LRT Lessons That Can Be Learned from Edmonton and Calgary

J. J. BAKKER

Although Edmonton established the first light rail transit (LRT) system on the North American continent, it did not sustain momentum. Edmonton learned from cities such as Cleveland, Frankfurt am Main, and Philadelphia. In turn Calgary learned from Edmonton. Now, 14 years since the first line in Edmonton opened, it is useful to sum up the lessons. First, continue at a steady rate of development so that there is continuity in the planning and design experience. This also allows local contractors to develop expertise. Second, keep the stations simple. With a proof-of-payment fare system, stations can be simple. Avoid changes in levels for passengers, and make the stations user friendly. Third, surface lines should be introduced early. Once tunneling has started, a constituency develops that wants to build a metro system rather than the light construction really needed. Fourth, ridership should be developed by first introducing express buses, which can later be transformed into feeder bus lines to the LRT. The transfer to a higher-class mode of transportation is not a deterrent to patronage. Catering to the car with plenty of parking near the outlying stations will also help in reducing peak hour traffic congestion. In an economic downturn LRT appears to hold its passengers better than a bus system. Fifth, land development around LRT stations is not a given. It requires sound planning policies. A strong central business district and a commitment to keeping it strong will help the viability of LRT. Both Calgary and Edmonton have placed major sports facilities near their LRT lines, which helps attract off-peak passengers and reduce the parking requirements near these venues.

Edmonton and Calgary have been rival cities since the start the century. This rivalry has manifested itself in the light rail transit (LRT) developments in both cities. It is worthwhile to compare what happened in both cities and also to see whether lessons can be learned from the experience of them both. Are there better ways to achieve good LRT results? In fact, could or should LRT lines have been planned or developed differently?

EDMONTON'S LRT IN RETROSPECT

Edmonton started some rail transit planning in 1961, but real planning came about from 1973 to 1974. In 1962–1963 a study was made by Bechtel (*1*) of the feasibility of a rail rapid transit system. A downtown tunnel under 102nd Avenue was suggested with three branches at each end. All junctions were grade separated in true Bay Area Rapid Transit (BART) style. The report was received as information.

In 1968 a balanced transportation plan (*2*) was proposed that had three railway branches, one to the northeast, one to the southwest via the University of Alberta, and one to the northwest. The downtown distribution was in the form of a loop with one-way operation, in tunnel under Jasper Avenue with a single track and above ground along the Canadian National (CN) right-of-way. In the early 1970s it was finally realized that Edmonton could not afford to build freeways towards the central business district (CBD). The planning evolved from heavy rail to light rail and, some would say, back again.

Department of Civil Engineering, University of Alberta, Edmonton, Alberta, T6G 2G7, Canada.

Influence of Other Cities

Edmonton's rail transit planning was influenced by several other cities, most notably Cleveland, Frankfurt am Main, and Philadelphia.

Cleveland

A visit by the author and planners of Edmonton Transit to Cleveland in the 1960s showed that a rail transit system could be developed along a rail right-of-way and that it should serve the CBD directly and not at the perimeter.

In Edmonton the use of the northeast and northwest CN rail rights-of-way was considered as well as the use of the High Level bridge to the south along the Canadian Pacific (CP) railroad without taking the line through the CBD. The conclusion after the visit to Cleveland was that rail rights-of-way could be used but serving Edmonton's CBD from those rights-of-way was eliminated from consideration.

Frankfurt am Main

A visit to Frankfurt am Main in 1969 showed that great improvements can be made to a streetcar system if, in the CBD, the tracks are taken underground and, in the outskirts, are longitudinally separated from other traffic. Although Frankfurt was upgrading streetcar lines, the task in Edmonton was to downgrade a full rail rapid system to something similar to what was being built in Frankfurt am Main. In fact, both Frankfurt and Edmonton were converging toward the new concept of an LRT system.

Philadelphia

In the Philadelphia area, the Port Authority Transit Corporation (PATCO) system demonstrated several ways in which

a new rail system should be operated. First, stations should be monitored with closed circuit television for security; second, when the system is opened passengers should be actively assisted through the new system; and third, the system operator should assist in developing a good rule book and later provide training for supervisors and trainers of drivers.

