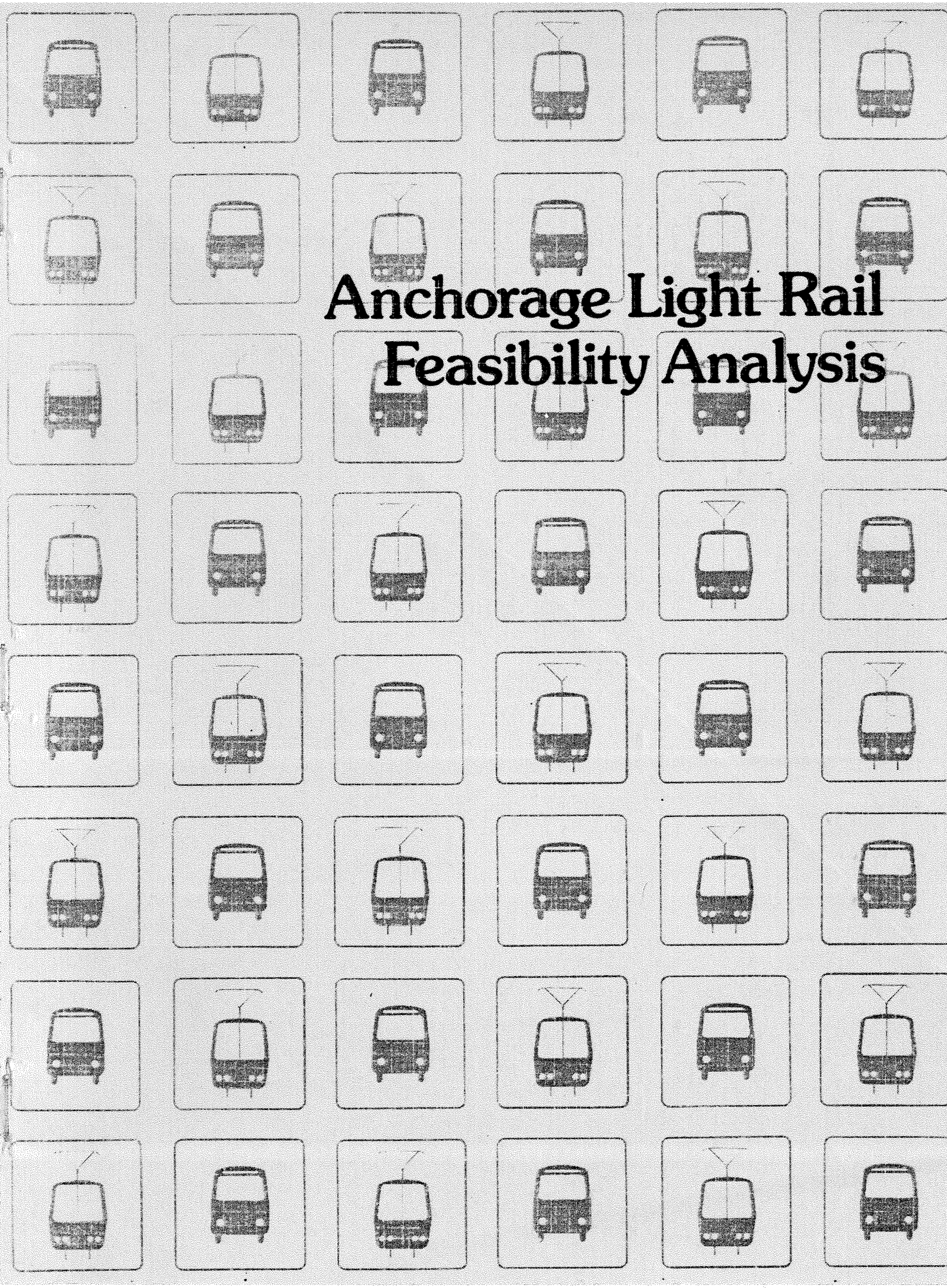

Anchorage Light Rail Feasibility Analysis

ANCHORAGE LIGHT RAIL
FEASIBILITY ANALYSIS

Prepared for Municipality of Anchorage, Alaska
In Cooperation with
Alaska Department of Transportation
and Public Facilitities

June, 1979

Project 981–100

prc
A Planning Research Company

Alan M. Voorhees & Associates, Inc.
Transportation, Environmental and Urban Planning Consultants
2150 Shattuck Avenue • Berkeley, California 94704

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SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

During the next 15-20 years the Municipality of Anchorage will face a doubling of its current population from about 200,000 to nearly 400,000 people by 1995. This projected growth will have profound impacts on the shape and character of the region, the lifestyle of its inhabitants, and the relative ease or difficulty of travel within the metropolitan area. It is clear that if current levels of mobility are to be maintained then a significant portion of urban travel will need to be shifted from the private automobile to public transportation.

BACKGROUND

This study is directed at exploring the feasibility of utilizing a light rail technology to satisfy these future needs for improved transit service in the Municipality. Conducted for the Municipality of Anchorage by Alan M. Voorhees & Associates, Transportation and Urban Planning Consultants, this study attempted to answer the following specific questions:

- Can a light rail system adequately serve major travel corridors in the Anchorage area, considering the prevailing relatively low land use densities?
- If so, what are the associated capital and operating expenditures and the system's cost-effectiveness as compared to an express busway system?
- What potential Federal funding sources are available to assist in the implementation and operation of such a system?
- What are the likely transportation/land use development implications of a light rail system, and can the two be mutually supportive?

Principally, the light rail transit (LRT) mode represents a modern version of transit systems traditionally called trams, trolleys and streetcars. An overhead power supply is utilized and lighter-weight cars can be operated singly or in trains. Heavy rail transit systems, such as BART and the Washington, D.C. Metro, have train characteristics and electric power collection techniques requiring an exclusive and fully grade-separated trackway. LRT systems, however, do not require grade separation and may be operated safely and effectively on City streets, transit malls, street medians, as well as on exclusive or grade-separated rights-of-way. It is principally these features of flexibility and adaptability that allow LRT systems to be built for considerably lower capital cost outlays than for other forms of rail rapid transit.

The expansion of LRT systems throughout the world has led to an incremental, but rapid, improvement of the Light Rail Vehicle (LRV) technology in the past decade. Many of the advances have been made by European manufacturers, although a very low degree of vehicle standardization has developed among different manufacturers. In the United States, the Urban Mass Transportation Administration (UMTA) has developed the specifications for a standard light rail vehicle for use by U.S. operators. This Boeing vehicle is being implemented in Boston and San Francisco, and is illustrated in Figure S-1.

Light rail vehicles are electrically powered, steel-wheeled and run on conventional gauge steel track. They are lighter in weight, smaller in capacity, more maneuverable, and less expensive than conventional urban rail vehicles. Typical operating speeds of LRT range from 10 to 30 mph including station stops, with capacities of up to 20,000 passengers per hour per direction. Maximum train speeds are typically around 50 mph.

By its very nature, the light rail mode lends itself to servicing high-density travel corridors where the majority of riders can walk to and from the line, and where traffic congestion is typically most severe. If a light rail system is feasible in Anchorage, then it would be most likely along these higher-density corridors. For this reason, several corridors were investigated which would produce a relatively high travel demand, not only today, but especially in the future.

FIGURE S-1
U.S. STANDARD LIGHT RAIL VEHICLE

The four separate travel corridors within the Municipality which were identified for detailed feasibility analysis are listed below, and are also shown in Figure S-2.

Corridor 1: Alaska Railroad Route (ARR) Corridor
Corridor 2: C Street Corridor
Corridor 3: East Northern Lights Boulevard/C Street Corridor
Corridor 4: West Northern Lights Boulevard/C Street Corridor

In the Alaska Railroad corridor, LRT would run within the existing ARR right-of-way. In the other three corridors, LRT would run parallel and adjacent to the existing roadway. Corridors 2, 3, and 4 would share a common section between downtown and Northern Lights Boulevard. A Busway in the C Street corridor was also evaluated, to allow a comparison of the operational and cost-effectiveness of the two modes.

Two design years were selected for study purposes, 1985 and 1995. In the shorter term, 1985 would represent the earliest possible date LRT could be implemented in the area. In the longer term, a 1995 design year allows for a wider ranging consideration of LRT feasibility including, for example, the interaction between light rail and land use development policies.

Potential LRT and Busway riderships were projected for both target years. Rather than attempting to forecast a specific ridership level, an "envelope" approach to forecasting ridership was adopted. This comprised low (pessimistic) and high (optimistic) assumptions, in order to estimate the minimum and maximum LRT riderships that may reasonably be expected in each of the four corridors.

The subsequent analysis and evaluation were based principally on the high ridership estimates. However, the sensitivity of various performance and economic criteria to the lower ridership estimates was also investigated at various points in the study.

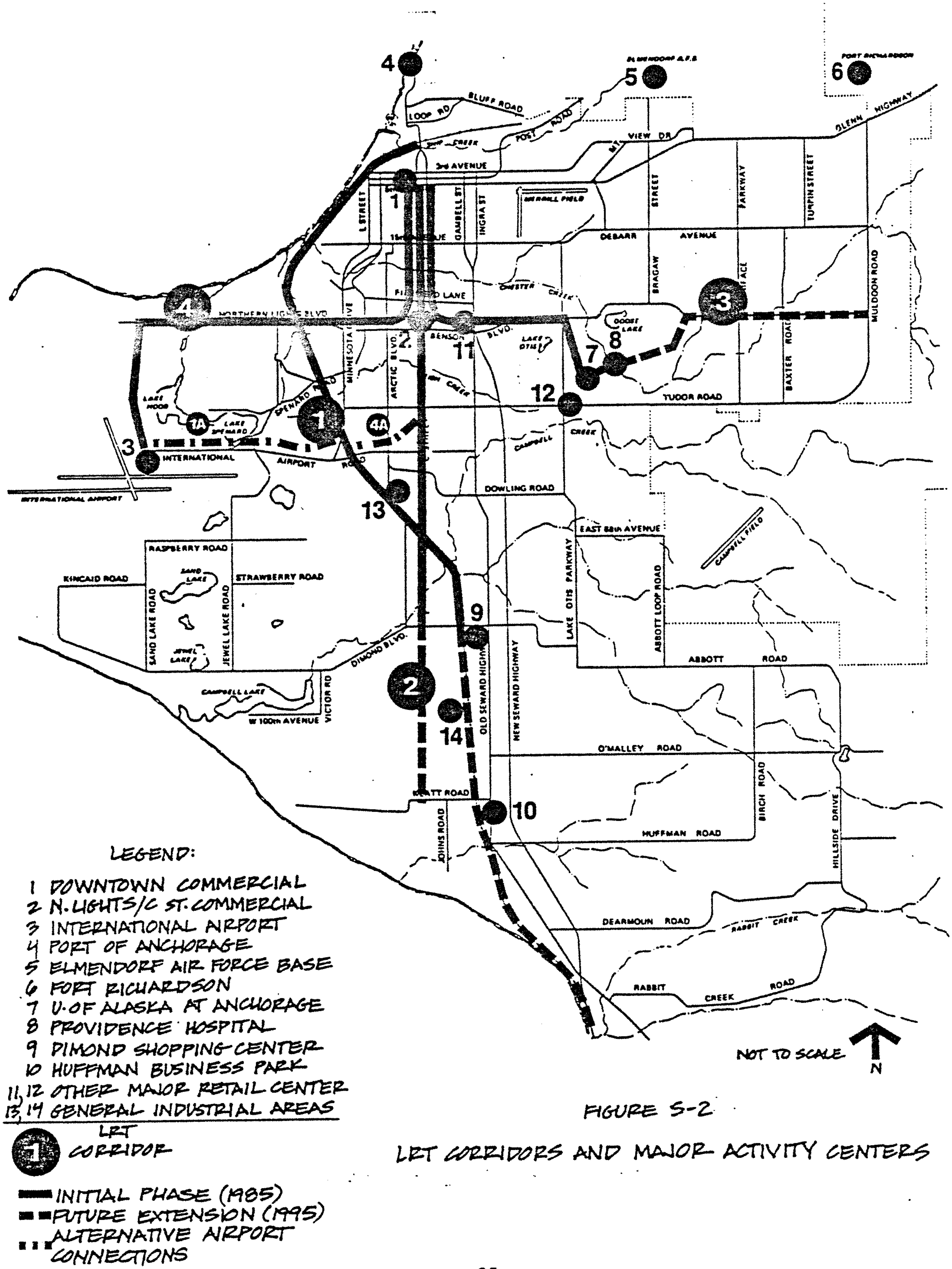

FIGURE S-2

LRT CORRIDORS AND MAJOR ACTIVITY CENTERS

The LRT and Busway service levels that would be necessary to carry the projected riderships were estimated for both 1985 and 1995. Aspects of transit service studied included hours of operation, train frequencies, route lengths and station spacing, train operating speeds, and travel time.

LRT service in 1985, representing initial construction and operation, would essentially comprise shorter routes, restricted service periods, and less frequent train service than the full system assumed for 1995. Initial hours of LRT operation would be from 6 a.m. to 8 p.m., Monday through Saturday, with no Sunday operation. By 1995, when the full lengths of the lines would be in operation, it is assumed that weekday service would be expanded to run from 6 a.m. to 12 a.m., and that a Sunday/Holiday service would operate between 8 a.m. and 10 p.m. Similar operating characteristics were assumed for the Busway.

ECONOMIC EVALUATION

Projected cost summaries for the LRT and Busway systems are presented in Tables S-1 to S-3. The costs were developed as planning estimates for study purposes, and are thus order-of-magnitude costs rather than detailed engineering cost estimates. However, since light rail transit utilizes principally "off-the-shelf" technology and hardware, development costs would not be a significant element of overall capital costs.

CAPITAL COST ESTIMATES

Table S-1 summarizes the total system capital costs by corridor for both 1985 and 1995. The capital costs for LRT in 1995 range from a low of $82.87 million for the West Northern Lights corridor to a high of $142.30 million for the East Northern Lights corridor, all uninflated in 1979 dollars. The C Street LRT line would be the second most expensive to build, at $134.41 million, with the Alaska Railroad corridor ranking third at $104.79 million. The difference in total system costs is a function of the varying LRT line lengths and right-of-way conditions, as

TABLE S-1

CAPITAL COST COMPARISON: 1985 AND 1995
($ million)1/

Total System Costs2/	LRT3/ ARR	LRT3/ C Street	LRT3/ East North Lights	LRT3/ West North Lights	Busway C Street
1985					
Excluding Vehicles					
Total	$53.60	$86.60	$82.23	$69.40	$33.50
Per Route Mile	7.88	15.46	16.78	10.68	5.98
Including Vehicles					
Total	59.90	99.20	92.13	77.50	37.00
Per Route Mile	8.81	17.71	18.80	11.92	6.61
1995					
Excluding Vehicles					
Total	$90.39	$107.41	$115.30	$70.27	$53.89
Per Route Mile	7.79	14.32	14.60	10.81	7.19
Including Vehicles					
Total	104.79	134.41	142.30	82.87	63.13
Per Route Mile	9.03	17.92	18.01	12.75	8.42

1/ 1979, Anchorage costs (includes 15% for engineering and administration and 25% for contingencies).

2/ Costs are based on "High" ridership estimates.

3/ Total costs for each individual LRT line. An LRT 'system' or joint implementation of some corridors would result in lower costs due to possibilities for sections of shared trackage.

well as the number of vehicles required.

The 1995 costs per route mile would be lowest for the Alaska Railroad corridor, at $9.03 million/mile, reflecting the availability of suitable right-of-way. The highest costs per route mile, of $18.01 million/mile and $17.92 million/mile, would be for the East Northern Lights and C Street corridors respectively. The higher costs per route mile for these two corridors would be due to two principal reasons. First is the more complex right-of-way conditions that would be faced, for example, the subway sections. The second principal reason would be the more intensive service levels that would be provided on these lines. The more frequent service and longer train lengths would require larger vehicle operating fleets. The costs of providing a busway in the C Street corridor would be about half the costs of providing LRT in the same corridor, $63.13 million for the busway compared to $134.41 million for LRT.

The lower 1985 capital costs for both LRT and the busway reflect the shorter service lines assumed for that year of system implementation, and also the generally lower service levels, and thus less vehicles required for the lower ridership projected in 1985.

OPERATING COST AND SUBSIDY ESTIMATES

The projected annual operating costs for all four LRT lines, and the C Street Busway are shown in Table S-2. Also shown in the Table are the projected annual revenues and annual operating subsidies that would be required for each system. As can be seen, the 1995 annual LRT operating costs would range from a low of $2.36 million for the West Northern Lights line to a high of $6.97 million for the C Street line. By comparison, annual operating costs for the C Street Busway would be $8.15 million, just over 15% higher than for LRT operating in the same corridor. None of the transit systems under evaluation, LRT or Busway, would generate sufficient revenue to cover operating expenses. All LRT lines and the busway would thus require varying amounts of operating subsidies.

TABLE S-2

1995 ANNUAL OPERATING COSTS, REVENUES AND SUBSIDIES REQUIRED
(1979 MILLION DOLLARS)

Corridor 1/	Annual Operating Cost	Annual Fare Revenue 2/	Annual Operating Subsidy 3/	Recovery Ratio 4/ Fare Revenue as % of Operating Cost
LRT 5/				
ARR	$4.71	$1.48	$3.23	16-31%
C Street	6.97	3.65	3.32	31-52%
East Northern Lights	6.08	2.79	3.29	27-46%
West Northern Lights	2.36	1.34	1.02	38-57%
Busway 5/				
C Street	$8.15	$3.54	$4.61	22-43%

1/ Costs assume independent operation of LRT lines.

2/ Revenue accruing to trunk line service. Based on average fare revenue of 25¢ per passenger for LRT and 19¢ per passenger for Busway. Lower Busway value due to greater proportion of line haul passengers using feeder services for this mode. Revenue estimates based on "High" ridership estimate.

3/ Total subsidy required from local, State and Federal sources.

4/ Ranges of recovery ratios correspond to low and high ridership estimates, and are based on high ridership service provision throughout.

5/ Represents line-haul portion only, exclusive of feeder bus system.

The C Street Busway would require the largest absolute operating subsidy, $4.61 million per year in 1995, or about 40% more than would be required for LRT in that corridor. The annual operating subsidies required for the LRT lines in the ARR, C Street, and East Northern Lights corridors would be very similar, all being about $3.3 million per year.

Table S-3 provides an overall summary of the economic characteristics of each alternative for 1995. The figures in Table S-3 apply to each corridor individually without consideration of potential cost reductions which would result from simultaneous implementation and operation of several corridors. In general, the operating costs would be affected very little, as each line would be operated independently to the downtown area. The combined capital costs, however, would be less due to the sharing of the tracks between the Northern Lights Boulevard/C Street intersection and downtown.

Of particular interest in Table S-3 are the annual operating subsidy per passenger and the total subsidy per passenger. In absolute terms the C Street LRT line would be the second most expensive to build and the C Street Busway would require the highest operating subsidy. However, on a per passenger basis these two facilities rank very favorably among the corridors studied in terms of both operating and total subsidies that would be required. This is due to the relatively high riderships that would be attracted to these systems compared to the other light rail alternatives evaluated.

CONCLUSIONS

- Light Rail Transit (LRT) would be technically feasible in all four corridors investigated without major engineering problems being encountered. Southcentral Alaska's winter conditions and local topographic features do not present any conflicts with the light rail mode.
- Although the four travel corridors analyzed would contain the highest activity and residential concentrations in the Municipality, projected population densities in the corridors for 1995 will remain significantly below those normally associated with light rail transit facilities in older and longer established urban areas.

TABLE S-3

COST COMPARISON OF ALTERNATIVES (1995)1/
(HIGH RIDERSHIP ESTIMATE)

Criterion	LRT Corridor				Busway
	Alaska RR	C Street	Northern Lights (East)	Northern Lights (West)	C Street
Weekday Passengers Carried	19,800	48,800	37,300	17,900	62,400
Annual Operating Costs	$4.7 million	$7.0 million	$6.1 million	$2.4 million	$8.1 million
Operating Cost/Vehicle Mile	$4.13	$4.13	$4.13	$4.13	$3.31
Annual Fare Revenue	$1.5 million	$3.7 million	$2.8 million	$1.3 million	$3.5 million
Annual Operating Subsidy	$3.2 million	$3.3 million	$3.3 million	$1.0 million	$4.6 million
Fare as % of Operating Cost	31%	52%	46%	57%	43%
Average Fare Revenue/Passenger	$0.25	$0.25	$0.25	$0.25	$0.19
Operating Subsidy/Passenger	$0.55	$0.23	$0.29	$0.19	$0.25
Total Capital Cost	$105 million	$134 million	$142 million	$ 83 million	$ 63 million
Capital Cost/Route Mile	$9.0 million	$17.9 million	$18.0 million	$12.8 million	$8.4 million
Annualized Capital Cost2/	$11.1 million	$14.3 million	$15.1 million	$ 8.8 million	$6.7 million
Annual Capital Cost/Passenger	$1.88	$0.98	$1.35	$1.64	$0.36
Total Subsidy3//Passenger	$2.43	$1.21	$1.64	$1.83	$0.61
Annual Total Cost (capital and operating)	$15.8 million	$21.3 million	$21.2 million	$11.2 million	$14.8 million

1/ In 1979 Anchorage dollars.

2/ Based on 10% amortization over 30 years.

3/ Annual capital and operating cost.

- The highest LRT riderships would be generated in the C Street and East Northern Lights corridors with respectively about 5,000 and 4,000 passengers per peak hour in the peak direction (under the more favorable ridership assumptions) in 1995. A C Street Busway would generate almost 30% more riders than an LRT line in that corridor primarily due to the non-transfer, door-to-door feature of the bus mode.

- It is estimated that the LRT lines tested would attract between 4.5% and 7.0% of the daily total person travel within the specific corridors. Even if the share of the local People Mover bus system (currently less than 1%) is added, the LRT system would fall considerably short of the areawide 14.4% transit modal split goal contained in the Long Range Plan Element.

- From a cost-economic standpoint, light rail appears to be feasible only if considerable capital funding and operating subsidies were committed. None of the LRT or busway alternatives tested would be financially self-supporting in terms of either capital or operating costs. Of the four LRT lines evaluated, the C Street line exhibits the most favorable cost-effectiveness and the ARR line the least favorable.

- In terms of total subsidies required per passenger (including both operating and annual capital costs), the alternatives would rank as follows:

C Street Busway	Lowest Subsidies
C Street LRT	↓
East Northern Lights LRT	
West Northern Lights LRT	
Alaska Railroad LRT	Highest Subsidies

- It seems very difficult to justify the construction of a light rail facility in the ARR corridor, even though the transportation right-of-way may be available at no or little cost. This is due principally to the low projected ridership demand, the high operating costs, and the interference between LRT and ARR industry spur track traffic.

- It also seems difficult to justify LRT implementation in the West Northern Lights corridor purely on economic criteria since a much larger ridership could be served in other major corridors more cost-effectively. The Anchorage International Airport was not found to generate sufficient demand in 1995 to support light rail access by itself.

- The C Street Busway would entail lower capital costs than LRT on C Street ($63 million versus $134 million) but would be more expensive to operate ($8.1 million annually versus $7.0 million).

- The operating subsidy per passenger would be about equal for both LRT and the Busway in the C Street corridor, at approximately 25¢ per passenger. The total annual subsidy required, however, (including capital financing), would be about half as low for the Busway as for LRT (61¢ per passenger versus $1.21 per passenger).

- A sensitivity analysis indicated that neither a 50% increase over projected ridership levels (representing an energy crisis scenario) nor a doubling of fares without service reduction, would produce fare revenues in excess of operating expenses. Both scenarios, however, would reduce the operating subsidies required.

- Potentially, Federal capital grants would be available for up to 80% of the construction costs of LRT or a busway, through the Urban Mass Transportation Administration (UMTA). Funding would not, however, be automatic as many cities and projects compete for limited funds. UMTA's current funding policies require a substantial local planning commitment to LRT. This would need to be expressed in the form of supportive land development policies and transportation management actions designed to enhance the proposed system's cost-effectiveness, patronage, and prospect for economic viability. In addition, UMTA would need to be assured of the availability of local funds to cover the local share of capital expenditures, and even more importantly, the recurring annual operating subsidies.

RECOMMENDATIONS

- Continuing efforts should be made to build up transit ridership in the three best performing study corridors and the Glenn Highway corridor. This will enhance the future feasibility of a higher capacity line haul transit mode in these corridors. Special attention should be given to the C Street corridor since future developments in Anchorage are projected to concentrate in the vicinity of this broad north-south corridor.

- A high capacity line haul mode such as express buses operating in their own right-of-way (busway) or light rail transit (LRT) should be retained as a long-term strategy for the C Street corridor. A realistic phasing program for stepwise implementation of public transportation improvements in the C Street corridor would comprise the following:

    1. Build up People Mover bus ridership in this corridor.

    2. Implement a busway in stages to bypass traffic congestion points as they develop and as construction opportunities arise. Especially, consider bus or high-occupancy vehicle lanes in conjunction with the planned A and C Street couplet implementation.

3. Consider conversion of the busway to light rail as transit demand increases and higher capacities are required. The current studies indicate that this phase would not be reached by 1995 under the current land development policies and plans.

A similar program appears to be justified for the Northern Lights/ Benson corridor primarily east of C Street to the vicinity of the University of Alaska at Anchorage.

- The available, but presently unutilized, transportation right-of-way of C Street south of 36th Avenue should be preserved for public transportation or shared transit/traffic purposes.

- Land development and transportation policies that are supportive of a busway or light rail system should be initiated. These would include:

  1. Channeling future development into more concentrated and denser corridors. Such patterns would be more suitable for higher capacity rail systems than the currently projected 1995 development patterns.

  2. Encouraging multi-family residential land uses along major corridors and concentrating employment in downtown and the Northern Lights/Benson/C Street area.

  3. Auto disincentive policies and actions to reduce the competition of the private automobile and achieve a higher transit modal split.

  In order for a light rail system to be viable, it would be necessary to approximately double the 1995 projected commercial densities in the downtown and Benson/Northern Lights/C Street area, and to almost triple the projected residential densities in the broad C Street corridor.

- Zoning and set/back regulations should be developed and implemented which will create, over a longer time span, a wider transportation right-of-way for use by public transportation at a future date. This would apply particularly to the C Street corridor north of 36th Avenue, the Northern Lights corridor, the 5th Avenue/Glenn Highway corridor, and possibly to other major corridors in the City.

- The feasibility of local and State funding options for major public transportation improvements such as a C Street Busway or Light Rail Line should be seriously explored. This is particularly pertinent since local funding capabilities appear to be the paramount prerequisite for any further light rail planning in the Anchorage region.

- Finally, it appears to be essential to determine whether or not land development policies or controls that would actively support light rail transit would be politically acceptable, given the past development history of the Anchorage region. The above issue is of immediate concern considering that the region's population will approximately double within the next 15 years. The existing transportation networks however, both roads and transit facilities, are scheduled to receive only relatively minor additions and capacity improvements over the same time span.

I
INTRODUCTION

I. INTRODUCTION

Over the coming 15-20 years the Municipality of Anchorage will face a doubling of its current population from about 200,000 to nearly 400,000 inhabitants by 1995; similarly, the employment level is also projected to increase almost twofold as shown in Table I-1 and Figure I-1. Considering the relatively young age of this city, this projected growth will have profound impacts on the shape and character of this region, and the life-style of its inhabitants. The most visible impact of these changes will likely be in a greater densification of land use and urban development and in the relative ease or difficulty of travel within the metropolitan area.

The projected population and employment growth, coupled with an only moderate increase of highway and street capacity over the life of the Long-Range Plan Element[1/] will, without doubt, negatively affect future traffic conditions and travel speeds in the major travel corridors in the Municipality unless a major portion of the urban travel can be shifted from the private automobile to public transportation. The Long-Range Plan indicates that over 14% of the daily urban travel in 1995 would have to be accommodated by public transit in order to achieve reasonable travel conditions and service levels on the region's highway system. Although, by general concensus, this diversion percentage is considered unrealistically high and in all likelihood not achievable on a regional basis, the figure illustrates the need to seriously consider alternative travel modes. Aside from future lack of adequate highway capacity, potential increases in fuel costs or limited availability of gasoline place further emphasis on providing for a convenient, fast and cost-effective public transportation system to serve the region's needs.

This current study is directed at exploring the feasibility of utilizing a light rail technology and upgrading of existing railroad passenger

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1/ Long-Range Element 1977-1995, Anchorage Metropolitan Area Transportation Study, October 1977.

TABLE I-1

POPULATION AND EMPLOYMENT PROJECTIONS
(ANCHORAGE BOWL)1/

Year	Population		Employment	
	No.	% Growth	No.	% Growth
1975	153,700		79,700	
		34%		31%
1980	205,800		104,500	
		30%		28%
1985	267,600		134,000	
		19%		18%
1990	317,900		157,800	
		18%		18%
1995	376,700		185,700	

1/ Including military bases, but excluding Eagle River-Chugiak.

Sources: "Metropolitan Anchorage Urban Study (MAUS)," by U.S. Army Corps of Engineers, Anchorage, Alaska, June 1977, and "1995 Employment, Population, and Land Use Forecasts," by Municipality of Anchorage Planning Department, March 1977.

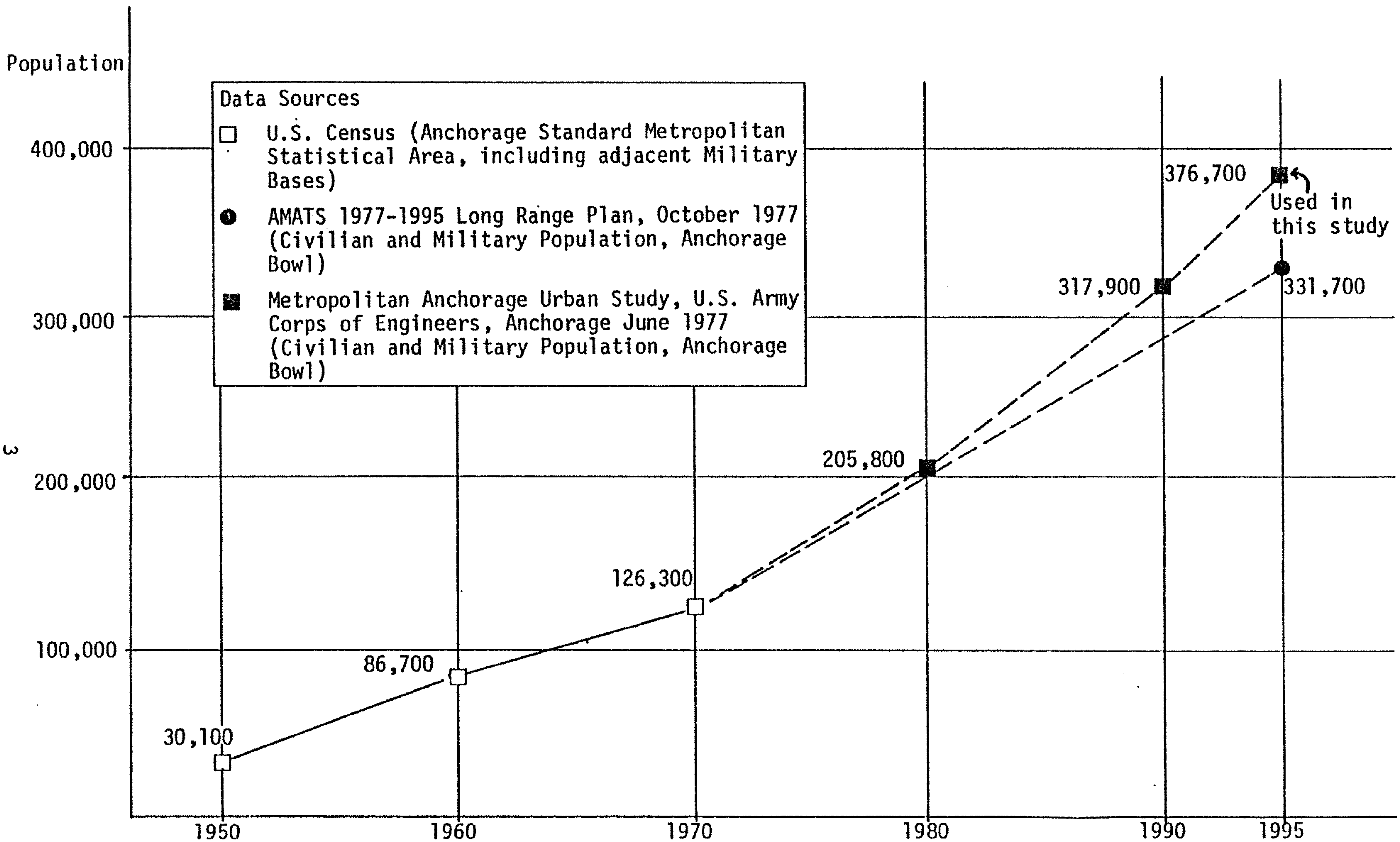


FIGURE I-1

PAST AND PROJECTED POPULATION GROWTH
MUNICIPALITY OF ANCHORAGE

service to satisfy these future needs for improved transit service. The studies, conducted for the Municipality of Anchorage by Alan M. Voorhees & Associates, Transportation and Urban Planning Consultants, attempted to answer the following specific questions:

- Can a light rail system adequately serve major travel corridors in the Anchorage area, considering the prevailing relatively low land use densities?
- If so, what are the associated capital and operating expenditures and the system's cost-effectiveness as compared to an express busway system?
- What potential Federal funding sources are available to assist in the implementation and operation of such a system?
- What are the likely transportation/land use development implications of a light rail system, and can the two be mutually supportive?
- Is it feasible and cost-effective to upgrade the existing passenger rail service on the Alaska Railroad to provide improved regional service for the communities to the north and south of Anchorage?

The findings, conclusions, and recommendations resulting from the analysis of these issues are documented in two separate reports: this report and a companion report entitled "Feasibility Analysis of Upgraded Passenger Rail Service on the Alaska Railroad." The first report deals with the feasibility of light rail within major urban travel corridors of Anchorage, while the second report addresses the feasibility of upgrading Alaska Railroad passenger service to Nancy Lake/Wasilla and Whittier/Portage.

It should be understood that the current studies are planning studies aimed at assisting in making long-range transportation policy decisions. Although the engineering feasibility of the various routes and alignments under study has been verified, detailed engineering and design studies will have to await a later time.

II

LIGHT RAIL TRANSIT AS AN URBAN TRANSPORTATION MODE

II. LIGHT RAIL TRANSIT AS AN URBAN TRANSPORTATION MODE

A growing recognition of the need for a balanced urban transportation system has led to a renewed interest in transit planning in recent years. This change in attitude has been caused by a number of reasons, including the concern for the negative environmental and social impacts created by the heavy dependence upon the auto mode, and the concern for the future scarcities of natural resources. As a result, public policies have evolved which provide financial and other assistance to public transit agencies.

