

Planning and Design of Park-and-Ride Facilities for the Calgary Light Rail Transit System

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Park-and-ride facilities are an integral part of the Calgary light rail transit (LRT) system. At the present time, there are approximately 6,800 parking stalls at 11 stations on 29 km of LRT line. On a systemwide basis, utilization is over 90 percent for long-term parking, and stations at two of the three terminals of LRT lines have 100 percent utilization of park-and-ride facilities. To determine the demand for surface park-and-ride facilities on the Calgary LRT system, a method has been developed based on the number of transit users in the station catchment areas using the automobile mode to reach the LRT system. Catchment areas are defined by a commutershed concept and vary in size and shape depending on station spacing and the road network in the immediate vicinity of a station. The primary market for LRT park-and-ride facilities within each catchment area is downtown employees. Planning guidelines for LRT park-and-ride facilities have also been developed. They include location criteria, access and egress considerations, and number and location of parking stalls (including short-term and long-term parking, kiss-and-ride, handicapped parking, and parking facilities for bicycles and motorcycles).

Park-and-ride has been an integral component of the Calgary light rail transit (LRT) system since it opened in 1981. The importance of the approximately 6,800 stalls at 11 stations on the 29 km of LRT line is manifested in an occupancy level of 90 percent on a systemwide basis.

Owing to the importance of park-and-ride as an access mode, the transportation department at the city of Calgary has developed procedures for the planning and design of such facilities and has learned several lessons from a decade of experience.

OVERVIEW OF PUBLIC TRANSIT IN CALGARY

Calgary's economy has been largely based on its favorable location as a service and distribution center for the vast agricultural lands of southern Alberta and for the oil and gas industry that developed in the area. The city has a (1991) population of approximately 708,000 and encompasses an area of 672 km² (see Figure 1). About one-third of the city's em-

ployment is in the central area, one-third along the east industrial area, and one-third spread throughout the city.

Downtown Transportation Strategy

Although the downtown area accounts for less than 20 percent of all travel in Calgary, the intensity of this travel, combined with crosstown traffic, causes congestion and disruption to the inner city. Maintaining a strong, viable downtown area is a goal of the city. Therefore a number of its objectives emanate from a desire to manage traffic in the downtown and inner city areas. The thrust of many of these objectives is to improve the physical environment of the downtown and inner city sectors, and this can be translated into one transportation objective: to reduce unnecessary vehicular traffic in this area.

The primary target for change is the downtown worker who contributes to peak hour congestion and who stores a vehicle downtown during the work day. The strategy to initiate change is based on the gradual reduction in the availability of parking relative to downtown growth while increasing public transit service between the suburbs and downtown. Complementary policies, such as traffic management, road capacity restrictions, improved pedestrian environments, and downtown residential development, complete the strategy.

Historical Development of Downtown Transit Service

The importance of transit steadily declined from a high point in 1945 to a low, in terms of rides per capita, in the mid-1960s. Rapid transit studies also began in the mid-1960s with the first plan recommending two legs of heavy rail transit and a downtown subway (1).

In the early 1970s, Calgary instituted a new bus service marketed as the Blue Arrow system. The Blue Arrow system acted as its own feeder in the farthest suburbs and interconnected with crossing feeder routes as it approached downtown. Limited stops between the outer suburbs and the downtown area gave it some of the characteristics of an express service. A series of park-and-ride lots were developed with particular emphasis on proposed future rail corridors. Thus the Blue Arrow and its feeder bus systems combined with park-and-ride facilities to form a prototype for the development of the LRT system in terms of service and corridors. Between 1971 and 1981 the percentage of work trips to down-