First Line to the Northeast

Edmonton's first line to the northeast (*3*) was mainly a 3.5-mi (5.6-km) surface line within a rail right-of-way with a 1-mi (1.6-km) downtown tunnel. The original Bechtel report suggested 102nd Avenue would be a good location. Later the alignment was shifted one block south to Jasper Avenue (see Figure 1) because this location made the design of curves easier. Tunneling was chosen because Edmonton had good tunneling experience with its trunk sewer system, ideal soil conditions, and relatively low tunneling costs. The examples of Frankfurt am Main, Cologne, and other German cities also were influential. The alternative of taking a surface line though the CBD was never really considered. It was believed that the traffic capacity, which was already limited to four roads in the east-west direction, should not be reduced. This concept was developed in the late 1960s and early 1970s when Edmonton experienced economic boom conditions.

Stations in Edmonton range from elaborate to simple. The underground stations in downtown Edmonton have a mezzanine level. With a proof-of-payment fare system such a separate floor is no longer really necessary. The first two surface stations, Stadium and Coliseum, have grade-separated pedestrian entrances, with pedestrians walking under the track. The next two stations are simpler. Belvedere passengers cross the track at grade, and at Clareview passengers walk from the end of platform to either bus or car park. The busiest stations are Belvedere (15 percent of total boardings), Clareview (16 percent) and Central (18 percent) (see Figure 2). Clearly a simple layout is not an obstacle to handling high volumes of passengers.

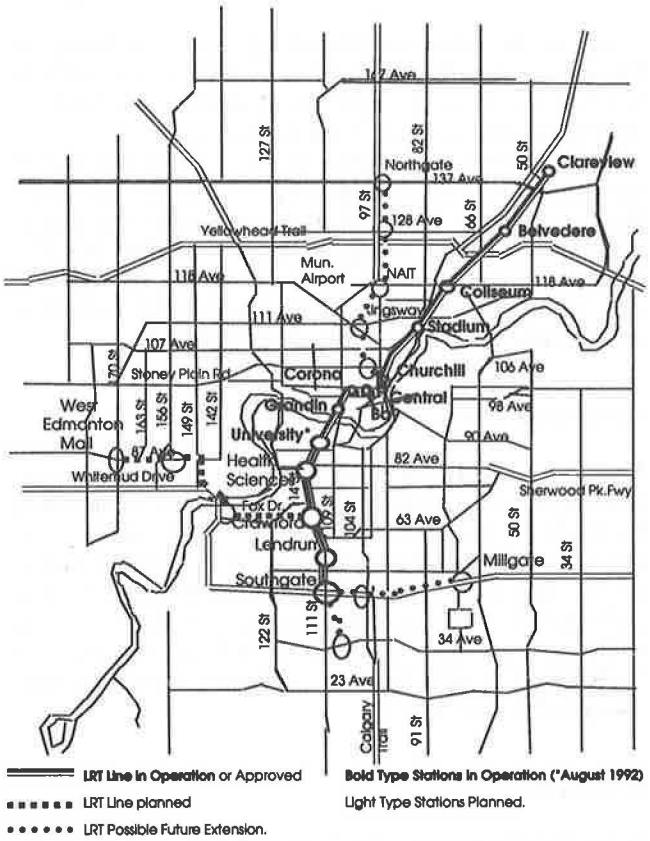
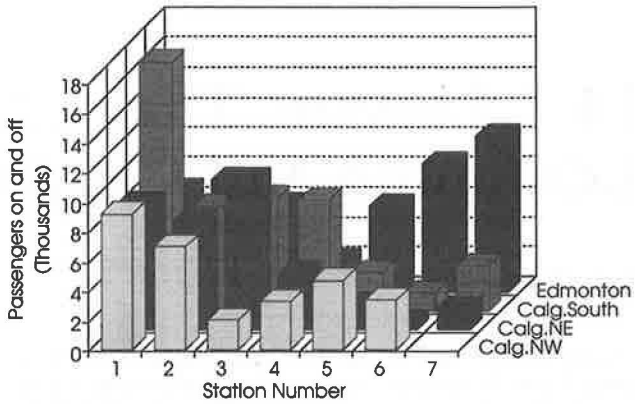


FIGURE 1 Edmonton L.R.T. Line.