The scope of transit planning has widened in the process, and transit planners have begun to realize that the prevalent U.S. transit modes of bus and rail transit may not be entirely adequate for the emerging transit needs of some U.S. cities. The high operating cost of buses, traffic congestion and downtown distribution problems, and the concern for fuel availability make a bus system relatively expensive to operate in medium to large-size cities. On the other hand, the high capital costs of rail systems make them economically infeasible in all but a few U.S. cities with high population densities and very high levels of transit patronage. Recognition of this gap has caused many U.S. cities to study alternative fixed guideway systems with lower capital investments than conventional rail rapid systems, such as automated guideway systems and busways; however, these modes have their specific deficiencies.

The considerable potential of Light Rail Transit (LRT) as an intermediate capacity mode has become more recognized in view of the European experience with LRT. Their experience indicates that the existing light rail systems in North America do not represent the full potential of the mode, and that light rail offers a potentially attractive concept due to its adaptability to a variety of urban settings, its potentially lower costs, and its capability of staged implementation. The Urban Mass Transportation Administration (UMTA) has recognized this potential and has authorized the development of a standard light rail vehicle (LRV) for implementation in the U.S., and requires the evaluation of LRT in the alternatives analysis requirements wherever appropriate as a condition of Federal capital assistance to new rapid transit projects.

As shown in Figure II-1, in terms of passenger capacity and capital investment, the LRT mode falls somewhere between the busway and rail rapid transit1/ in the spectrum of urban transportation modes. In general, the domain of LRT systems can be viewed as an intermediate or better level of transit service requiring an intermediate level of capital and operating costs. Intermediate levels of need and rider demand are most often found in large and intermediate urban areas, although a host of other factors should be analyzed to determine the optimal transit mode for an urban area. The experience of many European cities seems to indicate the feasibility of this mode over a wide range of city sizes. Figure II-2 shows that LRT has been implemented in cities with populations ranging from 100,000 to well over a million. It seems to indicate a correlation between transit mode and riding habits, since higher ridership rates are experienced in cities with rail modes than in cities with buses only.

The purpose of this chapter is to describe the light rail mode and to detail the recent experience of light rail systems in North America.

A. What is Light Rail Transit (LRT)?

LRT is the name given to the type of technology which has traditionally been called trams, trolleys, or streetcars; however, it is the application of this technology to operate safely and effectively through at-grade conflict points which distinguishes LRT from streetcars and makes it a more efficient mode. The following definition of LRT was adopted by the Transportation Research Board Committee on Light Rail Transit:

1/ Such as the San Francisco Bay Area Rapid Transit (BART) or Washington METRO systems.

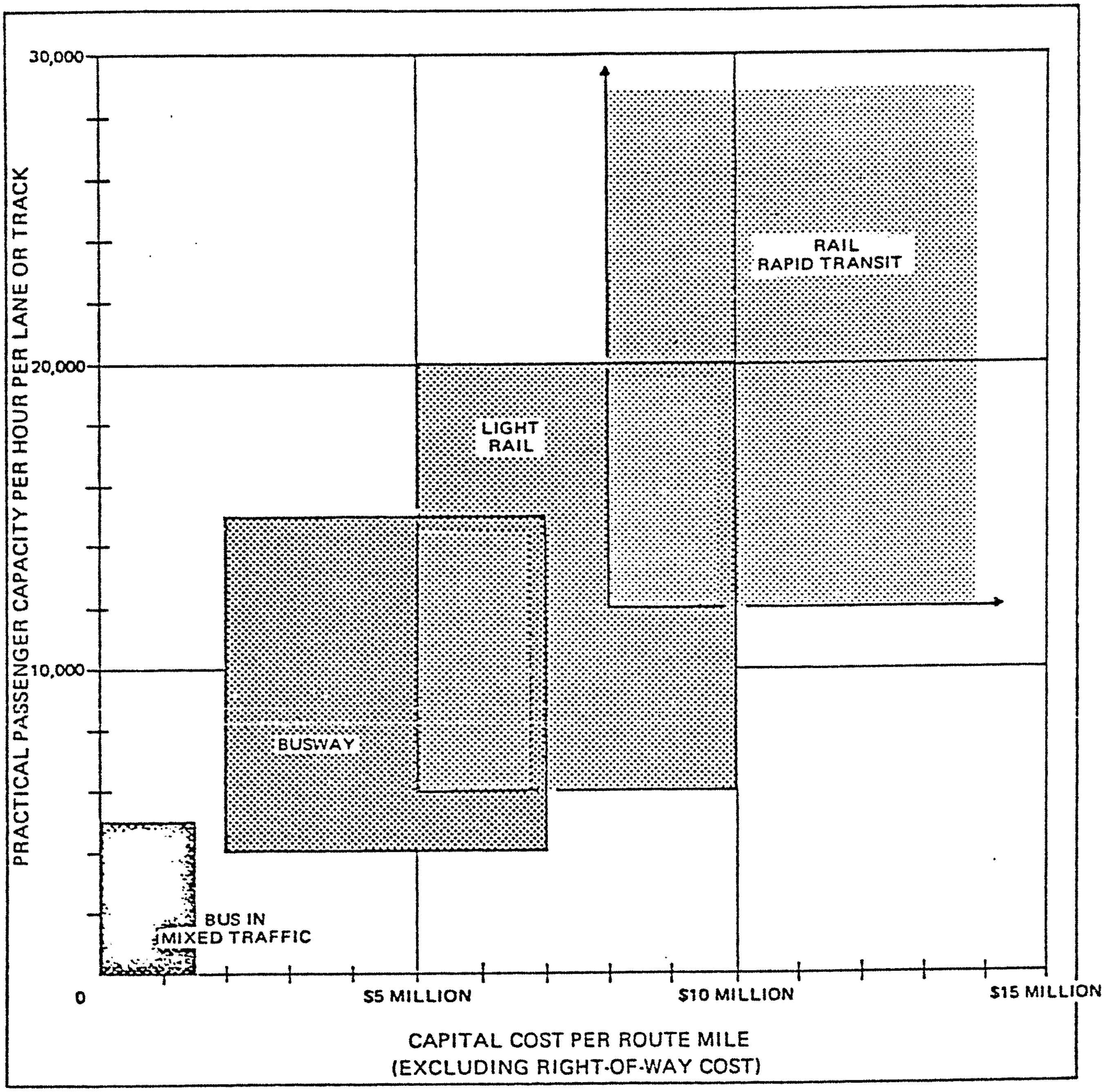
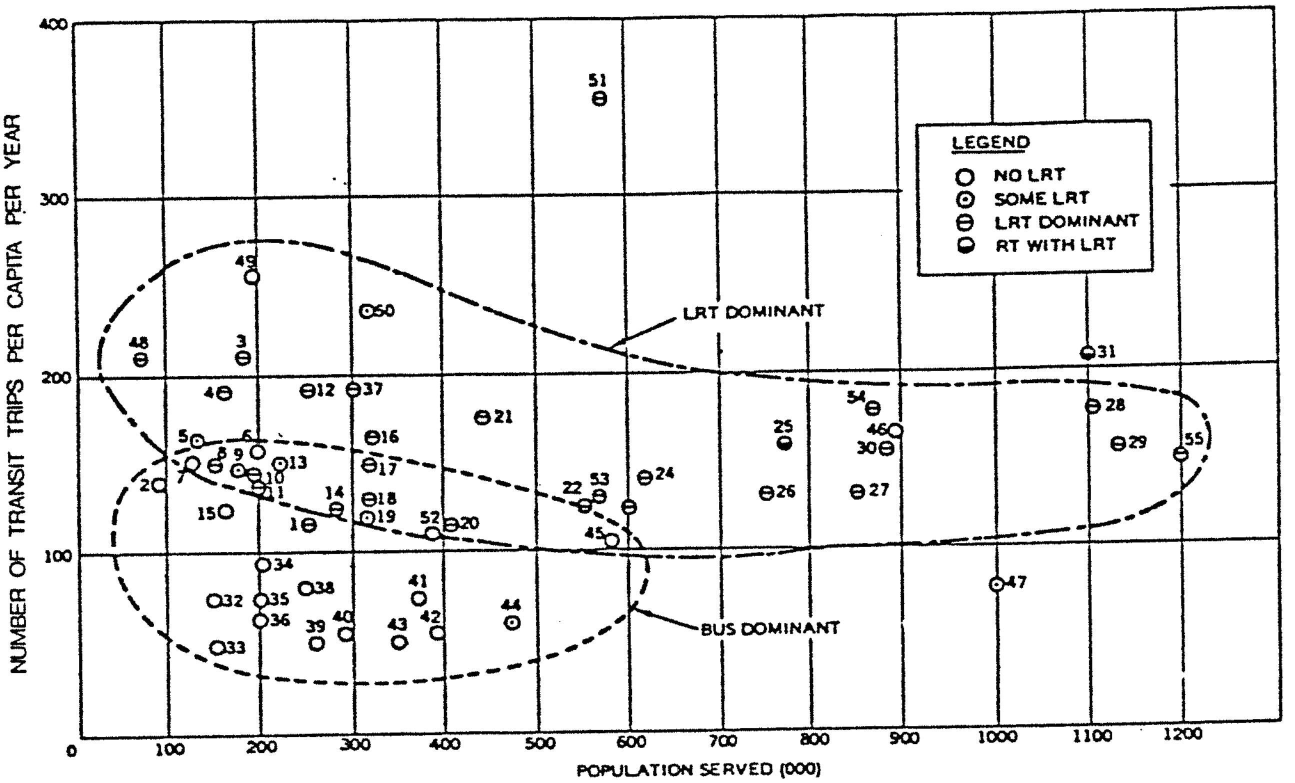


FIGURE II-1

SIMPLIFIED CAPACITY-COST ENVELOPES FOR URBAN TRANSIT SYSTEMS

Source: "A Manual Technique for Preliminary Transit Feasibility Analysis," by Alan M. Voorhees & Associates and others. Prepared for UMTA, New Systems Requirements Analysis Program, April 1973.



CITY/COUNTRY CLASSIFICATION

WEST GERMANY	1. HEIDELBERG 2. TRIER 3. LUDWIGSHAFEN 4. FREIBURG 5. ULM 6. OFFENBACH 7. PFORZHEIM 8. WURZBURG 9. BREMERHAVEN 10. DARMSTADT 11. MULHEIM	12. KASSEL 13. MAINZ 14. BIELEFELD 15. OSNABRUCK 16. KARLSRUHE 17. AUGSBURG 18. HAGEN 19. KIEL 20. BONN 21. MANNHEIM	22. WUPPERTAL 23. DUISBURG 24. BREMEN 25. NUREMBERG 26. ESSEN 27. HANNOVER 28. DUSSELDORF 29. COLOGNE 30. STUTTGART 31. MUNICH
FRANCE	32. METZ 33. LE MANS 34. TOURS 35. MULHOUSE 36. TOULON 37. SAINT-ETIENNE	38. NANCY 39. LE HAVRE 40. GRENOBLE 41. STRASBURG 42. NANTES	43. ROUEN 44. LILLE 45. BORDEAUX 46. LYON 47. MARSEILLE
SWITZERLAND	48. NEUCHATEL 49. LAUSANNE 50. GENEVA 51. ZURICH		
BELGIUM AND NETHERLANDS	52. UTRECHT 53. THE HAGUE 54. ROTTERDAM 55. BRUSSELS		

FIGURE II-2

RIDING HABIT AS A FUNCTION OF URBAN AREA SIZE
AND TRANSIT MODE PROVIDED

Source: "Light Rail Transit, A State-of-the-Art Review," by DeLeuw Cather & Company for Federal Department of Transportation, Washington, D.C., 1976.

"LRT is a mode of urban transportation utilizing predominantly reserved but not necessarily grade-separated rights-of-way. Electrically propelled rail vehicles operate singly or in trains."

The following paragraphs describe the technology and right-of-way operations of LRT.

1. Light Rail Vehicles

The LRT vehicle has evolved from the electrically powered, steel-wheeled vehicle traditionally used in streetcar operations. These vehicles are lighter in weight, smaller in capacity, and less expensive than conventional urban rail vehicles. In addition, these vehicles have several distinguishing features which permit different operating characteristics from conventional rail. An overhead electrical supply rather than a third rail power source can allow the system to operate in a mixed-traffic environment in addition to an exclusive right-of-way. The provision of high and low level loading (steps) capability allows the vehicle to operate from stations with or without high level platforms. Light rail vehicles may have on-board fare collection equipment so that the vehicle can operate at controlled access or open access stations. The above features permit an LRT system to be designed with elaborately designed, more costly stations in high activity areas, and simpler, less costly stations or no stations in low density areas. Other features may include an articulated vehicle designed to increase individual vehicle capacity and the ability to operate singly or in trains. In general, LRT can accommodate tighter turns and have lower acceleration characteristics than rapid rail vehicles.

Table II-1 provides a comparison of the operational and service aspects of Light Rail Transit with those of conventional Heavy Rail Transit modes. As can be seen, typical operating speeds of the LRT range from 10 to 30 mph depending on the degree of exclusive right-of-way with capacities of up to 20,000 passengers per hour per direction.

TABLE II-1

TECHNICAL AND SYSTEM CHARACTERISTICS OF URBAN RAIL MODES

	Light Rail Transit	Rail Rapid Transit	Regional Rail Transit
Fixed Facilities			
Right-of-way category	A, B or C	A only	A or B (occasionally)
Control	Visual/signal	Signal	Signal
Fare collection	On board/at station	At station	At station/on board
Power supply	Overhead/third rail	Overhead/third rail	Overhead/third rail or diesel
Stations: Platform height	Low or high level	High level	Low or high level
Stations: Access control	May be controlled	Fully controlled	Often controlled
Vehicle/Train Characteristics			
Minimum operational unit	1	1-2	1-2
Typical number of vehicles	2-4	2-10	2-10
Vehicle length (ft/m)	46-108/14-33	49-75/15-23	68-85/20-26
Vehicle capacity (seats/vehicle)	22-93	32-86	80-125
Vehicle capacity (total/vehicle) (for 2.7 ft^2 [0.25 m] per standee)	74-200	100-300	100-290
Operational Characteristics			
Operating speed (mph/kph)	10-30/15-45	15-40/25-60	20-45/30-70
Typical frequency peak hour, (per hour)	Up to 60	Up to 30	Up to 20
Capacity (passengers/hour)	Up to 20,000	Up to 40,000	10,000-40,000
Reliability	Moderate to high	High	High
System Aspects			
Network and area coverage	Good CBD coverage, branching capability	Predominantly radial, some CBD coverage	Radial, limited CBD coverage
Station spacing (ft/m)	800-2500/250-800	1600-6500/500-2000	4000-15,000/1200-4500
Average trip length	Short to long	Medium to long	Long (U.S. average; 22 miles [35 km])
Interface with other modes	Auto, pedestrian and bus feeders; can also feed other transit modes	Auto, pedestrian and bus feeders; can also feed other transit modes	Outlying: auto and bus feeders Center city: auto, pedestrian, bus, light rail and/or rail rapid transit

NOTE: Figures shown are based on existing systems.
The traditional form of streetcar operation is represented by the low end of the light rail transit performance spectrum.

Source: "Light Rail Transit, A State of the Art Review," by DeLeuw Cather & Co., for Federal Department of Transportation, Washington, D.C., 1976.

The expansion of LRT systems throughout the world has led to an incremental, but rapid, improvement of the LRV technology in the past decade. Many of the advances have been made by European manufacturers, although a very low degree of vehicle standardization has developed among different manufacturers. In the United States, UMTA has developed the specifications for a standard light rail vehicle for use by U.S. operators. This Boeing vehicle is being implemented in Boston and San Francisco, and is illustrated in Figure II-3.

2. Design Characteristics

Although the design and performance characteristics vary somewhat between the various light rail vehicle types, most design aspects are of the same order of magnitude as shown in Table II-2. Most significant for planning purposes, certain light rail vehicles can negotiate grades of up to 10% (and even higher on short stretches) and horitonzal curves as low as 40-50 feet.

While snow and ice conditions have some impact on the maximum grade capability, it appears safe to assume that grades of up to 8% could be negotiated by modern light rail vehicles in weather conditions similar to that of Anchorage.

3. Right-of-Way Options

The feature distinguishing LRT from streetcars is the use of exclusive or semi-exclusive rights-of-way. In a sense, LRT can be considered an evolutionary mode of transit where on-street running is gradually being replaced by reserved-way operation. The primary advantage of exclusive-way operation is the higher line speeds, which in turn increase vehicle productivity and lower operational costs. The increased speed also means a higher level of service and can result in higher transit patronage. Another advantage of exclusive operations is that the right-of-way can be designed for upgrading to a full rail operation. The primary consideration for light rail planning is to exploit the mode's at-grade capabilities and the technology and right-of-way designs which have evolved to the fullest.

FIGURE II-3

U.S. STANDARD LIGHT RAIL VEHICLE

TABLE II-2

LIGHT RAIL VEHICLE DESIGN CHARACTERISTICS

Vehicle	Boeing LRV	Tyne & Wear	DuWag B Type	DuWag U2	DuWag P8	DuWag Hannover	U.S. PCC Car	Canadian LRV	Tatra PCC T5	Tatra KT4D
Approximate design year	1973	1973	1971	1965	1970	1972	1933	1975	1972	1971
Systems using (planned for)	(Boston) (San Francisco) (Dayton)	(Tyne & Wear)	Cologne Bonn (Essen) (Dusseldorf)	Frankfurt (Edmonton)	Frankfurt	Hannover	Approximately 5000 built	(Toronto)	Prague – latest PCC design	8 cities in East Germany
Axles/articulation	6/1	6/1	6/1	6/1	8/2	8/2	4/0	4/0	4/0	4/1
Length, feet/meters	71.5/21.8	91.2/27.8	88.2/26.9	75.5/23.0	89.9/27.4	88.5/27.0	43.5 to 50.5/ 13.2 to 15.4	50.67/15.44	49.5/15.1	59.4/18.1
Width, feet/meters	8.85/2.70	8.70/2.65	8.70/2.65	8.70/2.65	7.70/2.35	7.85/2.40	8.33 to 9.0/ 2.54 to 2.74	8.50/2.59	8.53/2.60	7.20/2.20
Floor height, feet/meters	2.82/0.86	3.15/0.96	3.3/1.0	3.18/0.97	3.15/0.96	3.08/0.94	2.75/0.84	3.02/0.92	2.95/0.90	2.95/0.90
Roof height, feet/meters	11.5/3.51	11.3/3.45	11.0/3.37	10.8/3.28	10.7/3.26	10.9/3.31	10.1/3.08	11.0/3.37	10.37/3.16	10.2/3.11
Seats, number/layout	68/2+2	84/2+2	72/2+2	64/2+2	62/2+1	46/2+1	49 to 69/ 2+1 or 2+2	42 or 47 Varies	36/2+1	26/1+1 or 38/2+1
Doors per side										
Number	3 double	4 double	4 double and 2 single	4 double	2 double and 2 single	5 double	2 or 3 double	2 double	3 double	4 double
Type	Plug	Plug	Plug	Folding	Folding	Folding	Folding	Folding	Folding	Folding
Steps	High/Low	High	High/Low	High	High/Low	High/Low	Low	Low	Low	Low
Maximum speed, mph/kph	50/80	50/80	60/100	50/80	45/70	50/80	50/80	50/80	50/80	40/65
Acceleration loaded, feet/second^2	4.1	3.3	3.9	3.3	3.3	3.6	4.6	4.6	4.9	4.3
Deceleration loaded, feet/second^2	5.1	3.3	3.9	3.9	3.9	3.9	4.6	5.1	4.9	4.3
Emergency deceleration loaded, feet/second^2	8.8	10	10	10	10	10	9.5	10	7.5	7.5
Empty weight, 1000 pounds	68	86	86	66	75	85	33 to 42	52	40	44
Maximum design grade (percent)	9.0		6.0	4.4	4.4	5.0	10+	10+	10+	8
Minimum curve radius (feet)	Varies 32 or 42	160	82	82	56	59	Varies	38	66	52

Source: "Light Rail Transit, A State of the Art Review," by DeLeuw Cather & Company, for Federal Department of Transportation, Washington, D. C., 1976.

In the shared-mode of operation the streetcar vehicles operate in mixed traffic with other vehicles. This mode of operation requires the lowest level of capital investment, but is usually beset with high schedule unreliability due to traffic congestion, and is not considered ver desirable by transit patrons and operators alike. This has been a primary reason for the elimination of streetcars in many cities, but has prompted other cities to upgrade their streetcar operations to LRT levels by providing some exclusivity to the rights-of-way. However, this does not mean that LRT systems cannot have any shared operations. Shared operations may be very cost-effective in low-density areas which generally have low levels of traffic congestion and low levels of patronage.

Semi-exclusive rights-of-way represent a broad range of facilities that allow partially controlled access by other modes. LRV's could operate in an exclusive mode over most of their guideway but may share their right-of-way at grade crossings and elsewhere. This category includes facilities providing operation on street medians, on reserved transit lanes on streets, and priority treatment at grade crossings. Semi-exclusive rights-of-way permit LRV's to provide a high level of service without the high costs of exclusive rights-of-way.

Exclusive rights-of-way are fully-controlled grade-separated facilities that do not have any at-grade vehicular or pedestrian crossings. Rail rapid transit systems utilize this classification of facility exclusively. This type of facility permits the highest level of transit service, but it requires the highest level of capital investment and has the greatest impact on urban form and land use.

Although the standard gauge of North American railroads (4'8-1/2") is identical to the LRT gauge, there have been no known recent applications where active railroad tracks, such as the Alaska Railroad tracks in Anchorage, are used by LRT vehicles. Primary reasons for this are the interference with railroad freight traffic, conflicting labor union agreements, and differences in train control and operating procedures. Vertical and horizontal clearance requirements do not necessarily prohibit shared LRT/railroad freight operation, although high-platform stations would conflict with railroad freight train clearance requirements.

B. Recent Experience with LRT in North America

The number of streetcar systems in North America declined drastically with the increased popularity of the automobile; however, the resurgence of LRT systems in many European cities, and the conversion of existing streetcars to LRT systems seems to indicate the feasibility of this transit mode in North America. Several North American cities have analyzed their transit needs and are in the process of implementing, or are considering LRT systems as indicated in Table II-3. All but one of the operational systems shown on Table II-3 were inaugurated before World War II in large, densely populated areas, and may not be appropriate for comparison with Anchorage. The Edmonton system was opened in 1978 and represents the first new LRT system in North America since World War II. The Buffalo system has recently received final Federal approval before starting construction of its first LRT line.

The purpose of this section is to provide an overview of recent LRT experience in other North American cities and to determine their common characteristics with Anchorage.

1. Edmonton, Alberta

This city of nearly 500,000 people opened a 4.5 mile LRT line from the CBD to the northeast section of the city in April, 1978. One mile of the system is underground and 3.5 miles are at-grade on a Canadian National Railroad (CNR) right-of-way. Access to the 5 stations is controlled by coin turnstiles. Fourteen, 2-unit articulated cars based on the DuWag U2 design provide 5-minute headways in the peak period, and 10-minute off-peak headways. Average schedule speeds, including station stops, are on the order of 25 miles per hour.

The LRT concept emerged about 10 years ago when the City Transportation Department was established to coordinate and operate the transportation facilities and to develop a long-range transportation plan. A major theme throughout the plan was that auto use should be de-emphasized and

TABLE II-3

NORTH AMERICAN LIGHT RAIL TRANSIT (LRT)

	Population[3/]
Existing Systems[1/]	
Boston, Massachusetts	641,000
Cleveland, Ohio	751,000
Edmonton, Alberta, Canada	438,000
Newark, New Jersey	382,000
Philadelphia, Pennsylvania (Red Arrow)	1,950,000
Pittsburgh, Pennsylvania[2/]	520,000
San Francisco, California[2/]	716,000
Toronto, Ontario, Canada	713,000
Systems to be Implemented	
Buffalo, New York	463,000
Systems Under Consideration at One Time or the Other	
Portland, Oregon	380,000
San Diego, California	697,000
Santa Clara County, California	1,065,000
Dayton, Ohio	243,000
Denver, Colorado	515,000
Anchorage, Alaska Population (for comparison)	
1975	154,000
1995	377,000

1/ Does not include streetcar systems in New Orleans and Fort Worth.

2/ To be upgraded to LRT.

3/ Incorporated City only, not total metropolitan area (1970-1974 data).

and transit made attractive. One policy was that as express bus patronage developed, consideration should be given to converting these lines to a guideway system on an incremental basis. Rail line planning began in 1972 and LRT was given a high priority when it was found that cost savings could be realized if grade crossings were permitted and system expansion operations would be more extensive with light rail.

The initial system cost $65 million to implement. The City Council recently approved $260,000 to study the feasibility of a 10-mile extension to the south of the CBD. A summary of the Edmonton LRT system is shown on Table II-4.

2. Buffalo, New York

On September 15, 1978, the Federal government announced its decision to participate in the funding of an LRT system for this Northeastern city with a population of about 500,000, and a metropolitan population of about 1.3 million. The proposed system consists of a 6.4 mile guideway between the CBD and the State University of New York (Buffalo) campus to the north. The 1.2 mile section in the CBD will be street running with half of this section on an auto-restricted pedestrian mall, with 6 stations. The capital cost is expected to be $246 million for the initial 6.4 mile line, which is the initial increment of an ultimate approximately 17-mile system.

The implementation of a rapid transit system in the Buffalo-Amherst Corridor has been a major objective of the Niagara Frontier region for over a decade, and is part of the official regional transportation plan. Exhaustive alternatives analyses resulted in the selection of the LRT alternative by the Transportation Authority. A summary of the proposed line characteristics is shown in Table II-5.

Although several other North American communities have recently considered, or are presently studying light rail systems, none of these studies have resulted in firm implementation plans or assurance for funding. It is

TABLE II-4

EDMONTON, ALBERTA, LIGHT RAIL TRANSIT SUMMARY

Demographic Characteristics	
City Population	approximately 500,000 (incorporated area)
Service Area Population	N/A
City Employment	N/A
% City Employment in Downtown	N/A
Land Use Densities	N/A
System Description	
Inauguration	April 24, 1978
Network	1 line of 4.5 miles from CBD to northeast
ROW Characteristics	1 mile underground, 3.5 miles in railroad right-of-way
Number of Stations	5 stations
Rolling Stock	Siemens-Duwag U2, 2-unit articulated cars
Capital Cost	$65 million

Planning Background

Planning for light rail was guided by a transportation plan which de-emphasized auto use and focused on making public transit more attractive. A transportation policy was adopted which was aimed at generating transit ridership through the use of express buses and then converting these lines to a fixed-guideway system on an incremental basis. The advantages of light rail over heavy rail relative to costs and expansion flexibility became apparent in the planning stages. Recently, the City Council has approved a feasibility study for a 10-mile extension to the south.

Table II-5

BUFFALO, NEW YORK, LIGHT RAIL TRANSIT SUMMARY

Demographic Characteristics[1/]	
City Population	465,000 (incorporated area) 1.3 million in region
Service Area (Corridor) Population	489,000
City Employment	206,000 (in incorporated area)
% City Employment in Downtown	18%
Land Use Densities	11,200/sq. mi. in incorporated area
System Description	
Network	1 line of 6.4 miles from CBD to SUNY (Buffalo) campus in northeast
ROW Characteristics	1.2 mile surface section through CBD with half on auto-restricted pedestrian mall, 5.2 mile below-grade in exclusive right-of-way
Number of Stations	6 surface stations, 8 underground stations
Rolling Stock	UMTA LRV (proposed)
Capital Cost	$246 million (estimate)

Planning Background

A rail transit system for the Buffalo-Amherst corridor has been a major objective of the region for a decade, and is part of the official regional transportation plan. The light rail alternative was selected after exhaustive analysis of alternatives and is currently being implemented. The local cost share will be covered primarily by State of New York resources. While UMTA provides about 80% capital grants, the State will absorb the remaining 20% capital costs as well as a considerable portion of the operating expenses. Revenues from the State sales tax, State income tax, as well as general funds will be utilized to subsidize the LRT operation. The 20% capital share was funded by a statewide general transportation bond issue which also included other transportation projects.

1/ 1970 Data.

interesting to note that the population sizes of these cities range, with one exception, between about 250,000 and 700,000, which is comparable with a population of about 380,000 (including military population) projected for 1995 for the urbanized portion (Anchorage Bowl) of the Municipality of Anchorage.

3. Portland, Oregon

Portland is currently investigating the implementation of an about 15-mile long light rail line in the northeasterly Banfield Corridor between Portland and the suburb of Gresham. Several alignment alternatives are under study, ranging in capital costs between $110 million and $155 million. At the present, a draft environmental impact statement is being prepared as the basis for exploring funding opportunities.

While Portland appears to be seriously interested in implementing light rail, capital and operating funds have not yet been ascertained. Among potential sources currently being discussed are Federal funds, recapture of some of the increased land value along the transit corridor, use of uncommitted interstate highway funds, payroll taxes, and others.

4. San Diego, California

This Southern California city of about 700,000 population (in the incorporated area) has been considering a 15.9 mile LRT system between downtown San Diego and San Ysidro, Mexico. This system would run for the most part in an abandoned railroad right-of-way, have 18 stations, and cost about $85 million.

The Metropolitan Transit Development Board was established in 1976 to examine the possibilities for low-cost rail transit in San Diego after an earlier study had recommended a $3 billion, 60-mile heavy rail system. The Board decided on an LRT-type system after examining light rail systems in Europe and realizing the lower costs and higher flexibility of this technology relative to heavy rail. The South Bay Corridor was selected in part because of the availability of a railroad right-of-way and because it is a heavily travelled corridor.

However, in July, 1978, the San Diego City Council rejected the plan to build the light rail line coupled with an expanded bus system until questions regarding the financial future of the bus system are resolved. Further light rail plans have, therefore, an uncertain future in San Diego.

5. Santa Clara County, California

Although Santa Clara County represents low-density, spread-out, and auto-oriented communities in the southern tip of San Francisco Bay, a major study was recently undertaken to evaluate the feasibility of light rail in such an environment. These studies were conducted in response to increasing traffic congestion, and in an attempt to cause a major shift from auto travel to transit, to improve the air quality in this region.

Numerous travel corridors were examined for light rail and compared to an express bus system. Maximum LRT volumes for the heavier-travelled corridors ranged between 3,000 and 8,000 persons per peak hour per direction, which was not considered high enough to justify light rail. Projected development densities in Santa Clara County were found to be below those generally considered necessary to support light rail transit. It was found that "a considerable commitment to denser and more urban development would have to be made to support any fixed guideway mode in Santa Clara County by 1990."[1/] A system of express and local buses was found to be more appropriate for Santa Clara County.

Mainly because of these findings and the high price tag to go with LRT (about $730 million capital cost for a 59-mile, five corridor system, including rolling stock), it appears that LRT has lost its political momentum in Santa Clara County and that further light rail studies will not receive a high priority.

1/ Santa Clara Valley Corridor Evaluation, Phase III Summary Report, prepared for Joint Policy Committee of ABAG and MTC, Berkeley, 1977.

6. Dayton, Ohio

This city of about one-quarter million population was one of the first U.S. communities to explore a modern application of light rail. An application for Federal funding participation in the LRT system was, however, turned down by UMTA for lack of economic justification.

7. Denver, Colorado

For years, a fixed-guideway transit system was studied for Denver in which light rail was considered as one of the alternative fixed-guideway modes. However, these transit plans were abandoned when Federal approval and funding assistance could not be assured. Since then, the transit planning efforts have concentrated on improvements to the existing surface bus system, and on an 11-block downtown pedestrian and transit mall serving the main retail center of Denver. Public transportation over the mall would be provided by rubber-tired, battery-electrically operated vehicles to be custom built.

While the mall has been approved and UMTA funding has been committed, the specific vehicle system itself has not yet been decided upon. It is rather unlikely that light rail will be reconsidered in Denver within the immediate future.

III
POTENTIAL LRT CORRIDORS AND RIDERSHIP ANALYSIS

III. POTENTIAL LRT CORRIDORS AND RIDERSHIP ANALYSIS

This chapter outlines the analysis of several travel corridors in Anchorage for potential LRT use, and describes the socio-demographic characteristics projected for these corridors for 1995. It also contains an analysis of the projected future travel demands and estimates of 1995 and 1985 LRT ridership for each identified corridor, including an evaluation of the relative share of LRT of the total travel market in the Anchorage area.

A. Identification and Analysis of Potential LRT Corridors

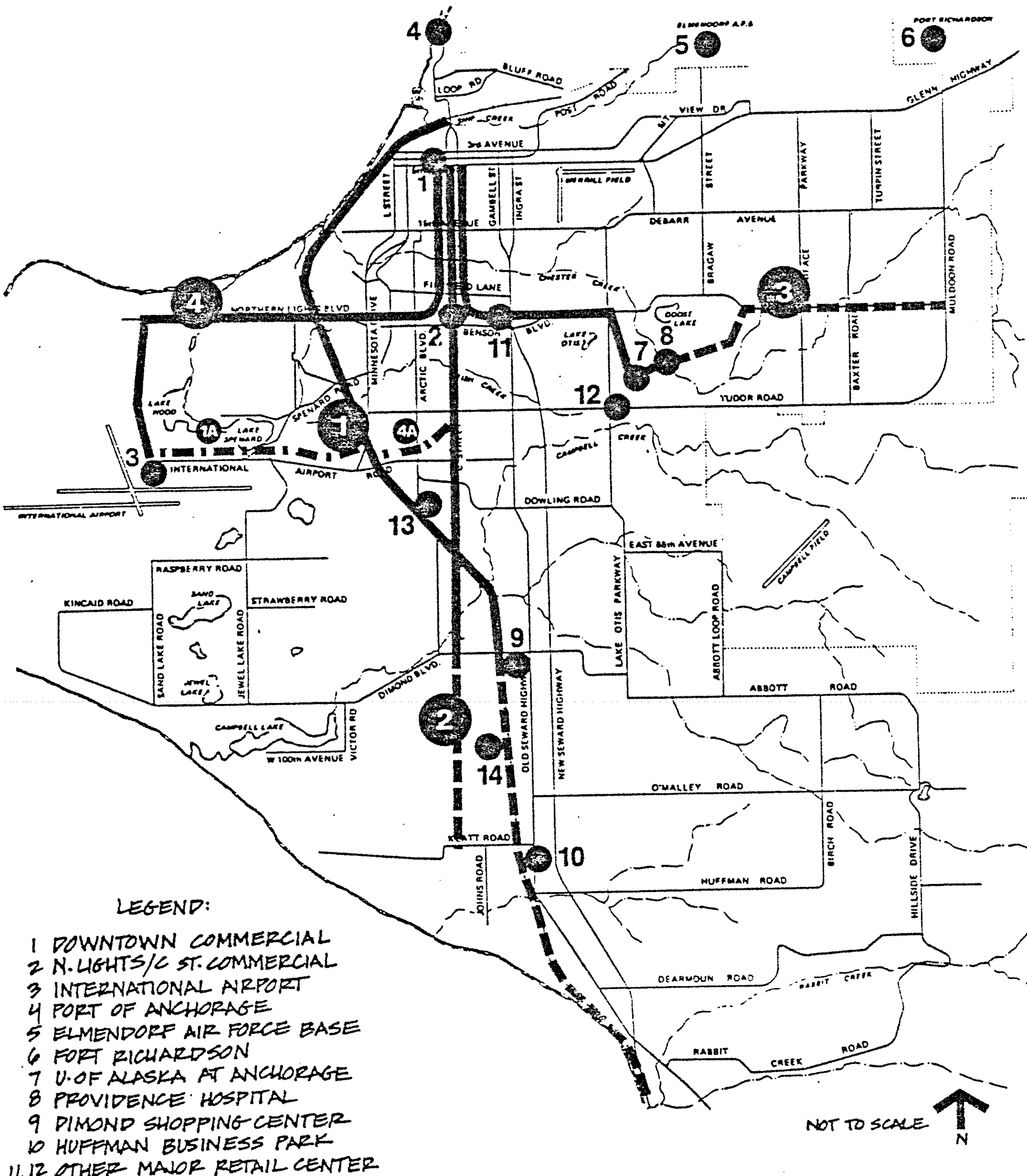
By its very nature, the light rail mode lends itself to servicing high-density travel corridors where the majority of riders can walk to and from the line, and where traffic congestion is typically most severe. If a light rail system is feasible in Anchorage, then it would be most likely along these higher-density corridors. For this reason, several corridors were investigated which would produce a relatively high travel demand, not only today but especially in the future.

