail passenger service in the CRANDIC corridor, tax changes could be used to encourage shifts in consumer behavior by promoting use of train service and discouraging use of private automobiles for work trips.

Local Option Taxes

Local option funding sources are an attractive option for the regional rail service program because it clearly addresses the benefit principle of tax equity considerations. The benefit principle directly relates revenues and expenditures based upon a *quid pro quo* arrangement whereby local government units contribute to the cost of capital improvement programs primarily designed to benefit local communities. However attractive this is in theory, the collective "consumption" of public transportation facilities is characterized by the exclusion principle. Benefits derived from travel efficiency resulting from less congestion on I-380 highway corridor apply collectively and are nearly indivisible. People from all across Iowa, the Mid-West and Canada will benefit to some degree from the improvements in the I-380 highway corridor resulting from CRANDIC rail passenger service operations. However, the travel efficiency benefits shared by people outside the corridor are so small as to within a rounding error of some of the cost estimates. Consequently, the benefit theory is not comprehensive enough in its application to serve as a general benchmark of equity in the distribution of tax burdens though it does possess merit. Therefore, local option taxes would be the only appropriate mechanism to fund a *pro rata* share of the cost of constructing, operating and maintaining the regional rail passenger service in East Central Iowa. The following local tax options should be considered.

Sales and Use Taxes - Experience indicates that local sales taxes are generally robust income generators and should be considered a viable funding option for the CRANDIC rail service program. For example, the state's sales tax generated over $ 134 million in general fund revenue from Linn and Johnson County in FY 1994. Local jurisdictions are permitted under Iowa law to add a 1 percent local option sales tax. Other smaller categories of sales and use taxes could include parking taxes levied on paid commercial parking typically in congested downtown areas such as Iowa City. This has evolved into a per space tax levied on the property owner.

Property Taxes - Property taxes are the primary source of revenue for school districts, counties, municipalities, townships and other local government units. Three major variables affect the taxes on individual pieces of property:

- The size of the combined budgets of the governmental units taxing the property;
- The value of the property in the governmental unit; and,
- The value of the individual piece of property.

Although local governmental budgets control the size of a political subdivision's taxes, there are limits on the amount of taxes that can be levied. Each unit of local government is limited in the dollars per thousand of taxable value it may tax. Property tax increases are usually subject to voter referendum. Property tax increases have considerable difficulty in passing if the benefits of the project are not broad and readily apparent to the electorate. In fact, many communities are freezing property taxes and attempting to eliminate property taxes altogether and replacing the revenues lost with other types of taxes. Considerable debate regarding the equity of property taxes has mobilized the anti-property tax constituency. However, the establishment of transit benefit property tax assessment districts have proven to be enormously successful in other cities. The tax benefit assessment district is designed to assign increased tax burdens on those property owners who will most likely benefit directly from transit infrastructure investments. These property owners are usually within ¼ to ½ mile of the transit stations and benefit by increased sales volume from increased vehicular and pedestrian traffic and through appreciation of property values. The Central Area Circulator Project in Chicago, IL generated $250 million in local matching funds for the proposed construction of a new streetcar system by increasing the property tax rate of property owners in the primary service area of the streetcar system. ECICOG can attempt to identify tax benefit districts within a ½ mile radius of station locations.

Similar to tax benefit assessment districts is the creation of tax increment financing districts. Under this arrangement, property taxes distributed to governmental agencies are frozen at current levels. After the transportation investment has been completed, incremental tax revenue derived from increased property valuations and new development is reserved for the benefit of the transportation agency responsible for the infrastructure improvement. In the case of CRANDIC, new development created by the proximity of the rail services would generate incremental property taxes that could be dedicated to servicing debt issued to finance construction of the rail improvements needed to support rail passenger service operations.

Administrative Fees - Increased license tag registration fees are frequently one component of a revenue enhancing program used in other states to finance transportation improvements. However, the relative size of the CRANDIC service area's vehicle and driver populations are such that large increases in such existing fees would be necessary to fund the capital improvements solely or partially from these sources.

Local Option Motor Fuels Taxes - The concept of having fuel tax revenues support the development and improvement of public transportation programs is a common and popular practice. A portion of the fuel tax revenue collected by the federal government is allocated to the transit assistance programs funded by the Federal Transit Act. The fiscal rationality criteria of effecting modest beneficial behavioral changes in transportation mode choice is the logic supporting fuel tax increases as the funding source for public transportation improvement.

Private Sources of Capital

Land use in areas adjacent to rail stations and the stations themselves represent significant community development opportunities. A rail station is a valuable community asset, providing both a physical and symbolic link to convenient, reliable and affordable transportation alternatives. The intrinsic value of the station is often reflected in increased property values within a defined radius of the station location. The physical relationship of the station to the surrounding development will generally prescribe the economic/land use patterns and interactions. Joint development opportunities that can leverage community development funding assistance could offer significant potential for station construction and renovation. Rental income represents another source of revenue that could support operating expenses. Of particular importance to rail passengers is the location of convenient retail activities. The stations could be designed to accommodate service businesses that attract the commuter market. Such businesses could include:

- Day care centers;
- Restaurants/coffee shops;

- Flower shops;
- Video rental stores;
- Dry cleaning outlets;
- Banking, ATM facilities; and,
- Convenience food/retail stores

REVENUE FORECASTS

To evaluate the financial feasibility of the CRANDIC rail passenger and express bus alternatives, revenue forecasts for the two county area were prepared. All revenue forecasts were prepared using socioeconomic and financial data provided by ECICOG or available from other public sources and the consulting team. The revenue forecasts were limited to passenger fares and sales taxes. A summary of revenue forecasts are presented in Table 9-15 and Table 9-16 summarizes the sources and uses of these funds.

Fare Revenue

Fare revenue is based on the ridership projections outlined in Section 7. For purposes of this section, the most optimistic ridership projections were used. Some commuter railroads require passenger fares to account for at least 15 percent of operating costs.

Sales Taxes

Sales taxes were selected for their revenue generating ability and fairness. Sales taxes generally are the most robust income generators and would be ideal for guaranteeing payment of bonded debt for capital cost expenditures. If constructed properly, the sales tax can be less regressive than other forms of taxation. A 1 percent local option sales tax imposed on all purchases in Johnson and Linn Counties would generate over $ 28 million annually.