Station #	1	2	3	4	5	6	7
Edmonton	Clareview	Belvedere	Coliseum	Stadium	Churchill	Central	West of Central
Calgary							
South	Anderson	Southland	Heritage	Chinook	39th Ave	Erlton	Stampede
Northeast	Whitehorn	Rundle	Marlbor.	Franklin	Barlow	Zoo	Bridgel
Northwest		Brentwood	University	Banff Tr	Lion Pk	SAIT	Sunnyside

FIGURE 2 Edmonton and Calgary station use.

The first portion of the line was built within budget and opened ahead of schedule. It was considered a success and stimulated many other cities of medium size to consider LRT as an alternative transportation option.

Lessons from the Period After Stage 1

Edmonton lost its momentum in LRT construction almost before the opening of the northeast line in April 1978. The small project team dispersed. The project manager went to Portland, Oregon, where his expertise was used and where LRT momentum continued. Meanwhile in Edmonton changes in management and planners resulted in a series of delays. Extensions were built underground downtown (to Corona by 1983 and to Grandin Station by 1989) and a surface extension was built northeast to Clareview (1980). Before taking LRT construction south, Edmonton built a major maintenance facility and bought additional cars to fill the facility even though the actual extension to the south was delayed.

The South LRT

Controversy developed over where to locate the south LRT line (*4*). LRT in Edmonton remained underground and tended

to be too much like a heavy rail system. To speed up service implementation, it was proposed that the line from Grandin Station to the new LRT bridge and from the bridge to the university be single-tracked. These proposed cost savings were never implemented. The LRT bridge, with a pedestrian bridge underneath it, is a very attractive-looking structure.

The University Station is 75 ft (23 m) below the surface, one of the deepest excavated stations. Normally it would be expected that such a deep station would be mined using the sequential excavation method (SEM) with sloping access from the surface. But local experience has been to use cover-and-cut with tangent piles. Three other factors played a role in the choice of excavation method: politics, the Kings Cross Underground Station fire in London, and the 1985 Alberta building code. Because of the slowdown in the economy it was politically desirable to have more but smaller contracts. SEM would have required one contractor. After the Kings Cross fire, the 1985 Alberta building code was applied to the University Station, particularly in regard to the stair width needed in case of fire. The station was designed for an occupancy of 1,000. This translates into a required exit width of 16.6 units based on 60 persons per exit width of 1 ft 7 in. (550 mm).

After the cover-and-cut-type of construction was chosen, tangent piles were driven, forming a wall around the station. This box was then covered with precast-prestressed concrete highway bridge beams, giving a clear span of 60 ft (18.2 m). The first concourse level is 13 ft (4 m) down. From there escalators carry passengers to another intermediate level 21 ft (6.5 m) below the concourse. Passengers then have to walk to a second set of escalators to get to the platform level another 18 ft (5.5 m) down. The layout of the staggered escalators is like that in a department store. An elevator and two sets of emergency stairs provide alternatives to the escalators. No allowance was made for the emergency exit of people through the rail tunnels.

Although the author is not aware of any other station with so much opportunity to exit in case of emergency, the layout of the escalators is such that it raises the suspicion that the designers hated passengers and wanted to make it as difficult to enter and leave the station as possible. Yet the University Station is likely to be the busiest station in the system.

During construction of the station, the bus terminal on 89th Avenue was temporarily moved about four blocks to southwest of 87th Avenue and 114th Street. The university administration then proposed that the bus station remain there. Such a move would have made transfers from bus to LRT even more difficult. Faculty, staff, and students blocked this proposal, which seemed to show a certain lack of concern by the university administration for transportation to and from their institution.

Neighborhoods south of the university want to keep the LRT underground. The city insists that the system be above ground because of costs. In fact the financing is not available to continue construction of an underground metro system. From the University Station the plan was to go south and up at a 4.5 percent grade with an intermediate underground station at the University Hospital. Then the line was to go under University Avenue and surface on 114th Street. This plan is now under review. The provincial government has cut funding to the cities by 40 percent, and any further extensions of LRT are in doubt unless other sources of funds are found or the provincial government changes. Along 114th Street, the proposal is to locate LRT on the west side with an at-grade crossing at 72nd Avenue.