1. LRT Corridor Description

Four separate travel corridors within the Municipality of Anchorage were identified for detailed analysis of LRT feasibility. The corridors, listed below, are also shown in Figure III-1.

Corridor 1: Alaska Railroad Route (ARR) Corridor
Corridor 2: C Street Corridor
Corridor 3: East Northern Lights Boulevard/C Street Corridor
Corridor 4: West Northern Lights Boulevard/C Street Corridor

The Alaska Railroad (ARR) corridor was originally identified as a potential LRT route by the Anchorage Metropolitan Area Transportation



LEGEND:

1 DOWNTOWN COMMERCIAL
2 N. LIGHTS/C ST. COMMERCIAL
3 INTERNATIONAL AIRPORT
4 PORT OF ANCHORAGE
5 ELMENDORF AIR FORCE BASE
6 FORT RICHARDSON
7 U. OF ALASKA AT ANCHORAGE
8 PROVIDENCE HOSPITAL
9 DIMOND SHOPPING CENTER
10 HUFFMAN BUSINESS PARK
11, 12 OTHER MAJOR RETAIL CENTER
13, 14 GENERAL INDUSTRIAL AREAS

(1) LRT CORRIDOR

INITIAL PHASE (1985)
FUTURE EXTENSION (1995)
ALTERNATIVE AIRPORT CONNECTIONS

FIGURE III-1

LRT CORRIDORS AND MAJOR ACTIVITY CENTERS

Study[1/] (AMATS) which recommended an independent feasibility study. This study is a result of that recommendation, and the opportunity was taken to also investigate the feasibility of LRT in other travel corridors within the Municipality. The additional three corridors selected for study were identified from an initial screening analysis with respect to the following principal criteria:

- 1995 areawide travel forecasts
- location of major activity centers
- 1995 population and employment forecasts
- 1995 population and employment densities

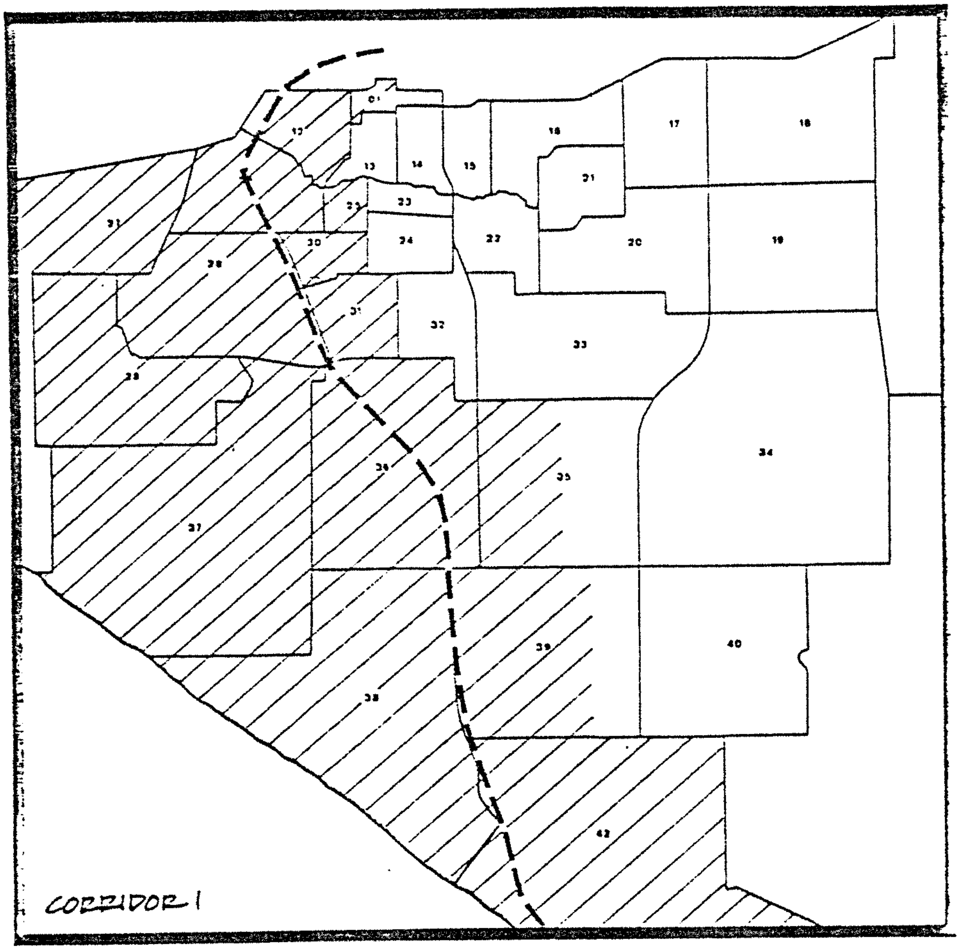
2. Service Areas of LRT Corridors

Each of the four LRT corridors has been defined in terms of a service area. These service areas are shown in Figures III-2 and III-3 in relation to the AMATS analysis districts, which were used as the basic area units for the data necessary for the evaluation of LRT service in each of the corridors. The service area of each LRT line represents the area from which LRT passengers would be drawn. In the case of fixed-guideway transit systems, such as LRT, the service area is generally a wedge shape, being narrowest at the major destination which acts as a focal point. For Anchorage, as in most cases, the downtown area would be the focal point and would thus represent the narrow end of the service area.

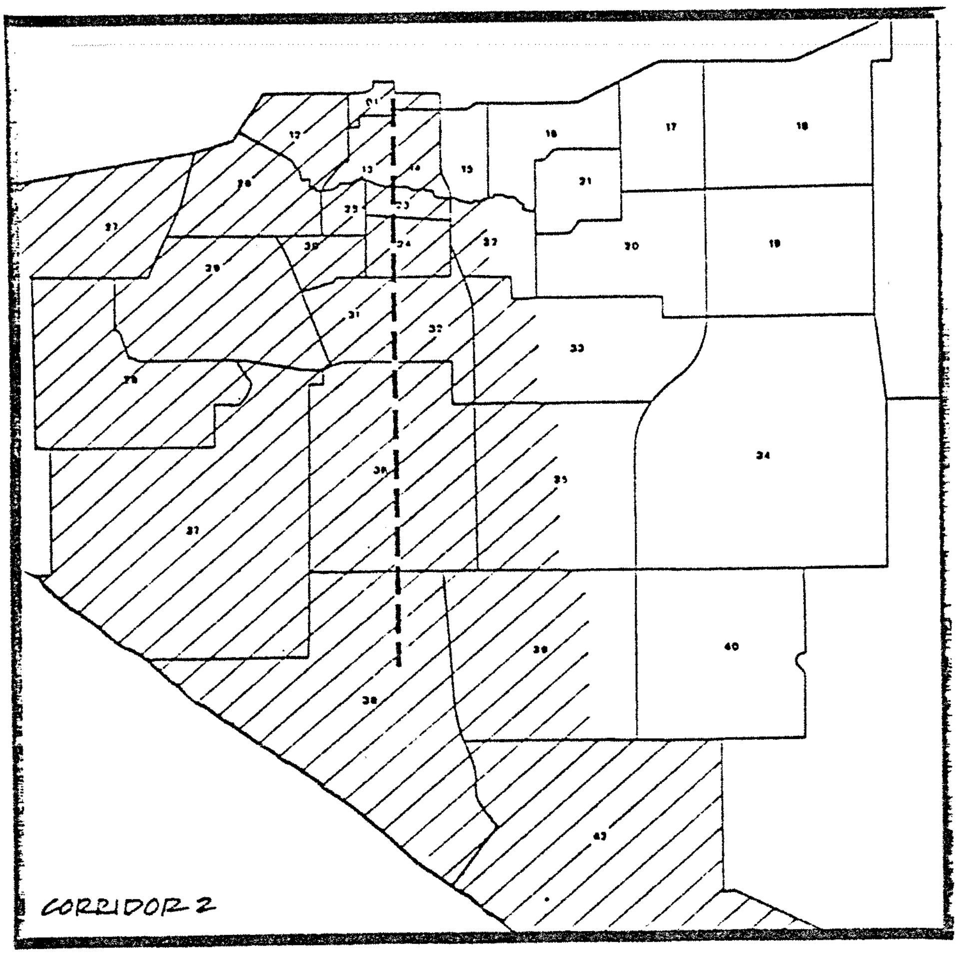
Further away from the downtown, the service area generally broadens out as transit becomes more advantageous with longer trip lengths and feeder services bring passengers into the main transit corridor. Trips originating outside the service area are generally too far from the transit line to use the transit service, as to do so would involve substantial route diversions and excessive trip lengths.

As can be seen from Figures III-2 and III-3, the service areas defined

1/ Anchorage Metropolitan Area Transportation Study, 1977-1995, Long Range Element, October 1977.



ALASKA RAILROAD CORRIDOR

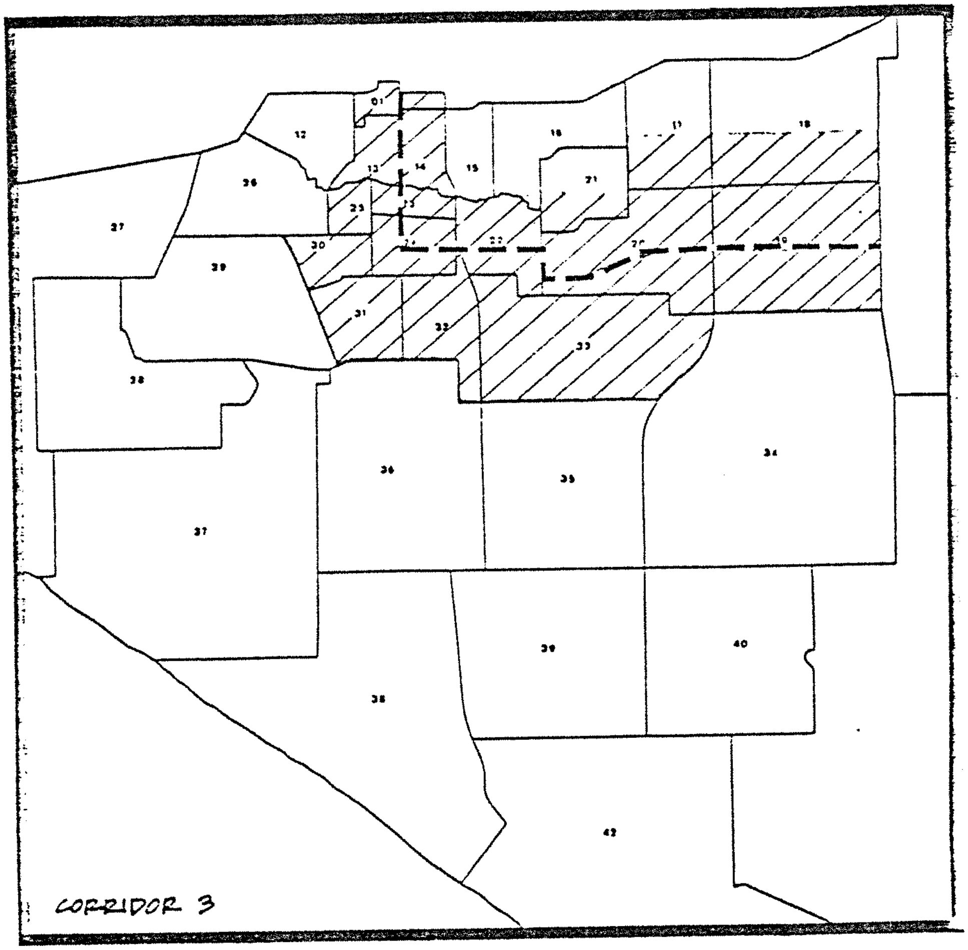


C STREET CORRIDOR

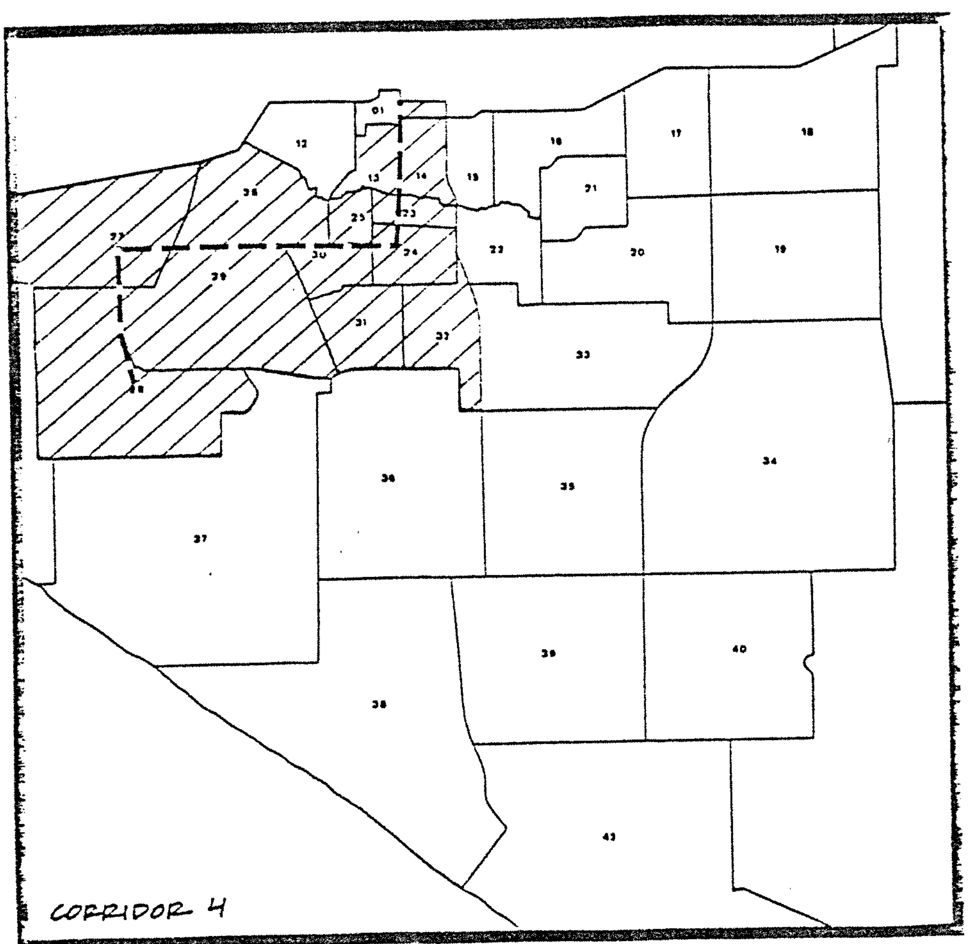
FIGURE III-2

LRT SERVICE AREAS
CORRIDORS 1 & 2

— DISTRICT BOUNDARY
22 DISTRICT DESIGNATION
– – LRT LINE
▨ AREA SERVED BY LRT



EAST NORTHERN LIGHTS CORRIDOR



WEST NORTHERN LIGHTS CORRIDOR

FIGURE III-3

LRT SERVICE AREAS
CORRIDORS 3 & 4

— DISTRICT BOUNDARY
22 DISTRICT DESIGNATION
- - LRT LINE
▨ AREA SERVED BY LRT

for the four LRT corridors correspond to this general pattern, particularly for the two north-south corridors. In determining the service areas for each LRT corridor, feeder bus services to the LRT line were assumed,[1/] as were park-and-ride facilities at some of the outlying stations. Thus, the use of the private car as an access to LRT would expand the LRT service area toward its outer terminus.

The LRT line in the ARR corridor would run from a northern terminal at the downtown ARR depot southwards along the line of the existing railroad tracks to a southern terminal near Potter Point, located just south of the intersection of Rabbit Creek Road and the Seward Highway. The LRT line in the C Street corridor would originate in the central downtown area and run southwards along C Street beyond Dimond Boulevard to Klatt Road, the southern terminal. The service areas of these two corridors would be similar, particularly south of Tudor Road. However, the area between the downtown and 36th Avenue, east of Arctic Boulevard, would not be served well by the ARR corridor, due to the route taken by the existing railroad right-of-way.

The other two corridors would serve east-west movement; both LRT lines originating from the central downtown area and running along C Street to the Northern Lights/C Street commercial area. The LRT line in the East corridor would then run easterly along Northern Lights Boulevard, dipping southwards through the campus area of the University of Alaska at Anchorage (UAA), before returning to Northern Lights Boulevard and continuing to an easterly terminal at Muldoon Road. The LRT line in the West corridor would continue from C Street, westerly along Northern Lights Boulevard, and then southerly to the International Airport, passing to the west of Lake Hood. In the case of these two east-west LRT corridors, the wedge-shaped service area is not as apparent, principally because the C Street/Northern Lights commercial area is included in both service areas, forming an L shape in both LRT lines.

For the subsequent ridership projections and LRT evaluation, the service

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1/ Feeder bus service was, however, not included in cost and revenue calculations (see also Chapter V).

areas shown in Figures III-2 and III-3 were assumed to be the maximum areas from which potential LRT ridership could be attracted. Person-trips with either trip end outside the service area were, therefore, excluded from the analysis.

The 1995 areawide travel demand projected by AMATS 1/ will to a large extent be constrained to three broad corridors by physical or land use barriers such as the International Airport and the large area of public undeveloped land surrounding Campbell Field. These areas will tend to channel travel from the south into the broad corridor defined by Minnesota Drive in the west and Lake Otis Parkway in the east. Travel demand from the northwest of the Municipality will be principally in the Northern Lights Boulevard and International Airport Road corridor, while the third principal area of travel demand will be in a broad eastern corridor defined by the Glenn Highway in the north and Tudor Road in the south.

Thus, three of the LRT corridors identified for evaluation would be within the principal areas of travel demand forecast for 1995. The fourth LRT corridor, the ARR route, would tend to overlap between two of these areas, the south and the west. The routes of the LRT lines were identified generally in the center of these travel demand corridors in order to achieve the largest possible service areas.

3. Major Activity Centers Served by LRT Corridors

Figure III-1 showed the four LRT corridors in relation to the major activity centers in the Municipality. The principal employment centers in 1995 will be the downtown and the C Street/Northern Lights commercial area, the International Airport, and the two military bases, Elmendorf Air Force Base and Fort Richardson. Substantial non-employment activity will also be generated by the downtown area (shopping) and the Airport (commercial passenger traffic and general aviation activity). Other major activity centers will include the Port of Anchorage, the UAA,

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1/ Anchorage Metropolitan Area Transportation Study.

the Providence Hospital, and the various retail and business/industrial facilities along the major corridors.

The Alaska Railroad corridor would serve the downtown area, the general industrial areas to the east and south of the International Airport, the Dimond Shopping Center, and the Huffman Business Park. The other three corridors would all link the downtown and C Street/Northern lights commercial areas, while the C Street corridor would also serve the general industrial areas south of Tudor Road, the Dimond Shopping Center, and the Huffman Business Park. The East Northern Lights corridor would provide direct connections between the downtown area, the Northern Lights/Benson commercial area, and the UAA/Providence Hospital complex.

None of the LRT corridors would serve the Port of Anchorage, Elmendorf Air Force Base, or Fort Richardson directly. These are all specialized facilities, relatively isolated in geographic location, and in the case of the military bases, largely self-contained in terms of employment. In view of these factors, and considering the topographical problems of installing LRT facilities across the intervening valley between these areas and the remainder of Anchorage, LRT service was not considered in this region.

4. Alaska Railroad Airport Spur Subcorridor

During the identification of the LRT corridors, the potential use of the existing ARR spur to the International Airport was considered, thereby linking the Airport to the ARR corridor or the C Street Corridor. The land use on either side of this spur is, however, generally industrial, and the small amount of residential land projected for 1995 is of relatively low density. A potentially higher LRT ridership could be achieved by serving the International Airport via the West Northern Lights corridor, which could also serve the general aviation facilities to the north of the airport, and the higher residential densities along Northern Lights Boulevard.

B. 1995 Population and Employment Characteristics

The population and employment projections utilized in this analysis are based on forecasts developed by the Municipality in March 1977[1/] and modified to reflect more recent estimates developed in the Metropolitan Anchorage Urban Study (MAUS).[2/] In addition, the future land use and residential density projections contained in the Comprehensive Development Plan[3/] were utilized in this analysis.

1. Employment and Dwelling Units by Analysis District

Figure III-4 shows the 1995 projected employment totals for the Anchorage area, by AMATS analysis districts. The Figure clearly shows the concentration of employment in the north-south corridor from the downtown in the north (District 1), through the C Street/Northern Lights commercial area (District 24), to Klatt Road (District 36) in the south. A total of 18,916 jobs are projected for 1995 in the downtown (District 1) and 17,937 jobs in the C Street/Northern Lights commercial area (District 24). The central core area, defined by the downtown, Arctic Boulevard, 36th Avenue, and Ingra Street (Districts 1, 13, 14, 23, and 24) will contain only about 26% of the total 1995 projected employment for the Municipality, while the current (1975) proportion is 29%. Outside of the areas discussed above, the next highest area of employment will be the International Airport (District 28) with a projected 10,260 jobs.

The 1995 projected dwelling units are shown in Figure III-5 by AMATS district. In the future, the highest residential density will be in the central core area, although absolute numbers of dwelling units will remain relatively low. Two further areas of high residential density will be in

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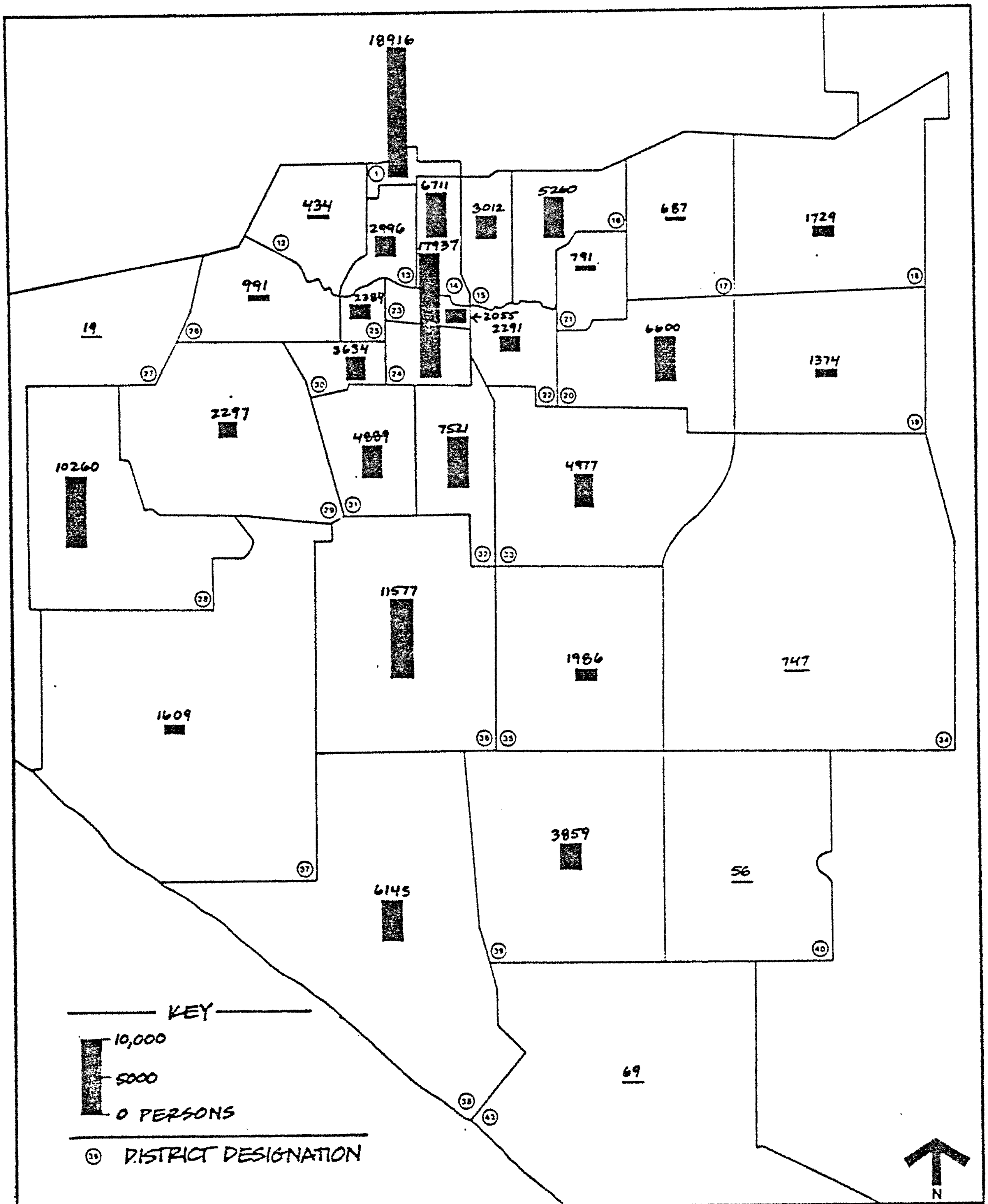
1/ "1995 Employment, Population and Land Use Forecasts," Municipality of Anchorage Planning Department, March 1977.

2/ Stage Two Report, by U.S. Army Corps of Engineers, Anchorage, Alaska, June 1977.

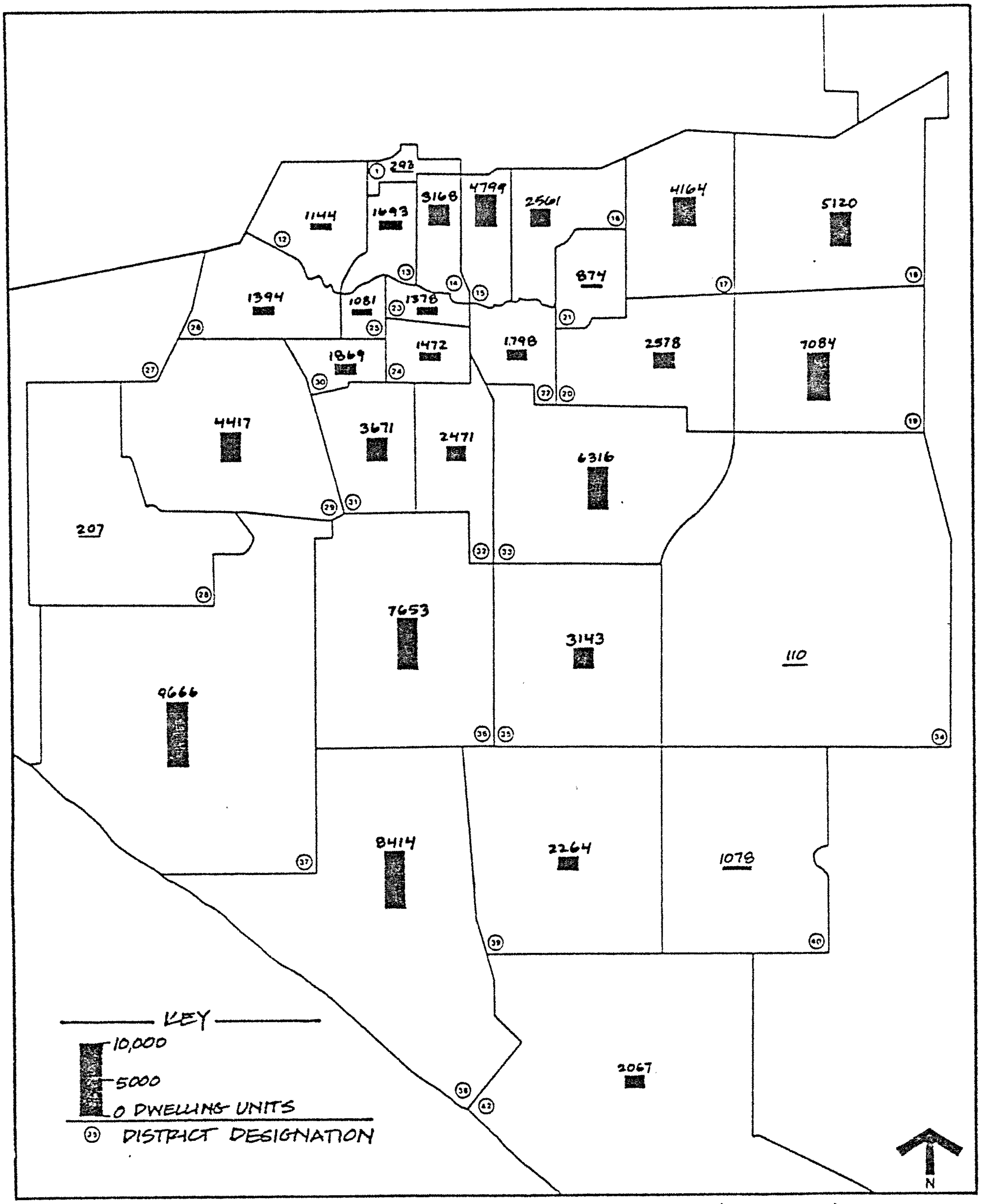
3/ Ordinance No. AO-18-75, Adopted July 1976.



SOURCE: MUNICIPALITY OF ANCHORAGE PROJECTIONS, MARCH '77
ADJUSTED FOR JUNE, 1977. MAUS PROJECTIONS

FIGURE III-4

1995 EMPLOYMENT DISTRIBUTION



SOURCE: MUNICIPALITY OF ANCHORAGE PROJECTIONS, MARCH '77
ADJUSTED FOR JUNE, 1977. MAUS PROJECTIONS

FIGURE III-5

1995 DWELLING UNIT DISTRIBUTION

the vicinity of the Seward Highway between Dowling Road and O'Malley Road, and to the east of the downtown between Tudor Road and the Glenn Highway, particularly adjacent to the Glenn Highway. This highway was not considered as a potential LRT route as only the areas south of the road are developed or planned for development (the military bases being to the north). A high proportion of the 1995 forecast vehicle traffic on this road would originate from outside the Municipality, and thus could not be well served by an LRT line.

2. Corridor Characteristics and Development Densities

The principal socio-economic characteristics of each of the LRT corridors as defined by their service areas are shown in Table III-1. In 1995, the C Street corridor would serve the highest number of jobs, at about 108,000 within the LRT service area. The two Northern Lights corridors would serve somewhat fewer job totals of 85,000 in the East corridor, and 81,000 in the West corridor. A large proportion of these jobs, about 50,000, would be in the area defined by the downtown in the north, and the C Street/Northern Lights/Benson commercial district in the south. This area is included in both Northern Lights corridors and the C Street corridor. The ARR corridor would serve the lowest number of jobs, 67,000, as the service area would not include the C Street/Northern Lights commercial district.

The C Street corridor would also service the highest population in 1995, at 57,000 dwelling units, followed by the Alaska Railroad corridor (45,000 dwelling units) and the East Northern Lights corridor (43,000 units). The West Northern Lights corridor would serve only about half these population levels, namely about 23,000 dwelling units in 1995.

Equally as important to transit ridership as the total number of people in the service area, is the development density within that area. Accessibility to a transit line generally being a prime determinant of transit ridership, the ideal situation for a transit route is to serve a heavily populated corridor of high development density, such that the

TABLE III-1

1995 SOCIO-ECONOMIC CHARACTERISTICS OF TRANSIT CORRIDORS

	LRT Corridors				Busway
	Alaska Railroad	C Street	Northern Lights (East)	Northern Lights (West)	C Street
Service Area Employment	67,000	108,000	85,000	81,000	112,000
Service Area Dwelling Units	45,000	57,000	43,000	23,000	63,000
Service Area Acreage	33,000	32,000	12,000	12,000	35,000
Service Area Employment Density (employees/acre)	2.0	3.3	7.3	6.7	3.2
Service Area Dwelling Unit Density (DUs/acre)	1.4	1.8	3.7	1.9	1.8

Source: Projections by Municipality of Anchorage, March 1977, adjusted for most recent (MAUS) projections.

maximum number of people live or work close to the route. As shown in Table III-1, the East and West Northern Lights corridors exhibit the highest 1995 employment densities, at 7.3 and 6.7 employees/acre respectively. Although serving a higher number of jobs, the greater area of the C Street corridor results in an overall employment density of 3.3 employees/acre. The ARR corridor, with the largest area, and the lowest number of jobs served in 1995, exhibits the lowest employment density at 2.0 employees/acre.

The East Northern Lights corridor also exhibits the highest residential density with 3.7 dwelling units per acre in 1995. The remaining three corridors would have broadly similar residential densities in 1995, ranging from 1.4 dwelling units per acre for the ARR corridor to 1.8 and 1.9 for the C Street and West Northern Lights corridors.

In establishing LRT corridors, consideration was also given to providing transit service to low-income areas which typically rely more heavily on public transportation. Several existing low-income pockets would fall within the established LRT corridors (Spenard area south of Northern Lights Boulevard and the area south of 15th Avenue). Others are and would be served by frequent surface bus lines. It can be expected that the location of future low-income areas may not necessarily be identical to the location of today's low-income area especially as urban redevelopment progresses in the future. It must, therefore, be assumed that future low-income areas will need to receive the attention of both LRT and local bus service, depending on their respective locations in the region.