SUMMARY

The rail passenger alternatives considered will add between $ 6.4 and $ 7.8 million annually to the existing operating budgets of the region's transit systems. This nearly doubles the existing regional aggregate operating budget of $ 8.7 million. Federal operating assistance is diminishing and is likely to be completely eliminated by federal FY 2000. The annualized capital costs for the rail alternatives adds an additional financial burden of between $ 4.1 to $ 6.8 million. The cost effectiveness measures do not meet the thresholds established by the Federal Transit Administration

Table 9-15

Sales and Use Tax Receipts and Forecast

General State Sales Tax (5 percent)	**1992**		**1993**	
	Retail Sales	Tax Receipts	Retail Sales	Tax Receipts
Linn County	$1,658,848,818	$66,306,578	$1,766,900,484	$83,955,014
Johnson County	763,408,165	26,931,025	717,876,037	34,089,009
Total Sales Tax Receipts	2,422,256,983	93,237,603	2,484,776,521	118,044,023
General State Sales Tax (5 percent)	**1994**		**Projected**	
	Retail Sales	Tax Receipts	Retail Sales	Tax Receipts
Linn County	$1,928,496,138	$96,363,432		
Johnson County	772,370,350	38,587,958		
Total Sales Tax Receipts	2,700,866,488	134,951,390	$2,814,576,169	$140,728,808
Local Option Tax (1 percent)				$28,145,762

Table 9-16

Funding Sources and Uses of Funds

Funds Analysis	**CRANDIC Corridor Alternatives**		
	Primary	**Secondary**	**Express Bus**
Funds Required			
Annualized O&M Costs	$6,464,256	$7,874,618	$1,451,532
Annualized Capital Costs	6,801,841	4,154,437	411,958
Total Annual Costs	13,266,097	12,029,055	1,863,490
Funds Available			
Fare Receipts	$339,968	$271,974	
Local Option Sales Tax Receipts (1%)	28,145,762	28,145,762	28,145,762
Total Local Funds	28,485,730	28,417,736	28,145,762
Surplus (Deficit)	$15,219,633	$16,388,681	$26,282,271

as a pre-qualification for continued federal financial assistance. The rail passenger alternatives are not cost justified. Funding for the construction of any of the rail transit service improvement alternatives for the CRANDIC corridor must be generated from local sources, through Iowa Legislative enactments or specific Congressional earmarking if the community desires to go forward with this project despite its poor economic reasonableness indices.

The express bus alternative adds $ 1.4 million to the annual cost of operating transit service and $ 412,000 in annualized capital costs in the region. Ridership forecasts for the bus service are extremely low and are reflective of the historical revealed preferences for mode choice in the region. This option also does not appear to be cost justified. A three month demonstration project utilizing existing bus equipment from the area's transit agencies would cost approximately $ 350,000. This demonstration project could test the feasibility of transit service in the corridor by gathering empirical data and comparing it to the synthetically derived ridership forecasts prepared for this study.

Federal operating assistance to transit agencies is likely to be eliminated by FY 2000. This will have an impact on the region's existing Transit Improvement Program. More local dollars will be needed to off-set the loss of federal operating assistance. Fewer local dollars will be available to leverage federal capital grant assistance. The potential for funding expanded transit services in the region is limited by the availability of local funding sources.

The study has indicated that Iowa state transportation funds are committed to support bridge replacement, interstate highway reconstruction, existing State highway maintenance and improvement projects and other public transportation programs throughout the State. To divert funds from these programs to pay for the CRANDIC rail passenger service initiative would degrade the quality and safety of the current State highway network and may cause interruptions and a decline in public transit service in other communities.

Based upon this planning context, it is most likely that new local funding sources must be found to provide a stable revenue stream in support of the restoration of rail passenger service in the CRANDIC corridor. New taxes or increases to existing tax rates are the primary funding sources available to local governmental units. This study examined various funding source options and identified that the 1 percent local option sales tax would generate sufficient streams of stable revenue to support the regional rail service program. It was demonstrated that the local option sales tax could generate additional surplus funds that could be dedicated to other public infrastructure investments.

Section 10

FINDINGS AND RECOMMENDATIONS

Section 10
FINDINGS AND RECOMMENDATIONS

The *East Central Iowa Commuter Rail Feasibility Study* focused on examining the reasonableness of restoring rail passenger service in the CRANDIC corridor. Primary and Secondary rail passenger alternatives and a comparable express bus alternative were subjected to an analysis of ridership potential and annualized capital, operating and maintenance costs to determine the comparative costs per passenger and cost per passenger-mile used as a measure of cost effectiveness. Ancillary social benefits such as the value of travel efficiencies, reductions in air pollution and enhancements in regional mobility were not considered. The ridership projections were so low as to make these benefits meaningless when compared to the costs required to upgrade track, signals and grade crossings in the corridor. The social benefits derived from the low ridership would have been within the margin of error of cost estimations of track upgrades. These ancillary benefits do not have a material impact on the conclusions of the financial assessments.

Under the Primary Rail Alternative, the Cedar Rapids to Iowa City regional rail service would begin immediately across the street from the Cedar Rapids GTC and would be connected to the GTC by pedestrian bridge. The terminal structure would require the adaptive reuse of existing historic structures on the east bank of the Cedar River. From here the alignment would extend west across a new bridge and new tracks constructed in the median of a reconstructed 4th Avenue SW to UP and then south along the UP right-of-way to the CRANDIC corridor at Wilson Avenue. The alignment then would extend south along the existing CRANDIC right-of-way to downtown Iowa City terminating at the renovated CRANDIC station 2½ blocks from the Iowa City Transit Mall. In addition to the terminal stations in Cedar Rapids and Iowa City, six intermediate stations would be constructed. These stations would be located near Hawkeye Downs, the Cedar Rapids Municipal Airport, Swisher, North Liberty, Oakdale, and Coralville. The distance of this alignment is 27.1 miles and the scheduled running time between the terminal stations is 32 minutes. The total capital expenditure for this alternative is $ 84.4 million.

A Secondary Rail Alternative was evaluated as a low cost option. Under the Secondary Rail Alternative, the regional rail passenger service would begin near the site of the former Union Depot across from Green Park. The terminal station would be a simple platform, shelter and suitable landscaping. From here, the alignment runs north along the UP right-of-way through the Quaker Oats plant and then westbound across the existing bridge spanning the Cedar River. The alignment turns south on the west bank of the river and follows the existing UP right-of-way to the junction with the CRANDIC. The alignment follows the CRANDIC right-of-way south to downtown Iowa City exactly like the Primary Rail Alternative and utilizes the same stations. The route is 28 miles long and requires 48 minutes of scheduled running time. The cost of this option is $ 51.5 million.

An Express Bus Alternative was evaluated as the only reasonable alternative to rail passenger service in the corridor. The terminal station in Cedar Rapids is the GTC. The terminal station in Iowa City would be the existing intercity bus depot located 1½ blocks from the Iowa City Transit Mall. This alternative follows the same route between Cedar Rapids and Iowa City as existing Greyhound and Burlington Trailways buses. This is a 26 mile non-stop route utilizing I-380 for most of the distance. The scheduled running time for the express bus option is 35 minutes. The present value of the total capital cost of this option is $ 3.2 million.

SUMMARY OF FINDINGS

There is some public sentiment favoring the restoration of rail passenger service in this region as a means to enhance regional mobility and promote alternate modes of travel. Some nostalgic sentiment exists for the restoration of rail passenger service based on a desire to preserve transportation heritage in the corridor. Although these motives are benevolent, the decision to restore rail passenger service in the CRANDIC corridor is difficult to justify on economic grounds when confronted with the major findings of this feasibility study.

The decision ultimately rests with the people of East Central Iowa and the public officials elected to represent them. The decision must be made based on what they believe to be is in the best long-term interest of the region and its residents. The decision should consider the following major findings of the feasibility study:

- **<u>Regional Population</u>** - Excluding the country's three largest urbanized areas, Chicago, Los Angeles and New York, the average population of urbanized areas with rail transit service is over 2 million. The smallest metropolitan region with urban rail service is Portland, OR with just a little over 1 million people. The United States Congress recently earmarked federal financial assistance for the City of Salt Lake City to design and build a new start light rail line. Salt Lake City has a population of 800,000 with a high growth rate. Linn and Johnson Counties combined have a total population of 264,886 people with a 1 percent annual growth rate. At this growth rate, it will take 111 years to grow to the size of Salt Lake City.