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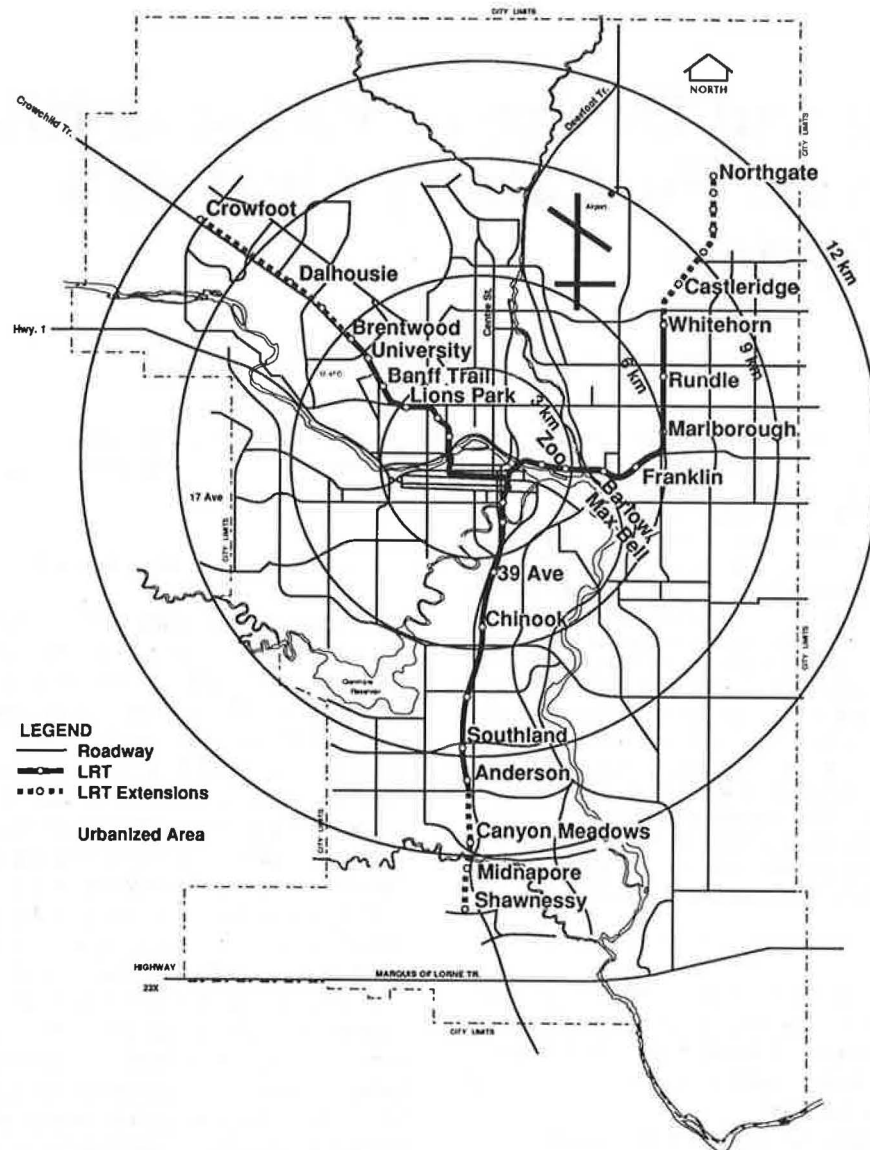


FIGURE 1 Calgary roadway and LRT network.

town by transit increased from 34 to 43 percent, a level that the LRT system has since maintained.

Implementation of Light Rail Transit

Implementation of the LRT system was a major impetus to the development of park-and-ride facilities in Calgary. These facilities have been planned in concert with other access modes (e.g., feeder bus, passenger pick up and drop off, walking, and cycling) to provide a comprehensive, balanced range of travel options for transit customers.

The LRT opened in 1981 with a 12.9-km (south) line served by 2,450 parking stalls. In 1985 another 9.8-km line was added (northeast) served by 2,100 parking stalls. In 1987 the 5.6-km northwest LRT leg opened and incorporated 530 parking stalls. The northwest line was extended by 1 km in 1990 and an

additional 905 parking stalls were provided at the new Brentwood Station.

Table 1 shows the current status of park-and-ride facilities provided by Calgary Transit. This information reflects an expansion of parking capacity on the south LRT (650 stalls), which was undertaken to respond to parking pressure at the suburban stations.

In 1991 the Calgary Transit system had 118 routes serving approximately 53.6 million revenue passengers annually (excluding transfers). The fleet is composed of more than 592 buses and 85 LRT vehicles, with 503 buses and 72 LRT vehicles operating in the peak hours. On weekdays the LRT system carries approximately 114,500 passengers (400 boarding passengers per operating hour). Average weekday bus ridership is approximately 156,600 passengers (39 boarding passengers per operating hour).

TABLE 1 Number of Park-and-Ride Stalls by Corridor, 1990

Corridor	Length of Line (km)	Year Opened	No. of Park-and-Ride Stalls
LRT south	12.9	1981	3,102
LRT northeast	9.8	1985	2,250
LRT northwest	6.6	1987 ^a	1,435
Bus express	— ^b	—	260
Total	29.3		7,047

^aIncludes 1-km extension in 1990.^bDenotes data not applicable.