C. LRT Ridership Analysis

1. Methodology for Developing Ridership Estimates

LRT ridership projections were prepared for each of the four corridors for two design years, 1985 and 1995, thus allowing the evaluation of LRT service being implemented incrementally - an initial stage of LRT provision in 1985 with expansion to full service by 1995.

The ridership projection methodology was based on data available for the Anchorage area and travel projections from earlier studies, principally the Anchorage Metropolitan Area Transportation Study (AMATS). The methodology focused on the 1995 design year as this was the AMATS design year, and thus the year for which data was most readily available. The 1985 LRT riderships that would be associated with a lesser scale of LRT provision were then estimated by appropriate factoring of the 1995 projections.

Ridership estimates were based on the AMATS projections of vehicle trips in the Municipality of Anchorage in 1995. These took the form of 24-hour vehicle trip tables, assuming no use of transit, and thus represented the projected total demand for travel by 1995. The daily vehicle trips within each LRT corridor (as defined earlier by the service area) were first adjusted upward by a factor of 1.2 to account for the most recent (MAUS)[1/] population projections, and then converted into daily person-trips by applying an average vehicle occupancy factor of 1.74.[2/]

No local modal split[3/] data were available for the projection of LRT ridership as the AMATS travel projection techniques did not include a modal split model. Precise estimates of LRT ridership were thus not

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1/ Metropolitan Anchorage Urban Study, U.S. Army Corps of Engineers, June 1977.

2/ AMATS average daily vehicle occupancy for all trip purposes.

3/ Modal split is the proportion of trips made by transit.

possible as the formulation of a modal split model and the collection of data necessary to make such a model operational were beyond the scope of this preliminary feasibility study.

Instead, an "envelope" approach to forecasting ridership was adopted in which low (pessimistic) and high (optimistic) assumptions were made to estimate the minimum and maximum LRT riderships that may reasonably be expected in each of the four corridors. The ridership estimation methodology is outlined in Figure III-6 and constituted two principal stages; the determination of the LRT market potential, and the estimation of the actual transit share of that potential.

The market potential of an LRT corridor (as defined by the service area) may be considered as the absolute maximum number of trips within the corridor that could potentially use LRT. This number would be less than the total number of daily person-trips in the corridor, since the LRT line could not serve all of the travel movements, such as for example, trips that are made across the corridor or are of very short length.

The actual LRT ridership would, however, be considerably less than the market potential, as a proportion of potential riders would choose to use other modes of travel, principally the automobile. The transit (LRT) share is thus the proportion of the market potential trips that would use the LRT line. The net product of the market potential and the transit share of each corridor represents the projected LRT ridership, and translates to an overall LRT modal split for the corridor.

Estimation of LRT Market Potential

The market potential of each LRT corridor was determined by estimating for each AMATS district-to-district movement the proportion of total person-trips that could potentially be served by the LRT line. These percentages were developed judgmentally, based principally on the LRT route in each corridor and the geographic location of the districts with respect to the route. Trips excluded from the market potential

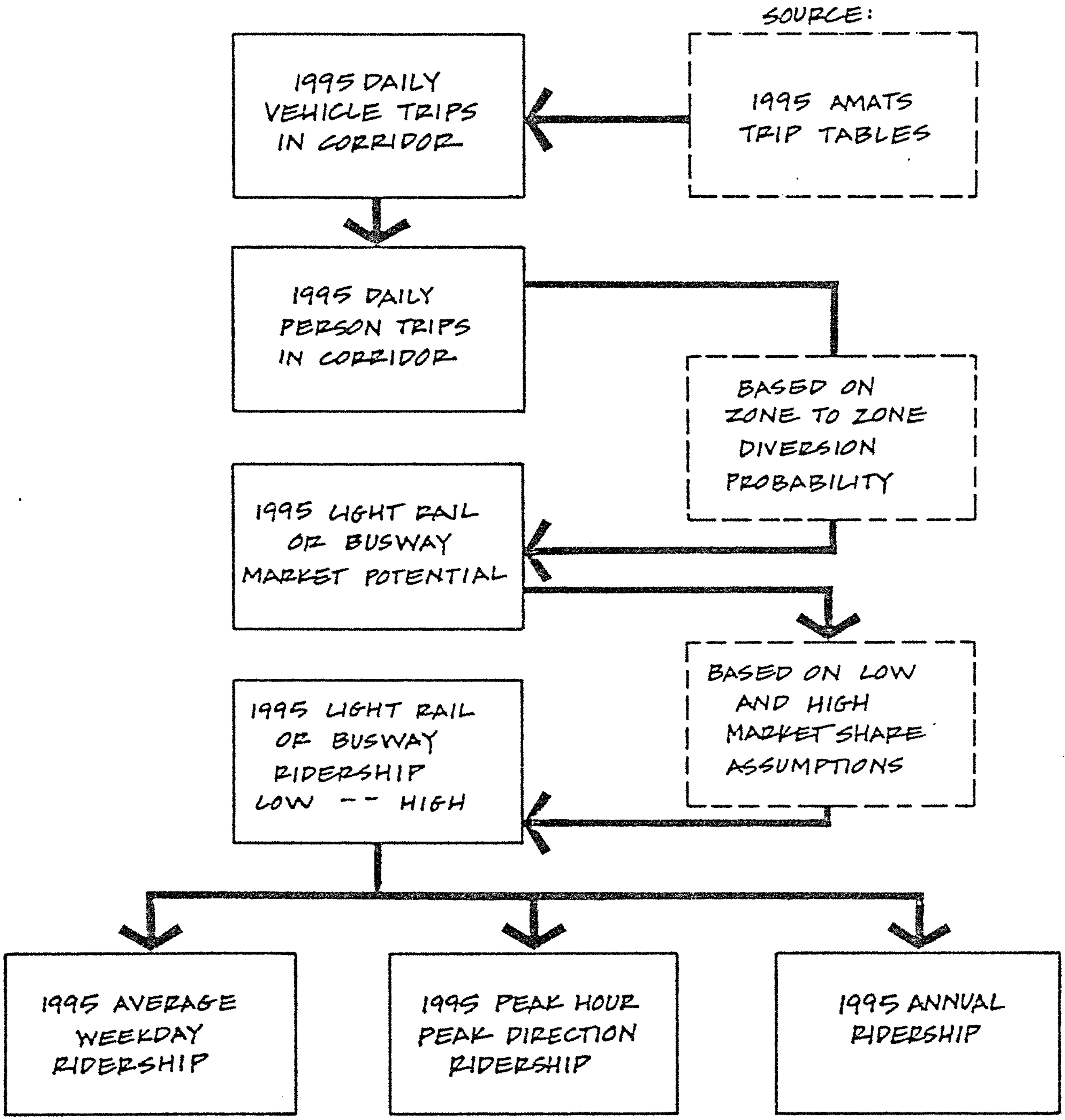


FIGURE III-6

METHODOLOGY FOR RIDERSHIP ESTIMATION

included those trips that, because of their origin and destination locations, could not be made by using the LRT line.

Estimation of (LRT) Transit Share

The overall transit share estimates for each corridor were developed from an analysis of transit (LRT)/auto travel time ratios for sample district-to-district movements within the corridors. The district-to-district movements which were analyzed varied with respect to accessibility to an LRT line, distance from the downtown area, and population and employment distribution and density.

The sample transit (LRT)/auto travel time ratios were analyzed in conjunction with transit diversion curves based on travel time ratios from elsewhere in the USA. The applicability of transit diversion curves from other areas must be recognized as being limited, due to the particular characteristics of the Anchorage area. Car ownership levels in the Municipality are relatively high (excluding the military bases) and this, along with various other factors such as the low density of the urban area, the winter weather conditions, and the short history of transit provision, results in relatively low existing levels of transit usage.

Thus, in preference to forecasting a specific transit share, low and high estimates were developed which produced an envelope of projected LRT ridership in each of the four corridors. The low estimate represents the continuation of current trends where the automobile plays the major urban transportation role. It also assumes the continuation of the present attitudes toward transit, lifestyles, and only a limited degree of integration of local transportation and land use policies. The high estimate assumes that a greater portion of the Anchorage residents will recognize the value of using public transportation as an alternative to their car at least for commute trips. It also reflects a public policy where greater emphasis is given to coordinate land use developments and transportation capacity such as encouraging higher density residential and commercial developments near the major transit corridors.

Neither of the two projection levels reflects a long-term gasoline crisis or a public policy that actively discourages or penalizes the use of private car over the use of transit.

The projections also assume the overall 1995 land use developments expressed in the current Comprehensive Development Plan. Any of these events occurring prior to or later than 1995, or a change in land use development directly supportive to an LRT line, could be expected to result in LRT riderships higher or lower than projected here.

Methodology for Busway Ridership Projections

To enable a comparative evaluation of alternative transit provision, the same methodology was applied to project 1995 ridership on an express bus service in the C Street corridor, with buses utilizing a busway along C Street. (See also Section C.) The assumptions made in calculating sample trip times for the market share analysis were similar to those made for LRT with the following exception. Since buses were assumed to circulate in the local residential areas for passenger collection, and then proceed via the busway, transferring between feeder and line-haul vehicles would not be required in the case of the busway alternative. The overall door-to-door time would, therefore, be somewhat less for most trips than for the LRT system.

Time and cost considerations precluded the possibility of undertaking similarly detailed projections of busway ridership in the other LRT corridors. The relationship between LRT and busway riderships derived for the C Street corridor was, however, assumed to be applicable to these other corridors, thus allowing order-of-magnitude busway ridership estimates to be developed for these corridors also.

Methodology for Interpolating the 1985 Ridership

As no total person-trip projections were available for the Anchorage area in 1985, a simplified approach was adopted to estimate the 1985 LRT ridership. The projected growth in population and employment between 1975 and 1995 was analyzed for each of the four corridors, and the projected 1995 LRT ridership factored downwards accordingly. The figures were then further adjusted to allow for the fact that the initial LRT provision proposed for 1985 would comprise shorter LRT lines, and thus smaller service areas (see Section IIIA) than in 1995. This last adjustment was based on the ratio of population and employment totals between the initial and full service areas.

2. LRT Market Share and Ridership Overview

Market Share Estimates

The estimated transit travel market share and 1995 daily ridership projections are summarized by LRT corridor in Table III-2. Both the low and high ridership estimates are shown in the Table and it will be noted that the low and high market share assumptions differ between the four corridors. The market share estimated for the C Street corridor (15-25%) is higher than that for the ARR corridor (10-20%) principally due to the fact that the C Street corridor would provide a more direct route to the major employment centers of the downtown and C Street/ Northern Lights commercial area. The stations on the C Street line would be closer to these destinations than those of the ARR line, and population and employment densities would be higher in the C Street corridor.

Although the East Northern Lights corridor exhibits a significantly higher development density than the C Street corridor, the market share estimates are equivalent, as the East Northern Lights corridor would not provide as direct a route to the downtown from its service area, and many areas north of the LRT line would be closer to the downtown, thus involving shorter highway access distances than corresponding areas to the south of the C Street corridor.

TABLE III-2

1995 DAILY TRANSIT RIDERSHIP ESTIMATES AND MODAL SPLITS

	LRT Corridors				Busway
	Alaska Railroad	C Street	Northern Lights (East)	Northern Lights (West)	C Street
Daily Vehicle Trips in Corridor	253,000	477,000	300,000	216,000	519,000
Daily Person-Trips in Corridor	440,000	830,000	522,000	376,000	902,000
Daily Transit Market Potential	99,900	195,000	149,000	119,000	208,000
Daily Transit Ridership					
Low Estimate					
Market Share	10%	15%	15%	10%	15%
Ridership	9,000	29,300	22,400	11,900	31,200
Corridor Modal Split 1/	2.3%	3.5%	4.2%	3.2%	3.5%
High Estimate					
Market Share	20%	25%	25%	15%	30%
Ridership	19,800	48,800	37,300	17,900	62,400
Corridor Modal Split 1/	4.5%	5.9%	7.0%	4.8%	6.9%

1/ For LRT and feeder bus (excludes trips made solely by local bus).

The West Northern Lights corridor would have the lowest market share, estimated at 10-15%. The station spacing would be closest on this line, resulting in the lowest average train operating speed of all the corridors. Much of the corridor would be within relatively easy reach by automobile of the downtown and C Street/Northern Lights employment centers, thus involving shorter journey times. The advantages of LRT increase with longer trip lengths where the transit wait time or transfer time constitutes a smaller proportion of the total travel time and thus becomes less significant in the choice of travel modes.

LRT Ridership Overview

As can be seen in Table III-2, the 1995 daily ridership estimates vary considerably between the four corridors; this variation being a function not only of the differential LRT market shares, but also of the relative size of the corridors, the geographic location and coverage of their service areas, and the projected 1995 total person-trips within each corridor. The four LRT corridors rank as follows with respect to the projected daily ridership:

Corridor	
C Street	29,300-48,800 daily LRT passengers
East Northern Lights	22,400-37,300 daily LRT passengers
West Northern Lights	11,900-17,900 daily LRT passengers
Alaska Railroad	9,000-19,800 daily LRT passengers

The C Street corridor, ranking first in projected daily ridership, also contains the highest number of total daily person-trips from which to draw LRT ridership. The 830,000 daily person trips (by all motorized modes) in this corridor would represent over 40% of the total daily trips projected for the Anchorage area in 1995. In comparison, the East Northern Lights and ARR corridors would contain about 27% and 22% respectively of total area daily trips. The higher ridership that would be attracted to LRT in the East Northern Lights corridor, ranking second in projected daily ridership, is principally a function of the higher land use density and the fact that the ARR line would not serve the C Street/Northern Lights commercial area directly.

3. Transit Modal Split Analysis

Also shown in Table III-2 are the resultant daily modal splits projected for each LRT corridor. These would range from 2.3% for the Alaska Railroad corridor to 4.2% for the East Northern Lights corridor, for the low ridership estimates. The high ridership estimates show daily modal splits would range from 4.5% to 7.0% respectively for these corridors. The C Street corridor, while attracting the highest ridership, would exhibit the second highest daily modal split of 5.9%. In comparison, current figures available for the Bay Area Rapid Transit (BART) system in San Francisco show that within a relatively large service area, compared to the LRT corridors in Anchorage, BART carries 2.4% of all daily trips.[1/]

Table III-3 shows the projected daily LRT ridership in each corridor expressed as a percentage of daily trips in the total Anchorage area in 1995, rather than per corridor. Again, it should be noted that these percentages do not include bus riders and that the overall modal split in the Municipality would be somewhat higher.

If all three LRT lines (C Street, East Northern Lights, and West Northern Lights) were implemented, it is estimated that the Anchorage areawide LRT modal split would range from about 2.4% for the low estimate to about 4.0% for the high estimate. In comparison, the present People Mover bus system carries about 1.0% of all daily trips[2/] and U.S. nationwide figures indicate a figure of 5.1% of work trips carried by transit in cities of population between 250,000 and 500,000.[3/] This 5.1% modal

1/ BART Impact Program travel surveys, May 1975.

2/ AMATS Fiscal Year 1978-1982, Transit Development Program, October 1977 (1978 projection).

3/ U.S. Department of Transportation, Federal Highway Administration, Nationwide Personal Transportation Study, August 1973.

TABLE III-3

1995 LRT RIDERSHIP AS PERCENTAGE OF TOTAL ANCHORAGE AREA DAILY PERSON-TRIPS1/

	Daily LRT Trips	% of Total Daily Person Trips
C Street	29,300-48,800	1.5% - 2.5%
East Northern Lights	22,400-37,300	1.1% - 1.9%
West Northern Lights	11,900-17,900	0.6% - 0.9%
Alaska Railroad (ARR)	9,000-19,800	0.5% - 1.0%
All Corridors Combined	-	2.4% - 4.0%

1/ Assuming 1,962,000 daily person-trips in 1995 in AMATS study area. (AMATS vehicle projections updated for most recent population projections) split is equivalent to about 2.5% of all daily trips carried by transit considering that the work trip modal split is generally at least twice as high as the transit modal split for all daily trips.

Assuming a 1% to 2% modal split in 1995 for trips made exclusively by bus without involving LRT, an overall 5%-6% transit modal split can be obtained for the Anchorage Bowl. This estimate is considerably lower than the 14.4% daily modal split contained in the Long-Range Element. However, it is felt that the 5-6% estimate represents a much more realistic projection than the earlier figure which was based on the lack of future highway capacity, rather than projected needs for transit travel.

4. Detailed LRT Ridership Projections

1995 LRT Ridership Estimates

The projected 1995 LRT ridership volumes are shown in Table III-4 separately by corridor and for an average weekday, the peak hour in the peak direction, and as an annual figure.

The following assumptions were used in developing annual and peak hour ridership estimates:

- the peak hour/peak direction flow as a percentage of the 24-hour two-directional flow is 10% for transit and 5% for highway travel
- the maximum load point volume is 80% of the total line volume for the peak hour/peak direction
- annualization factors for 1995 are:

  for patronage-related measures (ridership, fare revenue):

255 Weekdays @ 100%	255
52 Saturdays @ 50%	26
58 Sundays/Holidays @ 30%	18
Factor	299

  for service-related measures (vehicle miles, vehicle hours, operating costs):

255 Weekdays @ 100%	255
52 Saturdays @ 60%	32
58 Sundays/Holidays @ 35%	21
Factor	308

TABLE III-4

SUMMARY OF 1995 TRANSIT RIDERSHIP ESTIMATED BY CORRIDOR

		LRT Corridors				Busway
		1 Alaska Railroad	2 C Street C Street	3 Northern Lights (East)	4 Northern Lights (West)	C Street
Avg. Weekday	**Low Estimate**					
	Transit Riders	9,000	29,300	22,400	11,900	31,200
	Modal Split	2.3%	3.5%	4.2%	3.2%	3.5%
	High Estimate					
	Transit Riders	19,800	48,800	37,300	17,900	62,400
	Modal Split	4.5%	5.9%	7.0%	4.8%	6.9%
Peak Hour in Peak Direction	**Low Estimate**					
	Transit Riders	1,000	2,900	2,300	1,200	3,100
	Modal Split	4.7%	7.2%	9.2%	6.6%	7.1%
	Riders @ Max. Load Point	800	2,300	1,800	960	2,500
	High Estimate					
	Transit Riders	2,000	4,900	3,700	1,800	6,300
	Modal Split	9.5%	12.5%	15.3%	10.1%	15.0%
	Riders @ Max. Load Point	1,600	3,900	3,000	1,400	5,000
Annual	**Low Estimate**					
	Transit Riders	2,960,100	8,760,700	6,697,600	3,558,100	9,328,800
	High Estimate					
	Transit Riders	5,920,200	14,591,200	11,152,700	5,352,100	18,657,600

As can be seen in Table III-4, the 1995 peak hour/peak direction LRT volumes rank by corridor as follows:

Corridor	
C Street	2,900-4,900 LRT passengers
East Northern Lights	2,300-3,700 LRT passengers
West Northern Lights	1,200-1,800 LRT passengers
Alaska Railroad	1,000-2,000 LRT passengers

Compared with the typical passenger capacities of LRT as outlined in Figure II-1, (6,000-20,000 per hour per direction) the high-estimate ranges for the C Street and East Northern Lights corridors barely reach the lower capacity boundary of LRT. (For further evaluation see Chapter V.)

The transit modal split during the peak hour in the peak direction would range between 4.7% and 15.3%, depending on the corridor and level of estimate. Again, the C Street and East Northern Lights corridors rank highest among the four potential LRT corridors.

Also shown in Table III-4 are the projected maximum loads in one direction during the peak hour for each line, representing the maximum number of persons that would be using the system at any one point. For the high estimate, the loads range from 1,400 in the West Northern Lights corridor, to 3,900 person-trips in the C Street corridor. The estimated location at which the maximum load would occur, would in all cases be the C Street/Northern Lights commercial area, with the exception of the ARR corridor, where the maximum load is estimated to occur at the ARR downtown depot.

As mentioned earlier, the C Street busway alternative was found to be able to attract a somewhat higher ridership due to the fact that buses were assumed to collect riders in the local neighborhood and then proceed over the busway to their destination. This would not require a passenger to transfer as would be the case for the LRT. In the C Street corridor, the busway ridership would be between about 7% (low estimate) and 28% (high estimate) higher than the LRT ridership in the peak hour/peak direction.

1985 LRT Ridership Estimates

Table III-5 contains the estimated ridership volumes which could be expected if LRT were in operation in 1985. As would be the case in 1995, the relative highest demand would occur in the C Street LRT corridor, with 2,700 passengers per peak hour in the peak direction under the high estimate. Again, the C Street busway would attract up to about 40% more peak hour riders due to the reduced need for transferring between the feeder and line-haul systems.

TABLE III-5

SUMMARY OF 1985 TRANSIT RIDERSHIP ESTIMATES BY CORRIDOR

	LRT Corridors				Busway
	1 Alaska Railroad	2 C Street	3 Northern Lights (East)	4 Northern Lights (West)	C Street
Daily					
Low Estimate	5,500	16,300	11,800	8,400	19,000
High Estimate	11,000	27,100	19,700	12,600	38,000
Peak Hour/Peak Direction 1/					
Low Estimate	500	1,600	1,200	850	1,900
High Estimate	1,100	2,700	1,950	1,250	3,800
Maximum Load 2/	900	2,150	1,550	1,000	3,050
Annual 3/					
Low Estimate	1,545,000	4,580,000	3,316,000	2,360,000	5,339,000
High Estimate	3,091,000	7,615,000	5,536,000	3,541,000	10,678,000

1/ Based on 10% of 24-hour, 2-directional volume.

2/ Based on 80% of high estimate peak hour/peak direction line volume.

3/ Based on annualization factor of 281 assuming no Sunday/Holiday service in 1985.

IV

ASSUMED ROUTE, SERVICE AND OPERATIONAL CHARACTERISTICS

IV. ASSUMED ROUTE, SERVICE AND OPERATIONAL CHARACTERISTICS

The first section of this chapter describes in further detail the assumed route alignments in each of the four LRT corridors, including general and specific right-of-way requirements. This is followed by a discussion of the assumed LRT service levels, covering hours of operation, train frequencies, fare collection systems, and station design. The final section of the chapter summarizes assumptions regarding the remaining operational aspects of LRT, such as at-grade crossing operation, and signal/communications provision.

A. Assumed Route Alignments

1. General Considerations

Alignment Criteria

Within the four LRT corridors identified, specific LRT track alignments were assumed for the further analysis and evaluation of each LRT route. These alignments have not been developed to engineering specifications, and were identified in the absence of geological and subsurface soil analyses. The alignments have, however, been screened with respect to right-of-way requirements, maximum grades, light rail vehicle (LRV) performance, and overall operational and engineering feasibility.

The principal criteria adopted in developing the LRT route alignments are summarized in Table IV-1, along with the objectives underlying each criterion. While the criteria are generally compatible, conflicts do arise between certain criteria, for example the conflicts between "maximize LRT on separate right-of-way" and "minimize property take by LRT right-of-way", and also between "minimize LRT interference with street traffic" and "maximize proportion of LRT line at grade." It is thus inevitable that the assumed LRT route alignments represent, in some instances, a necessary compromise between various criteria. In these instances a higher priority was assigned to those criteria most compatible with the essential and advantageous features of light rail transit. Most prominent in this respect

TABLE IV-1

ROUTE ALIGNMENT CRITERIA

Criteria	Objective
1. Maximize LRT on separate right-of-way	• high LRT travel speed • low LRT impact on street network
2. Minimize LRT interference with street traffic	• high LRT travel speed • preserve road capacity
3. Minimize driveway and minor crossings by LRT	• high LRT travel speed • reduce capital costs (barriers, etc.) • low LRT-vehicular conflict potential
4. Minimize property take by LRT right-of-way	• reduce capital costs
5. Maximize convenience of pedestrian access to LRT	• high system accessibility • high walk-on ridership
6. Maximize proportion of LRT line at grade	• reduce capital costs
7. Minimize interference with existing railroad track and spurs/sidings (ARR corridor)	• reduce capital costs • reduce conflict potential

were the mode's at-grade capabilities, potential simplicity of station design, and vehicle size and maneuverability - all principal factors in the generally lower capital and operating costs of LRT when compared to heavy rail rapid transit systems.

Thus, the assumed LRT alignments are almost exclusively at grade. Grade separations, where assumed necessary at certain strategic locations, are identified in the description of each route alignment. Double track has been assumed for the full length of each LRT route, and each route has been considered principally as an individual entity. With the exception of the ARR and C Street routes which essentially cover the same corridor, any combination of the four routes could, however, be operated together as an LRT network. In such cases, it has been assumed that those routes utilizing the C Street corridor between the downtown and Northern Lights Boulevard would share the same double track provision between these two points. It has also been assumed that each route would still operate direct train service between downtown and its respective outer terminal, as opposed, for example, to operating one north-south and one east-west line (see Figure III-1).

LRT Right-of-Way Requirements

Right-of-way requirements for LRT depend principally upon system design criteria and track configuration, including such factors as: single or double track, LRT car width, at-grade, subway, or elevated operation, exclusive or shared right-of-way operation, and sophistication of station design.

LRT right-of-way width requirements for double track between stations generally range between about 22 ft. and 35 ft. The lower end of the range is more typical of European systems incorporating predominantly on-street operations. The upper end of the range, and above, is more typical of American design conditions in separated right-of-way with raised track beds and open drainage. Above 45 ft. of right-of-way width is generally considered to be a burden to the transit operator.

For study purposes a minimum right-of-way requirement of 28 ft. was assumed for double track provision between stations. This requirement is comprised as illustrated in Figure IV-1. Standard rail gauge of 4 ft. 8-1/2 inches has been assumed along with an LRV width of 9 ft. The Boeing LRV assumed as the design vehicle for this study, has an actual width of 8.9 ft. The 13 ft. allowance between track centers provides for a 4 ft. clearance between LRT cars. Center poles could be utilized for overhead wire suspension, reducing both the costs and visual intrusion of electrification.

Figure IV-1 also indicates the minimum right-of-way requirements at stations varying between 33 ft. and 38 ft., depending on station design and configuration. A double platform station, with both platforms directly opposite each other, would require about 38 ft. width of right-of-way. By offsetting the platforms and using reverse curves in the tracks, this width could be reduced to 33 ft. This could also be achieved by utilizing single platform stations.

2. Alaska Railroad Corridor Description

The assumed LRT alignment in the ARR corridor is shown in Figure IV-2. It was concluded that the LRT tracks should be located to the east of the existing ARR track for two principal reasons:

- There are less existing siding/spur tracks on the east side of the ARR tracks than on the west side. (The respective numbers are 10 and 15 for the length of the LRT line.)
- The terrain between 5th and 12th Avenues is considerably more suitable to the east side of the ARR tracks than to the west, where it drops away from the railroad embankment to the Knik Arm.

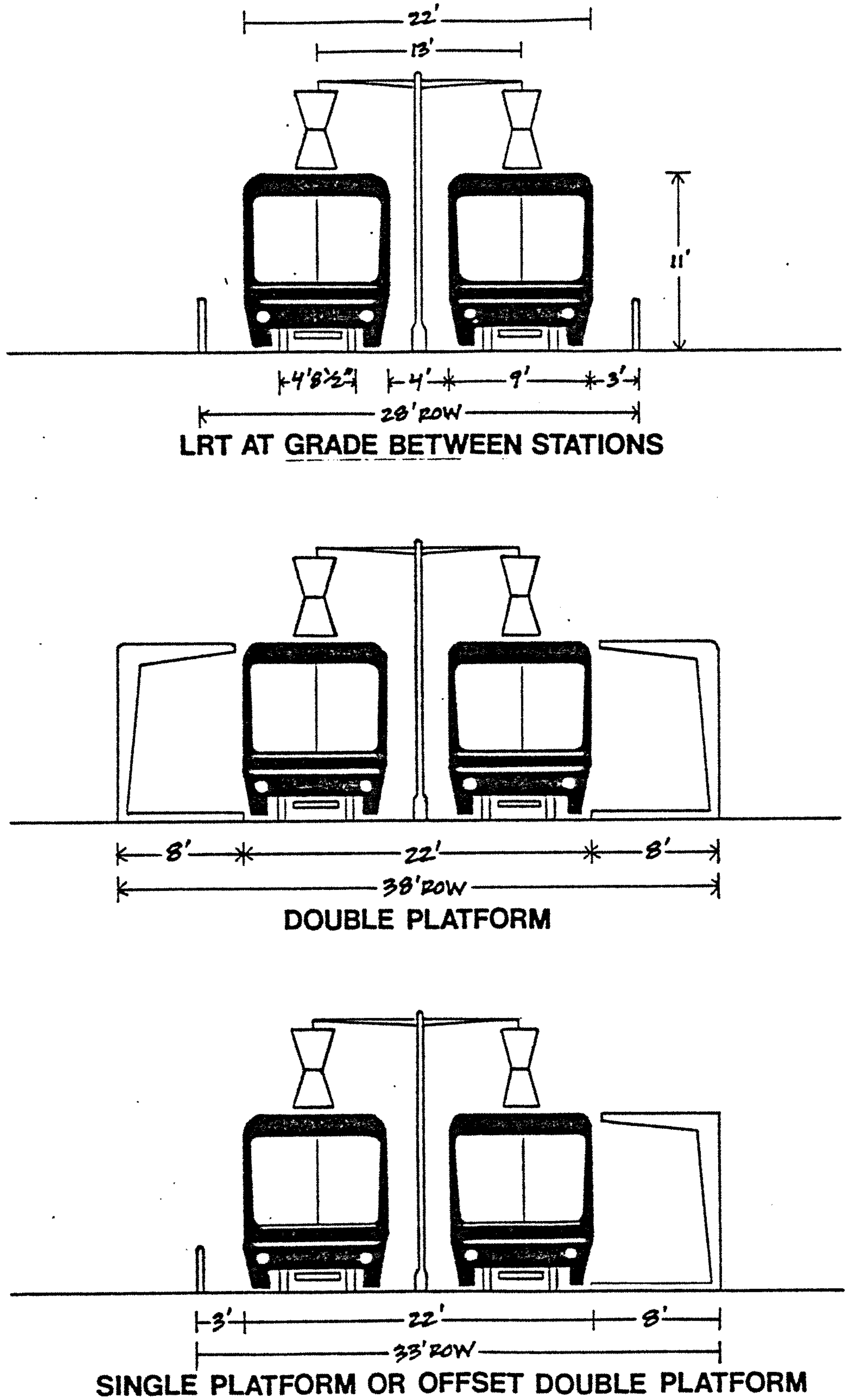


FIGURE IV-1

ASSUMED MINIMUM REQUIREMENTS FOR LRT RIGHT OF WAY AT GRADE OPERATION

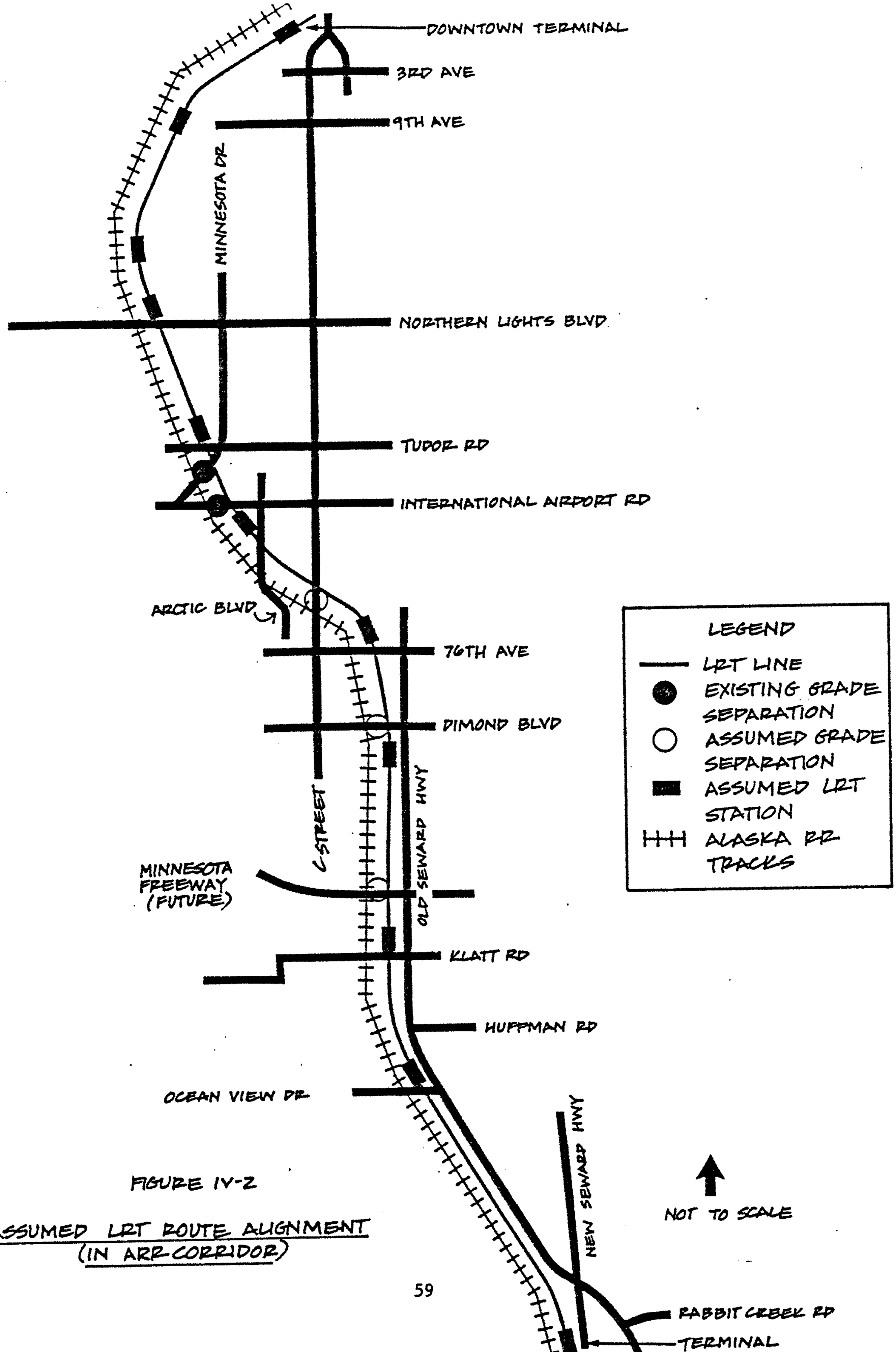


FIGURE IV-2

ASSUMED LRT ROUTE ALIGNMENT (IN ARR CORRIDOR)

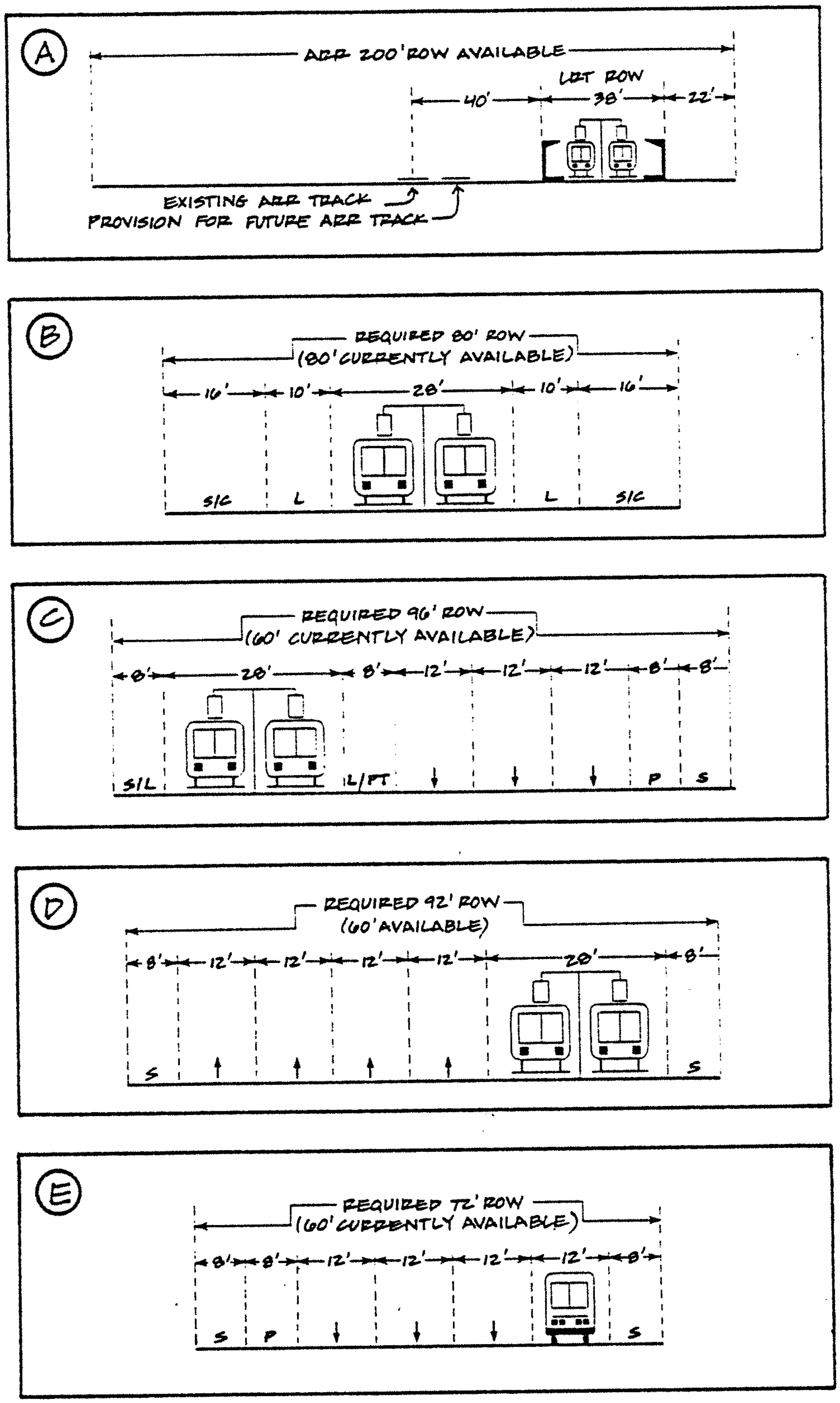
Additionally, it is clearly preferable for the LRT tracks not to cross the main ARR tracks at any point on the route, to avoid potential delays and conflicts between the two systems.