- **<u>Transportation Corridor Population</u>** - The population of the transportation corridor is more relevant than the aggregate population of the region. The market potential for transportation service is defined by the geographic location of the routes or stations. It is possible to have a viable rail passenger corridor in a relatively small urbanized area. What is needed is a relatively high concentration of people with origins and destinations adjacent to the rail line. The land use and population density adjacent to the rail line defines the total market potential for a corridor. The CRANDIC corridor connects its two namesake cities with a combined urbanized population of 170,972. The balance of the corridor can be characterized as rural. Two small towns are adjacent to the rail line: Swisher has a population of 645 and North Liberty has a population of 2,926. The third largest city in the corridor is Coralville with a population 10,347. The total population living within a two mile distance from the center line of the CRANDIC rail line is 139,000.

- **Station Area Population** - The population in a transportation corridor is relevant only to the extent that those people live (and work or go to school etc.) within reasonable access and egress distance from rail stations. Research indicates that walking and reasonable drive time distances are the limits of the station market influence area, often called the catchment area. For purposes of the ridership forecast, the walking distance was assumed to be ½ mile and the reasonable driving distance was assumed to be 3-miles from the station. This would maximize ridership potential from each station location. The total population living within all of the station influence areas in the corridor is 157,400. This is extremely low. In Singapore, for example, there are over 300,000 people living within ¼ mile walking distance of each of the Metro Rail stations.

- **Freight Railroad Conflicts** - The only serious conflicts with freight train movements occurs between downtown Cedar Rapids and the CRANDIC yards. Several alignments were examined that avoided conflicts with freight train movements in this congested segment of the CRANDIC corridor. Access to the Cedar Rapids Central Business District (CBD) was considered to be an important element of passenger train service in the corridor. Alignments were evaluated on the basis of capital and operating costs. The optimum alignment that emerged from this analysis became the Primary Rail Alternative.

- **Rail Passenger Service Options** - The CRANDIC Railway is parallel to I-380. Motorists can travel between Cedar Rapids and Iowa City in the relative comfort of an air conditioned automobile at speeds of between 55 and 65 mph. The average motorist can travel the 26 miles between the two cities in less than 30 minutes. Intercity bus service in the corridor has a scheduled running time of 35 minutes. Rail passenger service schedules must compete with this travel time. To upgrade the CRANDIC right-of-way to FRA Class 4 track and construct the infrastructure needed to support a scheduled running time of 35 minutes would require a capital expenditure of over $ 84 million. This includes the purchase of 5 trainsets capable of operating the schedule. Each trainset is valued at $ 3.5 million. This capital investment dictates that service levels must be relatively high in order to attract as many riders as possible from the limited market influence areas in the corridor. Passenger train schedules were developed with 20 minute peak hour and 40 minute off-peak service frequency. The cost of operating this train schedule would amount to over $ 6.4 million annually.

- **Highway Congestion** - An analysis of highway travel demand in the I-380 corridor revealed that daily vehicle miles travelled (DMVT) per lane-mile is 5,941 which is less than half of the undesirable congestion index of 13,000 DMVT per lane-mile. Further analysis based upon the Avenue of the Saints transportation model indicated that future growth in DMVT per lane-mile would not reach the undesirable 13,000 threshold until the year 2030. Highway traffic counts conducted specifically for this study further revealed that current passenger automobile traffic volume on I-380 generated by people living in Linn and Johnson County account for only 30 percent of the total volume on the freeway. The balance of the traffic volume is generated by truck traffic and automobiles from outside the CRANDIC corridor. The future growth in traffic volume and possible congestion that could occur on I-380 emanates from households outside the market influence area of the rail line.

- **Technology Options** - It was determined that diesel multiple unit (DMU) trains equipped with tilt body equipment were required to minimize the cost of upgrading the CRANDIC right-of-way and support the targeted 35 minute running time needed for competitive purposes. Train performance calculations utilizing the Association of American Railroads (AAR) train performance simulation model were conducted to determine if tilt trains could operate the desired schedule. The Siemens VT610 was selected as the optimum equipment. Simulations verified that the VT610 could run the alignment in 32 to 33 minutes assuming 30 second dwell times in Swisher and North Liberty. The VT610 seats 68 passengers and currently operates in revenue service in Germany. It is not FRA approved for operation on Class I railroads in the United States. A waiver to the buff strength requirements would be needed.

- **Propulsion Power** - The re-electrification of the CRANDIC Railway would cost in excess of $ 40 million. There were no statistically significant differences between the running times associated with modern light rail vehicles (LRV) and the VT610 DMU. Electric propulsion was dismissed and not considered further in the financial analysis.

- **Express Bus Alternative** - The only reasonable public transportation alternative to the restoration of rail passenger in the CRANDIC corridor is express bus service. The current operating schedules of Greyhound Lines and Burlington Trailways allow 35 minutes running time between the GTC in Cedar Rapids and the intercity bus depot in Iowa City. This service is operated on I-380 and is a non-stop service. The Express Bus Alternative would operate every 20 minutes during the peak hours and every 40 minutes during the off-peak periods. This schedule could be operated using 4 buses plus 1 spare for schedule maintenance. The immediate capital expenditure for the bus fleet would amount to over $ 1.6 million. Buses have a 12 year expected life requiring additional new purchases in years 12 and 24 of the economic life cycle of the option evaluated. The present value of these replacement buses in future years adds an additional $ 1 million to the capital cost. Improved traffic signaling, signal preemption and communication equipment adds an additional $ 500,000 to the capital costs raising the total expenditure to just over $ 3.2 million. The annualized operating and maintenance expenses for the Express Bus Alternative is $1.4 million.

- **CRANDIC Rail Passenger Ridership: Historical Reference Points** - Service began in 1904 and ridership on the line continued to grow steadily through the 1920's. The CRANDIC carried 554,306 annual riders in 1920. Interurban rail passenger service declined during the Great Depression and had sunk below 200,000 annually by 1940. Gas rationing, rubber shortages and patriotism curtailed the use of automobiles during the war years. From 1940 to 1943, ridership increased from 442 average daily riders to over 1,061 in 1943. The CRANDIC transported more than 573,000 passengers in 1945, the highest total annual ridership in its entire history. By 1950, the total annual passengers carried on CRANDIC trains dropped to 30,000. This is equal to an average daily ridership of only 90 passengers. The CRANDIC finally discontinued passenger service on May 30, 1953.

