Application of Light-Rail Transit Flexibility: Dallas Area Rapid Transit Experience

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The planning, design, and construction of a light-rail transit (LRT) line require that a wide range of complex issues be resolved. Although no one mode of transit can serve as the best alternative for every corridor, light rail has significant advantages in many applications. A unique feature of LRT is its flexibility, versatility, and ability to develop incrementally. It can be adapted to a wide variety of geographic and topographic conditions, financial capabilities, rights-of-way, and existing infrastructure. In addition, this flexibility can have a direct impact on the design of light-rail stations and the vehicle to be operated on the system. The Dallas Area Rapid Transit (DART) initial three line operating environments are described. DART's application and implementation of LRT technology in a variety of complex operating environments are summarized, and the paper concludes with a status report on the light-rail starter system construction program. Almost every segment of the 32.2-km (20-mi), 21-station starter system presents a different situation, ranging from on-street to grade-separated conditions. The starter system includes a new Trinity River Bridge, grade separations, aerial alignments, a subway, a central business district mall, joint use of a utility corridor, median running, and standard railroad environments. This flexibility has also been incorporated into the specifications for the light-rail vehicles and the stations that will be served. Revenue service is expected to begin in June 1996.

The planning, design, and construction of a light-rail transit (LRT) line require that a wide range of complex issues be resolved. Although it is recognized that no one mode of transit can serve as the best alternative for every corridor, light rail has significant advantages in many applications. A unique feature of LRT is its flexibility, versatility, and ability to develop incrementally. It can be adapted to a wide variety of geographic and topographic conditions, financial capabilities, rights-of-way, and existing infrastructure. Moreover, light rail can be developed incrementally; it can be expanded as demand and the ability to pay for it increase. This incremental feature of light rail is especially important in view of changing public-sector financial abilities. Finally, LRT in many cases is less costly than rapid transit. It does not have the overall high performance and capacity requirements of conventional rapid transit; consequently, construction and operating costs are lower. This lower cost makes LRT economically justifiable in urban areas where conventional rapid transit is not feasible because of cost or demand factors. In addition, this flexibility can have a direct impact on the design of light-rail stations and the vehicle to be operated on the system.

Although most LRT systems are, in fact, much less costly than rapid transit to construct, the Dallas Area

Rapid Transit (DART) did not find this to be true with its starter system. At approximately $26 million per kilometer ($42 million per mile), the DART system incorporates features not normally associated with LRT, a direct result of selecting alignments that required a wide variety of applications for their ability to address the many challenges that were presented.

DART has incorporated this flexibility into the design and construction of its LRT system. Summarized here are DART's application and implementation of LRT technology in a variety of complex operating environments, concluding with a status report on the light-rail starter system construction program. Almost every section of the 32.2-km (20-mi), 21-station starter system presents a different situation, ranging from on-street to grade-separated conditions. The starter system includes a new Trinity River Bridge, grade separations, aerial alignments, a subway, a central business district (CBD) mall, joint use of a utility corridor, median running, and standard railroad environments. This flexibility has also been incorporated into the specifications for the light-rail vehicles (LRVs) and the stations that will be served.

Background

The DART Board of Directors approved the Transit System Plan on June 27, 1989. The 1989 Transit System Plan was a major revision of DART's original plan adopted in 1983. The 1989 Transit System Plan recommended 106.3 km (66 mi) of LRT and 29 km (18 mi) of commuter-rail service and that an LRT starter system be constructed to serve CBD-oriented, medium-to-long work trips during the peak commute periods. The DART Board of Directors recently approved an update to the 1989 Transit System Plan. The revised plan will result in a total of 85.3 km (53 mi) of LRT and 59.6 km (37 mi) of commuter rail by 2010.

DART maintains and operates a fleet of 1,000 vehicles including buses and paratransit vans for mobility-impaired customers. Every weekday, up to 160,000 passengers board buses to reach destinations throughout the 1,813-km^2 (700-mi^2) service area. With the introduction of rail service, the bus system will be reoriented to provide fast, convenient service to new rail stations and transit centers.