OVERVIEW OF PARK-AND-RIDE IN CALGARY

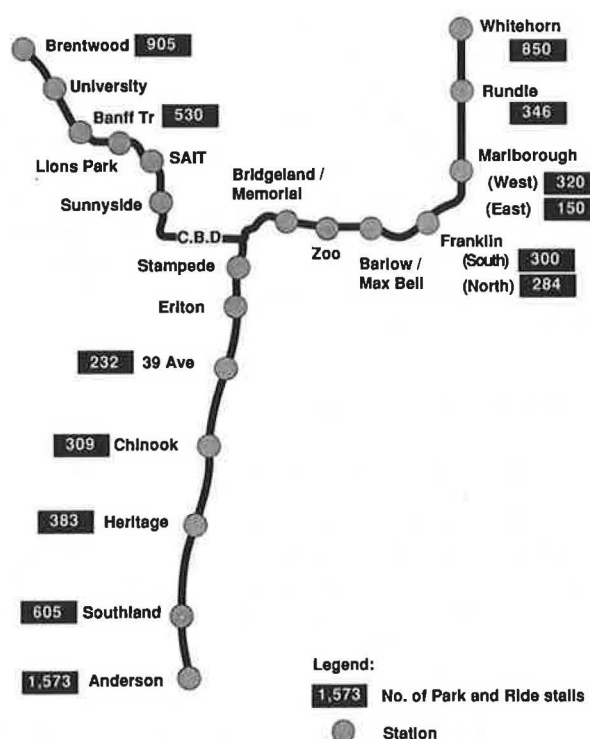
Planning Objectives and Location Criteria

The establishment of park-and-ride facilities along major LRT and main-line bus corridors has expanded the transit market in Calgary to include customers who wish to use their private automobiles for a portion of their trips. These facilities are appealing to the automobile commuter because they provide greater flexibility and comparatively faster travel time than accessing the main-line LRT and bus services via the feeder bus system. Free parking and automobile block heater plug-ins (to facilitate cold weather starting) are also provided at park-and-ride lots to encourage use of these facilities. Park-and-ride trips are intercepted upstream of heavier traffic congestion in proximity to the downtown; therefore use of these facilities also assists in peak period transportation demand management.

Park-and-ride facilities have been strategically developed at designated stations along existing and proposed rail transit corridors and at major transit terminals on main-line bus routes. The sites selected for park-and-ride facilities are generally beyond a minimum distance of 5 km from the downtown core to intercept automobile commuters at the earliest opportunity and to discourage continuation of the trip by private automobile. Approximately 97 percent of the existing park-and-ride stalls (approximately 6,800 stalls) provided by Calgary Transit are located at LRT stations (see Figure 2). Three percent of park-and-ride stalls (approximately 260 stalls) are distributed along main-line bus corridors.

LRT Station Access Design Guidelines

The existing design guidelines for suburban LRT stations provide for a range of customer access modes (e.g., bus, private automobile, walking, bicycle); however, feeder buses are intended to be the primary mode of access to the LRT. The existing policy target is to accommodate approximately two-thirds of total patron arrivals in this manner. This strategy recognizes that the trip generating capacity of a park-and-ride stall is quite low when compared to a feeder bus system (each park-and-ride stall in Calgary generates only 2.63 transit trips daily) and also addresses community concerns regarding the traffic and environmental impact of developing large parking facilities adjacent to residential areas.

**FIGURE 2** Calgary LRT network, stations, and park-and-ride.

To ensure the provision of a high-quality feeder bus service, every effort is made, as part of the route planning and service design process, to integrate feeder bus and LRT service effectively. In Calgary, public transit requirements are reviewed and incorporated at each stage of the development process (i.e., area structure plans/design briefs, concept plans, outline plans, subdivision plans, development and rezoning applications) as a condition of development approval. This iterative process contributes to the successful integration of transit within the community by maximizing area coverage and providing a high standard of access to transit service (i.e., interior walkways, sidewalks, lighting, bus zone aprons).

The frequency of service currently provided on the feeder bus networks in the existing three LRT corridors is generally in the 15- to 20-min range during peak periods. Base service operating during the weekday, midday, and Saturday periods is provided every 30 min on most routes. Evening and Sunday service operates on a 30- to 60-min frequency.