Edmonton is now trying to reorient to a true LRT system with the extensions from the University to Southgate and West Edmonton. The reorientation is one that is needed politically, in planning, in management, and in operations.

Financing, Costs, and Ridership

The overall financing philosophy of the city of Edmonton has limited the pace of the extensions. Edmonton wants to maximize the use of provincial contributions and minimize its municipal debt. One result was hardly any parking lots were provided along the northeast line. Another result was when the LRT extension south was delayed; a major maintenance facility was built and filled instead. The fleet of Edmonton's light rail vehicles (LRVs) is now 37, although only 21 are needed before service is extended to the university.

The provincial funding for Edmonton and Calgary initially was a capital grant of $7.5 million (Canadian) per year for 6 years. The grant was to be spent on transit, although money could have been placed in a bank to accumulate interest. Interest earnings also were to be spent on transit. The province exercised no planning or design control. Financial accountability was at the end of the year.

Later the capital grant formula was changed to 75 percent/25 percent split between the province and the city with an annual limit. Provincial project approval was also required. Edmonton spent $350.5 million for 12.7 km of LRT line (see Table 1). The provincial government paid $274.9 million or 78 percent. The cost per kilometer was $27.6 million.

Edmonton has discovered that underground stations are not necessarily cheap to maintain. The downtown underground stations all used the same construction with tangent piles on the side, covered with precast concrete beams, which in turn were covered with a membrane, insulation, and a concrete roadway cover. In March 1992 it became clear that this construction causes excessive leaking during and after rainstorms. Making the roofs of four stations waterproof with proper drainage will cost an additional $12 million over the next few years.

Ridership in Edmonton is shown in Figure 3. Ridership was affected by the recession of 1982. Edmonton developed its ridership prior to LRT with express buses running near future LRT stations were to be. These routes then were converted to feeder bus routes to the operational LRT. The transfer to a higher quality transit mode proved not to be a deterrent to ridership. LRT in Edmonton is primarily bus fed. Table 2 shows the number of buses feeding LRT. The LRT northeast line resulted in a faster trip to the CBD even though Edmonton Transit kept its operating speed fairly low (initially 60 km/hr maximum, now 72 km/hr, although the equipment is designed for 80 km/hr).

Land Development

Rail transit is often considered a tool for promoting land development. In Edmonton the results have been disappoint-

TABLE 1 Cost Comparison: Edmonton and Calgary

Line Segment	Length (km)	Construction Period	Cost[a] ($ Millions) Total	Provincial	Comments
Edmonton					
Central-Belvedere	7.2	1974–1978	65	45	Incl. 14 LRVs
Belvedere-Clareview	2.2	1978–1980	9	6.8	Incl. 3 LRVs
Central-Corona	0.9	1981–1983	96	82.0	Incl. 20 LRVs
Storage and Maintenance		1981–1983	30	27.9	
Corona-Grandin	0.8	1987–1989	61	45.8	Single track
Grandin-University	1.6	1989–1992	89.5[b]	67.4[b]	Incl. second track
Total	12.7		350.5	274.9	78 percent provincial
Calgary					
South LRT					
Mall & South Line	12.5	1977–1981	174.4	61.9	Incl. 27 LRVs
Track rehabilitation		1985–[c]	5.3	3.9	
Southland Crossover		1985–1988	0.8	0.6	
South LRT ext. study		1982–1984	0.9	0.9	
Southeast ext. study		1985–1986	0.1	0.07	
Northeast LRT	10.0	1982–1985	157.7	72.7	
Northwest LRT to University	5.6	1985–1987	101.1	76.1	
Northwest LRT University Brentwood	0.7	1988–1990	29.2	24.0	
56 LRVs		1984–1985	64.1	61.5	
LRV maint. & rebuilt		1986–[c]	3.3	2.5	
Total	28.8		536.9	304	57 percent provincial

[a]Average cost per km is Edmonton, $27.6 million; Calgary, $18.6 million.
[b]Budget.
[c]Ongoing.

ing. At Clareview the station is surrounded by pasture land because the New Town development did not occur, primarily because of a surplus of retail space in Edmonton as a result of the construction of West Edmonton Mall and the 1982 recession. Clareview Station has, however, excellent park-and-ride facilities.