Like many cities, Dallas has a number of railroad alignments leading to the downtown that parallel many of the commuter corridors of the city. Although many of these tracks are still in use by the railroads, this rail network has served as a reasonable starting point on which to plan the light-rail system. As a result of system planning, DART purchased approximately 219 km (136 mi) of right-of-way varying in width from 9.15 to 91.5 m (30 to 300 ft) during the period April 1988 through February 1992. Even with this aggressive purchasing program, DART has been unable to acquire all the necessary right-of-way from rail operators to make a continuous system. As a result, DART has selected various light-rail applications for implementation that will fill in the gaps and make the necessary connections to complete the system.

LRT Project Overview

The LRT starter system now under construction consists of approximately 32.2 km (20 mi) of radially oriented LRT lines connecting the Dallas CBD with north and south activity areas (Figure 1). The three lines are divided into five LRT corridors: North Central (NC), Central Business District (CBD), Oak Cliff (OC), South Oak Cliff (SOC), and West Oak Cliff (WOC). Provisions for future system expansion (funded from the build-out budget) are included for the Garland, Richardson, and Pleasant Grove connectors, as well as the Service and Inspection Facility. The LRT starter system project also includes the design and construction of three bus transit centers as part of the following: Illinois Station on line section SOC-1; Hampton Station on line section WOC-2; and Ledbetter Station on line section SOC-2.

Opening day ridership for the first 19.3 km (12 mi) and 14 stations opening in June 1996 is expected to be approximately 15,000 revenue passengers. When all of the starter system stations are open by May 1997, ridership is expected to be approximately 33,000 per day. (The CityPlace Station is expected to open in January 1999.)

Commuter-Rail Project Overview

DART's LRT project gets most of the attention, but another rail project now being developed by DART and the Fort Worth Transportation Authority (The T) is under construction. As planned, two-to four-car trains will operate peak-period service between Dallas and Irving. The service will eventually extend to Dallas-Fort Worth (D/FW) International Airport and Fort Worth. The DART Board approved the purchase of 13 rail diesel cars (RDCs) from VIA Rail Canada. The cars are being remanufactured for use on the DART commuter-rail system. They are scheduled to arrive in Dallas for testing in the fall of 1995. Each car will have the capacity to carry 96 seated passengers. Opening day ridership is expected to be approximately 1,000.

The commuter-rail project is segmented into three phases, with hours of service and capacity expected to increase as each phase is completed. Phase 1 of the