- **CRANDIC Rail Passenger Ridership: Forecasted** - Rail passenger demand forecasts for the East Central Iowa regional rail service are based upon the transportation models developed by Linn and Johnson Counties. The transportation planning models for each county had to be modified to account for intercounty trip origins and destinations. U.S. Census Bureau journey-to-work data supplemented by origin-destination travel surveys conducted specifically for this feasibility study were utilized to develop synthetic trip tables by transportation area zones (TAZ). In addition to this data, the residence addresses of the student population registered at Kirkwood Community College and the University of Iowa were input into the population data base and special trip generator tables for journey-to-school trips were developed by TAZ. A nested logit model previously developed by utilizing stated preference survey data for another commuter rail study with characteristics similar to the CRANDIC corridor was modified to fit the local travel demand conditions. The application of this model resulted in ridership estimates for the Primary, Secondary and Express Bus Alternatives. The average weekday and annualized ridership estimates for these alternatives, based upon the most optimistic assumptions, are summarized in Table 10-1:

Table 10-1

CRANDIC CORRIDOR
Ridership Estimates

Alternative	Average Weekday Ridership	Total Annualized Ridership
Primary Rail Alternative	1,670	447,328
Secondary Rail Alternative	1,336	357,862
Express Bus Alternative	100	26,590

- <u>**Cost Effectiveness Indices**</u> - The Federal Transit Administration has established threshold values of the cost per new rider index that would need to be met for a proposed project to continue receiving federal financial support through the various stages of the federally mandated planning process. To progress from systems level planning to the "alternatives analysis or major investment study" phase, the preliminary estimate of the cost per new rider should not exceed $10; to move from alternatives analysis to preliminary engineering, the estimated cost per new rider should not exceed $6. As is clearly indicated in Table 10-2, these costs are outside the thresholds for a federally funded project. This is illustrated more clearly in Figure 10-1.

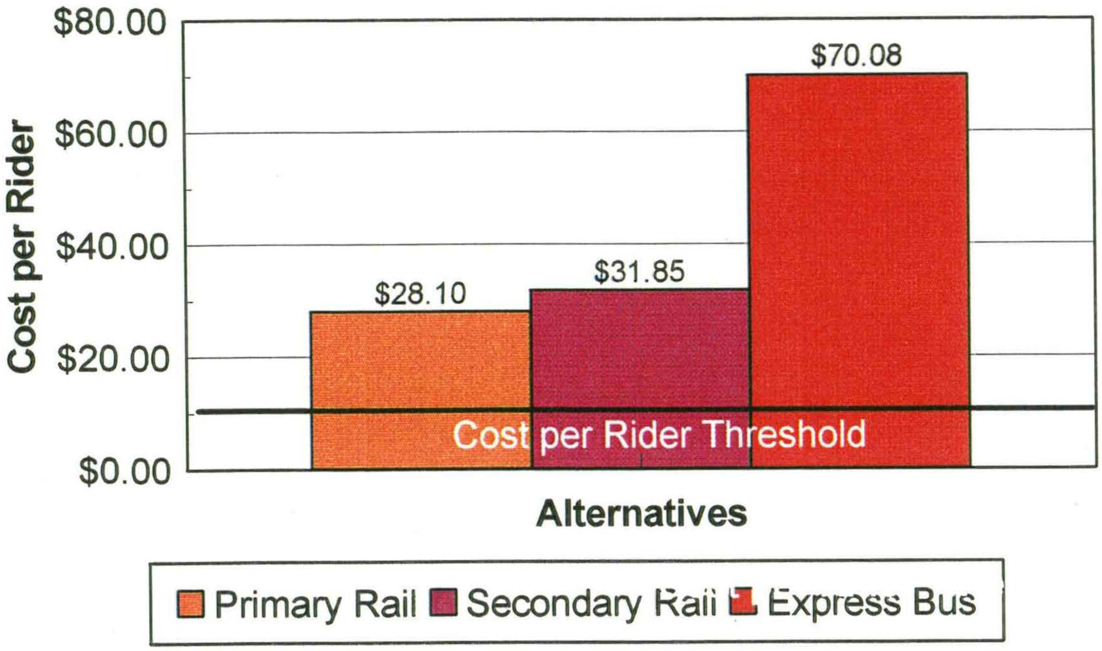
Table 10-2

CRANDIC CORRIDOR
Cost Effectiveness Indices

Alternative	Cost per Rider	Cost per Passenger-mile
Primary Rail Alternative	$28.10	3.40
Secondary Rail Alternative	$31.85	3.85
Express Bus Alternative	$70.08	2.19

Figure 10-1

Cost Effectiveness Index



- **Funding Options** - The annualized capital, operating and maintenance costs for the Primary and Secondary Rail Alternatives range between $ 12 and $ 13 million. These funds would likely have to be raised primarily through local option sales taxes. A one percent sales tax would generate sufficient revenue to support local initiatives to restore rail passenger service in the CRANDIC corridor and other infrastructure investments.

CONCLUSIONS

The *East Central Iowa Commuter Rail Feasibility Study* has found very low ridership potential in the corridor to support restoration of a high speed interurban rail passenger service that would be competitive with automobile travel times. The development patterns that define the corridor today are better suited to automobile travel and less well suited to rail passenger services. The population base within rail station catchment areas is insufficient to generate the level of ridership that could justify the heavy capital investment needed to upgrade the existing freight railroad trackage to passenger service standards.

At population growth rates currently being experienced in the region, it would take 111 years before Linn and Johnson Counties could achieve the level of urbanization marginally required to support urban rail passenger service. Expected growth in traffic volumes on I-380 will not produce undesirable measures of congestion until the year 2030. Even then, the congestion would result from traffic generated by travel demand outside the rail passenger station influence areas. Only 30 percent of traffic on I-380 comes from passenger automobiles registered to people in the two county area. The balance of the traffic is generated by trucks and by cars from outside the two county area.

Population growth rates and adjacent land use patterns are not expected to change in the next several years to provide any expectation that the future will be dramatically different than what the East Central Iowa Council of Governments has already accounted for in its existing long range transportation plans and forecasts. Radical changes must occur in growth patterns supplemented by aggressive land use planning in the region before rail passenger service could be successful in this corridor. Future residential development must be dense, adjacent to the rail line and linear in form rather than the dispersed and polycentric form that has marked the development pattern for the fifty years since the end of the Second World War. For example, residential and economic development must be "transit friendly." This means that residential development must occur within easy walking distance of the rail line and jobs must be concentrated in the central business districts anchoring each end of the rail line. Public policies should encourage construction of dense housing patterns such as town houses, cluster homes, and multi-family dwellings adjacent to the rail line.

The ridership analysis has indicated that some linear growth is occurring between North Liberty and Iowa City. This growth pattern should be encouraged and fostered through passage of "transit friendly development" land use zoning ordinances and improvements in bus service to build transit riding habits in this segment of the corridor. The development patterns in this segment of the CRANDIC corridor may potentially support a medium capacity rail transit service.

The East Central Iowa commuter rail service in the CRANDIC corridor fails to hurdle generally accepted marginal thresholds of economic reasonableness. The capital costs are extremely high, the ridership is very low and the requirements for annualized public subsidy is nearly double the total operating expenses of all the other regional public transit providers combined. High speed interurban rail passenger service between Cedar Rapids and Iowa City on the CRANDIC Railway is an idea whose time has long since past. The taxpayers of Linn and Johnson County should not resurrect interurban rail service in the CRANDIC corridor.

RECOMMENDATIONS

1) Further consideration of resurrecting rail passenger service discontinued by the CRANDIC Railway in 1953 is not justified now or in the foreseeable future. No further study of the entire CRANDIC corridor is recommended.