At Belvedere, land southeast of the station that was owned by the city, which decided to locate an equipment maintenance facility for the engineering department on this site. Because the soil conditions were poor, a park-and-ride lot would have been a better and more economic alternative.

Near the Coliseum and Stadium stations some possibilities for redevelopment still exist, but nothing major has occurred. However, the Coliseum, the Northlands Exhibition Grounds, and the Commonwealth Stadium attract off-peak passengers to the LRT.

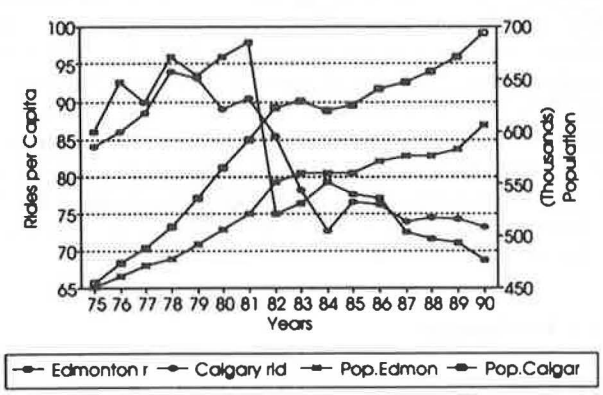


FIGURE 3 Comparison of rides per capita and population in Edmonton and Calgary.

In the CBD many redevelopments have taken place. At first sight, a map showing developments since the decision was made to proceed with LRT looks impressive. Yet very few of these developments are directly because of LRT. One major redevelopment that was because of LRT was Canada Place, an office complex for federal government offices just east of Churchill Station. In the CBD an extensive pedway system has evolved linking such major developments as the Convention Centre, Canada Place, and the Citadel Theater with Churchill Station. Edmonton Centre was also connected with a pedway to Churchill Station in 1991. Unfortunately the signing in these interconnecting pedways is almost nonexistent.

The Central and Bay stations are connected to adjacent developments. The Grandin Station is connected via tunnels to the Legislature Building and other provincial government buildings. The walks, however, are long.

The University Station is connected to the university by an overhead pedestrian system at the east end of the station. At the west end the station initially will not interconnect with the university buildings. However, the design allows for future connections.

In general it can be said that Edmonton should have had stronger policies promoting development next to the LRT stations. In several cases proposals were so poorly dealt with at the bureaucratic level that nothing happened.

Future Extensions in Edmonton

Edmonton has committed itself to an LRT extension from the university as far as Southgate. The holdup is funding and a difference of philosophy between the provincial govern-

TABLE 2 Bus-LRT Connections

Edmonton			Calgary		
	Buses/Hour			Buses/Hour	
Station	Midday	Peak	Station	Midday	Peak
			South		
Clareview	12	44	Anderson	25.5	45
Belvedere	18	46	Southland	13.22	26
Coliseum	24	50	Heritage	19.5	43
Stadium	10	20	Chinook	13.1	29
University	35	74	39 Avenue	1.5	3.9
Total Edmonton			Erlton	2	2
Before University opening	64	160	Total	74.8	148.9
After University opening	99	234	Northeast		
			Whitehorn	14.6	35.5
			Rundle	8	18
			Marlborough	17.3	32.6
			Franklin	2.4	4
			Barlow	5.9	14
			Zoo	0	0
			Bridgeland	0	0
			Total	45.8	100.1
			Northwest		
			Brentwood	31	57
			University	0	
			Banff Trail	0	0
			Lions Park	19.5	25.5
			SAIT/Jubilee	0	0
			Sunnyside	3	3
			Total	53.5	85.5

NOTES: Edmonton uses clock-headways on all routes, giving integer numbers in buses per hour.
Calgary uses nonclock-headways on some bus routes, giving non-integer numbers in buses per hour.
Both Edmonton and Calgary use an LRT headway of 10 min midday and 5 min in the peak hour.
SOURCES: Edmonton Transit and Calgary Transit maps

ment, which wants to see road construction, and the city, which wants to extend the LRT. An extension to Southgate would save 18 buses per hour north of Crawford Station and a further 36 buses per hour north of Southgate Station. The extension to Southgate would be built in two stages. The staging would limit the size of contracts and the rate of funding.