The current access design guidelines for suburban LRT stations allow for approximately one-third of the total patron arrivals by private automobile either through automobile passenger drop off (kiss-and-ride) or park-and-ride activities.

Access Mode	Modal Share (%)
Bus	60–65
Park-and-ride	15–20
Kiss-and-ride	15
Walk	5

Suburban park-and-ride lots on the two initial LRT lines in the south and northeast corridors were sized to accommodate 15 percent of all LRT trips based on the estimated maximum

development of the transit market within the catchment area for each station. In response to parking pressure experienced at the south LRT stations, the park-and-ride design guidelines were increased in 1986 to a range of 15 to 20 percent of all LRT trips. Subsequent to this decision park-and-ride lots at five LRT stations on the south LRT leg were expanded to increase parking capacity by approximately 650 stalls. A subsequent review of park-and-ride requirements at the proposed northwest LRT stations also concluded that additional parking would be required to accommodate an expanded modal share for park-and-ride travel.

LRT Park-and-Ride Inventory

At present approximately 6,800 park-and-ride stalls have been developed for the initial three-leg LRT system (see Table 2), with the potential for an additional 5,900 stalls when future extensions to the south, northwest, and northeast LRT lines are opened, for a total of approximately 12,700 stalls. Other plans call for more short-term and handicapped parking and special storage for bicycle security.

A proportion of the park-and-ride stalls at each LRT station has been allocated for short-term parking (4 hours maximum), automobile passenger pick up (15 min maximum), and handicapped parking (by permit only). The existing practice is to initially designate approximately 10 to 15 stalls at each LRT park and ride lot for short-term parking (between 5 a.m. and 4 p.m.) and 2 stalls for handicapped parking. The 4-hour parking area is converted to 15-min passenger loading after

4 p.m. Also, parallel curbside parking may be assigned for kiss-and-ride (also referred to as passenger pick up or drop off) activities depending on the parking lot design. The quantity of parking designated as short-term (4-hour), kiss-and-ride, and handicapped parking may be increased if demand is demonstrated for additional capacity.

Role of Park-and-Ride

Although park-and-ride at LRT stations is regarded as an effective method of expanding the transit market to include automobile drivers, it is essential that an appropriate balance between park-and-ride and other access modes be maintained to sustain a viable feeder bus system and to avoid generating an undesirable impact upon adjacent residential areas.

Parking development beyond the capacity constraints of each site will create major delays at the access points and within the parking areas, thereby reducing the attractiveness of the park-and-ride travel option. This congestion would also affect the operation of the feeder bus network and the environment of the adjacent communities. Experience has demonstrated that provision of park-and-ride facilities also affects the use of other station access modes (e.g., feeder buses), thereby limiting the ridership gains achieved through parking expansion programs. A survey of northeast LRT riders indicates that approximately 60 percent of existing park-and-ride users were bus riders before LRT service began. Information obtained following the opening of the new 905-stall park-and-ride lot at Brentwood Station on the northwest LRT

TABLE 2 Inventory of Park-and-Ride Stalls on the Calgary LRT System, 1990

Station	Existing Parking				Future Parking
	Total Stalls	Short-Term ^a	Kiss-and-Ride ^b	Handicapped	
South LRT					
39 Avenue	232	6	6	8	
Chinook	309	12	12	2	
Heritage	383	7	13	2	
Southland	605	9	9	2	
Anderson	1,573	16	15	2	
Canyon Meadows					200
Midnapore					1,000
Shawnessy					1,000
Northeast LRT					
Franklin					
South	300	11	21	2	
North	284	16	16	2	
Marlborough					
West	320	13	13	2	
East	150	4	4	2	
Rundle	346	7	7	2	
Whitehorn	850	10	30	5	
Castleridge					500
Northgate					1,000
Northwest LRT					
Banff Trail	530	4	28	2	
Brentwood	905	15	15	4	
Dalhousie					1,200
Crowfoot					1,000
Total	6,787				5,900

^aFour-hour parking.

^bFifteen-minute parking.

also revealed that although 37 percent of park-and-ride users were new transit customers, one-third previously made the trip by Calgary Transit bus (2). These high diversion rates may be partially related to the restructuring of the bus network; nevertheless it does support the conclusion that easing constraints on LRT parking may trigger some shift from other modes such as kiss-and-ride and feeder buses to park-and-ride.