The LRT line could be constructed and operated entirely within the existing 200 foot right-of-way owned by the Alaska Railroad. This right-of-way width extends over the full length of the assumed LRT line from downtown to the Potter Point Terminal, with the exception of a segment north of 8th Avenue, which is about 100 feet wide. A typical cross-section of the LRT line located within the ARR right-of-way is shown in Figure IV-3. Such a layout would provide more than adequate safety clearance between ARR and LRT operations, and would also accommodate the laying of a second ARR track if desired at some future point in time.

While it is technically feasible for LRT and railroad operations to share the same trackage (the track gauge is equivalent), there are a number of severe operational, safety, and jurisdictional problems. The problems arise principally from the fundamental differences between the two modes. LRT comprises short train consists of one or two cars, with a high frequency of service and high acceleration and deceleration rates. Railroad operations on the other hand, being principally freight movements, generally entail long train consists moving infrequently, at low speeds, and thus low rates of acceleration and deceleration. In addition to the safety problems, LRT service can thus be severely impacted through long delays from railroad operations if trackage is shared.

In the case of the ARR, train rescheduling would thus be necessary. This would involve an average of 2 passenger trains and 2-3 freight trains a day. The rescheduling of the passenger trains is clearly not a realistic proposition for the ARR. For these reasons it has been assumed that LRT and the ARR would not share the same physical track provision.

As the LRT tracks would be in the railroad right-of-way, the line would be totally at grade, and would not be subject to any vertical or horizontal



A: LRT IN ALASKA RAILROAD CORRIDOR (LOOKING NORTH)

B: LRT ON 5TH AVENUE TRANSIT MALL (LOOKING WEST)

C: LRT ON C STREET BETWEEN 5TH AVENUE AND FIREWEED LANE (LOOKING NORTH)

D: LRT ON EAST NORTHERN LIGHTS BETWEEN C STREET AND SEWARD HWY (LOOKING WEST)

E: BUSWAY ON C STREET BETWEEN 5TH AVENUE AND FIREWEED LANE (LOOKING NORTH)

LEGEND

- S SIDEWALK
- C COMMERCIAL LOADING (TIME RESTRICTED)
- L LRT LOADING AREA
- P PARKING
- T TURN LANE

FIGURE IV-3

ASSUMED TYPICAL LRT CROSS-SECTIONS

curvature problems. Virtually no building take would be necessary as the right-of-way is almost completely undeveloped.

The line length would total 11.6 miles with an average station spacing of 1.2 miles. Station locations have been assumed as shown in Figure IV-2. The existing ARR depot has been assumed as the downtown terminal. As indicated in Table IV-2, and Figure IV-2, the LRT line would cross 17 roadways in total, 8 major arterials and 9 minor roadways. Of the major arterial crossings, the following 4 locations would be grade-separated:

- Minnesota Drive
- International Airport Road
- Dimond Boulevard
- C Street

The first two listed are already grade-separated and it is assumed that grade-separation between the ARR and both C Street and Dimond Boulevard would be carried out prior to 1995. The remaining 4 major arterials which would be crossed at grade are:

- Northern Lights Boulevard
- Spenard Road
- 44th/Tudor Road
- Arctic Boulevard

The operation of these at-grade crossings is discussed further in Section C of this chapter.

3. Description of Downtown Route Alignments

The downtown route alignments assumed for each corridor are shown in Figure IV-4. The ARR depot has been assumed as the downtown terminal for the ARR route. Access to central downtown would be via a pedestrian walkway to 3rd Avenue, or a shuttle bus service could be operated between the depot and various strategic downtown locations. Topographical

TABLE IV-2

ROUTE ALIGNMENT CHARACTERISTICS

	LRT Routes				Busway
	ARR	C Street	Northern Lights (East)	Northern Lights (West)	C Street
Route Length (miles)	11.6	7.5	7.9	6.5	7.5
Number of Stations	11	12	16	13	12
Average Station Spacing (miles)	1.2	0.7	0.5	0.5	0.7
Route mileage (and % age of route)					
• within existing ROW	11.6 (100%)	3.5 (47%)	3.7 (47%)	3.0 (46%)	3.5 (47%)
• requiring additional ROW (up to 40' max.)	0.0 (0%)	4.0 (53%)	4.2 (53%)	3.5 (54%)	4.0 (53%)
• at grade	11.6 (100%)	7.2 (96%)	7.6 (96%)	6.3 (97%)	7.5 (100%)
• underground	0.0 (0%)	0.3 (4%)	0.3 (4%)	0.2 (3%)	0.0 (0%)
No. of grade-separated crossings	4	4 1/	1 1/	0 1/	3
No. of at-grade crossings 2/					
• major arterial	4	4	5	6	7
• minor road	9	16	29	24	16

1/ Excludes subway section of route alignment.

2/ Excludes downtown and assumed 5th Avenue transit mall.

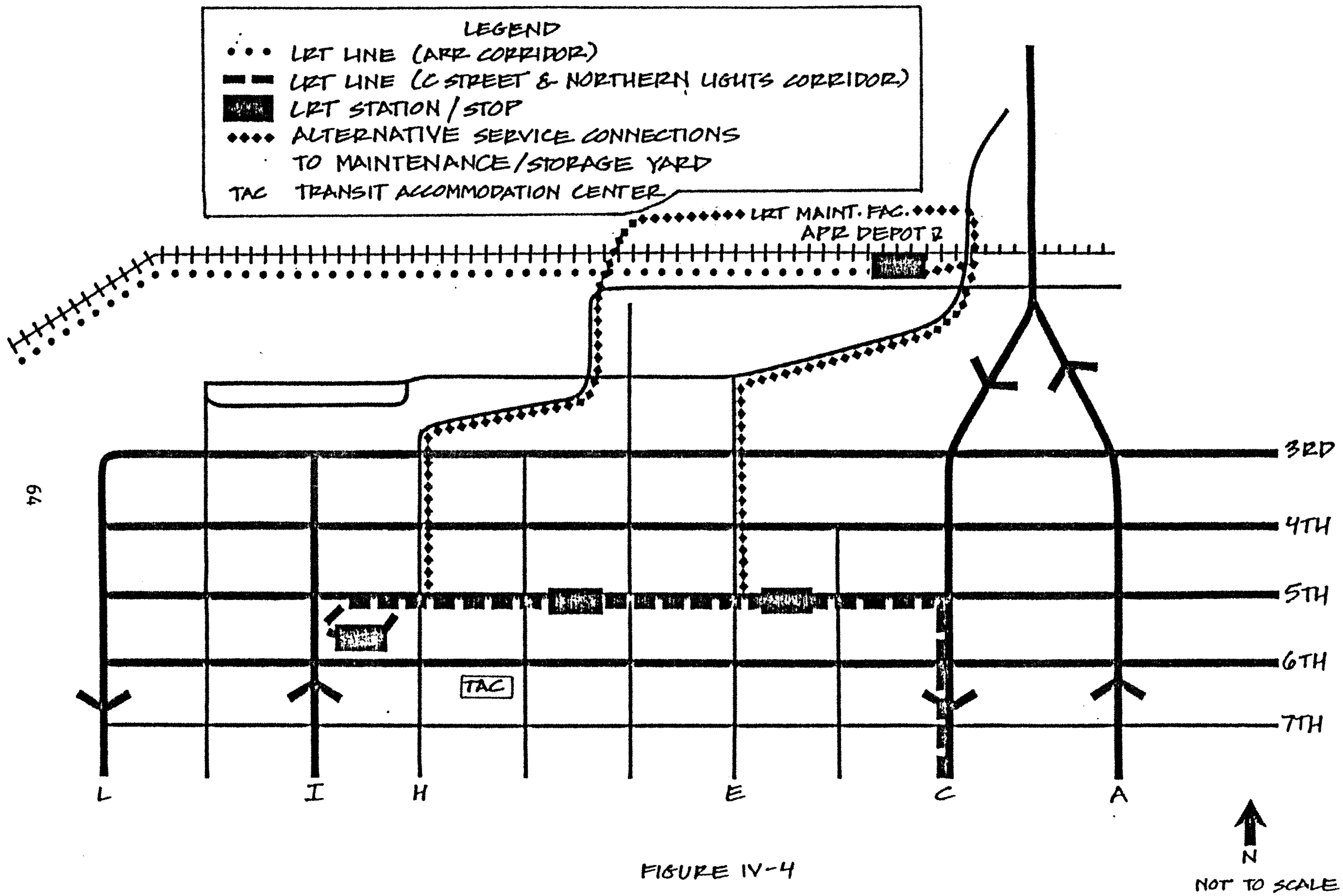


FIGURE IV-4

ASSUMED DOWNTOWN LRT ROUTE ALIGNMENTS & TRAFFIC CIRCULATION conditions and the high cost of tunneling would preclude the possibility of LRT in the ARR corridor penetrating directly into the central downtown area.

Also shown in Figure IV-4 is the common downtown alignment assumed for the C Street route and both Northern Lights routes. From a separated right-of-way on the west side of C Street (described in the C Street alignment section), the LRT tracks would swing west along 5th Avenue to a terminal/turnaround facility on the south side of 5th Avenue between I and H Streets. Due to the high cost of acquiring additional right-of-way in the central downtown, it is assumed that LRT would operate on-street along 5th Avenue. This would provide an ideal opportunity to create a transit mall focused around LRT, along 5th Avenue between C and I Streets. Fourth and 6th Avenues would provide for principal east-west traffic circulation in the area.[1/]

Very few potential locations currently exist for an LRT storage/maintenance yard in any of the four corridors, particularly the more heavily developed Northern Lights corridors. For analysis purposes, a yard located on ARR property to the north of the downtown depot has been assumed (see Figure IV-4). Access to the yard from the ARR route would be straight-forward. From the remaining three corridors, LRT vehicles would need to traverse the slopes from 5th Avenue to the railroad tracks. Two alternative alignments could be utilized, E Street and H Street. E Street has a 5.8% average grade over about 1500 feet of significant grade section, while H Street has a 4.9% average grade over a similar section length.

Preliminary grade profile analysis confirmed that H Street would provide the preferable LRT access route. The maximum grade of 11.4% over a short section of the route could be reduced to about 7% by moderate re-grading, bringing the entire profile within the $\pm 9\%$ maximum grade limitation of the Boeing LRV. Rather more re-grading would be required on E Street to provide a similarly acceptable profile.

1/ A realignment of the extension of Glenn Highway would be required to feed directly into 4th Avenue rather than into 5th Avenue.

4. C Street Corridor Description

The assumed LRT route alignment in the C Street corridor is shown in Figure IV-5. As it would be necessary to preserve at least the existing traffic capacity of C Street, it has been assumed that LRT would operate in a semi-exclusive right-of-way, physically separated from the C Street traffic lanes. Vehicular traffic would not be permitted access to the LRT right-of-way except to cross it where necessary to execute turn maneuvers from or into C Street. Figure IV-3 shows an assumed typical cross-section of LRT in the C Street corridor between 5th Avenue and Northern Lights Boulevard. Separation measures between LRT tracks and the traffic lanes could range from simply differential pavement colorings or markings, through raised curbs, to low fences.

As indicated in Table IV-2, about 50% of the line could be constructed within existing right-of-way. Much of the additional right-of-way required would be in the section between 5th Avenue and Benson Boulevard where up to 30 ft. of additional right-of-way width would be necessary. Building take in the additional right-of-way would be moderate, and the least impact would be caused by locating the LRT line to the west of C Street, particularly since the recent construction of the Federal Building on the east side at 7th Avenue. This alignment offers the further advantage of direct access to West 5th Avenue and the LRT downtown terminal without the LRT line crossing C Street in the downtown.

South of Benson Boulevard, track alignment to the east of C Street was assumed for the following reasons:

- between Benson Boulevard and 36th Avenue there is more room currently available, between the pavement and existing development, on the east side of the street
- between 36th Avenue and Dimond Boulevard, the existing C Street pavement is offset westwards within the right-of-way alignment, which varies in total width from a minimum of 200 ft. to 280 ft.

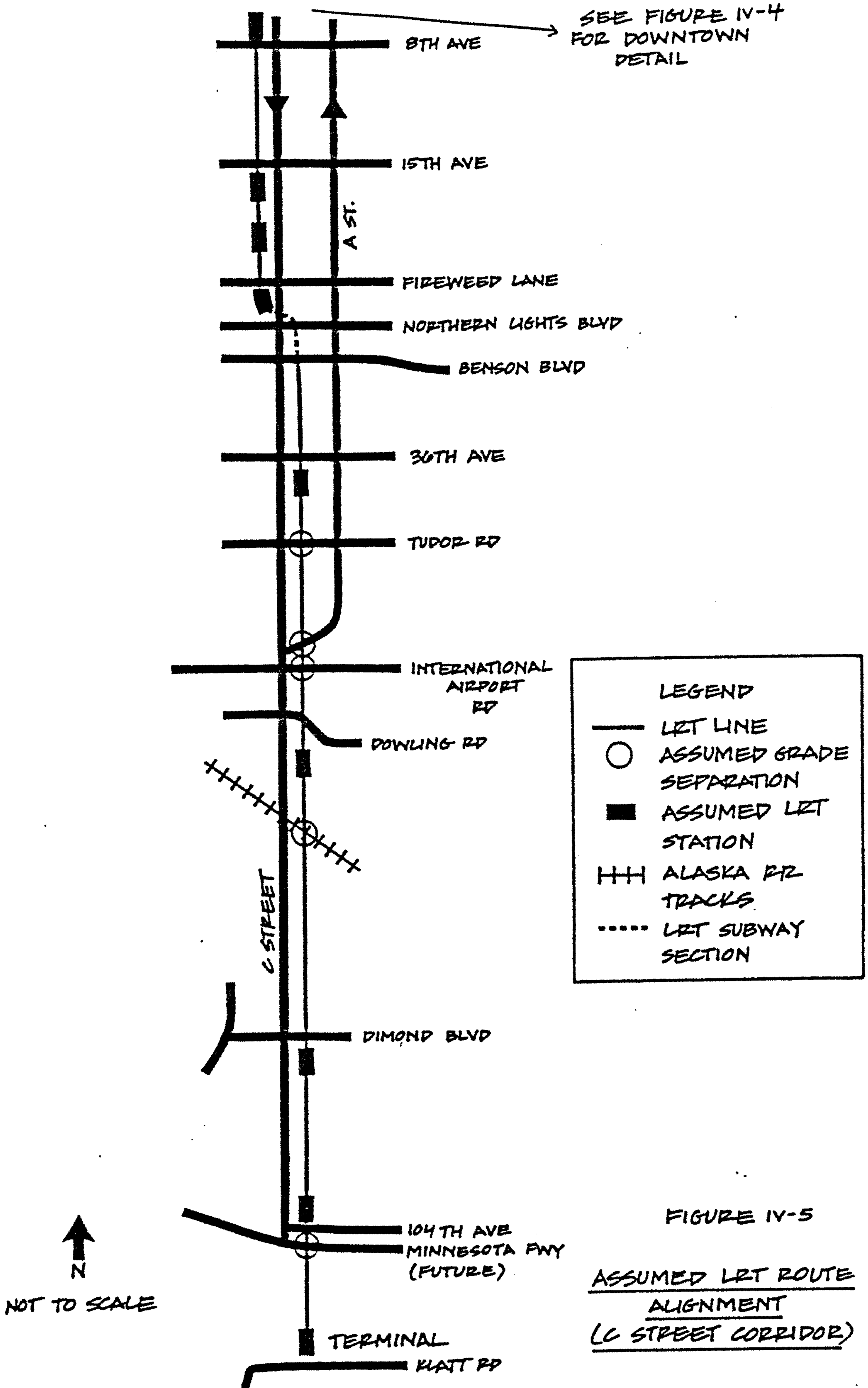


FIGURE IV-5

ASSUMED LRT ROUTE ALIGNMENT (C STREET CORRIDOR)

Building take south of Benson Boulevard for the LRT right-of-way would be negligible.

About 95% of the total 7.5 mile line could be constructed at grade. It has been assumed that the remaining 0.3 miles would be constructed in subway section in the area of Northern Lights Boulevard and Benson Boulevard, as shown in Figure IV-5. The grade separations between LRT and Northern Lights and Benson Boulevards would be necessary due to the level of commercial activity and employment projected for this locality by 1995. The projected development of this area as a secondary CBD will result in considerable traffic volumes being loaded onto the arterial road network. Surface operation of LRT would result in conflicts detrimental to both LRT and traffic operations, particularly if either or both of the Northern Lights LRT routes were operated in conjunction with the C Street LRT route.

The subway section has been assumed from south of Fireweed Lane to south of Benson Boulevard. This would also allow the transition of LRT alignment from the west to east side of C Street to be made below grade. An underground station has been assumed mid-block between Fireweed Lane and Northern Lights Boulevard on the west side of C Street. If the Northern Lights LRT line(s) were also constructed, this station would function as a transfer point between lines. Major building take in this area would be minimal with this alignment. The Alaska National Bank currently located on the northwest corner of C Street and Northern Lights, for example, would remain unaffected.

Figure IV-5 shows the assumed station locations. Including the downtown and Klatt Road terminals these 12 stations would provide for an average station spacing of 0.7 miles over the full length of the line. With the exception of the station at Northern Lights Boulevard, all stations would be at grade.

Excluding the subway section, four grade separations with major arterials have been assumed for the C Street alignment, as follows:

- Tudor Road
- A Street/International Airport Road
- Alaska Railroad
- Minnesota Freeway

The first two listed would be required specifically for LRT. The proximity of the A Street and International Airport Road crossings would require the LRT line to remain below grade between the intersections, and they have therefore been assumed as one entity. It is assumed that grade separation between C Street and the ARR and the planned Minnesota Freeway would be completed prior to 1995, even without LRT.

The LRT line would cross 20 roadways at grade, of which 16 would be minor roadways, and the following 4 would be major arterials:

- West 15th Avenue
- Fireweed Lane
- East 36th Avenue
- Dimond Boulevard

Preliminary grade analysis indicates LRT to be operationally feasible along the full length of the C Street route. Although the maximum design capability of the Boeing LRV is ±9%, a grade of about 8% would probably be the preferable upper limit for LRT operations. Much of the alignment is relatively flat, the principal exception being in the area of Chester Creek between 11th Avenue and Fireweed Lane. Grades of 8% currently exist at various locations along this section of C Street. Some of the less steep grades could be reduced during construction as a certain amount of landfill would be required to cross Chester Creek. The most critical sections would be between 11th and 12th Avenues, and between 15th and 16th Avenues. The short section of 8% grade just south of 11th Avenue holds little potential for reduction without major earthwork or grade separation, due to the proximity to the 11th Avenue intersection. The existing 8% grade sections between 15th and 16th Avenues could be reduced to about 5% with moderate re-grading. South of Chester Creek, with minimal re-grading, the maximum grade would be 5 or 6%.

5. East Northern Lights Corridor Description

The assumed LRT alignment in this corridor is shown in Figure IV-6. Between the downtown and Northern Lights Boulevard, the alignment along C Street would be as identified for the C Street corridor. If both the LRT corridors were operated, the trackage would be shared over this section of common route.

As for the C Street corridor, the LRT line in the East Northern Lights corridor would operate in a semi-exclusive right-of-way. Table IV-2 shows that about 47% of the line could be constructed within the existing right-of-way along the route. From C Street to Lake Otis Parkway, alignment to the north of Northern Lights Boulevard has been assumed principally for the following reasons:

- this alignment avoids the LRT line having to cross Benson Boulevard where this street rejoins Northern Lights Boulevard
- the existing parklike strip immediately north of Northern Lights Boulevard between La Touche Street and Lake Otis Parkway offers an ideal LRT right-of-way
- there would be less impact with major existing development on the north side

Figure IV-3 shows an assumed typical LRT cross-section in this area.

The local topography would dictate the LRT route being aligned on the east side of Lake Otis Parkway. The LRT would cross diagonally through the center of the Northern Lights/Lake Otis intersection on a separate traffic signal phase, since the high cost of grade separation would not appear justified at this location.

Alighment north of Providence Avenue has been assumed because there are fewer driveways, and it would provide direct access to the University

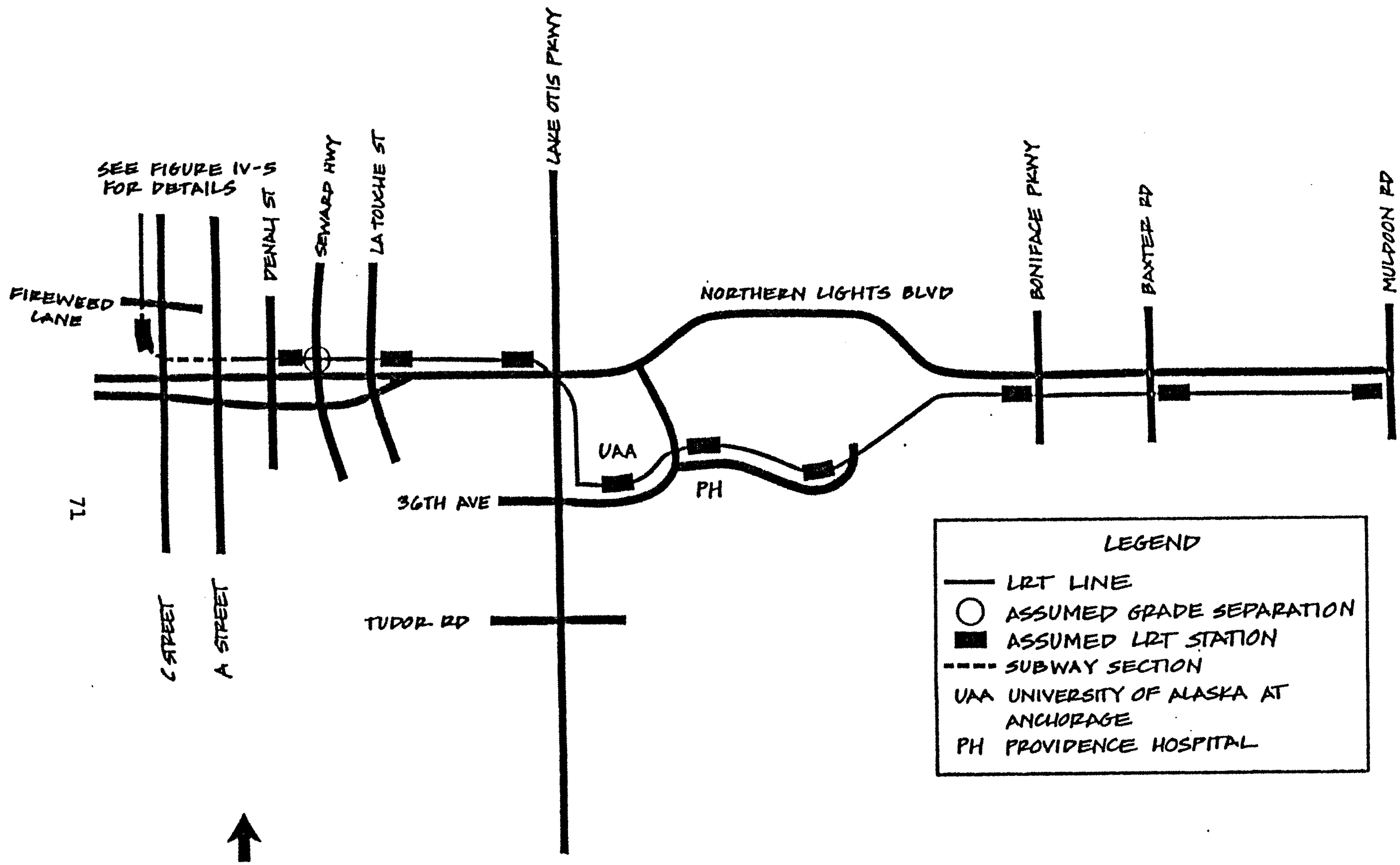


FIGURE IV-6

ASSUMED LRT ROUTE ALIGNMENT (EAST NORTHERN LIGHTS CORRIDOR) of Alaska at Anchorage (UAA). Between Boniface Parkway and the assumed outer terminal at Muldoon Road, an alighment through the predominantly park area immediately south of Northern Lights Boulevard, utilizing the existing utilities eastement, would minimize both building take and additional right-of-way requirements. Building take for the line as a whole would be moderate.

Of the 7.9 mile line, 7.6 miles would be constructed at grade with the remaining 0.3 mile in subway section between just east of A Street and just south of Fireweed Lane. A total of 16 stations, including both outer and downtown terminals, would result in an average station spacing of 0.5 miles. All stations except the C Street/Northern Lights station would be at grade. The assumed station locations are indicated in Figure IV-6.

Excluding the subway section, only one other grade separation is assumed. This is with the Seward Highway, and it has been assumed that this grade separation would be implemented prior to 1995, irrespective of LRT potential. The assumed LRT line in this corridor would cross a total of 34 streets at grade. Of these, 29 would be minor roadways, the remaining 5 crossings would be with the following major arterials:

- West 15th Avenue
- Fireweed Lane
- Lake Otis Parkway/Northern Lights Boulevard
- Providence Avenue
- Boniface Parkway

With respect to vertical grades, the same situation would apply to the Chester Creek area as for the C Street LRT line. These grades would be the maximum grades encountered in the corridor as the Northern Lights Boulevard section of this route is relatively flat in comparison. Suitable potential alignments were identified between Providence Hospital and Boniface Parkway that would involve grades of less than 5%.

6. West Northern Lights Corridor Description

Figure IV-7 indicates the assumed route alignment for LRT in the West Northern Lights corridor. As for both the C Street and East Northern Lights corridors, LRT operation in a semi-exclusive right-of-way has been assumed, with a common corridor alignment along C Street between downtown and Northern Lights Boulevard.

About 46% of the line could be constructed within existing right-of-way. As the 200 ft. right-of-way reservation planned by the State for an access corridor between Northern Lights Boulevard and the International Airport could be utilized for an LRT alignment, additional right-of-way requirements would be limited to sections along Northern Lights Boulevard and C Street.

The assumed alignment on the north side of Northern Lights Boulevard was selected for various reasons:

- this alignment avoids crossing Northern Lights Boulevard until the western extremity where traffic levels are lower
- there is a lesser impact on existing multi-story development
- west of the ARR crossing, an LRT alignment could be accommodated to the north of the roadway with minimal residential property take. This would not be the case on the south side.

An alignment to the west of the airport access road has been assumed as providing the minimal level of interference at the International Airport.

Thirteen stations would be located along the route, as shown in Figure IV-7, providing an average station spacing of 0.5 miles. All stations, with the exception of C Street/Northern Lights would be at grade. For maximum accessibility, the LRT outer terminal at the International Airport should be located as close to the passenger terminal as possible. The current rental car parking area would be an ideal location, for example.

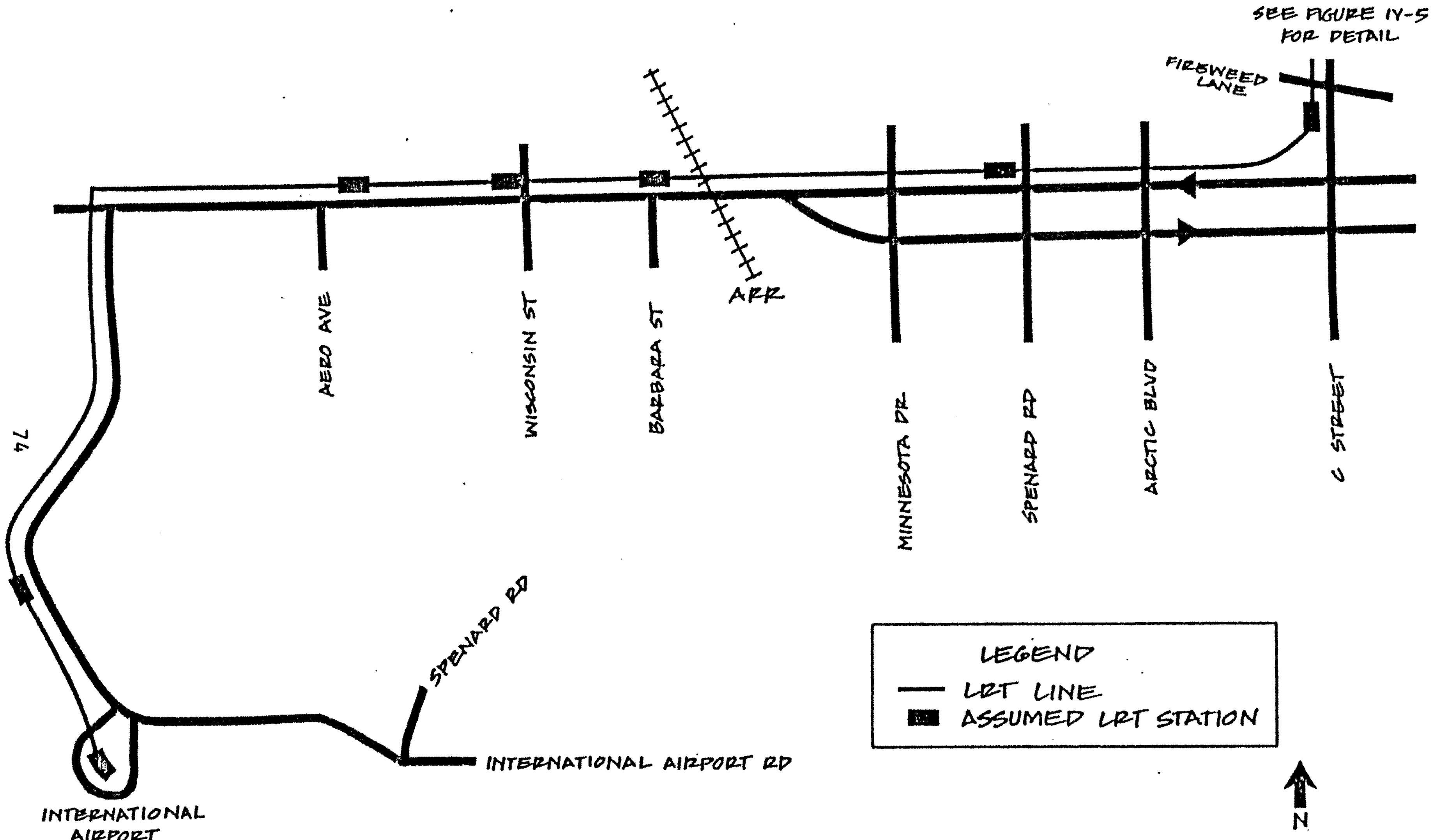


FIGURE IV-7

PROPOSED LRT ROUTE ALIGNMENT (WEST NORTHERN LIGHTS CORRIDOR)

No grade separations at street crossings have been assumed for this LRT route as either they would not be warranted by the traffic volumes, or LRT could be accommodated within normal traffic signal phasing at the intersections. The route would cross 30 roadways at grade, of which 24 would be minor roads, and the following 6 would be major arterials:

- West 15th Avenue
- Fireweed Lane
- Arctic Boulevard
- Spenard Road
- Minnesota Drive
- Alaska Railroad track

No part of the alignment would contain grades above the 8% design limit, although grades of 8% currently exist for short sections on Northern Lights Boulevard between the Alaska Railroad and Lois Drive. This could be reduced to about 6% between the ARR and Forest Park Drive with a minimum of engineering work. In the vicinity of Churchill Drive, it would be very difficult and costly to reduce the existing 8% grade without considerable earthwork and the closing off of Churchill Drive.