Stage 1 would extend LRT service from the university to the Crawford Centre (113th Street and about 68th Avenue), a distance of about 2.3 km. Two intermediate stations would be built at the University Hospital and at 76th Avenue and 114th Street. No additional LRVs would be required. Stage 2 would extend LRT service from Crawford Centre to Southgate, a distance of about 2 km, with probably one intermediate station at Lendrum (111th Street and 57th Avenue).

Edmonton is also doing preliminary planning on an extension to West Edmonton Mall. From Southgate LRT would go further south to Kaskitayo, intercepting 22 buses per hour, or east to Millgate Transit Centre, where it would intercept 40 buses per hour in the peak period, or both. To the north a line is being considered from Churchill Station via NAIT to Northgate. These extensions are not being planned in detail.

CALGARY'S LRT IN RETROSPECT

Calgary followed the lead of Edmonton, then deviated briefly, and finally improved on Edmonton's LRT. Calgary also started with a grade-separated rapid rail transit proposal (*5*). The 1966 proposal recommended a south and north line converging on a CBD distributor and splitting again in northwest and southwest lines. In addition, a northeast-CBD-west express bus system was proposed. The plan was viewed as something to consider in the future.

A "balanced transportation concept" for Calgary was proposed in 1973 that called for the planning of a rapid transit system to commence. Although no particular system was recommended, the concept implied that the system should be computer operated and respond to travel demand. The concept had similarities to a Denver proposal. The idea of an on-demand computer-controlled system was dropped because technology was not that advanced yet. In the meantime, Calgary implemented an expanded express bus system supplemented with some dial-a-ride services in addition to the regular bus system.

In 1977 Calgary chose an LRT alternative (3 years after Edmonton) rather than an exclusive busway system for South Calgary (*6*). The reasons given were that LRT is reliable, uses a proven technology, has a high level of service, has low labor use, has a low environmental impact, and would be effective in guiding land use. It was also stated that LRT would improve the mobility of the handicapped and the elderly; however, when constructed the south line was not made accessible. Notwithstanding the reasons given, the real reason LRT was chosen was that Edmonton had started building an LRT and Calgary could not stay behind its rival city to the north. In addition the capital grants from the province as

formulated for Edmonton were also available to Calgary. Because Calgary was not ready for LRT when this provincial financing program began, the city invested first in a new bus storage and maintenance facility (along 32rd Avenue N.E.).

However, once Calgary began its LRT program, it learned from the experiences of Edmonton. Calgary was also helped by nature in that its soil conditions do not permit easy tunneling. Hence, Calgary stayed above ground, wherever possible, particularly downtown.

Stage 1 to the South

Calgary started its LRT program by building a maintenance facility (near Anderson Station) and buying LRVs.

Like Edmonton, Calgary built its first line along a rail right-of-way. With the exception of one station, the south line has costly, elaborate stations that are awkward for passengers. The line is located in a tunnel under a cemetery mainly because the transportation department wanted to widen McLeod Trail (which cuts through the cemetery) at the same time (see Figure 4). Calgary also used concrete ties that give better gauge control and track stability. There were, however, some cracking problems with the grouting pads used with track on concrete base. Also, because of a design error, a bridge toppled. Fortunately all parties were insured with the same insurance company so litigation was avoided. In operations Calgary's LRT has from the beginning operated at a higher speed than Edmonton's, saving passengers significant travel time. One of the distinct features of the Calgary south line, completed in 1981, is the extensive availability of parking lots.