The challenge presented by the park-and-ride transit option is to determine an appropriate balance of these facilities relative to other access modes. Too much parking can be detrimental to the viable operation of the feeder bus network. Too little parking merely restricts the transit market in the corridor and may result in overspill parking into adjacent communities. The appropriate balance of this option, within the spectrum of public transit services, is critical to maximize overall system efficiency.

Park-and-Ride Utilization

South LRT

Surveys undertaken by Calgary Transit of the park-and-ride facilities at the south LRT stations, indicate that park-and-ride accounts for 21 percent of the access modal share (3) (see Table 3). At present the demand for park-and-ride facilities on the south LRT exceeds the existing supply. All park-and-ride lots are generally full by 9 a.m. Complaints from patrons encountering a full park-and-ride lot have not been sufficient to warrant expansion of the lots.

Northeast LRT

In contrast to the popularity of park-and-ride facilities on the south LRT, park-and-ride use along the northeast LRT corridor has been lower, at 15 percent modal share (4). The northeast LRT line has unused parking capacity (see Table 4).

Northwest LRT

In September 1990 the northwest LRT extension to Brentwood was opened. This new station incorporates 905 park-and-ride stalls. Although current information on access mode

TABLE 4 Northeast LRT Park-and-Ride Occupancy Levels, November 1989

	No. of Stalls	Occupancy Level (%)
Whitehorn Station	850	80
Rundle Station	346	93
Marlborough		
West	320	82
East	150	100
Franklin		
South	300	100
North	284	80
Total	2,250	89 (average)

changes resulting from the Brentwood LRT Station is not yet available, a dramatic shift has occurred in park-and-ride demand from Banff Trail Station to Brentwood Station. Parking at Banff Trail has been reduced from 100 percent to 30 percent of available capacity. Existing parking stalls at Brentwood are generally fully occupied on weekdays.

Customer Response to Park-and-Ride Facilities

Based on the high use of existing parking facilities at LRT stations, it is apparent that park-and-ride transit is popular with automobile commuters. The 15- to 20-percent design guideline applied to park-and-ride travel has provided sufficient parking capacity to accommodate corridor demand on the northeast and northwest LRT lines.

Recent surveys of south and northwest LRT park-and-ride users have confirmed that time savings and convenience are major considerations in choosing park-and-ride over feeder bus travel. Respondents cited a number of reasons for choosing to travel by Calgary Transit, primarily relating to the cost of travel and, in particular, the high cost of parking in the downtown area. It is interesting to note that, in spite of the parking pressure at the south LRT stations, respondents ranked additional parking below other potential transit improvements such as increased peak period train frequency, extension of the south LRT, and increased feeder bus frequency. Eighty-two percent of respondents claim that they would discontinue use of the park-and-ride facilities if a fee were charged for parking (5).

It is anticipated that parking pressure on the south LRT line will ease when the LRT is extended south to Midnapore (expected before the end of the decade) and additional park-and-ride is developed at the new terminal station.

GUIDELINES FOR PLANNING PARK-AND-RIDE LOTS

The following general guidelines have been developed for the Calgary LRT system (6):

1. Park-and-ride lots should be on major transportation corridors served by high-speed, high-quality public transit (LRT or express bus) and roadways of major arterial or expressway standards.

TABLE 3 LRT Park-and-Ride Access Mode Modal Share

	Access Mode	Modal Share (%)
South LRT	Feeder bus	51
	Park-and-ride	22
	Automobile drop off	5
	Walk	21
	Other	1
Total		100
Northeast LRT	Feeder bus	55
	Park-and-ride	15
	Kiss-and-ride	7
	Walk	23
Total		100

2. Park-and-ride lots should be located so as to intercept motorists upstream of the heavier traffic congestion.

3. Park-and-ride lots should be in corridors with good roadway access leading directly to the facility. Access and egress should be quick and easy.

4. The total transit travel time from the park-and-ride lot to the central business district (CBD) should be equal to or preferably less than travel time by car.

5. The percentage of travel time on transit should represent more than 50 percent of the total journey time.

6. Ideally the park-and-ride facility should be no closer than 5 to 6 km to the downtown, although there may be exceptions as a result of natural and man-made geographic barriers. For example, the Barlow/Max Bell Station (see Figure 2), is within 4 km of the downtown on a major escarpment and has attracted park-and-ride activity on a vacant development site.