7. C Street Busway Alternative

The concept of a busway in the C Street corridor was developed and analyzed to enable a comparative evaluation of the operational and cost-effectiveness of an LRT line with an alternative form of transit provision. The busway concept would provide for a two-lane busway located principally in a separated and semi-exclusive right-of-way adjacent to C Street. As for LRT, all other vehicles would be prohibited from using these reserved bus lanes (with the exception of turning traffic), although use by vehicles carrying three or more passengers could be considered. Bus speeds and journey times would thus not be unduly constrained by automobile traffic, allowing a fast, reliable service to be provided.

Cross-sectional right-of-way requirements for a two-directional busway comprise two 12 ft. bus lanes and an 8 ft. shoulder for emergency purposes, a total of 32 ft. This would be 4 ft. more than the average right-of-way required for LRT operation. If the busway were operated immediately adjacent to the other traffic lanes, an optional 1 ft. divider strip could be included.

At bus stopping points (for passenger pick up and drop off) the minimum right-of-way width necessary if both loading areas were directly opposite each other would be 52 ft., comprising two 12 ft. lanes, two 8 ft. pullout bays, and two 6 ft. sidewalk/loading areas. Staggering the loading areas would reduce the width required to 38 ft. These requirements would be greater than the 38 ft. and 33 ft. respective widths necessary for LRT loading areas, as buses would have to pull out of the bus lanes to load and unload passengers.

The busway route alignment assumed for study purposes is shown in Figure IV-8. The alignment is the same as that assumed for LRT in the C Street corridor (including the 5th Avenue transit mall) except for the section between 5th Avenue and International Airport Road. Over this route section the busway would be split directionally into 2 one-way sections following the planned A and C Streets one-way couplet.

Northbound, the busway would comprise a 12 ft. lane on the west side of A Street, while in the southbound direction a 12 ft. lane has been assumed on the east side of C Street. Minimal physical separation between the busway and traffic lanes would allow buses to pull over into these lanes in emergencies or to bypass a stalled bus, thus eliminating the need for an 8 ft. shoulder specifically for the bus lane. Figure IV-3 shows a typical assumed cross-section of busway operation in this section of C Street. At bus stopping points, pullouts and passenger islands would increase the right-of-way requirement to 28 ft.

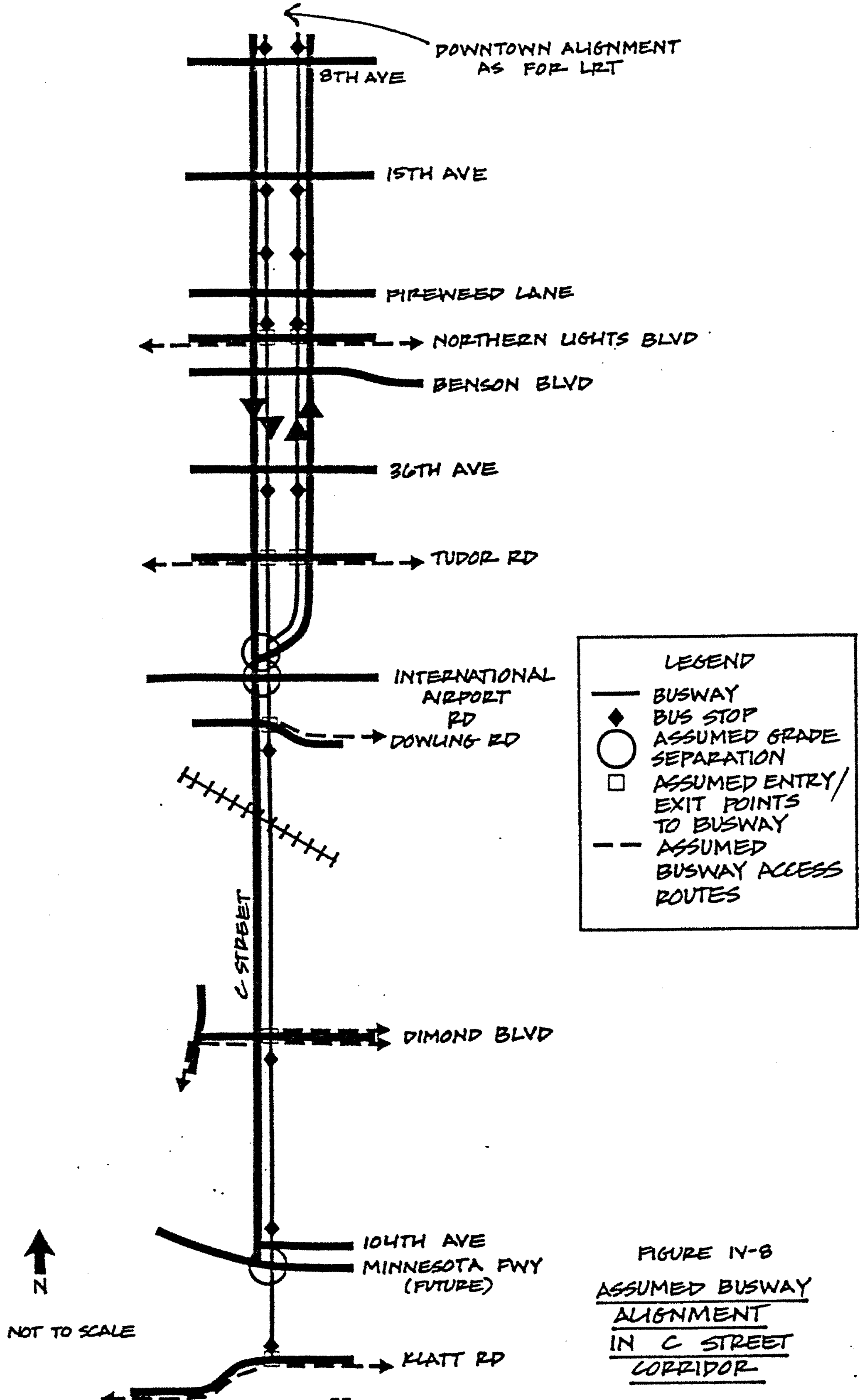


FIGURE IV-8

ASSUMED BUSWAY ALIGNMENT IN C STREET CORRIDOR

Similarly to LRT, about 50% of the busway could be constructed within existing right-of-way. Where additional right-of-way were required, this would generally be less than for LRT along C Street, although additional right-of-way would also be required on A Street for the busway alternative. The busway has been assumed almost entirely at grade. A subway section at the Northern Lights/Benson Boulevard area would not be necessary as service would be one-directional, compared to two-directional service for LRT. Buses, being shorter than an LRT train, would not create as severe an impact on traffic flows. Grade separation has, however, been assumed at the ARR crossing and with the Minnesota Freeway, and also as being necessary at the start of the A-C Street one-way couplet as shown in Figure IV-8.

B. Assumed Service Levels

LRT service levels were assumed for 2 different time horizons, 1985 and 1995, to enable an evaluation of the staged implementation of LRT service. The assumed service levels represent significant differences in LRT provision, and are summarized in Tables IV-3 and IV-4.

LRT service in 1985, representing initial construction and operation, would essentially comprise shorter routes, restricted service periods, and less frequent train service than the full system assumed for 1995. It is assumed that in the initial stage, the LRT lines in the ARR and C Street corridors would terminate at Dimond Boulevard. Similarly, in 1985 the East Northern Lights line would terminate at Providence Hospital.

Initial hours of LRT operation would be from 6 a.m. to 8 p.m., Monday through Saturday, with no Sunday operation. By 1995, when the full lengths of the lines would be in operation, it is assumed that weekday service would be expanded to run from 6 a.m. to 12 a.m., and that a Sunday/Holiday service would operate between 8 a.m. and 10 p.m.

1. LRT Service Frequencies

LRT service frequencies (or train headways) have been assumed for five different time periods during an average weekday, to illustrate the type of service that could be expected throughout the day in 1985 and 1995. These service frequencies, along with typical train lengths (number of cars per train) are summarized in Tables IV-3 and IV-4. Weekend service frequencies, which would be constant between 6 a.m. and 8 p.m., would be similar to weekday off-peak service.

For the purposes of analysis, the assumed service frequencies are based upon the high estimate LRT ridership projections at the corridor maximum

TABLE IV-3

ASSUMED SERVICE LEVELS - 1985

	LRT Lines				Busway
	ARR	C Street	Northern Lights (East)	Northern Lights (West)	
	Line 1	Line 2	Line 3	Line 4	C Street 1/
Length of Route (mi.)	6.8	5.6	4.9	6.5	5.6
No. of Stations/Stops	8	10	12	13	10
Avg. Station/Stop Spacing	1.0	0.6	0.5	0.5	0.6
Terminals - downtown outer	ARR depot Dimond Blvd.	5th Ave/I St. Dimond Blvd.	5th Ave/I St. Providence Hosp.	5th Ave/I St. Inter. Airport	5th Ave/I St. Dimond Blvd.
Hours of Operation					
Weekday	6 am-8 pm	6 am-8 pm	6 am-8 pm	6 am-8 pm	6 am-8 pm
Saturday	6 am-8 pm	6 am-8 pm	6 am-8 pm	6 am-8 pm	6 am-8 pm
Sunday/Holiday	no service	no service	no service	no service	no service
Service Frequencies (weekdays)					
6 am-9 am (train length)	15 min. (2 cars/train)	7.5 min. (2 cars/train)	10 min. (2 cars/train)	15 min. (2 cars/train)	1 min. 2/ (6 min.)
9 am-3 pm (train length)	30 min. (2 cars/train)	12 min. (2 cars/train)	15 min. (2 cars/train)	30 min. (2 cars/train)	2.5 min. (15 min.)
3 pm-6 pm (train length)	15 min. (2 cars/train)	7.5 min. (2 cars/train)	10 min. (2 cars/train)	15 min. (2 cars/train)	1 min. (6 min.)
6 pm-8 pm (train length)	30 min. (2 cars/train)	12 min. (2 cars/train)	15 min. (2 cars/train)	30 min. (2 cars/train)	2.5 min. (15 min.)
Speeds - maximum operating	45 mph 25 mph	45 mph 20 mph	45 mph 17 mph	45 mph 15 mph	50 mph 23 mph 3/
One-way journey time (length of line)	16.5 min.	17 min.	17 min.	26 min.	15 min.

1/ Refers to line haul portion of busway system only.

2/ Bus frequency for all routes combined on line haul busway. (Average individual route frequency in parentheses.)

3/ Average speed on feeder routes would be 14 mph.

TABLE IV-4

ASSUMED SERVICE LEVELS - 1995

	LRT Lines				Busway
	ARR	C Street	Northern Lights (East)	Northern Lights (West)	
	Line 1	Line 2	Line 3	Line 4	C Street 1/
Length of Route (mi.)	11.6	7.5	7.9	6.5	7.5
No. of Stations/Stops	11	12	16	13	12
Avg. Station/Stops Spacing	1.2	0.7	0.5	0.5	0.7
Terminals - downtown outer	ARR depot Rabbit Cr. Rd.	5th Ave/I St. Klatt Rd.	5th Ave/I St. Muldoon Rd.	5th Ave/I St. Inter. Airport	5th Ave/I St. Klatt Rd.
Hours of Operation Weekday Saturday Sunday/Holiday	 6 am-12 am 6 am-12 am 8 am-10 pm	 6 am-12 am 6 am-12 am 8 am-10 pm	 6 am-12 am 6 am-12 am 8 am-10 pm	 6 am-12 am 6 am-12 am 8 am-10 pm	 6 am-12 am 6 am-12 am 8 am-10 pm
Service Frequencies (weekdays)					
6 am-9 am (train length)	10 min. (2 cars/train)	6 min. (3 cars/train)	7.5 min. (3 cars/train)	10 min. (2 cars/train)	40 sec. 2/ (6 min.)
9 am-3 pm (train length)	15 min. (2 cars/train)	10 min. (3 cars/train)	12 min. (3 cars/train)	20 min. (2 cars/train)	90 sec. (15 min.)
3 pm-6 pm (train length)	10 min. (2 cars/train)	6 min. (3 cars/train)	7.5 min. (3 cars/train)	10 min. (2 cars/train)	40 sec. (6 min.)
6 pm-8 pm (train length)	15 min. (2 cars/train)	10 min. (3 cars/train)	12 min. (3 cars/train)	20 min. (2 cars/train)	90 sec. (15 min.)
8 pm-12 am (train length)	30 min. (2 cars/train)	20 min. (2 cars/train)	20 min. (2 cars/train)	30 min. (2 cars/train)	5 min. (45 min.)
Speeds - maximum operating (avg)	45 mph 25 mph	45 mph 20 mph	45 mph 17 mph	45 mph 15 mph	50 mph 23 mph 3/
One way journey time (full length of line)	28 min.	22.5 min.	28 min.	26 min.	20 min.

1/ Refers to line haul portion of busway system only.

2/ Bus frequency for all routes combined on line haul busway. (Average individual route frequency in parentheses.)

3/ Average speed on feeder routes would be 14 mph.

load points, as identified earlier in this report.[1/] They represent the level of LRT service that would be necessary to carry those riderships, and constitute an optimal balance between train frequency and train length. (For example, in any given hour, a train service of 10 minute frequency using 2-car trains could carry the same number of passengers as 4-car trains running at a 20-minute frequency. The more frequent service is more convenient and, therefore, more attractive to potential passengers. It is also, however, the more expensive to provide and operate.)

During the initial stages of LRT operation (1985), a 15-minute frequency during the peak period, and 30-minute frequency during the off-peak, would be adequate to service the projected LRT passenger demand for the ARR corridor and West Northern Lights corridor. Slightly higher frequencies would be required for the East Northern Lights corridor, while in the C Street corridor a 7.5-minute peak frequency and 12-minute off-peak frequency would be required. Two-car trains would be adequate during all time periods in all the LRT corridors.

In 1995, at full service, peak frequencies in the ARR and West Northern Lights corridors would need to be increased to 10 minutes, with corresponding increases in off-peak services. Train lengths in these corridors would remain at 2 cars per trains. By 1995, a 7.5-minute peak frequency would be necessary in the East Northern Lights corridor, and a 6-minute peak frequency would be needed in the C Street corridor. Three-car train consists would be operated between 6 a.m. and 8 p.m. in these 2 corridors. (A maximum of 4 Boeing LRV's can be put together to form an LRT train.) Off-peak frequencies in 1995 would range from 10 minutes in the C Street corridors to 20 minutes in the West Northern Lights corridor.

The peak period LRT service levels are based on an assumed peak period vehicle design capacity of approximately 130 persons per light rail car.

1/ See Chapter III.C.4, and Tables III-4 and III-5.

The Boeing LRV has 68 seats per car, so the assumed service levels would imply about 50% of passengers would be standees during the peak hour at the maximum passenger load point of the LRT lines. This would, however, be considerably below the design capacity of the cars, which is set by Boeing at 219 passengers, 68 seated and 151 standing. During the peak-hour transit service, virtually anywhere in the world, standing passengers are generally the rule, rather than the exception, as it is impractical and economically infeasible to design for 100% of passengers to be seated during rush hours. The new Boeing LRV's operating in Boston for example, are currently regularly carrying peak-hour passenger loads above the 219 per car design standard.

The design capacity assumed for the Anchorage LRT lines is, therefore, considered to be well within acceptable comfort standards for peak-hour transit service, particularly as light rail vehicles are oriented to standing passengers through design features, such as wide aisles and adequate ceiling height in the vehicles. The fact that LRT is a track-based system also provides for a smoother ride than can usually be experienced on bus services. The percentage of standing passengers would, of course, be lower outside of the peak hour and away from the maximum load point of the route. For off-peak service levels, the design capacity of the light rail vehicle was assumed to be 68 persons, i.e. 100% of passengers would be seated.

The LRT corridor service levels assumed for 1995 would leave considerable potential surplus capacity available for future ridership expansion. In the C Street corridor, for example, the assumed service levels of a 6-minute frequency with 3-car trains, and a 130 passenger/car design limit, would provide for a line capacity of 3,900 passengers per hour per direction (equivalent to the maximum projected 1995 peak-hour volume). Increasing the service frequency to 2 minutes, while retaining the vehicle capacity standard and train lengths, would provide for a line capacity of 11,700 passengers per hour per direction. At the technically maximum frequency of 1 minute between trains and the same train lengths and vehicle capacity, an ultimate line capacity of 23,400 could be achieved, which would be six times as high as the 1995 projected demand.

The maximum train speed has been assumed at 45 mph in all the LRT corridors, although with the exception of the ARR corridor, such a speed would probably not be sustained for any length of time, due to the average station spacings and the number of roadway crossings. Estimated average operating speeds for the LRT lines would range from 15 mph in the West Northern Lights Boulevard corridor to 25 mph in the ARR corridor. These operating speeds would result in the journey times shown in Tables IV-3 and IV-4 for each of the LRT lines. Average journey times would be below these figures as not all passengers would ride the full length of the LRT line. The average journey time between the downtown and the C Street/ Northern Lights/Benson Boulevard commercial area, for instance, would be about 7 to 8 minutes.

2. Busway Service Frequencies

Tables IV-3 and IV-4 also summarize the assumed service levels for the busway operation. Similar route characteristics, station/stop locations, and hours of service operation, to LRT have been assumed in order to support the comparative evaluation of the two modes.

Operation of the busway, by its very nature, has been assumed to be rather different to the strictly line haul functions of an LRT system. The busway would not be limited to line haul operation, and has been assumed to comprise 10 bus routes, functioning as neighborhood collector services before joining the busway, and then switching to the line-haul function with few stops. Figure IV-8 indicates the assumed entry points to the busway of these routes. No transfer between vehicles would be necessary at these points as buses would proceed directly onto the busway. This would result in the busway service area being rather larger and extending further east than the service area for LRT operations in the C Street corridor. The number of jobs and dwelling units served would thus be slightly higher for the busway than for LRT, although the employment and population densities would be virtually identical between the service areas of the two modes. (See Section III.B.2 and Table III-1.)

The service frequencies assumed in Tables IV-3 and IV-4 are for all busway routes combined, on the busiest busway section (between downtown and Northern Lights Boulevard). Also shown, in parentheses, are the resulting average service frequencies for individual routes utilizing the busway. These are intended to be illustrative only, as some routes would probably have higher or lower headways depending on the type and destination of the route.

Based on the high estimate ridership projections derived for the busway corridor, an average busway route frequency of 6 minutes has been assumed for peak periods in 1995. This would translate to a combined vehicle headway for all routes of about 40 seconds, equivalent to 90 buses an hour, on the busway between downtown and Northern Lights Boulevard. South of Northern Lights, the combined vehicle headway would reduce, as less routes would be on the busway. South of Dowling Road, for instance, 5 routes would operate on the busway, providing a combined frequency of about 80 seconds, or 45 buses an hour.

The required bus service frequency was based on an assumed peak period bus design capacity of 56 persons, 45 seated and 11 standing. Thus about 25% of bus passengers under peak load conditions would be standees, a rather lower percentage than assumed for LRT due to the less stable ride offered by the bus mode and the slightly higher average trip length that may be expected due to no transfer being necessary.

The assumed level of busway operation in 1995, of 90 buses per hour per direction in the peak period, would provide for a carrying capacity of 5000 passengers per hour (equivalent to projected ridership levels). This would represent the desirable capacity of the busway, although the actual maximum capacity of the busway would be slightly higher at 120 buses per direction per hour, or a carrying capacity of 6700 passengers per hour.

Off-peak period route frequency in 1995 has been assumed at 15 minutes, or a 90 second combined route bus frequency on the busway. Off-peak bus capacity was assumed at 45 persons, or 100% of passengers seated.

As indicated in Tables IV-3 and IV-4, a slightly higher busway operating speed has been assumed than for LRT in the C Street corridor. This is designed to reflect the probability that certain bus runs may operate in the express mode, making only limited stops between joining the busway and downtown. All LRT trains, on the other hand, would stop at each station.

3. Stations and Access/Transfer Facilities

Sophisticated and elaborate station design can significantly add to the capital costs of LRT provision. The cost-effectiveness of such stations is questionable in the context of light rail systems, particularly in the initial stages of operation. Considerable flexibility in station design is facilitated by the capability of modern light rail vehicles for both high and low level loading. The type of fare collection system utilized can also affect station design and costs.

For study purposes, simple station design with low-level platforms has been assumed for all LRT corridors. While high level platforms provide for a more rapid loading capability, low level platforms offer the advantages of simplicity, inexpensive cost (both capital and operating), and flexibility in that stop patterns can readily be added or modified. Low-level platforms are also less visually intrusive. Most existing LRT systems, having evolved from street railways, continue to utilize low level loading, particularly in Europe. The Boston and San Francisco systems utilize both low and high level loading within their systems.

Platforms would be at ground level, and typically would be about 8 ft. wide and about 225 ft. long to accommodate three-car trains. Right-of-way reservations would need to be about 300 ft. in length to allow for 4-car trains at some future point in time. Platform areas could be delineated by being raised a few inches or having differential pavement surfaces or markings. Due to the inclement winter weather conditions in Anchorage, shelters have been assumed at all stations. These shelters would need to be heated and of adequate size and pleasant appearance.

Any new LRT system would need to meet UMTA requirements with respect to providing full accessibility to handicapped persons, including people in wheelchairs. Such access could be provided in 3 principal ways:

- wheelchair lift mechanism on vehicles
- wheelchair ramp to high level boarding
- high platform access, with ramp from gound level to platform level

High platform provision solely as a means of providing handicapped access is clearly not cost-effective. The individual wheelchair ramp presents operational problems as the LRT train has to stop with a doorway exactly aligned to it. The ramp also restricts general platform circulation. The assumed method of providing wheelchair access was thus a lift mechanism on one doorway of the vehicle or LRT train. The capital costs of handicapped access would, therefore, be included in light rail vehicle costs.

Compatible with the assumption of simple station design, is the assumed on-board method of fare collection. The LRT stations would thus be unmanned and access to the system would be very similar to boarding a bus. As the stations would be unmanned, a telephone information system would be provided for passengers.

The only exception to this assumed station design would be the C Street/ Northern Lights Boulevard station, common to the C Street and Northern Lights LRT corridors. As previously discussed, this station has been assumed to be underground, and would have high level platforms. Elevators would need to be provided for wheelchair access.

Due to the capability of LRT vehicles to load from both low and high levels, the selection of low level loading would not preclude high level loading at a later date. As ridership demand increased, stations could readily be converted to high platform loading as finances allowed.

The locations of LRT stations, outlined in the previous section of this report, were assumed for study purposes and were not subject to rigorous analysis of market potential or optimum location. The following criteria are fundamental to station location and were considered in the study assumptions:

- stations should be close to principal traffic generators, such as institutions, office buildings, shopping areas, educational and medical facilities, and sports arenas
- stations should be located close to major arterial intersections to allow good surface access for both feeder bus service and auto users
- stations should be located such that convenient walk access is provided, particularly in high density residential areas

Transfer facilities have been assumed at all LRT stations for bus operations, particularly as it would be expected that the majority of LRT passengers would arrive at LRT stations by bus-feeder service. The number of walk-on passengers would be limited by the generally low densities of the Anchorage area. Adequate bus-bays and pull-ins would need to be provided at LRT stations as the bus service in each LRT corridor would be reorganized to support and feed the LRT line. It is assumed this would involve route and schedule reorganization only, and no new buses would be required. While service frequency would be increased in some cases, route lengths would probably be shortened to serve the LRT line.

Park-and-ride lots have been assumed at major outlying stations and at outer terminals, particularly in the ARR and C Street corridors, where commuters from outside Anchorage could drive in as far as the outer terminal and take LRT to destinations in downtown and central Anchorage

Stations/stops on the busway would be similar to those described for LRT in that simplicity of design would be comparable, with of course on-board fare collection. Bus transfer facilities would not be necessary to the extent they would be for LRT, as buses would feed directly onto the busway. Park-and-ride lots have, however, been assumed at major outlying stops to accommodate people not living close to the bus feeder services.

4. Fare Assumptions

Passenger fares for the LRT (and busway) service have been assumed to be identical to those currently in effect on the People Mover system. This means a flat fare structure of 50¢ for adult regular riders, 25¢ for students, and free transit for the elderly and handicapped. Instead of the current token system, monthly passes would be sold at a 20% discount (or for $16 per month) to encourage daily commute riders.

Although the LRT system would have faster operating speeds than do the existing bus routes, it has been assumed that transit fares would be kept reasonably low as a matter of policy in order to attract as many automobile users as possible. Furthermore, door-to-door travel times may not differ too greatly for certain riders due to the need to transfer between LRT and feeder buses.

It has also been assumed that transfers between the feeder bus and LRT system or between the various LRT lines would be free. A zonal fare structure or distance-graduated fares are not considered desirable in Anchorage due to the relatively short route length on the one hand, and the greater complexity and costs associates with a graduated fare system on the other hand. As was mentioned earlier, on-board fare collection similar to that now used on the People Mover system has been assumed.

C. Operational Characteristics

This section of the report briefly summarizes the principal remaining assumptions made in defining the operating systems previously described for LRT and the busway.

1. Combined LRT Line Operation

The LRT lines have been identified as separate potential operations to enable the principal evaluation of the feasibility of each line independently. It is possible, however, that one or more lines could operate simultaneously, and comprise a system of LRT routes. The most likely scenario would be the C Street and the East and West Northern Lights lines operating together. In such an event, it has been assumed that each line would continue to operate over its full length. Service would thus be centered on the downtown in a radial fashion and train service would operate over each line from the outer terminal to the downtown. No direct cross-line service has been assumed (e.g. direct service between Muldoon Road or Klatt Road to the International Airport) as adequate transfer facilities would exist at the C Street/Northern Lights Boulevard station, and the expected ridership demand for these movements would not justify direct service. This assumption would not, however, preclude the introduction of such service as, and when, the demand justified.

The assumed radial service pattern would also result in a more frequent service being provided between the downtown and the "secondary downtown" projected for the C Street/Northern Lights area. By 1995, with the growth of the secondary CBD, considerable movement may be expected between these two areas. As shown in Table IV-4, service provided individually by the 3 LRT lines considered in this corridor would range from 6 to 10 minute frequencies. If all 3 lines were operating together, in the manner described above, the combined train frequency over this section of route would average about 2.5 minutes in 1995.

This combined service pattern is evaluated further in a later section of this report.

2. Crossing Control and Operation

With the exception of grade separation locations already identified, the majority of LRT line crossings with the street system would be at grade. It is assumed that minor roadways and driveways would be protected by stop and warning signs, with the responsibility resting on the car driver to check the LRT lines in both directions before crossing the right-of-way. This method of crossing operation is the most common among existing LRT systems, both in Europe and the U.S. In cases of particularly heavy turning movements across the LRT lines, the turning movement could be signalized.

Where the assumed LRT alignment crosses a major arterial at grade, LRT could cross the arterial during the appropriate green phase of the intersection traffic signals, causing minimal if any interference with intersection operation. LRT trains would be required to observe and comply with a red signal in exactly the same manner as traffic on the adjacent arterial. Clearly the potential would exist for LRT signal pre-emption if required, although there would be a trade-off between LRT pre-emption and traffic levels of service at the intersections. The average operating speeds assumed for the LRT lines assume a maximum of 50% LRT pre-emption or priority at intersections along the routes.

Crossing control assumed for the ARR line is rather different in that many ARR crossings are currently protected with barriers and flashing lights. These would need to be retained as many of the ARR crossings are not adjacent to intersections where arterial traffic is regularly stopped anyway. Delays to traffic at these crossings would be minimal, considering the projected 1995 LRT frequency of 10 minutes in the peak period in this corridor.

3. Signals and Communications

For the C Street and Northern Lights corridors no signalization has been assumed with the exception of additional signal heads oriented to LRT at the major at-grade crossings at intersections. Train control would be visual/manual control by train drivers, eliminating the need for wayside or cab signals.

Two exceptions have been assumed. Firstly, if all 3 LRT lines were operated together, wayside signals would be necessary at the C Street/ Northern Lights station, where the three lines merge. Secondly, the ARR corridor would require a signal system interfaced with the ARR signal system to protect both LRT and ARR train movements. A wayside signal system has been assumed in this instance.

Centralized train control has not been assumed to any degree of sophistication, as it would not be necessary for individual LRT lines. Radio communication with all vehicles has, however, been assumed as essential.

V

PROJECTED COSTS, REVENUES AND SUBSIDIES

V. PROJECTED COSTS, REVENUES AND SUBSIDIES

This chapter describes the estimated costs of constructing and operating the LRT systems defined for each of the four corridors. The costs of busway construction and operation are also considered. The costs described below were developed as planning estimates for study purposes, and are thus order-of-magnitude costs, rather than detailed engineering cost estimates.

As is usual with preliminary capital cost estimates of this nature, an allowance has been included of 15% of total capital costs for engineering and administration, and of 25% for contingencies. The contingency allowance is included to provide for unpredictable cost items which may arise due to the preliminary design nature and early state of project definition.

All costs described here, both capital and operating, are expressed in 1979 dollars, adjusted to Anchorage cost levels. Costs were adjusted where necessary from the source data using the LSI Labor/Material Index[1/] to adjust to 1979 prices,[2/] and the LSI Major Cities Cost Index to derive an overall adjustment factor of 1.5 to adjust lower 48 states prices to Anchorage levels.

It should be noted that all costs, both capital and operating, for all LRT corridors and for the busway, relate to the line haul service only. Thus, the costs of providing a feeder bus service to the LRT line are excluded. Similarly, only the line haul portion of the busway operation, i.e., the busway itself, is included in the cost estimates, the feeder/suburban route sections being excluded.

1/ LSI Current Construction Costs, 15th Annual Edition, Lee Saylor, Inc., 1978.

2/ 1978-79 price growth assumed at 9.0%.

A. Capital Costs

1. Basis of Costs

The following components were included in the estimation of LRT capital costs:

- right-of-way acquisition
- guideway preparation
- trackwork
- electrification
- signalization and control
- stations and support facilities
- maintenance/storage facilities
- transit vehicles

Various sources were utilized in the preparation of capital cost estimates, the principal base reference being Light Rail Transit - A State of the Art Review, published by U.S. Department of Transportation in Spring 1976. Many references were also made to the rapidly increasing stock of LRT literature, and to studies of LRT feasibility and design in other areas of the United States. The order-of-magnitude nature of the projected capital costs should be emphasized by the fact that while LRT has been studied in many North American cities, very few new systems have actually been constructed. There is, therefore, a scarcity of hard data on LRT construction experience in this country. The limitations of comparison with and between either existing or planned systems should also be realized, due to the considerable differences in system characteristics.

In estimating capital costs, it has been assumed, however, that since light rail transit utilizes principally "off-the-shelf" technology and hardware, development costs would not be a significant element of total costs. The Boeing Light Rail Vehicle (LRV) for example, has undergone extensive testing and development as part of the contractual delivery to the Boston and San Francisco transit systems, and is now operational in Boston. Furthermore, European LRVs have a long history of development and usage and operate reliably in large numbers in a wide variety of applications in European countries. Track, electrification and signal/control systems are all known and tested hardware items that can readily be applied directly to the LRT environment with a minimum of testing and development. The major LRT capital cost elements are thus described below.

Right-of-Way

The right-of-way costs include for land acquisition and property take, derived from estimates of the additional right-of-way that would be required in each corridor, and local land/property costs. Estimated right-of-way requirements include for LRT stations, but exclude the maintenance/storage facility which it is assumed could be constructed on ARR property near the downtown depot.

Guideway

Guideway costs constitute a major element of total LRT system costs, and comprise the preparation of the guideway for installation of the tracks. This includes any earthworks necessary, excavations, grading, preparation of sub-base, drainage, as well as an allowance for utility relocation and obstacle removal, fencing and landscaping. Guideway costs would include for any redesign and reconstruction work necessary at street intersections with the LRT route. Costs for underground guideway preparation assume cut and cover techniques.

Trackwork

Trackwork costs include for the acquisition and installation of double track with average provision for turnouts and crossovers. Rails would either rest on wooden ties and ballast, or be bolted to concrete slab base where the LRT tracks crossed roadway sections. The trackwork costs would include the restoration of the pavement on streets traversed by the LRT route, and at street intersections.

Electrification

Electrification estimates include all costs involved in supplying power to the light rail vehicles. Overhead power supply is assumed via a contact wire supported by slender poles. Costs include underground feeder cables and power substation/rectifier units.

Signalization and Crossing Control

For the Alaska Railroad corridor, signalization and crossing control costs include for a wayside signal system fully interfaced with an ARR signal system to provide complete protection for both LRT and ARR train movements. Such signal systems would be necessary due to the number of spur tracks and sidings that the LRT would cross in this corridor.

Minimal signalization and crossing control has been assumed for the other three corridors. The projected costs allow for the provision of additional traffic signal heads oriented to LRT at signalized intersections, possible signal retiming, and the installation of LRT signal pre-emption devices at certain locations. The costs also include for wayside signals and simple rear end protection in the subway sections of the C Street/ Northern Lights area of these three corridors.

Stations

At-grade station costs include for the provision of two low-level platforms per station, each with enclosed heated shelters of adequate size. Estimates for this item also allow for a telephone information service and adequate bus pull-in and transfer facilities. The costs of providing park-and-ride lots at stations have been excluded from the cost estimates.

Cost estimates for the C Street/Northern Lights underground station assume high-level platforms, escalators, and the provision of elevators for handicapped access. No fare collection equipment has been assumed at stations.

Maintenance and Storage Facilities

The costs of providing a maintenance and storage facility, based on a unit cost per vehicle, include site preparation, earthworks, drainage and utilities, buildings and shops, shop equipment, parts storage, yard equipment, electrification, and security. The same location, just north of the downtown ARR has been assumed for each of the four corridors. The size of facility would, however, vary for each corridor, depending on the fleet size.

Access to the storage/maintenance yard has been assumed to be single track, as it is not considered double track would be necessary for the number of movements that would take place between the facility and the LRT revenue routes.

Vehicles

Vehicle costs are estimates based on recent car manufacturer bid costs for urban light rail systems in the U.S., adjusted to Anchorage prices. While the Boeing LRV, the UMTA-endorsed standard light rail vehicle, has been assumed as the reference vehicle, it is unlikely that the price offered by other European manufacturers would be significantly lower for delivery of a vehicle to Alaska.

Vehicle costs have been assumed to include for wheelchair lifts for the handicapped, and radio communication for the driver to a central control center. It is assumed the cars would be equipped for both low and high level loading.