2) The existing right-of-way has intrinsic value as a transportation corridor. Public sentiment in the region to preserve the CRANDIC right-of-way for future transportation uses should be acknowledged. The right-of-way should be preserved for continued rail freight service or future alternate transportation modes the CRANDIC decides to abandon the Iowa City subdivision. Preservation of the corridor for recreational uses such as hiking and bicycle trails should be considered in long range transportation plans for Linn and Johnson County.

3) The ridership analysis found evidence that a smaller segment of the corridor (North Liberty to Iowa City) could be an emergent market for medium capacity rail transit service. Vintage trolley service is a medium capacity transit operation that could serve this emergent market. Perhaps limited rail passenger service in this short segment of the corridor would be feasible. A vintage trolley operation also would be a marvelous tourist attraction adding to the economic development potential of the region

4) The development of a vintage trolley service in East Central Iowa is worth studying. In fact, another vintage trolley service could operate from Cedar Rapids to the Amana Colonies as a tourist line along a different route alignment. The economic development potential and tourist appeal of these operations should be examined by the ECICOG.

5) Because growth and development patterns change, ECICOG should consider examining rail passenger and interurban bus service options on a regular basis as a part of their long range planning process. It is recommended that the CRANDIC corridor be examined after the next census in the year 2000.

Appendix A

UNIT WORK DESCRIPTIONS

APPENDIX A
UNIT WORK DESCRIPTIONS

Track Work

- Remove Track: (TF) remove rail, ties, other track material (OTM) and ballast to subgrade, dispose of materials.
- Remove No. 8 TO: (EA) remove rail, ties, OTM and ballast to subgrade; dispose of materials.
- Remove No. 10 TO (EA) remove rail, ties, OTM and ballast to subgrade; dispose of materials.
- New Mainline 115# Timber Tie Track: (TF) On prepared subgrade, furnish and install ballast, main line timber ties, 115RE CWR, line and surface, complete ready for service.
- New Siding Track: (TF) Prepare subgrade, furnish and install ballast, timber ties, 100RE jointed rail, line and surface, complete ready for service.
- Install 115RE No. 10 TO on Timber Ties: (EA) On prepared subgrade, furnish and install No. 10 TO including ballast, timber ties, 115RE rail, RBM frog, 16'-6" switch points, all plates and rods complete. Include geotextile.
- Install 115RE No. 20 TO on Timber Ties: (EA) On prepared subgrade, furnish and install No. 20 TO including ballast, timber ties, 115RE rail, RMB frog, 39' switch points, all plates and rods compete ready for signal equipment installation. Include geotextile.
- Crossing Diamond: (EA) Furnish and install 90 degree 136RE or 115RE crossing diamond on timber ties as appropriate. Include geotextile.
- Shift Track: (TF) Using existing track, widen ballast section and throw track up to 10 feet laterally. Line and surface.
- Track Upgrade/Renew Ties: (EA) Furnish and install timber main line ties.
- Track Upgrade/Renew Rail: (TF) Furnish and install 136RE or 115RE CWR including OTM.
- Track Upgrade/Line & Surface: (TF) Furnish ballast for 2 inch lift, line and surface track.
- Grade Crossing (LF) Furnish and install grade crossing track and rubber panels at roadway. Includes all staging, subgrade prep with geotextile fabric and drainage, track upgrade, Redhawk or equal rubberized grade crossing panels and paving within 6 feet of centerline of track.

- Relay rail salvage Value: (TON)
- Scrap value credit for Rail: (TON)
- Scrap value credit for Turnouts: (EA)
- Scrap value credit for OTM: (TON)
- Scrap value credit for Ties: (EA)

Structures

- Construct Single Track Bridge: (LF) precast concrete ballast deck bridge including pile foundation, abutments, pier caps, deck spans of 24 ft. unit length. Includes all site work for bridge and access. Excludes track on bridge.
- Construct crashwall, (LF). Excavate foundation, cast foundation, form, place and cure reinforced concrete crashwall. Remove forms, cleanup site.
- Construct Single Track Bridge Over 24-Foot Spans: (LF) Steel girders with a concrete ballast deck including pile foundation abutments. Includes all site work for bridge and access. Excluding track on bridge.
- Safety Barrier: (MI) Construction of a New Jersey style reinforced concrete barrier 2' - 6" thick at the base tapering down to one foot at the top with an overall height along both sides of the medians. In addition, a two-foot extrusion would be installed a top this wall resulting in a total height of 4' - 8" to support this wall, aid in drainage and restrain the tracks roadbed. Concrete foundation walls would also be constructed - $2,000,000.
- Fencing: (MI) A six-foot chain link fence will be erected on top of the Safety Barrier to minimize debris and deter trespassers - $223,850.
- Median Drainage: (MI) Includes the installation of a longitudinal french drain system constructed with 18-inch perforated pipe on either side of the track which is fed into existing highway cross drains - $392,500.

Sitework

- Construct Adjacent Subgrade, 15 foot centers: (LF) Construct from borrow lime rock; clear roadbed, place and compact fill for new roadbed adjacent to existing roadbed for one track, complete with subballast. Average depth of fill for new roadbed section is 5 feet.

- Construct Two Track Subgrade: 15 foot centers: (LF) Construct from borrow lime rock; clear roadbed, place and compact fill for new roadbed separate from existing roadbed for two tracks, complete with subballast. Average depth of fill for new roadbed section is 5 ft.
- Construct Single Track Subgrade: (LF) Construct from borrow lime rock; clear roadbed, place and compact fill for new roadbed separate from existing roadbed for one track, complete with subballast. Average depth of fill for new roadbed section is 5 ft.
- Widen Existing Subgrade: (LF) Construct 6 feet wide addition to existing subgrade from borrow lime rock. Clear roadbed, place and compact fill complete with subballast. Use 5 foot depth for subgrade.
- Regrade road for grade crossing. (SY) Includes removal of existing roadway, curb, gutter, and sidewalks, regrading approaches to grade crossing, repaving roadway and restoration of curb, gutter and sidewalk.
- Remove Grade Crossing (LF) Remove grade crossing panels, track ballast. Reconstruct road to existing profile.

Signalization

- Single Track Signalization: (MI) $350,000/mile.
- Double Track Signalization: (MI) $350,000/mile.
- Major interlocking: (EA) $2,000,000

Grade Crossing Protection

- Signalize one track, including gates: (EA) $120,000.
- Signalize two tracks, including gates: (EA) $155,000.
- Upgrade signalization from one to two tracks: $90,000.
- Upgrade signal circuits for an increase in speed: (EA) $10,000.
- Highway signal preemption: (EA) $10,000

Stations

- Construct Station Side Platform: (EA) Earthwork, farmwork, concrete for 150' by 12' station platform including handrails, and canopies - $150,000.
- Train Annunciator System: (STATION) System will consist of AFO train detection circuits on approaches, train-approaching lights and warning chimes - $110,000.

Electrifications

- Single Track Electrification: (MI) Includes construction of complete electric power and distribution system - $650,000.
- Double Track Electrification: (MI) Includes construction of complete electric power and distribution system - $1,150,000.