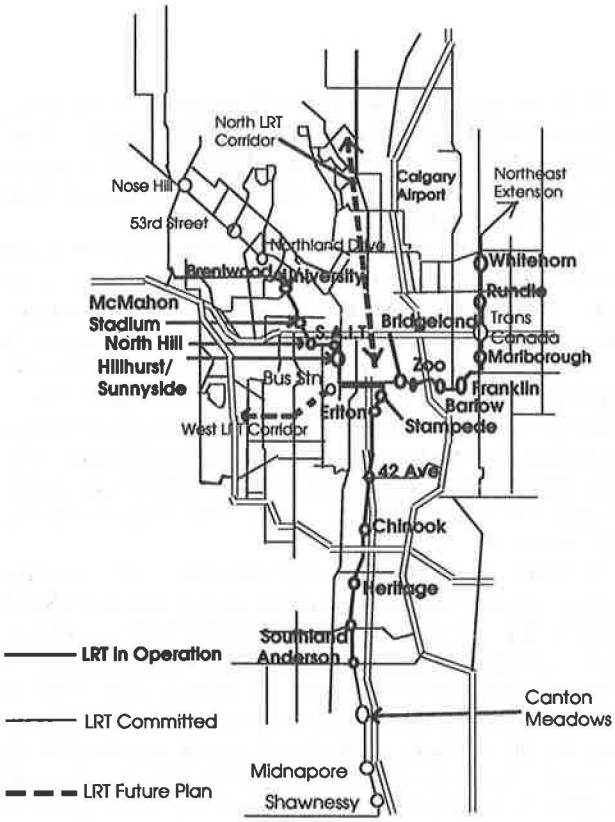


FIGURE 4 Calgary's L.R.T. System.

Downtown Transit Mall

Although Calgary has more east-west avenues, each avenue is narrower than Edmonton's four east-west routes. Calgary could therefore dedicate one avenue as a surface transit mall. Both elevated and subway alternatives were also examined. The at-grade route along Seventh Avenue was finally chosen because of its low cost, minimum disruption during construction, and low impact on pedestrians. The possibility of later constructing a subway under Eighth Avenue remains an option.

The transit mall was completed in 1981. The only problem seems to be the high-level platforms do not have enough capacity in the peak hours. Otherwise the system has been working satisfactorily.

Stage 2 Became Stage 3

Calgary wanted to extend the LRT to the northwest, an extension made more important by the winter Olympics that were awarded to Calgary in 1981 for 1988. Some of the communities adjacent to the city's center objected, however, so Calgary continued construction first to the northeast instead.

Northeast Line

The northeast line is a real LRT line, except for its stations. Along 36th Street N.E. residential development is east of the road and commercial/wholesale development is on the west. Some valuable location lessons could be learned from the northeast line regarding median versus side location; station complexity versus simplicity, and land use and LRT. The LRT line was placed in the median although an eastside location could have kept the station access at grade and would have greatly simplified the design. Stations have to be reached by overhead walkways, which present an obstacle to passengers.

Northwest Line

What is noticeable about the northwest line is the sensitivity in construction, the efforts at landscaping and the simplification in stations. The neighborhoods adjacent to Calgary's downtown did not like the Ninth Street N.W. route proposed for the LRT line. Either 10th Street N.W. or 14th Street N.W. was considered to be less intrusive. Although the city insisted on the Ninth Street N.W. location, more landscaping was used to minimize the intrusion. As in Edmonton, the university was not a willing transit partner. The line is at the perimeter, which is good for further extensions, but not for university patronage. But at least the university is being served—5 years ahead of Edmonton's.

Financing, Costs, and Ridership

Calgary was prepared to go into debt to speed up and continue LRT construction. The city spent $536.9 million for 28.8 km of LRT line, of which the provincial government paid $303.97 million or 57 percent. The cost per kilometer in Calgary was $18.6 million.

LRT was completed to the northwest in time for the Winter Olympics. Calgary has a far more extensive and true LRT system than Edmonton, and this shows in the ridership figures—Calgary's ridership is more than four times that of Edmonton's (see Figure 3). Like Edmonton, Calgary developed its initial ridership by operating express buses from future LRT station locations and converting these lines to feeder routes (see Table 2). Calgary does not always use clock-headways, which is not a problem when connecting to a frequent LRT service, but it does not allow for good bus-to-bus connections. Clock-headways are also easier to remember, particularly if the service is infrequent.

Land Development

The city of Calgary has had stronger land use policies than Edmonton. Calgary did not permit a development like West Edmonton Mall and was able to strengthen its CBD. Calgary also developed a "15+" pedestrian concept that provides a grade-separated pedestrian level connecting various buildings at a height of 15 ft (4.6 m).

Like Edmonton, Calgary has not attracted much development near its outlying LRT stations. One reason could be that the land close to the stations is occupied by park-and-ride lots.