7. Park-and-ride facilities should be in corridors and areas along corridors with a strong link to the destination zone (e.g., residential zones with a high proportion of downtown workers).

8. Park-and-ride facilities should be where the local traffic impact on residential neighborhoods would be minimal.

9. Park-and-ride facilities should be developed within a framework of an overall metropolitan planning strategy to limit long-term parking within the downtown and the provision of fast, frequent transit to the downtown.

10. Park-and-ride lots should be viewed not only as a transportation focal point but as a community asset in terms of attractive station design, landscaping, and passenger security.

Estimating the Demand for Park-and-Ride

The size of a park-and-ride facility is influenced by the estimated demand, which has been calculated in Calgary by the following method (6).

Commutershed Concept

The commutershed concept is used to determine the primary catchment area for estimating the demand for park-and-ride. The general shape of a commutershed is illustrated in Figure 3. The commutershed is roughly a parabolic-shaped area of varying dimensions with the park-and-ride facilities at the focus of the parabola. For the Anderson and Brentwood terminal stations, the parabola is approximately 6 km long and 8 to 10 km wide at the base. For inner stations, the commutershed dimensions will vary according to land use and geographic and man-made barriers, such as rivers, major arterial roads, and rail lines.

Primary Market

The primary market for estimating the demand for park-and-ride within a station catchment is downtown employees. Secondary markets would include downtown-destined nonwork trips or crosstown trips to destinations with a limited parking supply, such as the university, Calgary Stampede, or the Saddledome (where hockey games are played). It is the primary market, however, that is used to size park-and-ride lots.

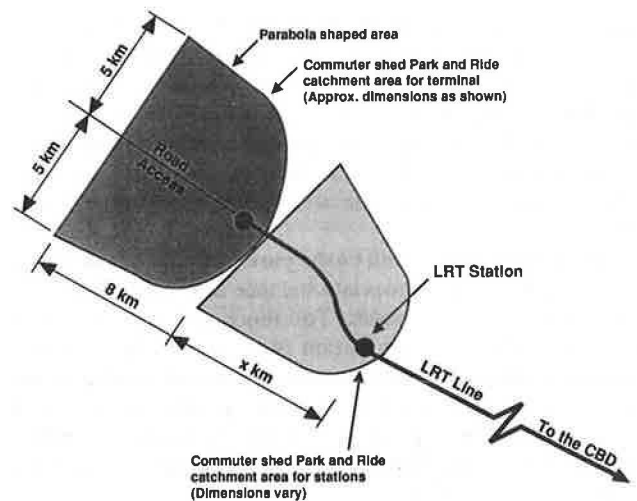


FIGURE 3 Commutershed concept for determining the catchment area for LRT park-and-ride.

Demand Forecast Procedure

The five basic steps in estimating the demand for park-and-ride are as follows:

1. Define the catchment area for each station.
2. Determine the primary market. The primary market is defined as downtown employees residing within a catchment area. In the case of Calgary the magnitude of the primary market is based on home-interview, origin-destination surveys.
3. Determine the primary demand, which is based on the observed and expected modal split for home-based work trips to the CBD. In the case of Calgary a modal split of 40 to 45 percent has been observed for CBD-oriented home-based work trips.
4. Estimate the proportion of primary demand attracted to park-and-ride. City of Calgary design guidelines for park-and-ride make provision for accommodating 15 to 20 percent of the primary demand. These guidelines are based on the observed demand for park-and-ride, an automobile occupancy of 1.2, and the lots operating at 95 percent efficiency with a stall turnover of 1.2. Accommodating 15 to 20 percent of primary demand at park-and-ride lots represents a strategy to strike a balance between satisfying the demand for park-and-ride and maintaining a viable feeder bus service. Oversupply of park-and-ride stalls is not only economically undesirable but also could result in unacceptable environmental and community effects. Undersupply of park-and-ride can also result in unacceptable community effects such as overspill parking on adjacent streets. Undersupply can also discourage potential public transit patronage by commuters presently driving to work downtown.
5. The demand for short-term parking and special needs parking (such as handicapped parking) at park-and-ride lots is taken as a proportion of long-term demand.