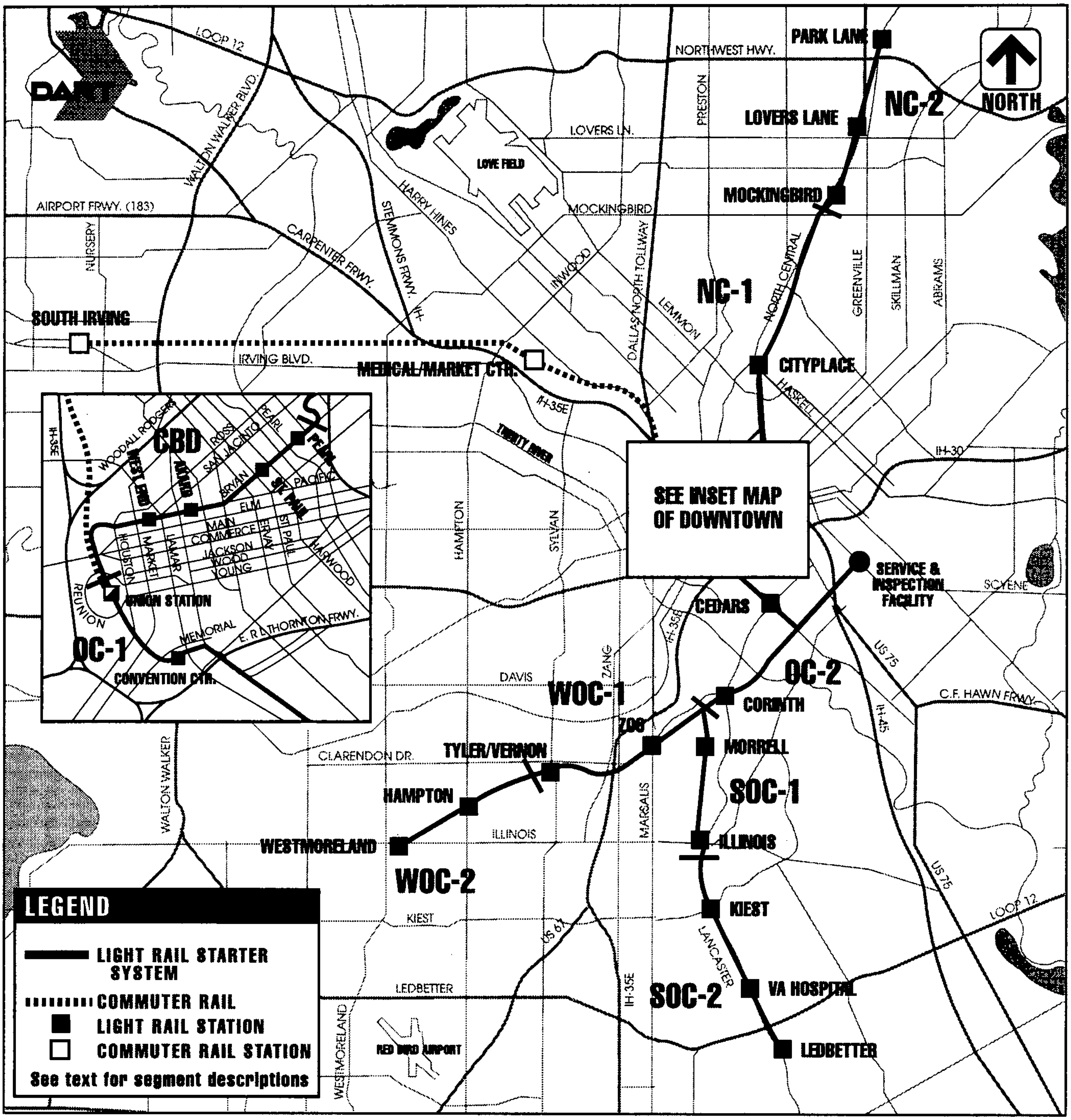

FIGURE 1 DART light-rail and commuter-rail starter system.

commuter-rail system consists of 16.1 km (10 mi) of passenger service between Dallas and Irving connecting three stations: Union Station in downtown Dallas, Medical Center/Dallas Market Center, and the existing South Irving Transit Center (Figure 1). Future phases will extend service to Fort Worth in several subphases, to D/FW International Airport, and possibly to the Dallas Convention Center. An equipment maintenance facility, including storage tracks, will be located in Irving and will be partially funded by The T.

The light-rail and commuter-rail systems have been planned to complement each other by sharing a passenger stop at Union Station, which will allow passengers to transfer between the two rail networks or use a bus to travel to a downtown destination. Union Station will become a true multimodal station, serving buses and three types of rail systems (LRT, commuter-rail service, and Amtrak).

DART ALIGNMENT AND APPLICATION

Special Attributes of LRT

LRT has a number of special attributes that have a direct influence on the planning and design of this particular mode. LRT is extremely flexible in its geometry and therefore may have many route options. LRVs can negotiate much sharper curves and steeper grades than heavy-rail rapid transit and can utilize a wide variety of rights-of-way.

Light-rail service can efficiently utilize many kinds of right-of-way, depending on cost, availability, and condition. Circumstances will dictate which type, or what combination, should be applied to a given corridor or route. The seven rights-of-way used in Dallas are

- Center street, with as much transit priority as is feasible;
- Park strip, median, or boulevard (similar to the first type but exclusive and with crossing safety features);
- Jointly used light-density railroad trackage;
- Power line;
- Aerial structures at highway, railroad, or river crossings, with private right-of-way between crossings;
- Subway, or below-grade; and
- Abandoned railroad corridor.

The vertical alignment of a light-rail system is perhaps the single most important issue in that it largely determines the cost of the project. An at-grade line is considerably less expensive to build but may lower operating efficiency and increase traffic conflicts. Although LRT is somewhat suited for mixed traffic operations, operations over long routes must have priority over automobile traffic in order to avoid slow run times, unreliable schedules, and consequently poor operational performance. Underground and elevated alignments, on the other hand, raise costs significantly and fail to capitalize on the flexibility of LRT technology. If the LRT line is completely grade separated, it duplicates a typical rapid transit heavy-rail system and the cost may exceed the benefits.