Future Extensions in Calgary

Calgary has plans for several extensions.

Two extensions are proposed for the northwest line:

- Brentwood (31st Street N.W.) to Dalhousie (53rd Street N.W.)—This extension would be 1.9 mi (3.0 km) long and would require seven LRVs.
- Dalhousie to Nose Hill Drive (85th Street N.W.)—This extension would be 2.5 mi (4.0 km) long and would also require seven LRVs. Major park-and-ride facilities are planned.

Two extensions are also proposed for the south line:

- Anderson to Midnapore Station (146th Avenue S.)—This extension would be 2.2 mi (3.6 km) long with one intermediate station at Canyon Meadows. Again seven additional LRVs would be required as well as an extension to the LRV storage facilities.
- From Midnapore the options are to go southwest and southeast—These extensions are in a preliminary stage only.

The proposed northeast extension would leave 36th Street N.E. and go more directly through the residential area. There is no proposal to link this line to the Calgary airport (about 4.5 km or 3 mi).

The proposed west extension may only go as far as the bus station, which is just west of the CBD.

RIDERSHIP IN EDMONTON AND CALGARY

The populations of Edmonton and Calgary are, roughly speaking, the same size. Edmonton's city population is slightly less, but its metropolitan population is greater because the metro area includes the populations of the two independent municipalities of St. Albert and Sherwood Park. Revenue passengers are also similar in volume. In rides per capita, that is revenue passengers per capita in 1 year, Calgary's figure is slightly less than Edmonton's. Both cities suffered from the 1982 economic recession. The change from almost full employment to 15 percent unemployment meant also about a 15 percent reduction in transit use. In addition, Edmonton had a transit strike for 6 weeks, which further prompted passengers to find alternative transportation. Both systems added to the reduction in passengers by drastically reducing bus services and increasing fares.

The most noticeable aspect of transit use is that LRT patronage either remained stable or continued to increase, whereas bus patronage continued to decline. Because Calgary has more LRT lines it also has more revenue passengers. In both systems LRT relies on feeder buses, and so the number of boardings (and transfers) has also increased. In Edmonton the feeder buses have kept their riders, although the rest of the system suffered a greater decline. Calgary, however, has more park-and-ride facilities, which reduces the need for more feeder services.

It should also be noted that all lines in Edmonton and Calgary attract most passengers at the outlying stations (see Figure 2). The inner stations attract fewer passengers, which may be because of the flat fare system as well as a resistance to transferring from bus to LRT close to the destination. Also note that the free fare zone in downtown Calgary attracts 20,000 passengers per day. Edmonton allows free travel downtown midday between 9 a.m. and 3 p.m.

THE LESSONS

What are the real lessons to be learned from the Edmonton and Calgary LRT experiences?

Continue momentum even if it means going into debt. It is very hard to start up again after a time lapse.

Continuity means that the project team and the local contractors keep developing their expertise.

Keep stations simple and user friendly. Both Edmonton and Calgary have user-unfriendly stations that could have been designed to be less elaborate at lower cost, and without up or down stairs.

Introduce surface lines early. Once tunneling begins a constituency of politicians (prestige), consultants, and contractors develops that will push for a real metro system. A surface LRT, however, has better two-way visibility between potential customers and businesses. The average cost per kilometer

in Calgary is two-thirds that of Edmonton (see Table 1) because Edmonton chose to tunnel.

Calgary is therefore a good example of LRT. Once Edmonton has developed its surface lines to Southgate and West Edmonton Mall, it also will have a real LRT system.

Land development is not automatic when rail transit is introduced. Land development or redevelopment will only occur if strong planning policies are in place and if these policies are adhered to. Both Edmonton and Calgary have located major sports facilities close to their LRT lines, fueling off-peak ridership and reducing parking requirements near the sporting facilities. However, a strong CBD will make an LRT line more successful. A mega-mall detracts from a CBD.

Ridership should first be developed by introducing express buses, which can later be transformed into feeder bus lines to the LRT. The transfer to a higher class mode is not a deterrent. Catering to the car with plenty of parking near the outlying stations will also help reduce peak hour traffic congestion.

In an economic downturn LRT appears to hold its passengers better than a bus system.

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