Busway Capital Costs

Compatible assumptions were made with respect to Busway capital costs in order to provide as realistic a comparison as possible between the two modes. The guideway and pavement costs include all costs necessary for preparation of the guideway base and installation and completion of the pavement cross-section. This cost item, as for LRT, would also include for any redesign and reconstruction work necessary at street intersections.

Signalization costs would be rather lower than for the LRT lines, as rear end protection would not be required at any point on the route.

Station costs for the busway were assumed to be 25% lower than for LRT due to the shorter platform length required.

With respect to vehicles required to operate the busway, it was assumed that route changes to run some existing services on the busway section, rather than say on Seward Highway or Arctic Boulevard, would provide some of the total bus fleet required. An estimated total of 94 buses would be required in 1995 for busway operation. Allowing for some additional routes being necessary to replace service gaps created by route orientation to the busway, and allowing for spare vehicles, it is projected that an additional 66 buses would need to be purchased for busway operation. The remaining buses would be drawn from the operating fleet at that time.

2. Capital Cost Estimates

Table V-1 summarizes the total system costs by corridor for both 1985 and 1995. Also shown in the Table are the system costs per route mile, both excluding and including rolling stock costs. The costs are projected for the service levels assumed in Table IV-4, i.e. to serve the high ridership estimates. The detailed capital costs, broken down by cost element, are shown for each of the LRT corridors and the C Street Busway in Tables 1 through 4 of Appendix A.

The capital costs for LRT in 1995 range from a low of $82.87 million for the West Northern Lights corridor to a high of $142.3 million for the East Northern Lights corridor. The C Street LRT line would be the second most expensive to build, at $134.41 million, with the Alaska Railroad corridor ranking third at $104.79 million. The difference in total system costs is a function of the varying LRT line lengths (see Table IV-4) as well as different levels of service provision and right-of-way conditions.

TABLE V-1

CAPITAL COST COMPARISON: 1985 AND 1995
($ million)1/

Total System Costs2/	LRT3/				Busway
	ARR	C Street	East North Lights	West North Lights	C Street
1985					
Excluding Vehicles					
Total	$53.60	$86.60	$82.23	$69.40	$33.50
Per Route Mile	7.88	15.46	16.78	10.68	5.98
Including Vehicles					
Total	59.90	99.20	92.13	77.50	37.00
Per Route Mile	8.81	17.71	18.80	11.92	6.61
1995					
Excluding Vehicles					
Total	$90.39	$107.41	$115.30	$70.27	$53.89
Per Route Mile	7.79	14.32	14.60	10.81	7.19
Including Vehicles					
Total	104.79	134.41	142.30	82.87	63.13
Per Route Mile	9.03	17.92	18.01	12.75	8.42

1/ 1979, Anchorage costs. (includes 15% for engineering and administration and 25% for contingencies).

2/ Costs are based on "High" ridership estimates.

3/ Total costs for each individual LRT line. An LRT 'system.' or joint implementation of some corridors would result in lower costs due to possibilities for sections of shared trackage.

The costs per route mile would be lowest for the Alaska Railroad corridor, at $9.03 million/mile, reflecting the availability of suitable right-of-way. The higher costs per route mile, of $18.01 million/mile and $17.92 million/mile for the East Northern Lights and C Street corridors respectively, reflect both the more complex right-of-way conditions (for example the subway sections) and the more intensive service levels that would be provided on these lines, thus requiring a larger vehicle fleet.

The costs of providing a busway in the C Street corridor would be about half the costs of providing LRT in the same corridor, $63.13 million for the busway compared to $134.41 million for LRT. As both transit facilities would cover the same line length, the difference is due to the lower costs per route mile projected for the busway, at $8.42 million per mile compared to $17.92 million per mile for LRT.

The lower 1985 capital costs for both LRT and the busway reflect the shorter service lines assumed for that year of system implementation, and also the generally lower service levels, and thus less vehicles required for the lower ridership projected in 1985.

B. Operating Costs, Revenues and Subsidies

1. Basis of Costs and Revenues

Essentially the same sources were utilized for the estimation of operating costs as were used for capital costs. Detailed LRT operating costs based on precise operating plans, manpower requirement scheduling, maintenance and administrative procedures were outside the scope of this feasibility study. Rather, the approach adopted was to derive unit cost estimates for principal LRT operating cost components, and to check these where possible for compatibility to the assumed LRT systems in the four Anchorage corridors. Outline operating plans were then developed for the purposes of estimating vehicle-miles-travelled, the base parameter for operating costs.

LRT unit costs for numerous individual aspects of LRT operation[1/] were consolidated into five principal operating cost categories. These were:

- maintenance of ways and structures
- maintenance of vehicles and equipment
- power consumption
- transportation
- administrative and general services

These categories are generally self-explanatory, power consumption including all power necessary to operate LRT, i.e. power to the vehicles as well as power consumed by stations and by the maintenance facility.

Transportation costs cover all operating labor costs, including wages, salaries and fringe benefits. The unit costs are expressed in terms of dollars per vehicle (LRT car) mile travelled ($/VMT). The final

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1/ The principal source for unit cost data was Light Rail Transit - A State of the Art Review, U.S. Department of Transportation, Spring 1976, as verified by other more recent studies.

cost category, administrative and general was assumed to account for 15% of direct operating costs. Due to inevitable uncertainty associated with cost projections made during early stages of the planning process, such as this study, a contingency factor of 20% was added into total operating costs. As for capital costs, the LRT unit operating costs were converted to 1979 prices and then adjusted to Anchorage levels by applying a multiplier of 1.5. The assumed unit operating cost for LRT in 1995 is shown in Table B-1, Appendix B, broken down to the five major cost elements identified above. For study purposes it was assumed that the same unit operating cost would apply to all four LRT lines.

Busway Operating Costs

The busway unit operating cost, also related to vehicle-miles-travelled, was based on operating cost data available for 1978 for the Anchorage People Mover. These unit costs were then adjusted to 1979 prices and also to allow for a shift over the years from small bus to large bus operation.1/ Similarly to LRT, a contingency factor of 20% was incorporated into final unit operating costs.

Unit Operating Cost Summary

The unit operating costs utilized for costing purposes are thus summarized below.

	Cost ($/VMT)	
Mode	1985	1995
LRT	$4.54	$4.13
Busway	$3.64	$3.31

The unit costs for the 1985 transit systems were derived from the 1995 unit costs and were assumed to be 10% higher due to the lower productivity and over-provision of service that would be associated with the start-up of LRT operations, and the 1985 ridership levels.

1/ Cost per VMT was increased by 11% to represent planned increase in proportion of large buses in fleet. Based on data provided in "The Applicability of Non-Standard Buses for Service in the Washington Metropolitan Area," Prepared for WMATA by Alan M. Voorhees & Assoc., 1978.

LRT and Busway Operations

The operating costs are projected for the system service levels outlined in Chapter IV and summarized in Tables IV-3 and IV-4. They, thus, relate to the high ridership estimates. System parameters input to the operating cost calculations, such as systemwide vehicle miles travelled, are summarized in Table B-2 in Appendix B.

Revenue

Revenue estimates were based on Anchorage People Mover data indicating an average revenue per passenger of about 30¢. This is lower than the cash fare of 50¢ due to school children, the elderly, the handicapped, and transit passes. As it was assumed that transfers would continue to be free between vehicles throughout the transit system, it was necessary to adjust the 30¢ figure to reflect the revenue that would be gained by the line haul systems under evaluation. (It will be remembered that costs were calculated only for the line haul systems. Revenues accruing to feeder services were thus also excluded from the projections.) These adjustments resulted in an assumed average revenue of 25¢ per LRT passenger, and of 19¢ per busway passenger. The lower value for the busway is due to the fact that a higher proportion of riders could use the bus directly from their homes without having to transfer. It is anticipated that a larger number of passengers would either drive or walk to the light rail transit line than to the busway. (See also page 84.)

2. Operating Costs, Revenues and Required Subsidies

The projected annual operating costs for all four LRT lines, and the C Street Busway are shown in Tables V-2 and V-3 for 1985 and 1995, respectively. Also shown in the Tables are the projected annual revenues and thus the annual operating subsidies that would be required for each system.

None of the transit systems under evaluation, LRT or Busway, would generate sufficient revenue to cover operating expenses. All LRT lines and the busway would thus require varying amounts of operating subsidies.

TABLE V-2

1985 ANNUAL OPERATING COSTS, REVENUES AND SUBSIDIES REQUIRED
(1979 MILLION DOLLARS)

Corridor 1/	Annual Operating Cost	Annual Fare Revenue 2/	Annual Operating Subsidy 3/	Recovery Ratio 4/ Fare Revenue as % of Operating Cost
LRT 5/				
ARR	$1.49	$0.77	$0.72	26-52%
C Street	2.71	1.90	0.81	42-70%
East Northern Lights	1.82	1.38	0.44	46-76%
West Northern Lights	1.42	0.89	0.53	42-63%
Busway 5/				
C Street	$4.31	$2.03	$2.28	23-47%

1/ Costs assume independent operation of LRT lines.

2/ Revenue accruing to trunk line service. Based on average fare revenue of 25¢ per passenger for LRT and 19¢ per passenger for Busway. Lower Busway value due to greater proportion of line haul passengers using feeder services for this mode. Revenue estimates based on "High" ridership estimate.

3/ Total subsidy required from local, State and Federal sources.

4/ Ranges of recovery ratios correspond to low and high ridership estimates, and are based on high ridership service provision throughout.

5/ Represents line-haul portion only exclusive of feeder bus system.

TABLE V-3

1995 ANNUAL OPERATING COSTS, REVENUES AND SUBSIDIES REQUIRED
(1979 MILLION DOLLARS)

Corridor 1/	Annual Operating Cost	Annual Fare Revenue 2/	Annual Operating Subsidy 3/	Recovery Ratio 4/ Fare Revenue as % of Operating Cost
LRT 5/				
ARR	$4.71	$1.48	$3.23	16-31%
C Street	6.97	3.65	3.32	31-52%
East Northern Lights	6.08	2.79	3.29	27-46%
West Northern Lights	2.36	1.34	1.02	38-57%
Busway 5/				
C Street	$8.15	$3.54	$4.61	22-43%

1/ Costs assume independent operation of LRT lines.

2/ Revenue accruing to trunk line service. Based on average fare revenue of 25¢ per passenger for LRT and 19¢ per passenger for Busway. Lower Busway value due to greater proportion of line haul passengers using feeder services for this mode. Revenue estimates based on "High" ridership estimate.

3/ Total subsidy required from local, State and Federal sources.

4/ Ranges of recovery ratios correspond to low and high ridership estimates, and are based on high ridership service provision throughout.

5/ Represents line-haul portion only, exclusive of feeder bus system.

Table V-3 shows that in 1995, the annual LRT operating costs would range from a low of $2,36 million for the West Northern Lights line to a high of $6.97 million for the C Street line. By comparison, annual operating costs for the C Street Busway would be $8.15 million, just over 15% higher than for LRT operation in the same corridor.

Annual fare revenue in 1995 would be highest for the C Street LRT line at $3.65 million. This would be marginally higher than the projected $3.54 million annual revenue for the C Street Busway, despite the lower ridership estimated for the LRT. The reason for this is the higher proportion of revenue that would be recoverable on the line haul facility with LRT. The West Northern Lights LRT line would generate the lowest annual revenue at $1.34 million.

As shown in Table V-3, the C Street Busway would require the largest absolute operating subsidy, $4.61 million per annum in 1995, or about 40% more than would be required for LRT in that corridor. The annual operating subsidies required for the LRT lines in the ARR, C Street, and East Northern Lights corridors would be very similar, falling in the range of $3.23 million - $3.32 million per annum. LRT in the West Northern Lights corridor would require an annual operating subsidy of $1.02 million, the lowest of all the systems under evaluation.

The final column of Table V-3 indicates the recovery ratio projected for each of the systems. The recovery ratio expresses the annual fare revenue as a percentage of the annual operating cost. A figure of 100% indicates breakeven conditions. The recovery ratio for each system is presented as a range. The upper end of the range relates to the costs, revenues and subsidies already discussed, and thus to the high ridership estimates. The lower end of the range indicates the recovery ratio assuming the low ridership estimates, but with no reductions in service levels (thus representing more 'ideal' design conditions with a greater proportion of passengers being seated).

The projected recovery ratios would range from 31% for the LRT line in the ARR corridor, to 57% for the West Northern Lights LRT line. The second highest recovery ratio would be obtained with the C Street LRT line at 52%, compared to 43% for the C Street Busway. However, the Table also shows that if only the low ridership demand were achieved, recovery ratios could be as low as 16% of the operating costs (for LRT in the ARR corridor). Under the low ridership demand the highest recovery ratio would be 38% for the West Northern Lights corridor.

Table V-2 contains the annual operating cost, fare revenues and operating subsidies projected for 1985. The annual operating costs would generally be considerably less in 1985 than in 1995 due to the lower level of transit service provided. With the exception of the West Northern Lights LRT line and the C Street Busway, 1985 annual operating costs would be about 30-40% of the 1995 costs. Annual fare revenue would be closer to 50% of 1995 levels, however. The recovery ratios would thus be rather higher in 1985, ranging from about 50% to 75% compared to 30% to 60% in 1995. The absolute annual operating subsidies required would also be less, ranging from $0.44 million for the East Northern Lights LRT corridor to $0.81 million for the C Street LRT corridor. By comparison, a $2.28 million annual subsidy would be required for the C Street Busway in 1985.

It should be noted that the 1985 recovery ratios are more favorable than the 1995 ratios principally due to the considerable differences in service levels provided in the two years. For example, the LRT lines would be up to 70% longer by 1995 with a significant increase in operating frequency (see Tables IV-3 and IV-4). Also, in 1985 no late evening or weekend service would be operated. It is these time periods when the marginal operating costs are highest as service is maintained for proportionately fewer passengers than during the day.

VI
EVALUATION AND IMPLEMENTATION ISSUES

VI. EVALUATION AND IMPLEMENTATION ISSUES

This chapter evaluates the various potential LRT lines and compares their respective impacts with each other and with the assumed C Street Busway. Also included is a special analysis to determine how sensitive the resulting cost and performance characteristics are with respect to changes in the basic input assumptions. Since current, and especially future, lane use configurations and policies will have a significant impact on the feasibility of light rail in Anchorage, a discussion is provided on the aspects of land use/transportation interaction. Finally, the chapter addresses preliminary issues of potential funding sources and levels.

A. Comparison of Alternatives

1. Quantitative and Cost Comparison

Tables VI-1 and VI-2 summarize the public transit subsidies that would be required to cover operating and annualized capital expenses for the various study corridors. These costs and subsidies are expressed on a per-passenger basis and constitute ranges reflecting the estimated "low" and "high" ridership demands for both 1985 and 1995. Since the "high" ridership estimates assumed fairly high passenger loading conditions (see Chapter IV), no reduction in service levels and thus operating costs has been assumed for the "low" ridership condition of this analysis. The ranges shown in Tables VI-1 and VI-2, therefore, reflect a "pessimistic minimum" and "optimistic maximum" envelope within which an actual performance of LRT and Busway would fall.

As can be seen in Tables VI-1 and VI-2, the C Street Busway produces the lowest total subsidy required at $0.61-$1.40 per passenger in 1995. These figures include depreciation of capital investment. If only annual operating subsidies are considered, each passenger trip would have to be subsidized at $0.23-$0.55 for the C Street LRT, and at $0.25-$0.68 for the C Street Busway.

TABLE VI-1

1985 ANNUAL COSTS AND SUBSIDIES PER PASSENGER

Corridor	Annual Operating Cost $/passenger	Annual Fare Revenue $/passenger	Annual Operating Subsidy $/passenger	Annual 1/ Capital Cost $/passenger	Total Annual Subsidy $/passenger
LRT					
ARR	0.48-0.96	0.25	0.23-0.71	2.05-4.11	2.28-4.82
C Street	0.36-0.59	0.25	0.11-0.34	1.38-2.29	1.49-2.63
East Northern Lights	0.33-0.55	0.25	0.08-0.47	1.76-2.95	1.84-3.42
West Northern Lights	0.40-0.60	0.25	0.15-0.35	2.32-3.48	2.47-3.83
Busway					
C Street	0.40-0.81	0.19	0.21-0.62	0.37-0.74	0.58-1.36

TABLE VI-2

1995 ANNUAL COSTS AND SUBSIDIES PER PASSENGER

Corridor	Annual Operating Cost $/passenger	Annual Fare Revenue $/passenger	Annual Operating Subsidy $/passenger	Annual Capital Cost $/passenger	Total Annual Subsidy $/passenger
LRT					
ARR	0.80-1.59	0.25	0.55-1.34	1.88-3.76	2.43-5.10
C Street	0.48-0.80	0.25	0.23-0.55	0.98-1.63	1.21-2.18
East Northern Lights	0.55-0.91	0.25	0.29-0.66	1.35-2.25	1.64-2.91
West Northern Lights	0.44-0.66	0.25	0.19-0.41	1.64-2.47	1.83-2.88
Busway					
C Street	0.44-0.87	0.19	0.25-0.68	0.36-0.72	0.61-1.40

Note: First figure reflects "High" ridership and second figure reflects "Low" ridership estimates.

1/ Based on 10% amortization over 30 years.

The 1985 total subsidies per rider are typically of the same order-of-magnitude as in 1995, although the operating subsidies are lower in 1995. This is due to the fact that the transit systems were assumed not to operate beyond 8 p.m. or on Sundays/Holidays in 1985 when ridership is relatively low.

Among the light rail lines tested, the C Street corridor performs best at a 1995 total subsidy of $1.21-$2.18 per rider, and an operating subsidy of $0.23-$0.55, depending on the actual future ridership levels. Using the C Street LRT as a basis, the other corridors can be ranked in 1995 as follows:

	Operating Subsidy	Total Subsidy
C Street LRT	base	base
West Northern Lights Blvd.	- 20%	+ 40%
East Northern Lights Blvd.	+ 25%	+ 35%
ARR	+140%	+115%
C Street Busway	+ 15%	- 40%

- = less expensive
+ = more expensive

As can be seen, while the C Street Busway would be about 15% more expensive to operate, it would also be approximately 40% less expensive in terms of total required subsidy than a light rail line in this corridor. This confirms other studies which have generally found that busways have somewhat higher operating costs than light rail systems, while being significantly less expensive in terms of capital expenditures.

A decision on the relative weight to be assigned to operating vs capital expenditures will depend on issues such as the availability of federal capital grants, local fare policies and also the likely future energy cost differential between diesel fuels (buses) and electric energy (light rail). As oil-derived fuels may increase proportionally faster than other forms of energy, the above mentioned 15% higher operating costs for the

C Street Busway may actually tend to increase in future years relative to LRT.

The above data assume the currently prevailing People Mover fare levels. There may be some justification for a higher fare for a new LRT or Busway system because such systems would offer increased service qualities. Such fare increases may be more acceptable to the public when an entirely new mode (LRT) is introduced than if a system of busways is selected. The effect of higher fares on the required subsidies is explored in Section 3 below.

Table VI-3 provides an overall summary of the economic characteristics of each alternative for 1995. It should be kept in mind that, since the figures shown in Table VI-3 reflect the "High" ridership volumes, the per-passenger ratio would be proportionally higher for the "Low" ridership estimates as previously explained. The figures in Table VI-3 apply to each corridor individually without consideration of potential cost reductions which would result from simultaneous implementation and operation of several corridors. In general, the operating costs would be affected very little, as each line would be operated independently to the downtown area. The combined capital costs, however, would be less due to the sharing of the tracks between the Northern Lights Boulevard/C Street intersection and downtown.

2. Qualitative Comparison

Table VI-4 evaluates each alternative with respect to various impact criteria grouped into the following three major categories:

- service and operational impacts
- general public and environmental impacts
- fiscal and economic impacts

In overall terms, little difference exists between the LRT and Busway corridors in terms of service and operational impacts. For example, LRT

TABLE VI-3

COST COMPARISON OF ALTERNATIVES (1995)1/
(HIGH RIDERSHIP ESTIMATE)

Criterion	LRT Corridor				Busway
	Alaska RR	C Street	Northern Lights (East)	Northern Lights (West)	C Street
Weekday Passengers Carried	19,800	48,800	37,300	17,900	62,400
Annual Operating Costs	$4.7 million	$7.0 million	$6.1 million	$2.4 million	$8.1 million
Operating Cost/Vehicle Mile	$4.13	$4.13	$4.13	$4.13	$3.31
Annual Fare Revenue	$1.5 million	$3.7 million	$2.8 million	$1.3 million	$3.5 million
Annual Operating Subsidy	$3.2 million	$3.3 million	$3.3 million	$1.0 million	$4.6 million
Fare as % of Operating Cost	31%	52%	46%	57%	43%
Average Fare Revenue/Passenger	$0.25	$0.25	$0.25	$0.25	$0.19
Operating Subsidy/Passenger	$0.55	$0.23	$0.29	$0.19	$0.25
Total Capital Cost	$105 million	$134 million	$142 million	$ 83 million	$ 63 million
Capital Cost/Route Mile	$9.0 million	$17.9 million	$18.0 million	$12.8 million	$8.4 million
Annualized Capital Cost2/	$11.1 million	$14.3 million	$15.1 million	$ 8.8 million	$6.7 million
Annual Capital Cost/Passenger	$1.88	$0.98	$1.35	$1.64	$0.36
Total Subsidy3//Passenger	$2.43	$1.21	$1.64	$1.83	$0.61
Annual Total Cost (capital and operating)	$15.8 million	$21.3 million	$21.2 million	$11.2 million	$14.8 million

1/ In 1979 Anchorage dollars.

2/ Based on 10% amortization over 30 years.

3/ Annual capital and operating cost.

TABLE VI-4

QUALITATIVE EVALUATION OF ALTERNATIVES

<table>
<tr><th rowspan="2">Impact Criteria</th><th rowspan="2">Existing People Mover</th><th colspan="4">Light Rail Transit</th><th>Busway</th></tr>
<tr><th>Alaska Railroad</th><th>C Street</th><th>Northern Lights Boulevard-East</th><th>Northern Lights Boulevard-West</th><th>C Street</th></tr>
<tr><td><u>Service & Operational Impacts</u></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Ridership volume</td><td>6[1/]</td><td>5</td><td>2</td><td>3</td><td>4</td><td>1</td></tr>
<tr><td>Ability to accommodate sudden ridership increases</td><td>poor</td><td colspan="4">good</td><td>medium</td></tr>
<tr><td>Ability to generate high transit modal split</td><td>6</td><td>5</td><td>3</td><td>1</td><td>4</td><td>2</td></tr>
<tr><td>Need to transfer between modes</td><td>good</td><td colspan="4">medium</td><td>good</td></tr>
<tr><td>Schedule reliability (future)</td><td>poor</td><td colspan="4">good</td><td>medium</td></tr>
<tr><td>Peak period travel time</td><td>poor</td><td colspan="4">good</td><td></td></tr>
<tr><td>Handicapped access</td><td colspan="6">All modes can be made accessible</td></tr>
<tr><td>On-vehicle convenience and comfort</td><td>medium</td><td colspan="4">good</td><td>medium</td></tr>
<tr><td>Winter operation capability</td><td>depends on street snow removal</td><td colspan="4">Snow removed by LRT train</td><td>requires special snow removal</td></tr>
<tr><td>Ability to reduce reliance on auto access</td><td>good</td><td>poor</td><td>poor</td><td colspan="2">medium</td><td>good</td></tr>
<tr><td><u>General Public & Environmental Impacts</u></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Ability to influence land use development</td><td>poor</td><td>medium</td><td colspan="3">good</td><td>medium</td></tr>
<tr><td>Need for additional transportation right-of-way</td><td>none</td><td>none</td><td>moderate</td><td colspan="2">considerable</td><td>moderate</td></tr>
<tr><td>Displacement of housing and businesses</td><td>none</td><td>none</td><td>little</td><td colspan="2">moderate</td><td>little</td></tr>
<tr><td>Institutional constraints for implementation</td><td>none</td><td>considerable</td><td colspan="3">moderate</td><td>none</td></tr>
<tr><td>Air quality impact</td><td>moderate</td><td colspan="4">good</td><td>moderate</td></tr>
<tr><td>Noise impact</td><td>moderate</td><td colspan="4">good</td><td>moderate</td></tr>
<tr><td>Energy impact (fuel oil)</td><td>moderate</td><td colspan="4">good</td><td>moderate</td></tr>
<tr><td>Generation of construction jobs</td><td>none</td><td colspan="4">considerable</td><td>some</td></tr>
<tr><td>Generation of permanent jobs</td><td>some</td><td colspan="4">some</td><td></td></tr>
<tr><td><u>Fiscal & Economic Impacts</u></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Level of capital expenditures</td><td>NA</td><td>3</td><td>4</td><td>5</td><td>2</td><td>1</td></tr>
<tr><td>Level of operating expenses</td><td>NA</td><td>2</td><td>4</td><td>3</td><td>1</td><td>5</td></tr>
<tr><td>Ability to provide cost-effective operation (total cost per passenger trip)</td><td>NA</td><td>5</td><td>2</td><td>3</td><td>4</td><td>1</td></tr>
</table>

NA - not applicable.

1/ Scale: 1 Most favorable, positive ranking
:
6 Least favorable, negative ranking

would have a greater inherent route capacity than would the busway which would be a significant consideration in case of future gasoline shortfalls. On the other hand, the busway is capable of attracting greater ridership volumes than LRT due to its door-to-door service, while LRT would, for most riders, involve a transfer to and from the feeder system.

With respect to general public and environmental impacts, the various alternatives also rank rather close. The C Street LRT and Busway would be easiest to implement since right-of-way does already exist, or is planned for. The use of the Alaska Railroad right-of-way corridor may entail institutional and operational problems aside from its low ridership potential.

From a fiscal and economic viewpoint, the C Street Busway tends to rank best if both operating and capital expenditures are considered. However, if federal and state sources would pay for the required capital, then the remaining local subsidies would be almost identical for the C Street LRT and Busway alternatives.

3. Sensitivity of Planning Assumptions

The analysis summarized below presents the sensitivity of the projected cost characteristics to various changes in the basic input assumptions. Three scenarios were identified to represent significant departures from various of the parameters assumed for the main analysis, particularly ridership and fare levels. These scenarios are described as follows. It should be noted that the sensitivity analysis was based on the 1995 systems assumed for the high ridership estimates.

> Scenario I: Energy Crisis - This scenario assumes a 50% increase in ridership, with no increase in either fares or transit service levels. This increase in ridership, while arbitrarily selected, reflects a potential fairly sudden gasoline supply shortage with decreased auto use and a correspondingly greater dependence on, and usage of, public transit.

Scenario II: Fare Increase - This scenario assumes a 100% increase in fares over levels assumed for the main analysis (from a 50¢ to a $1.00 adult basic cash fare) with no increase in transit service levels. Various reasons could in future years support such a scenario, for example, higher fares could be justified through the improved service offered by both LRT and a Busway. This scenario could also represent an economic philosophy of attempting to recoup a higher proportion of operating costs through farebox revenue.

Scenario III: Local Cost Share - The cost analysis and evaluation thus far has included the full capital cost of constructing the transit systems under review. Annualized capital costs included in the total annual subsidy projections were based on 100% of capital costs. An alternative method of computing these criteria is to include only the 20% of capital costs that would be borne locally and to exclude the 80% of capital costs that could potentially be provided from Federal sources through the Urban Mass Transportation Administration (UMTA). Scenario III thus assumes the same levels of ridership, fares, and transit service, but includes only 20% of capital costs in the economic analysis.

The sensitivity to these scenarios of the two critical economic criteria, the annual operating subsidy per passenger, and the annual total subsidy per passenger, are shown in Tables VI-5 to VI-7. It will be noted that none of the three scenarios would lead to any of the four LRT lines or the Busway producing an operating surplus. Even with a doubling of fares, or a 50% increase in ridership, all the systems under review would continue to require operating subsidies.

Under Scenario I a 50% ridership increase, with no change in fare levels or service levels, would result in a direct increase of 50% in fare revenue totals, and thus recovery ratios. The ratio for the C Street LRT line for example would increase from 52% to 78%. The resultant decreases in the annual operating subsidy per passenger would range from 50-70% depending on the transit corridor. Decreases in the annual total subsidy (including annual capital costs) would be on the order of 35-45%.

Under Scenario II, fares would be increased 100% with no changes in service levels. The higher fares would, however, detract some passengers from continuing to use transit, and these people would thus divert to

TABLE VI-5

1995 SENSITIVITY ANALYSIS: SCENARIO I - ENERGY CRISIS

Corridor	Daily Ridership		Annual Operating Subsidy		Annual Total Subsidy	
	Number	% Difference 1/	$/passenger	% Difference 2/	$/passenger	% Difference 2/
LRT						
ARR	29,700	+50%	0.28	-49%	1.53	-37%
C Street	73,200	+50%	0.07	-70%	0.72	-40%
East Northern Lights	56,000	+50%	0.11	-62%	1.01	-38%
West Northern Lights	26,900	+50%	0.05	-74%	1.15	-37%
Busway						
C Street	93,600	+50%	0.10	-60%	0.34	-44%

1/ Difference from base case as shown in Table III-4.

2/ Difference from base case as shown in Table VI-2.

TABLE VI-6

1995 SENSITIVITY ANALYSIS: SCENARIO II - FARE INCREASE

Corridor	Daily Ridership		Annual Operating Subsidy		Annual Total Subsidy	
	Number	% Difference 1/	$/passenger	% Difference 2/	$/passenger	% Difference 2/
LRT						
ARR	14,900	-25%	0.56	+ 2%	3.07	+26%
C Street	36,600	-25%	0.14	-39%	1.44	+19%
East Northern Lights	28,000	-25%	0.23	-20%	2.04	+24%
West Northern Lights	13,400	-25%	0.09	-53%	2.28	+25%
Busway						
C Street	46,800	-25%	0.20	-20%	0.68	+11%

1/ Difference from base case as shown in Table III-4.

2/ Difference from base case as shown in Table VI-2.

TABLE VI-7

1995 SENSITIVITY ANALYSIS: SCENARIO III - LOCAL COST SHARE

Corridor	Daily Ridership		Annual Operating Subsidy		Annual Total Subsidy	
	Number	% Difference 1/	$/passenger	% Difference 2/	$/passenger	% Difference 2/
LRT						
ARR	19,800	0%	0.55	0%	0.93	-62%
C Street	48,800	0%	0.23	0%	0.43	-64%
East Northern Lights	37,300	0%	0.29	0%	0.56	-66%
West Northern Lights	17,900	0%	0.19	0%	0.52	-72%
Busway						
C Street	62,400	0%	0.25	0%	0.32	-48%

1/ Difference from base case as shown in Table III-4.

2/ Difference from base case as shown in Table VI-2. (Based on "high" ridership estimates.)

other modes. It is estimated that a 100% increase in fares would lead to a 25% decrease in ridership.[1/] As the joint effect of these two changes is identical in terms of absolute fare revenue as the 50% ridership increase of Scenario I, the recovery ratios would also be the same. The lower ridership totals would, however, lead to significantly different unit cost figures. Thus Scenario II, as shown in Table VI-6, would lead to reductions in the annual operating subsidy per passenger of between 20-55%, rather less than Scenario I. The exception would be the LRT line in the ARR corridor which would suffer a 2% increase in the operating subsidy per passenger.

However, due to the reduced riderships, the annual total subsidy per passenger (including annual capital costs) would be increased between 10-25%. The lowest increase, 11%, would be for the C Street Busway, while the increase for the C Street LRT line would be 19%. Increases for the other LRT lines would be on the order of 25%.

Under Scenario III, the local cost share scenario, the ridership and annual operating subsidies would, of course, be unchanged. However, the exclusion of the 80% Federal share of capital costs from the calculations would lead to reductions in the annual total subsidies ranging from 48% to 72%. As the Busway would have the lowest capital costs, this mode would be the least affected by this scenario. The effect on the LRT lines would be similar, ranging between 62-72% reductions in annual total subsidies per passenger.

1/ Based on derived elasticity of transit ridership with respect to fare of a 0.25% decrease in ridership for every 1% fare increase. (Source: "The Effect of Fare Reduction on Transit Ridership in the Atlanta Region: Technical Report Number 2, Analysis of Transit Passenger Data." Metropolitan Atlanta Rapid Transit Authority, Atlanta, Georgia, February, 1974.)

B. Potential Funding Sources

Funds for capital and operating costs would be available principally from the following three sources:

- Fare Revenues
- Federal Sources (UMTA)
  - Section 3: Discretionary Grants
  - Section 5: Formula Grants
- Local Sources
  - State based
  - Municipality based

These funding sources are briefly described below.

Fare Revenues

Farebox revenue generated by the transit operation would be an important revenue source. The fare assumptions for this study and the potential revenue totals are fully described in Chapter V, and summarized in Tables V-2 and V-3. The fare revenues would not, however, cover operating expenses for any of the transit systems evaluated. Projected revenues range from as low as 31% of operating costs for the LRT line in the ARR corridor to 52% for the C Street LRT line. This funding source would, therefore, not be available for capital cost payments. Even if the assumed 50¢ fares would be doubled, the fare revenues would cover only about 78% of the C Street LRT operating costs.

Federal Funding Sources

Under current Federal policy, there exist two potential sources of Federal funds, relating to two programs — Discretionary Capital Grants (Section 3) and Formula Grant Program (Section 5). As the two sections are structured rather differently with varying requirements and constraints, each is briefly summarized here.

Section 3 funds are discretionary in nature, comprising capital grants available on an application basis. Monies are available for up to 80% funding of project capital costs. The funds are not guaranteed, however, and worthiness must be exhibited in the grant application. A local commitment to the remaining 20% share is also required. As competition for these funds is intense among numerous cities, the Urban Mass Transportation Administration (UMTA) has produced policy guidelines 1/ for their award. The following are paramount in these guidelines:

> "The Department will continue to finance the construction of new rail lines and extensions to existing rail systems in those urban corridors whose population densities, travel volumes and growth patterns indicate a need for high-capacity, high-performance mass transportation service. In making decisions on initial rail segments, preference will be given to corridors serving densely populated central portions of metropolitan areas, including central cities and close-in suburbs."

and

> "Preference will also be shown to metropolitan areas which view rail transit investment as part of a long-term regional strategy to protect the environment, conserve energy, promote urban economic development, and support orderly patterns of metropolitan growth."

Two further UMTA requirements are critical to the funding process. First, there should be a full alternatives analysis of all modes, with a clear demonstration of superiority of the proposed transit mode over the alternatives in terms of ridership, capital and operating expenses, transportation service and environmental, urban, and energy conservation objectives.