Early in the planning process DART identified, defined, and tested the many available route options to permit selection of an optimum route. The testing to prove or disprove the functional viability of each route was conducted to ensure that the selected alternative was the best available. The results of the testing led DART to consider and develop a variety of route applications in its light-rail system.

A discussion of DART's starter system alignment and the variety of light-rail applications follows.

North Central Line

The North Central line extends northward 10.8 km (6.7 mi) from Routh Street in the CBD, roughly paralleling the North Central Expressway, to Park Lane. The North Central Expressway (US–75) is a major suburban city–central city commuter route. Revenue service is projected for December 1996. The North Central line contains two line sections.

The NC-1 line section extends 5.6 km (3.5 mi) from Routh Street in the CBD transit mall through a double tunnel under the North Central Expressway to Mockingbird Lane. The alignment enters a portal at Ross Avenue and remains grade separated in a cut-and-cover configuration under the North Central Expressway frontage road to Woodall Rodgers Freeway. North of the Woodall Rodgers Freeway, the alignment enters a 4.8-km (3-mi) tunnel and exits through a portal north of Mockingbird Lane. There will be one underground station at CityPlace (a joint development venture of CityPlace Corporation and DART), located between Lemmon and Haskell avenues.

Upon surfacing north of Mockingbird Lane, the NC-2 line section follows the former Southern Pacific right-of-way purchased by DART in 1988. The alignment continues northward approximately 4 km (2.5 mi) along the DART right-of-way to Park Lane. North of Mockingbird the right-of-way is at grade with aerial crossings at Lovers Lane. An 8200-m (2,500-ft) aerial alignment is used from Southwestern to Caruth Haven. The aerial alignment returns to grade before it rises again to cross Northwest Highway. Aerial crossings were selected to avoid interfering with the high traffic volumes (in the range of 30,000 per day) and the relatively short distance available between the North Central Expressway frontage roads and Greenville Avenue with an operating rail right-of-way in between, resulting in a short queue length. Stations are located at Mockingbird Lane (750 parking spaces and four bus bays), Lovers Lane (no parking and two bus bays), and Park Lane (532 parking spaces, plus temporary leased parking until the line is extended, and eight bus bays). The alignment ends on the south side of Park Lane at a temporary at-grade station; however, a new station will be built on the north side in conjunction with the extension of the North Central line over Park Lane.

North Central Tunnel

In the early planning stages for this corridor, various alternative alignments were under consideration. Use of a nearby railroad right-of-way was eliminated early because of neighborhood opposition. The Dallas City Council passed a resolution that removed any chance of using the rail right-of-way. This action was significant because DART's enabling legislation requires the approval by a city of any alignment through that city. Therefore, the 1989 Transit System Plan reflected an undefined configuration within the North Central Expressway right-of-way. When planning and design began on the reconstruction of the expressway by the Texas Department of Transportation (TxDOT), several alternatives were evaluated. An aerial alignment in the median of the expressway was considered briefly but discarded because of neighborhood opposition on the grounds of neighborhood intrusion. At grade in the median was not selected because of wider right-of-way requirements for the roadway project and high cost and impact.

After further planning and analysis, twin-bore tunnels were selected in conjunction with fewer freeway lanes as the preferred alternative. Later, it was changed to cut and cover under the frontage roads because of the perceived high cost of deep-bore tunnels. DART became increasingly concerned about the uncertain schedule for the freeway reconstruction, which would have resulted in unacceptable delays and cost increases. At the same time, TxDOT was having great success in boring a large drainage tunnel below the expressway. The area geology consists of Austin Chalk (limestone), which is very conducive to deep-bore tunneling. After additional analysis and cost estimates for the cut-and-cover options, the decision was reversed to the deep-bore twin tunnels beneath the roadway based in part on the success of TxDOT and new cost data.

With a 290-Mg (320-ton) boring machine, work started on the 4.8-km (3-mi) twin tunnels at Mockingbird Lane on the northern end of the southbound tunnel on November 4, 1992. Delays were encountered caused by pockets of petroleum products and methane gas. The southbound bore was completed on August 17, 1993. Tunneling work was then started on the northbound tunnel, which was completed on January 3, 1994.