Appendix B

DETAILED COST ESTIMATES

Table B–1

ESTIMATED COST
OF
CEDAR RAPIDS CBD ACCESS ALTERNATIVE NO. 1

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
Remove #8 TO	EA	2	$4,090	$8,180
New Mainline 115# Tmbr Tie Trk	TF	21,327	115	2,452,605
New Siding Track	TF	2,640	65	171,600
New 115# RE #10 TO (S.H.)	EA	6	20,000	120,000
New 115# RE #20 TO Timber	EA	1	56,000	56,000
Shift Track	TF	2,000	17	34,000
Renew Ties	EA	1,988	50	99,400
Switch Ties	MBM	35	1,600	55,360
Renew Rail 115#	TF	13,992	45	629,640
Line & Surface	TF	13,992	2	27,984
New Single Trk Steel Ballast Deck Bridge	LF	1,132	3,500	3,962,000
New Highway Bridge (4–Lane)	LF	200	5,000	1,000,000
New Grade Crossing	LF	3,225	650	2,096,250
Rework Grade Crossing	LF	105	250	26,250
Install Crossbucks	EA	2	150	300
New Single Trackbed	LF	357	215	76,755
New Double Trackbed	LF	2,640	260	686,400
New Trackbed Adj to Exist Track	LF	17,370	120	2,084,400
Rail Crossing Diamond	EA	2	150,000	300,000
Grade Crossing Protection 1–Track	EA	10	120,000	1,200,000
Grade Crossing Protection Upgade	LS			370,000
Train Control	LS			3,750,000
CONSTRUCTION SUBTOTAL				**$19,207,124**
CONTINGENCY	%	30		5,762,137
TOTAL CONSTRUCTION COST				**$24,969,261**
DESIGN COST	%	7		1,747,848
CONSTRUCTION MANAGEMENT	%	8		1,997,541
PROJECT MANAGEMENT	%	3		749,078
PROJECT SUBTOTAL				**$29,463,728**
Relay Rail Salvage Value	TN	536	–475	(254,600)
Scrap Value for Rail	TN	79	–75	(5,925)
Scrap Value for TO's	EA	2	–1075	(2,150)
Scrap Value for OTM	TN	98	–75	(7,350)
Scrap Value for Ties	EA	2,498	–1	(2,498)
PROJECT TOTAL				**$29,191,205**

SOURCE: Wilbur Smith Associates ––> August 1995

Table B–2

ESTIMATED COST
OF
CEDAR RAPIDS CBD ACCESS ALTERNATIVE NO. 2

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New Mainline 115# Tmbr Tie Trk	TF	32,738	$115	$3,764,870
New 115# RE #10 TO Timber	EA	2	41,000	$82,000
New 115# RE #20 TO Timber	EA	1	56,000	56,000
New Single Trk Steel Ballast Deck Bridge	LF	4,550	3,500	15,925,000
New Highway Bridge (4–Lane)	LF	100	5,000	500,000
New Grade Crossing	LF	850	650	552,500
New Single Trackbed	LF	28,978	215	6,230,270
Crash Wall	LF	90	260	23,400
Retaining Wall	SF	60,000	45	2,700,000
Safety Barrier	MI	4	2,000,000	7,500,000
Fencing	MI	4	223,850	978,225
Median Drainage	MI	4	392,500	1,471,875
Grade Crossing Protection 1–Track	EA	6	120,000	720,000
Train Control	LS			500,000
CONSTRUCTION SUBTOTAL				**$41,004,140**
CONTINGENCY	%	30		12,301,242
TOTAL CONSTRUCTION COST				**$53,305,381**
DESIGN COST	%	7		3,731,377
CONSTRUCTION MANAGEMENT	%	8		4,264,431
PROJECT MANAGEMENT	%	3		1,599,161
PROJECT SUBTOTAL				**$62,900,350**
Relay Rail Salvage Value	TN		–475	0
Scrap Value for Rail	TN		–75	0
Scrap Value for TO's	EA		–1075	0
Scrap Value for OTM	TN		–75	0
Scrap Value for Ties	EA		–1	0
PROJECT TOTAL				**$62,900,350**

SOURCE: Wilbur Smith Associates ––> August 1995

Table B–3

ESTIMATED COST
OF
CEDAR RAPIDS CBD ACCESS ALTERNATIVE NO. 5

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
Remove #8 TO	EA	2	$4,090	$8,180
New Mainline 115# Tmbr Tie Trk	TF	16,592	115	1,908,080
New Siding Track	TF	2,640	65	171,600
New 115# RE #10 TO (S.H.)	EA	8	20,000	160,000
New 115# RE #20 TO Timber	EA	1	56,000	56,000
Shift Track	TF	2,000	17	34,000
Renew Ties	EA	3,786	50	189,300
Switch Ties	MBM	37	1,600	58,880
Renew Rail 115#	TF	13,992	45	629,640
Istall Rail Anchors	EA	5,178	2	10,356
Line & Surface	TF	26,651	2	53,302
New Single Trk Steel Ballast Deck Bridge	LF	282	3,500	987,000
New Grade Crossing	LF	385	650	250,250
Rework Grade Crossing	LF	625	250	156,250
Joint Servicing	MI	2	3,000	7,200
Install Crossbucks	EA	2	150	300
New Double Trackbed	LF	2,640	260	686,400
New Trackbed Adj to Exist Track	LF	16,592	120	1,991,040
Rail Crossing Diamond	EA	2	150,000	300,000
Grade Crossing Protection Upgade	LS			780,000
Train Control	LS			3,750,000
CONSTRUCTION SUBTOTAL				**$12,187,778**
CONTINGENCY	%	30		3,656,333
TOTAL CONSTRUCTION COST				**$15,844,111**
DESIGN COST	%	7		1,109,088
CONSTRUCTION MANAGEMENT	%	8		1,267,529
PROJECT MANAGEMENT	%	3		475,323
PROJECT SUBTOTAL				**$18,696,051**
Relay Rail Salvage Value	TN	536	–475	(254,600)
Scrap Value for Rail	TN	79	–75	(5,925)
Scrap Value for TO's	EA	2	–1075	(2,150)
Scrap Value for OTM	TN	98	–75	(7,350)
Scrap Value for Ties	EA	4,296	–1	(4,296)
PROJECT TOTAL				**$18,421,730**

SOURCE: Wilbur Smith Associates ––> August 1995

Table B–4

ESTIMATED COST
OF
CEDAR RAPIDS CBD ACCESS ALTERNATIVE NO. 6

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
Remove #8 TO	EA	2	$4,090	$8,180
New Mainline 115# Tmbr Tie Trk	TF	5,000	115	575,000
New Siding Track	TF	2,640	65	171,600
New 115# RE #10 TO (S.H.)	EA	2	20,000	40,000
New 115# RE #20 TO Timber	EA	1	56,000	56,000
Switch Ties	MBM	9	1,600	14,720
New Single Trk Steel Ballast Deck Bridge	LF	282	3,500	987,000
New Grade Crossing	LF	40	650	26,000
New Double Trackbed	LF	2,640	260	686,400
New Trackbed Adj to Exist Track	LF	2,360	120	283,200
Grade Crossing Protection Upgade	LS			100,000
CONSTRUCTION SUBTOTAL				**$2,948,100**
CONTINGENCY	%	30		884,430
TOTAL CONSTRUCTION COST				**$3,832,530**
DESIGN COST	%	7		268,277
CONSTRUCTION MANAGEMENT	%	8		306,602
PROJECT MANAGEMENT	%	3		114,976
PROJECT SUBTOTAL				**$4,522,385**
Relay Rail Salvage Value	TN	0	−475	0
Scrap Value for Rail	TN	79	−75	(5,925)
Scrap Value for TO's	EA	2	−1075	(2,150)
Scrap Value for OTM	TN	18	−75	(1,350)
Scrap Value for Ties	EA	1,500	−1	(1,500)
PROJECT TOTAL				**$4,511,460**