Northwest LRT Park-and-Ride Example

Before the extension of the northwest LRT line from the University of Calgary to the Brentwood Terminal, this method was used to estimate the park-and-ride stall requirements assuming that the line would be extended in stages beyond the University Station to Brentwood, Dalhousie, and Crowfoot. Figure 4 shows the catchment area for each station and major transportation facilities. It is noted that as the line is being extended in stages, the interim terminal park-and-ride facility must serve a larger catchment area than required when the LRT line is extended. Thus the Banff Trail park-and-ride shown in Figure 4, with a capacity of 530 stalls, served as the terminal facility for the northwest LRT for a period of 3 years. In fact before the extension of the northwest line, 85 percent of the Banff Trail park-and-ride patrons originated in the Brentwood catchment.

Table 5 gives the main assumptions used to estimate the size of the Brentwood park-and-ride facility. The catchment population of the Brentwood Terminal was estimated at 83,700 for a corresponding citywide population of 750,000. The primary market for the Brentwood Terminal was based on the number of home-based work trips originating in the Brentwood catchment and destined for the CBD. A modal split of 40 percent was used to estimate the primary demand.

Table 5 indicates that 758 and 1,008 stalls would be required for 15 and 20 percent, respectively, of primary demand using park-and-ride. A total of 905 stalls were constructed at Brentwood, which was the maximum number that could be built on the land available. The 1,200 and 1,000 stalls planned for future LRT extensions to terminals at Dalhousie and Crowfoot, respectively, were estimated by a similar procedure.

The high use of the Brentwood park-and-ride lot is attributed to the fact that it is the outermost terminal on the north-