Second, the proposed rail system should be supported by additional local supportive policies and a TSM (transportation systems management) program designed to enhance the proposed system's cost-effectiveness and patronage. Such supportive actions would include:

1/ Policy Towards Rail Transit, Department of Transportation, Urban Mass Transportation Administration. Federal Register, March 7, 1978, Part III.

- zoning policies and development incentives to stimulate high density development in the transit corridor and around transit stations

- land use plans that are supportive of or encourage the developmental impact and shaping influence of the rail transit system

- coordinated bus and/or paratransit feeder services to the rail system, particularly in low density and suburban areas

- adequate parking and other mode transfer facilities at suburban transit stations

- appropriate TSM measures designed to manage peak period automobile usage and to increase transit ridership in the selected corridor(s) (e.g. higher parking fees, traffic metering, tolls, elimination of employer-subsidized parking)

From among the cities that have at one time or the other considered or are considering now light rail systems, Portland, Oregon appears to be farthest advanced toward potentially receiving Federal assistance. It can be expected that in the future several other metropolitan areas will submit LRT plans, especially if the present sporadic gasoline shortages should become more permanent. There is little question that Anchorage would have to compete with other cities for discretionary UMTA funds on the ground rules summarized above.

<u>Section 5</u> funds, the second Federal source, are funds available under a Formula Grant Program, and are allocated nationally on the basis of population and population density. Section 5 funds may be used either for capital projects with an 80% Federal share and a 20% local share, or towards operating costs on a 50% Federal and 50% local share basis.

<u>Local Funding Sources</u>

The third principal source of funds would be locally, including both the State of Alaska and the Municipality of Anchorage. Local funding would be an important revenue source, particularly as a 20% local fund commitment would be necessary to qualify for UMTA Section 3 capital funds.

A recent AMATS analysis of local funding sources is summarized in Table VI-8. Of these, the municipal sales tax and the gasoline sales tax would offer considerable potential. A half, or one percent sales tax has the advantage of also being applied to tourists and visitors to the city. Financial support for the transit system would therefore not be borne exclusively by local residents, as would be the case for say a municipal income or property tax approach to funding transit. The use of a local sales tax as a continuing funding source for major transit investments in not uncommon, and has been applied during recent years in several cities, as for example in the San Francisco Bay Area and in Atlanta, Georgia.

The local cost share of the most recent LRT implementation in the U.S., the Buffalo, New York LRT system, was covered primarily by State of New York resources. While UMTA provided about 80% capital grants, the State absorbed the remaining 20% capital costs as well as a considerable portion of the operating expenses. Revenues from the State sales tax, State income tax, as well as general funds are being utilized to subsidize the LRT operation. The 20% capital share was funded by a statewide general transportation bond issue which also included other transportation projects.

In analyzing potential local funding sources it should be realized that the LRT and Busway systems identified in this report would not be the only transportation projects in the Anchorage area requiring funding over the next 15-20 years. A considerable amount of funding will, in future years, be required for the various elements of the AMATS Long Range Plan, as well as to cover increased operating costs for a significantly expanded People Mover system, with or without the LRT or Busway projects evaluated here.

TABLE VI-8

INVENTORY OF LOCAL FUNDING SOURCES
FOR TRANSPORTATION IMPROVEMENTS IN ANCHORAGE

Source	Level of Increase or Allocation	Estimated Revenues/Year (1977 million dollars)	Responsible Agency
Permanent Fund	5% for Anchorage	$10 (10 year average 1977-1986)	State
Prudhoe Bay Revenues on Resources	5% for Anchorage	$7.5	State
Shared Revenues	$10 increase/ person/year	$2.0	State
Motor Vehicle Registration (All)	$10 increase/ person/year	$1.5	State
Driver License Fee	$10 increase/ person/year	$1.1	State
Sales tax	1% increase	$5.4	Anchorage
Gasoline Sales Tax	5%	$4.8	State/Anchorage
Income Tax	1% increase	$20	State/Anchorage
Property Tax	1 mill in Anchorage	$4.2	Anchorage

Source: "Anchorage Metropolitan Area Transportation Study (AMATS)," Long Range Element 1977-1995, 1977.

C. Transit and Land Use Interrelationships

Due to inherent system capacities and other technical and cost characteristics, each public transportation mode requires certain land use densities and development patterns under which its operating performance is optimized. While the bus mode generally can tolerate dispersed and lower-density urban development patterns, the light rail mode generally requires more concentrated urban corridors and denser land uses so that its capacity potential can be satisfied.

The Urban Mass Transportation Administration's (UMTA) Policy Toward Rail Transit[1/] recognizes these land use/transportation interrelationships by requiring "the development and implementation of a program of local supportive policies and actions designed to enhance the proposed [rail] system's cost-effectiveness, patronage and prospect for economic viability." Among others, the supportive actions cited in UMTA's policy include the following:

- zoning policies and development incentives to stimulate high density private real estate development around selected transit stations;
- land use plans that support or reinforce the developmental impact and shaping influence of the rail transit system;
- station area improvements in the form of plazas, malls, walkways, open spaces and other pedestrian amenities that might help reverse the physical deterioration of the central business district or revitalize declining residential neighborhoods

Translated into the Anchorage context, it would appear that the presently existing land use policies and 1995 projections as expressed in the Comprehensive Development Plan Ordinance and Metropolitan Anchorage Urban Study, would have to be intensified in certain corridors in order to support potential light rail lines in these corridors. The

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1/ Federal Register, March 7, 1978, Volume III.

light rail lines analyzed in this study assumed some limited densification of residential and commercial land uses around stations. However, such minor land use adjustments were expected to occur in response to the introduction of LRT itself, rather than as the result of active land use and zoning policies especially designed to support a light rail system.

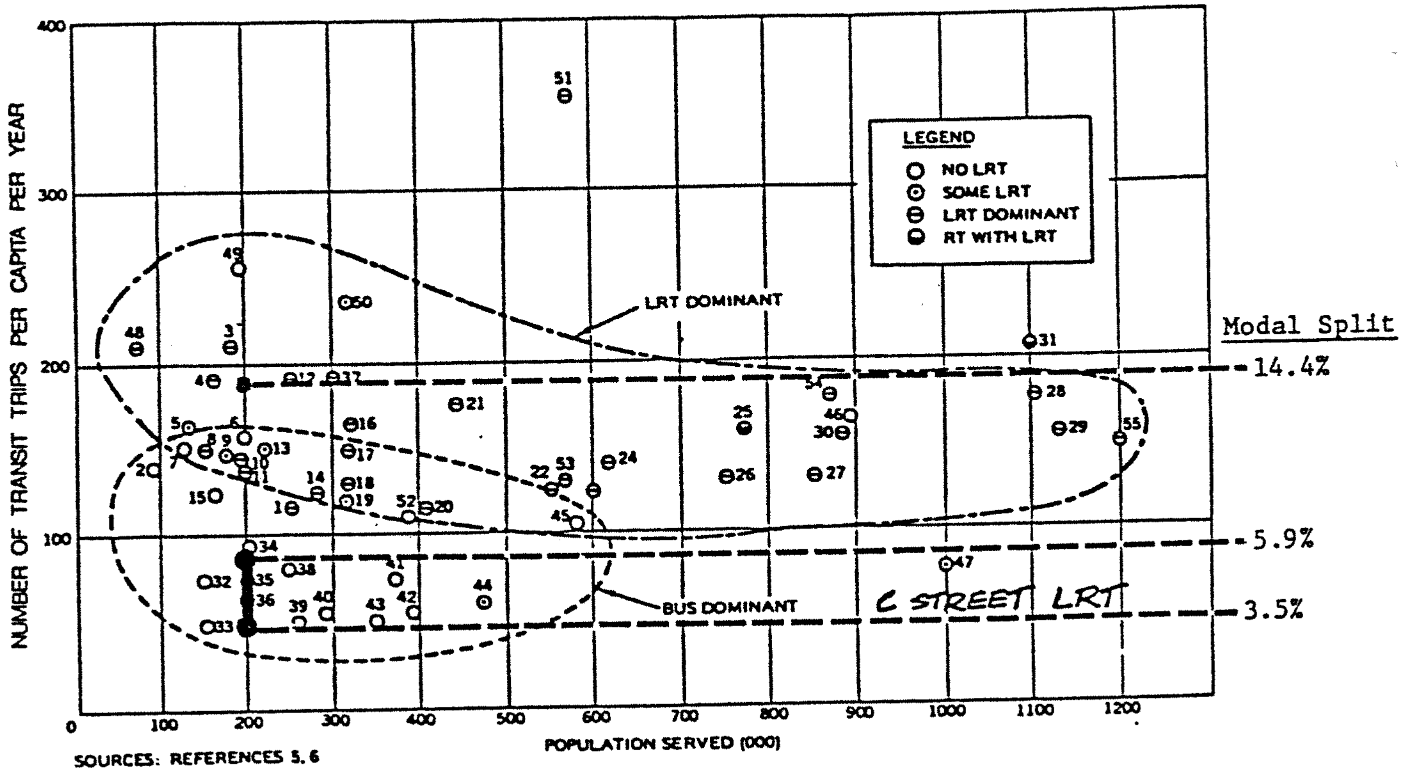
In order to determine the degree to which the Municipality's projected (1995) development patterns and densities in the C Street corridor would fit a light rail mode, a special analysis was conducted using criteria and standards developed in previous studies.1/ The following three criteria were utilized in this investigation:

- population served vs transit trips per capita
- downtown size (in square feet of non-residential floor space)
- residential density in tributary corridor

Population Served Vs. Transit Trips per Capita

Figure VI-1 illustrates the LRT and bus domains as observed in European cities (see also Chapter II). If the 1995 transit trips per capita and the population served by the C Street light rail line is superimposed on the graph, it can be seen that the "high" and "low" ridership estimates of the C Street LRT fall within the domain of bus service. If a mode split of 14.4% as projected by the Long Range Plan Element could be achieved, the C Street corridor would clearly be suitable for light rail, its domain starting at about 10% transit use. However, the ridership estimates prepared in this study indicate that a mode split range of 3.5%-5.9% would be more realistic, and would represent in all probability the maximum transit use that can be expected, unless stringent land development controls or auto travel penalties are imposed.

1/ Primarily in "Public Transportation and Land Use Policy," by Pushkarev and Zupan, A Regional Plan Association Book, Indiana University Press, 1977.



SOURCES: REFERENCES 5, 6

CITY/COUNTRY CLASSIFICATION

WEST GERMANY	1. HEIDELBERG 2. TRIER 3. LUDWIGSHAFEN 4. FREIBURG 5. ULM 6. OFFENBACH 7. PFORZHEIM 8. WURZBURG 9. BREMERHAVEN 10. DARMSTADT 11. MULHEIM	12. KASSEL 13. MAINZ 14. BIELEFELD 15. OSNABRUCK 16. KARLSRUHE 17. AUGSBURG 18. HAGEN 19. KIEL 20. BONN 21. MANNHEIM	22. WUPPERTAL 23. DUISBURG 24. BREMEN 25. NUREMBERG 26. ESSEN 27. HANNOVER 28. DUSSELDORF 29. COLOGNE 30. STUTTGART 31. MUNICH
FRANCE	32. METZ 33. LE MANS 34. TOURS 35. MULHOUSE 36. TOULON 37. SAINT-ETIENNE	38. NANCY 39. LE HAVRE 40. GRENOBLE 41. STRASBURG 42. NANTES	43. ROUEN 44. LILLE 45. BORDEAUX 46. LYON 47. MARSEILLE
SWITZERLAND	48. NEUCHATEL 49. LAUSANNE 50. GENEVA 51. ZURICH		
BELGIUM AND NETHERLANDS	52. UTRECHT 53. THE HAGUE 54. ROTTERDAM 55. BRUSSELS		

FIGURE VI-1

COMPARISON OF C-STREET LRT WITH EUROPEAN TRANSIT EXPERIENCE

Source: "Light Rail Transit, A State of the Art Review," by DeLeuw Cather and Co., for the Federal Department of Transportation, Washington, D.C., 1976.

Downtown Size

The transit modes suited to various sizes of downtown areas are shown in Figure VI-2. Two Anchorage conditions were estimated and superimposed on Figure VI-2: one condition that assumes a rather narrow interpretation of "downtown" comprising the traditional downtown area, while the other condition reflects a broader interpretation which includes commercial areas to the east of the present central business district and the Benson/Northern Lights/C Street commercial district. The first interpretation would contain in 1995 about 5 million sq. ft. non-residential floor space while the second definition would comprise over 15 million sq. ft.

Figure VI-2 indicates that a downtown size of approximately 20 million sq. ft. would be necessary before light rail even begins to become suitable and that about 30 million sq. ft., double the forecast amount, is needed before a convincing case can be made for light rail, according to the previously referenced studies conducted by the New York Regional Plan Association.

Residential Density in Tributary Corridor

Table VI-9 relates the minimum necessary residential density in dwelling units per acre to various urban transit modes. The average corridor density required to support express bus service is 3 dwelling units per acre, while the light rail requirement is about three times as high or 9 dwelling units per acre. For 1995, the average residential density in the densest 24 sq. mile portion of the C Street corridor that is closest to downtown is projected at approximately 3.5 dwelling units per acre. The total service area density in 1995 is projected to be about 2 dwelling units per acre. According to Table VI-9, these 1995 density conditions do not appear to justify light rail, but would be suitable for express bus service.

According to the above three criteria, a light rail system in the C Street corridor would have to have the full support of transit travel inducing

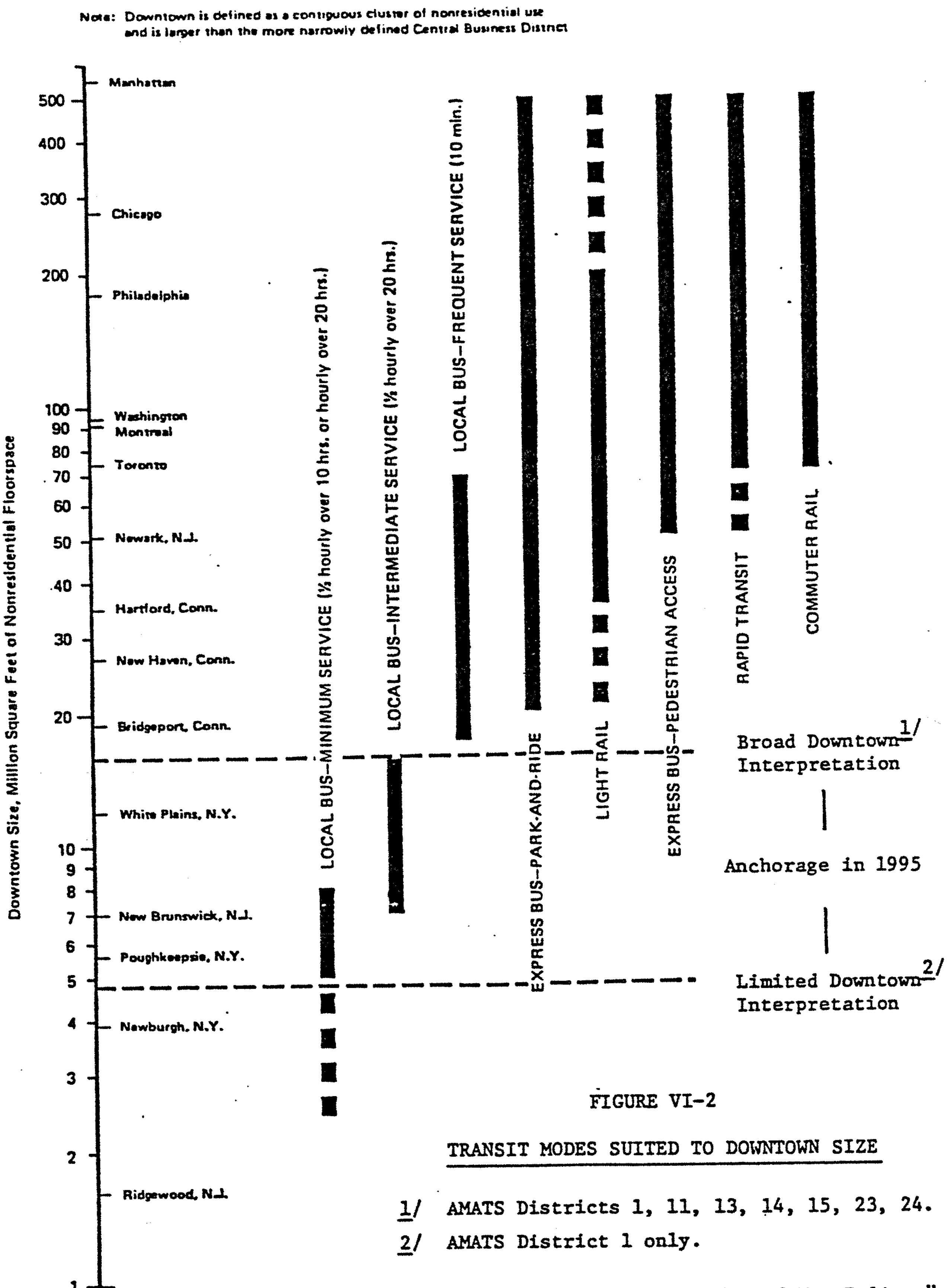


FIGURE VI-2

TRANSIT MODES SUITED TO DOWNTOWN SIZE

1/ AMATS Districts 1, 11, 13, 14, 15, 23, 24.

2/ AMATS District 1 only.

Source: "Public Transportation and Land Use Policy," by Pushkarev and Zupan, 1977.

TABLE VI-9

TRANSIT MODES RELATED TO RESIDENTIAL DENSITY

Mode	Service	Minimum Necessary Residential Density dwelling units per acre	Remarks
Dial-a-bus	Many origins to many destinations	6	Only if labor costs are not more than twice those of taxis
Dial-a-bus	Fixed destination or subscription service	3.5 to 5	Lower figure if labor costs twice those of taxis; higher if thrice those of taxis
Local bus	"Minimum," ½ mile route spacing, 20 buses per day	4	Average, varies as a function of downtown size and distance from residential area to downtown
Local bus	"Intermediate," ½ mile route spacing, 40 buses per day	7	
Local bus	"Frequent," ½ mile route spacing, 120 buses per day	15	
Express bus —reached on foot	Five buses during two hour peak period	15 Average density over two square mile tributary area	From 10 to 15 miles away to largest downtowns only
Express bus —reached by auto	Five to ten buses during two hour peak period	3 Average density over 20 square mile tributary area	From 10 to 20 miles away to downtowns larger than 20 million. square feet of non-residential floorspace
Light rail	Five minute headways or better during peak hour.	9 Average density for a corridor of 25 to 100 square miles	To downtowns of 20 to 50 million square feet of nonresidential floorspace
Rapid transit	Five minute headways or better during peak hour.	12 Average density for a corridor of 100 to 150 square miles	To downtowns larger than 50 million square feet of nonresidential floorspace
Commuter rail	Twenty trains a day	1 to 2	Only to largest downtowns, if rail line exists

Source: "Public Transportation and Land Use Policy," by Pushkarev and Zupan, A Regional Paln Association Book, Indiana University Press, 1977.

actions and favorable land use/development policies in order to be viable. These policies would ultimately have to achieve the following:

1. To produce a transit modal split of at least 10% on a daily basis within the corridor. This appears possible only through auto disincentive measures.

2. To concentrate future commercial and employment intensive land uses in either the downtown area or the Benson/Northern Lights/C Street district so that a total combined size of 30 million sq. ft. or more can be obtained. This represents a level that is approximately twice as high as called for by the current 1995 projections for these areas.

3. To provide for considerably denser residential development along the major broad travel corridors so that average densities of approximately 9 dwelling units per acre would exist in the future. For the C Street corridor this means that the residential densities would have to increase about 2.5 fold over the densities projected by the Comprehensive Development Plan and the recent Metropolitan Anchorage Urban Study for 1995.

It will become necessary, therefore, to project the likely future development patterns and levels of the Municipality beyond the year 1995 to determine whether light rail would or would not be feasible. In addition, it needs to be explored whether or not land development policies or controls that actively would support light rail would be politically acceptable given the past development history of the Anchorage region. However, such issues should be of immediate concern considering that the region's population will approximately double within the next 15 years while the existing transportation networks, both roads and transit facilities, are scheduled to receive only relatively minor additions and capacity improvements over the same time span.

VII
CONCLUSIONS AND RECOMMENDATIONS

VII. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations can be drawn from the feasibility analysis of a light rail transit system in major travel corridors within the Municipality of Anchorage.

Conclusions

- Light Rail Transit (LRT) would be technically feasible in all four corridors investigated without major engineering problems being encountered. Southcentral Alaska's winter conditions and local topographic features do not present any conflicts with the light rail mode.

- While it would appear from a cursory review of future available highway capacity that the needs for transportation improvements are greater in the east-west travel direction than along north-south corridors, the future travel demand is expected to be considerably larger in the north-south direction. This is due to a greater availability of development space in the southern parts of the Municipality. The broad C Street corridor would, therefore, serve the highest population and employment totals. The least number of people would be served by the Alaska Railroad (ARR) and West Northern Lights corridors.

- Although the four travel corridors analyzed would contain the highest activity and residential concentrations in the Municipality, projected population densities in the corridors for 1995 will remain significantly below those normally associated with light rail transit facilities in older and longer established urban areas.

- The highest LRT riderships would be generated in the C Street and East Northern Lights corridors with respectively about 5,000 and 4,000 passengers per peak hour in the peak direction under the more favorable ridership assumptions in 1995. A C Street Busway would generate almost 30% more riders than an LRT line in that corridor primarily due to the non-transfer, door-to-door feature of the bus mode.

- It is estimated that the LRT lines tested would attract between 4.5% and 7.0% of the daily total person travel within the specific corridors. Even if the share of the local People Mover bus system (currently less than 1%) is added, the LRT system would fall short of the areawide 14.4% transit modal split goal contained in the Long Range Plan Element.

- From a cost-economic standpoint, light rail appears to be feasible only if considerable capital funding and operating subsidies were committed. None of the LRT or busway alternatives tested would be financially self-supporting in terms of either capital or operating costs. Of the four LRT lines evaluated, the C Street line exhibits the most favorable cost-effectiveness and the ARR line the least favorable.

- The projected farebox recovery ratios of operating costs would range from a low of 31% for the LRT line in the ARR corridor, to a high of 52% for the C Street LRT line assuming that current People Mover bus system fares would apply to LRT with free transfer privileges.

- In terms of total annual subsidies required per passenger (including both operating and annual capital costs), the alternatives would rank as follows:

C Street Busway	Lowest Subsidies
C Street LRT	↓
East Northern Lights LRT	
West Northern Lights LRT	
Alaska Railroad LRT	Highest Subsidies

- In view of the low projected ridership demand, the high operating costs, and the interference between LRT and ARR industry spur track traffic, it seems very difficult to justify the construction of a light rail facility in the ARR corridor, even though the transportation right-of-way may be available at no or little cost.

- It also seems difficult to justify LRT implementation in the West Northern Lights corridor purely on economic criteria since a much larger ridership could be served in other major corridors more cost-effectively. The Anchorage International Airport was not found to generate in 1995 sufficient demand to support light rail access by itself.

- The C Street Busway would entail lower capital costs than LRT on C Street ($63 million versus $134 million) but would be more expensive to operate ($8.1 million annually versus $7.0 million).[1/]

- The operating subsidy per passenger would be about equal for both LRT and the Busway in the C Street corridor at approximately 25¢ per passenger. The total annual subsidy required, however, (including capital financing) would be about half as low for the Busway as for LRT (61¢ per passenger versus $1.21 per passenger).[1/]

1/ Represents costs (and revenues) for the line-haul portion only. Feeder bus system costs would be very similar for LRT and Busway.

- A sensitivity analysis indicated that neither a 50% increase over projected ridership levels (representing an energy crisis scenario) nor a doubling of fares without service reduction, would produce fare revenues in excess of operating expenses. The 50% ridership increase would increase the proportions of operating expenses recovered from fares to 69% (for the East Northern Lights LRT line) and 78% (for the C Street LRT line). The doubling of fares would have an identical impact.

- There is a potential for obtaining up to 80% Federal capital grants for construction of LRT or a busway. However, the Urban Mass Transportation Administration's (UMTA) current funding policies require a local commitment to LRT in the form of supportive land development policies and transportation management actions designed to enhance the proposed system's cost-effectiveness, patronage and prospect for economic viability. In addition, UMTA would need to be assured of the availability of local funds to cover the local share of capital expenditures, and even more importantly, the recurring annual operating subsidies.

- To be economically viable, LRT would need the full support of transit travel inducing actions, as well as favorable and supportive land use development policies. It is estimated that a daily transit corridor modal split of at least 10% would be required, compared to the 5-7% projected for the C Street and East Northern Lights corridors respectively.

Recommendations

- Continuing efforts should be made to build up transit ridership in the three best performing study corridors and the Glenn Highway corridor. This will enhance the future feasibility of a higher capacity line-haul transit mode in these corridors. Special attention should be given to the C Street corridor since future developments in Anchorage are projected to concentrate in the vicinity of this broad north-south corridor.

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There is a potential for obtaining up to 80% Federal capital grants for construction of LRT or a busway. However, the Urban Mass Transportation Administration's (UMTA) current funding policies require a local commitment to LRT. This would need to be expressed in the form of supportive land development policies and transportation management actions designed to enhance the proposed system's cost-effectiveness, patronage and prospect for economic viability. In addition, UMTA would need to be assured of the availability of local funds to cover the local share of capital expenditures, and even more importantly, the recurring annual operating subsidies.

2. Implement a busway in stages to bypass traffic congestion points. Especially, consider bus or high-occupancy vehicle lanes in conjunction with the planned A and C Street couplet implementation.

3. Consider conversion of the busway to light rail as transit demand increases and higher capacities are required. The current studies indicate that this phase would not be reached by 1995 under the current land development projections.

A similar program appears to be justified for the Northern Lights/Benson corridor primarily east of C Street to the vicinity of the University of Alaska at Anchorage.

- The available, but presently unutilized, transportation right-of-way of C Street south of 36th Avenue should be preserved for public transportation or shared transit/traffic purposes.

- Land use zoning and development policies that are supportive of a busway or light rail system should be initiated, such as channeling future development into more concentrated and denser corridors which are more suitable for higher capacity rail systems than the currently projected 1995 development patterns. In order for a light rail system to be viable, it would be necessary to approximately double the 1995 projected commercial densities in the downtown and Benson/Northern Lights/C Street area, and to almost triple the projected residential densities in the broad C Street corridor. In addition, auto disincentive actions and policies would have to be initiated so that the competition of the private automobile is reduced and a higher transit modal split can be achieved.

- Zoning and set-back regulations should be developed and implemented which will create, over a longer time span, a wider transportation right-of-way in the C Street corridor, the Northern Lights corridor, the 5th Avenue/Glenn Highway corridor, and possibly other corridors for use by public transportation at a future date.

- The feasibility of local and State funding options for major public transportation improvements such as a C Street Busway or Light Rail Line should be seriously explored. This is particularly pertinent since local funding capabilities appear to be the paramount prerequisite for any further light rail planning in the Anchorage area.

- In addition, it appears to be essential to determine whether or not land development policies or controls that actively would support light rail would be politically acceptable given the past development history of the Anchorage region. However, the above issues are of immediate concern considering that the region's population will approximately double within the next 15 years while the existing transportation networks, both roads and transit facilities, are scheduled to receive only relatively minor additions and capacity improvements over the same time span.

APPENDIX A
CAPITAL COST DETAILS

TABLE A-1

CAPITAL COST ESTIMATES FOR LRT IN ARR CORRIDOR - 1995

Item	Unit Cost 1/ ($ million/mile)	Quantity	Cost 1/ ($ million)
Right-of-way 2/	-	11.6m	-
Guideway	1.30	11.6m	15.08
Trackwork (double track)	1.95	11.6m	22.62
Electrification	1.15	11.6m	13.34
Signalization and Crossing Control	0.50	11.6m	5.80
Stations	0.33/station	11	3.63
Maintenance and Storage Facilities	0.12/vehicle	16 3/	1.92
Access to Maintenance/Storage Yard (single track)	2.45	0.2m	0.49
Subtotal: Ways and Structures Construction:			62.88
Engineering/Design/Administration (15%):			9.43
Contingency (25%):			18.08
Total: Ways and Structures Construction:			90.39
Cost per mile (Ways and Structures):			7.79
Vehicles	0.90	16 3/	14.40
Total: System:			104.79
Cost per mile (System):			9.03

1/ All costs expressed in 1979 dollars, adjusted to Anchorage costs.

2/ Assumes no property acquisition costs for ARR right-of-way.

3/ Total fleet size including 10% spares.

TABLE A-2

CAPITAL COST ESTIMATES FOR LRT IN C STREET CORRIDOR - 1995

Item	Unit Cost[1] ($ million/mile)	Quantity	Cost[1] ($ million)
Right-of-way	1.42	7.5m	10.65
Guideway: At Grade	1.96	7.2m	14.11
Subway	40.00	0.3m	12.00
Trackwork (double track)	1.65	7.5m	12.38
Electrification	1.15	7.5m	8.63
Signalization and Crossing Control	0.08	7.5m	0.60
Stations: At Grade	0.33/station	11	3.63
Subway	7.50/station	1	7.50
Maintenance and Storage Facilities	0.12/vehicle	30[2]	3.60
Access to Maintenance/Storage Yard (single track)	2.45	0.66m	1.62
Subtotal: Ways and Structures Construction:			74.72
Engineering/Design/Administration (15%):			11.21
Contingency (25%):			21.48
Total: Ways and Structures Construction:			107.41
Cost per mile (Ways and Structures):			14.32
Vehicles	0.90	30[2]	27.00
Total: System:			134.41
Cost per mile (System):			17.92

1/ All costs expressed in 1979 dollars, adjusted to Anchorage costs.

2/ Total fleet size including 10% spares.

TABLE A-3

CAPITAL COST ESTIMATES FOR LRT IN
EAST NORTHERN LIGHTS CORRIDOR - 1995

Item	Unit Cost[1/] ($ million/mile)	Quantity	Cost[1/] ($ million)
Right-of-way	1.63	7.9m	12.88
Guideway: At Grade	1.96	7.6m	14.90
Subway	40.00	0.3m	12.00
Trackwork (double track)	1.65	7.9m	13.04
Electrification	1.15	7.9m	9.09
Signalization and Crossing Control	0.08	7.9m	0.63
Stations: At Grade	0.33/station	15	4.95
Subway	7.50/station	1	7.50
Maintenance and Storage Facilities	0.12/vehicle	30[2/]	3.60
Access to Maintenance/Storage Yard (single track)	2.45	0.66m	1.62
Subtotal: Ways and Structures Construction:			80.21
Engineering/Design/Administration (15%):			12.03
Contingency (25%):			23.06
Total: Ways and Structures Construction:			115.30
Cost per mile (Ways and Structures):			14.60
Vehicles	0.90	30[2/]	27.00
Total: System:			142.30
Cost per mile (System):			18.01

1/ All costs expressed in 1979 dollars, adjusted to Anchorage costs.

2/ Total fleet size including 10% spares.

TABLE A-4

CAPITAL COST ESTIMATES FOR LRT IN
WEST NORTHERN LIGHTS CORRIDOR - 1995

Item	Unit Cost[1/] ($ million/mile)	Quantity	Cost[1/] ($ million)
Right-of-way	1.72	6.5m	11.18
Guideway	1.75	6.5m	11.38
Trackwork (double track)	1.65	6.5m	10.73
Electrification	1.15	6.5m	7.48
Signalization and Crossing Control	0.08	6.5m	0.52
Stations	0.33/station	13	4.29
Maintenance and Storage Facilities	0.12/vehicle	14[2/]	1.68
Access to Maintenance/Storage Yard (single track)	2.45	0.66m	1.62
Subtotal: Ways and Structures Construction:			48.88
Engineering/Design/Administration (15%):			7.33
Contingency (25%):			14.05
Total: Ways and Structures Construction:			70.27
Cost per mile (Ways and Structures):			10.81
Vehicles	0.90	14[2/]	12.60
Total: System:			82.87
Cost per mile (System):			12.75

1/ All costs expressed in 1979 dollars, adjusted to Anchorage costs.

2/ Total fleet size including 10% spares.

TABLE A-5

CAPITAL COST ESTIMATES FOR BUSWAY IN C STREET CORRIDOR - 1995

Item	Unit Cost[1/] ($ million/mile)	Quantity	Cost[1/] ($ million)
Right-of-way	1.42	7.5m	10.65
Guideway and Pavements[2/]			
A-C Street Couplet	0.40	6.3m	2.52
South of A-C Street Couplet	4.10	4.1m	16.81
Signalization	0.04	7.5m	0.30
Stations	0.25/station	13	3.25
Maintenance and Storage Facilities	0.06/vehicle	66[3/]	3.96
Subtotal: Ways and Structures Construction:			37.49
Engineering/Design/Administration (15%):			5.62
Contingency (25%):			10.78
Total: Ways and Structures Construction:			53.89
Cost per mile (Ways and Structures):			7.19
Vehicles	0.14	66[3/]	9.24
Total: System:			63.13
Cost per mile (System):			8.42

1/ All costs expressed in 1979 dollars, adjusted to Anchorage costs.

2/ Assumes no guideway costs on 5th Avenue. Buses would run on existing streets.

3/ Total number of new buses required including 10% spares.

APPENDIX B
OPERATING COST DETAILS

TABLE B-1

ASSUMED OPERATING UNIT COSTS (DOLLARS PER VMT)[1/]
(COSTS IN 1979 ANCHORAGE PRICES)

Cost Category	$ per VMT
Maintenance of Ways & Structures	0.983
Maintenance of Vehicles & Equipment	0.533
Power	0.323
Transportation	1.155
Administrative and General	0.443
Subtotal	3.44
20% Contingency	0.69
TOTAL OPERATING COST	$4.13

1/ VMT = vehicle miles travelled.

TABLE B-2

TRANSIT SYSTEM PARAMETERS INPUT TO OPERATING COST ESTIMATES

Corridor	1985 VMT 1/	1985 Total 2/ Fleet Size	1995 VMT	1995 Total Fleet Size
LRT				
ARR	327,200	7	1,139,600	16
C Street	597,000	14	1,687,800	30
East Northern Lights	401,800	11	1,472,200	30
West Northern Lights	313,400	9	571,300	14
Busway				
C Street	1,183,900	66	2,460,900	104

1/ Vehicle miles travelled.

2/ Includes for 10% spares over peak fleet requirements.

The following persons were the main participants in this project:

Alan M. Voorhees & Associates	Juergen A. Fehr, Project Manager Michael Bates, Senior Transportation Planner Warren Yamamoto, Senior Engineer Gerald Walters, Transportation Planner Marlene Friedman, Graphics Emily Demir, Editing/Production Janice Eklund, Technician
AMATS/Municipality of Anchorage	Reed Gibby, Program Coordinator