SOURCE: Wilbur Smith Associates – – > August 1995

Table B–5
ESTIMATED COST
OF
OPERATING SENARIO NO. 1

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	12,950	50	647,500
Renew Switch Ties	MBM	22	1,600	35,200
Renew Rail 115#	TF	116,160	45	5,227,200
Istall Rail Anchors	EA	13,788	2	27,576
Line & Surface	TF	179,526	2	359,052
Rework Grade Crossing	LF	1,692	250	423,000
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	62	150	9,300
Bridge Improvements	LF	239	250	59,750
Grade Crossing Protection 1–Track	EA	14	120,000	1,680,000
Grade Crossing Protection Upgade	LS			50,000
CONSTRUCTION SUBTOTAL				**$8,840,678**
CONTINGENCY	%	30		2,652,203
TOTAL CONSTRUCTION COST				**$11,492,881**
DESIGN COST	%	7		804,502
CONSTRUCTION MANAGEMENT	%	8		919,431
PROJECT MANAGEMENT	%	3		344,786
PROJECT SUBTOTAL				**$13,561,600**
Relay Rail Salvage Value	TN	352	–475	(167,200)
Scrap Value for Rail	TN	2,870	–75	(215,250)
Scrap Value for TO's	EA	16	–1075	(17,200)
Scrap Value for OTM	TN	835	–75	(62,625)
Scrap Value for Ties	EA	12,950	–1	(12,950)
PROJECT TOTAL				**$13,086,375**

SOURCE: Wilbur Smith Associates ––> August 1995

Table B-6

ESTIMATED COST
OF
OPERATING SENARIO NO. 2

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	12,950	50	647,500
Renew Switch Ties	MBM	22	1,600	35,200
Renew Rail 115#	TF	116,160	45	5,227,200
Istall Rail Anchors	EA	13,788	2	27,576
Line & Surface	TF	152,638	2	305,276
Rework Grade Crossing	LF	1,692	250	423,000
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	62	150	9,300
Bridge Improvements	LF	102	250	25,500
Grade Crossing Protection 1-Track	EA	14	120,000	1,680,000
Grade Crossing Protection Upgade	LS			50,000
CONSTRUCTION SUBTOTAL				**$8,752,652**
CONTINGENCY	%	30		2,625,796
TOTAL CONSTRUCTION COST				**$11,378,448**
DESIGN COST	%	7		796,491
CONSTRUCTION MANAGEMENT	%	8		910,276
PROJECT MANAGEMENT	%	3		341,353
PROJECT SUBTOTAL				**$13,426,568**
Relay Rail Salvage Value	TN	352	-475	(167,200)
Scrap Value for Rail	TN	2,870	-75	(215,250)
Scrap Value for TO's	EA	16	-1075	(17,200)
Scrap Value for OTM	TN	835	-75	(62,625)
Scrap Value for Ties	EA	12,950	-1	(12,950)
PROJECT TOTAL				**$12,951,343**

SOURCE: Wilbur Smith Associates --> August 1995

Table B-7

ESTIMATED COST OF OPERATING SENARIO NO. 3

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	19,150	50	957,500
Renew Switch Ties	MBM	44	1,600	70,400
Renew Rail 115#	TF	116,160	45	5,227,200
Istall Rail Anchors	EA	13,788	2	27,576
Line & Surface	TF	179,526	2	359,052
Rework Grade Crossing	LF	1,692	250	423,000
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	62	150	9,300
Additional Curve Spiking	LS			26,689
Bridge Improvements	LF	239	250	59,750
Grade Crossing Protection 1-Track	EA	14	120,000	1,680,000
Grade Crossing Protection Upgade	LS			50,000
Train Control	LS			6,000,000
CONSTRUCTION SUBTOTAL				**$15,212,567**
CONTINGENCY	%	30		4,563,770
TOTAL CONSTRUCTION COST				**$19,776,337**
DESIGN COST	%	7		1,384,344
CONSTRUCTION MANAGEMENT	%	8		1,582,107
PROJECT MANAGEMENT	%	3		593,290
PROJECT SUBTOTAL				**$23,336,078**
Relay Rail Salvage Value	TN	352	-475	(167,200)
Scrap Value for Rail	TN	2,870	-75	(215,250)
Scrap Value for TO's	EA	16	-1075	(17,200)
Scrap Value for OTM	TN	907	-75	(68,025)
Scrap Value for Ties	EA	19,150	-1	(19,150)
PROJECT TOTAL				**$22,849,253**

SOURCE: Wilbur Smith Associates --> August 1995

Table B–8

ESTIMATED COST
OF
OPERATING SENARIO NO. 4

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	19,150	50	957,500
Renew Switch Ties	MBM	44	1,600	70,400
Renew Rail 115#	TF	116,160	45	5,227,200
Istall Rail Anchors	EA	13,788	2	27,576
Line & Surface	TF	169,998	2	339,996
Rework Grade Crossing	LF	1,692	250	423,000
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	62	150	9,300
Bridge Improvements	LF	184	250	46,000
Grade Crossing Protection 1–Track	EA	14	120,000	1,680,000
Grade Crossing Protection Upgade	LS			50,000
Train Control	LS			6,000,000
CONSTRUCTION SUBTOTAL				**$15,153,072**
CONTINGENCY	%	30		4,545,922
TOTAL CONSTRUCTION COST				**$19,698,994**
DESIGN COST	%	7		1,378,930
CONSTRUCTION MANAGEMENT	%	8		1,575,919
PROJECT MANAGEMENT	%	3		590,970
PROJECT SUBTOTAL				**$23,244,812**
Relay Rail Salvage Value	TN	352	–475	(167,200)
Scrap Value for Rail	TN	2,870	–75	(215,250)
Scrap Value for TO's	EA	16	–1075	(17,200)
Scrap Value for OTM	TN	835	–75	(62,625)
Scrap Value for Ties	EA	19,150	–1	(19,150)
PROJECT TOTAL				**$22,763,387**

SOURCE: Wilbur Smith Associates – – > August 1995

Table B–9

ESTIMATED COST
Crandic's Third Subdivision
And
Wye Track Construction
(Maximum Speed 25 MPH)