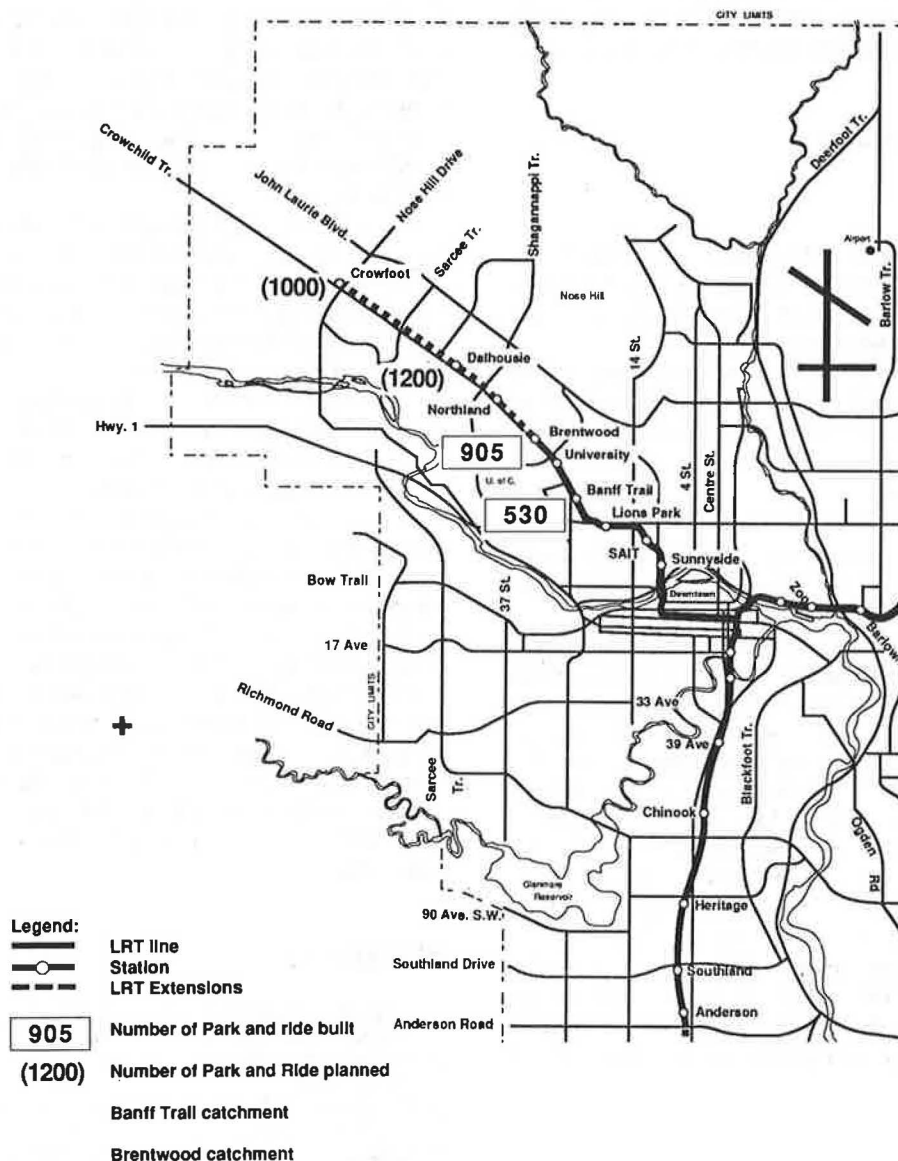


FIGURE 4 Northwest LRT park-and-ride catchment areas.

TABLE 5 Estimated Number of Park-and-Ride Stalls for Northwest LRT Line Extension to Brentwood Terminal

Station	Catchment Population ^a	Stalls Required by Percent Primary Demand ^b		Parking Stalls Constructed
		15	20	
Banff Trail	12,350	116	154	530
Brentwood	83,700	758	1,008	905
Total Northwest corridor catchment	96,050	875	1,162	1,435

^aBased on city population of 250,000.^bUsing park-and-ride.

west LRT line, which intercepts inbound traffic on Crowchild Trail, and the fact that the Brentwood catchment in reality extends approximately 50 km beyond the city limits, encompassing dormitory communities, country estates, and small towns. Recent surveys indicate that approximately 8 percent of park-and-ride commuters at the Brentwood Terminal came from outside the city.

Other Planning Considerations

Walking Distances

The attractiveness of a park-and-ride facility depends on the walking distance from the parking area to the transit boarding area. The maximum desirable and maximum walking distance are 125 m and 250 m, respectively.

Observations at the McMahon and Anderson stations, with a 5-min walk, have indicated that the distance (approximately 450 m) is undesirable and detracts from the use of the facility.

Maximum and Minimum Size

Little research has been undertaken to determine the maximum or minimum facility size. Observations of existing lots indicate that the Anderson Terminal at 1,600 stalls is larger than desirable in terms of walking distances and traffic generation. As a general guideline, the maximum and minimum size of future lots has been set at 1,200 and 200 stalls, respectively. The suggested maximum limit of 1,200 stalls is consistent with the walking distance guidelines just noted for a single park-and-ride lot. If it is feasible to develop parking in a concentric pattern around the LRT station, the quantity of parking could be increased beyond 1,200 stalls. Having determined the general location of an LRT station and the approximate capacity of parking needed, specific sites must be evaluated through more detailed analysis. Site selection must take into account factors other than the park-and-ride component. It is noted that the city of Calgary LRT design guidelines, developed in 1981, are constantly being updated to incorporate changing design parameters such as the size of the parking module (7).

CONCLUSIONS

Based on two decades of operating experience, Calgary's transportation department has concluded that the importance of park-and-ride is best illustrated by the fact that there is 90

percent utilization of stalls provided on a systemwide basis and 100 percent utilization at terminal stations. The primary demand for park-and-ride arises from downtown employees, and procedures for estimating demand from this market are based on a 15 to 20 percent access modal share for park and ride. Accommodating 15 to 20 percent of primary demand at park-and-ride lots represents a strategy to strike a balance between the demand for park-and-ride and maintaining a viable feeder bus service. This design guideline has been found to be satisfactory for sizing park-and-ride lots in the Calgary LRT system.

The importance of park-and-ride, not only as an access mode but in contributing to a growth of downtown work trip modal split, has been confirmed by passenger surveys. Market surveys found that 46 percent of LRT passengers using park-and-ride stated that they did so because it was faster and more convenient than a feeder bus.

The most important lessons learned are to reserve adequate space for park-and-ride facilities well in advance of line extension and to minimize neighborhood impacts. The financial burden of long-term land reservation can be minimized through joint land use or interim land use, such as a mobile home park. Local problems, such as overspill parking or increased traffic on residential streets, can be minimized by careful signing of access roads leading to the park-and-ride lot, appropriate sizing of the lot, and special attention to the location of access and egress points on major arterials.

Other factors that have contributed to the success of park-and-ride and LRT include provision of short-term and hand-capped parking, kiss-and-ride, bicycle storage facilities, good signage, and lighting for safety and security.

Plans include an additional 5,900 stalls on LRT extensions, which will create a total of 12,700 long term LRT park-and-ride stalls.

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