ITEM	UNIT	QUAN.	UNIT COST	COST
Rewnew Rail 115# (Includes OTM)	TF	11,104.0	$40.00	$444,160
Renew Crossties	EA	10,900.0	50.00	545,000
Switch Ties (Installed)	MBM	25.0	1,600.00	40,000
Rail Anchors (Installed)	EA	24,000.0	2.00	48,000
Joint Servicing	MI	21.8	3,000.00	65,400
Surface/Line Track (Including Ballast)	TF	115,104.0	2.00	230,208
Rework Grade Crossings (Including Materials)	TF	300.0	250.00	75,000
Bridges Repairs	LS			150,000
Wye Construction	LS			667,500
SUBTOTAL				**$2,265,268**
CONTINGENCY	%	30		679,580
TOTAL CONSTRUCTION COST				**$2,944,848**
DESIGN COST	%	7		206,139
CONSTRUCTION MANAGEMENT	%	8		235,588
PROJECT MANAGEMENT	%	3		88,345
SUBTOTAL				**$3,474,921**
Scrap Value for Rail	TN	430	(75)	(32,250)
Scrap Value for TO's	EA	0	(1,075)	0
Scrap Value for OTM	TN	78	(75)	(5,850)
Scrap Value for Ties	EA	10,900	(1)	(10,900)
PROJECT TOTAL				**$3,425,921**

Source: Wilbur Smith Associates --> February 1995

Table B-10

ESTIMATED COST
OF
OPERATING SENARIO NO. 1A

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	12,192	50	609,600
Renew Switch Ties	MBM	22	1,600	35,200
Renew Rail 115#	TF	108,160	45	4,867,200
Istall Rail Anchors	EA	13,788	2	27,576
Line & Surface	TF	164,346	2	328,692
Rework Grade Crossing	LF	1,647	250	411,750
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	60	150	9,000
Bridge Improvements	LF	239	250	59,750
Grade Crossing Protection 1-Track	EA	12	120,000	1,440,000
Grade Crossing Protection Upgade	LS			50,000
CONSTRUCTION SUBTOTAL				**$8,160,868**
CONTINGENCY	%	30		2,448,260
TOTAL CONSTRUCTION COST				**$10,609,128**
DESIGN COST	%	7		742,639
CONSTRUCTION MANAGEMENT	%	8		848,730
PROJECT MANAGEMENT	%	3		318,274
PROJECT SUBTOTAL				**$12,518,772**
Relay Rail Salvage Value	TN	251	-475	(119,225)
Scrap Value for Rail	TN	2,691	-75	(201,825)
Scrap Value for TO's	EA	16	-1075	(17,200)
Scrap Value for OTM	TN	778	-75	(58,350)
Scrap Value for Ties	EA	12,192	-1	(12,192)
PROJECT TOTAL				**$12,109,980**

SOURCE: Wilbur Smith Associates --> August 1995

Table B-11

ESTIMATED COST
OF
OPERATING SENARIO NO. 2A

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	12,192	50	609,600
Renew Switch Ties	MBM	22	1,600	35,200
Renew Rail 115#	TF	108,160	45	4,867,200
Istall Rail Anchors	EA	3,024	2	6,048
Line & Surface	TF	3,696	2	7,392
Rework Grade Crossing	LF	1,647	250	411,750
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	60	150	9,000
Bridge Improvements	LF	102	250	25,500
Grade Crossing Protection 1-Track	EA	12	120,000	1,440,000
Grade Crossing Protection Upgade	LS			50,000
CONSTRUCTION SUBTOTAL				**$7,783,790**
CONTINGENCY	%	30		2,335,137
TOTAL CONSTRUCTION COST				**$10,118,927**
DESIGN COST	%	7		708,325
CONSTRUCTION MANAGEMENT	%	8		809,514
PROJECT MANAGEMENT	%	3		303,568
PROJECT SUBTOTAL				**$11,940,334**
Relay Rail Salvage Value	TN	251	-475	(119,225)
Scrap Value for Rail	TN	2,691	-75	(201,825)
Scrap Value for TO's	EA	16	-1075	(17,200)
Scrap Value for OTM	TN	778	-75	(58,350)
Scrap Value for Ties	EA	12,192	-1	(12,192)
PROJECT TOTAL				**$11,531,542**

SOURCE: Wilbur Smith Associates --> August 1995

Table B-12
ESTIMATED COST OF OPERATING SENARIO NO. 3A

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	17,942	50	897,100
Renew Switch Ties	MBM	44	1,600	70,400
Renew Rail 115#	TF	108,160	45	4,867,200
Istall Rail Anchors	EA	13,788	2	27,576
Line & Surface	TF	164,346	2	328,692
Rework Grade Crossing	LF	1,647	250	411,750
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	60	150	9,000
Additional Curve Spiking	LS			26,689
Bridge Improvements	LF	239	250	59,750
Grade Crossing Protection 1-Track	EA	12	120,000	1,440,000
Grade Crossing Protection Upgade	LS			50,000
Train Control	LS			5,693,182
CONSTRUCTION SUBTOTAL				**$14,203,439**
CONTINGENCY	%	30		4,261,032
TOTAL CONSTRUCTION COST				**$18,464,471**
DESIGN COST	%	7		1,292,513
CONSTRUCTION MANAGEMENT	%	8		1,477,158
PROJECT MANAGEMENT	%	3		553,934
PROJECT SUBTOTAL				**$21,788,075**
Relay Rail Salvage Value	TN	251	-475	(119,225)
Scrap Value for Rail	TN	2,691	-75	(201,825)
Scrap Value for TO's	EA	16	-1075	(17,200)
Scrap Value for OTM	TN	778	-75	(58,350)
Scrap Value for Ties	EA	17,942	-1	(17,942)
PROJECT TOTAL				**$21,373,533**

SOURCE: Wilbur Smith Associates --> August 1995

Table B–13
ESTIMATED COST OF OPERATING SENARIO NO. 4A

ITEM	UNIT	UNIT QUAN.	UNIT COST	TOTAL COST
New 115# RE #10 TO (S.H.)	EA	16	$20,000	$320,000
Renew Ties	EA	18,342	50	917,100
Renew Switch Ties	MBM	44	1,600	70,400
Renew Rail 115#	TF	108,160	45	4,867,200
Istall Rail Anchors	EA	13,788	2	27,576
Line & Surface	TF	154,818	2	309,636
Rework Grade Crossing	LF	1,647	250	411,750
Joint Servicing	MI	1	3,000	2,100
Install Crossbucks	EA	60	150	9,000
Bridge Improvements	LF	184	250	46,000
Grade Crossing Protection 1–Track	EA	12	120,000	1,440,000
Grade Crossing Protection Upgade	LS			50,000
Train Control	LS			6,000,000
CONSTRUCTION SUBTOTAL				**$14,470,762**
CONTINGENCY	%	30		4,341,229
TOTAL CONSTRUCTION COST				**$18,811,991**
DESIGN COST	%	7		1,316,839
CONSTRUCTION MANAGEMENT	%	8		1,504,959
PROJECT MANAGEMENT	%	3		564,360
PROJECT SUBTOTAL				**$22,198,149**
Relay Rail Salvage Value	TN	251	–475	(119,225)
Scrap Value for Rail	TN	2,691	–75	(201,825)
Scrap Value for TO's	EA	16	–1075	(17,200)
Scrap Value for OTM	TN	778	–75	(58,350)
Scrap Value for Ties	EA	18,342	–1	(18,342)
PROJECT TOTAL				**$21,783,207**

SOURCE: Wilbur Smith Associates --> August 1995

DATE DUE