The North Central light-rail tunnels consist of two 6.5-m (21-ft 6-in.) diameter tunnels running underneath the North Central Expressway from Mockingbird Lane to the Woodall Rodgers Freeway interchange at depths varying from 12.2 to 36.6 m (40 to 120 ft), a short cut-and-cover box section under Woodall Rodgers Freeway, cross passages every 244 m (800 ft), and a number of underground rooms for mechanical and electrical equipment. There is to be one subway station—CityPlace—which will not be in service until 1999, pending final contractual discussions with the CityPlace developer. Another station midway between Mockingbird and CityPlace has been caverned out but is not budgeted for completion at this time. Work on the tunnel is scheduled to be complete by the early part of 1996. At that point, the tunnels will be turned over to DART for installation of the rail system components.

Central Business District

Early plans called for a subway through the downtown area. Because of the number of stations and related costs, plans for the subway were dropped and a surface transitway was proposed.

The CBD Mall line section extends from the NC-1 tunnel transition section near the intersection of San Jacinto Street and Routh Avenue along Bryan Street and Pacific Avenue through downtown Dallas. The CBD Mall section will serve the commercial and high-rise office complexes, Arts District, and the West End. The Mall will allow limited parallel vehicular access but no through traffic, although most cross streets remain open. Four stations are located on this section: Pearl, St. Paul, Akard, and West End. Construction of all four stations is on schedule and they are expected to open for revenue service in June 1996.

CBD Mall

The CBD Mall line section extends from the NC-1 tunnel transition section near the intersection of San Jacinto Street and Routh Avenue along Bryan Street and Pacific Avenue for a distance of 1.9 km (1.2 mi) through the West End Historic District. The transitway mall connects the north and south light-rail lines to the CBD. The mall will be pedestrian-friendly, with restricted automobile traffic, wide sidewalks, benches, trees, decorative artwork, and other features. There are four stations: Pearl, St. Paul, Akard, and West End. Each station has been designed to complement the surrounding architecture and features passenger amenities, covered waiting areas, benches, information displays, and special access facilities. In the CBD, light-rail trains will operate every 5 to 10 min. The mall is expected to stimulate the downtown economy as retail shops and restaurants open there to serve rail passengers. Interest in redevelopment has already begun around the Pearl and West End stations. The West End Historic District currently contains more than 100 restaurants, specialty shops, and nightclubs housed in turn-of-the-century warehouses. Street vendors, sidewalk cafes, and surrey rides add to the district's appeal. Recent additions include a 10-screen movie theater and Planet Hollywood. The West End Historic District mitigation plan avoids Section 110 conflicts with the John F. Kennedy Assassination National Historic District and preserves the historic nature of the district.

The CBD Mall generally requires rebuilding the existing street and sidewalk and relocation of utilities. The design includes placement of embedded double-track girder rail, installation of brick and concrete pavers, and placement of trees and lights along the street. Benches, trash receptacles, and the vehicle power system (catenary) have been designed to complement the architectural standards of the area. Local traffic and emergency access needs are included in the design. Through traffic on the affected streets is diverted to nearby streets. Most cross streets remain open, with the traffic signals coordinated with the light-rail operation. The mall begins at the intersection of Pacific Avenue and Houston Street in the West End Historic District, follows Pacific Avenue to Bryan Street, where it turns to follow Bryan Street to Hawkins Street. The line turns north on Hawkins Street to San Jacinto and then east across Routh Street to the North Central portal. Additional right-of-way is required to transition in and out of Hawkins Street. The remainder of the mall is generally within the public right-of-way. A future connection to the proposed Pleasant Grove LRT line is being constructed near the intersection of Bryan and Hawkins streets, and the future Carrollton connection will occur at the West End.

There are several parking garages and off-street loading docks along the CBD Mall that require access to and from Pacific Avenue or Bryan Street. As a result, some blocks continue to have at least one lane for vehicular access. Otherwise, only emergency traffic is accommodated along the mall. Minor streets such as Austin, Crockett, Federal, and Hawkins will be closed. Other existing streets crossing Pacific Avenue and Bryan Street will remain open.

Oak Cliff Line

The Oak Cliff line is being developed in two segments, designated OC-1 and OC-2. The OC-1 line section runs from the western end of the CBD Mall through Union Station and Convention Center to a point beyond The Cedars (Lamar) Station. The OC-2 line section includes the segment that runs from below The Cedars Station to the Yard Lead for the Service and Inspection Facility and south along the Santa Fe corridor to the junction with the West Oak Cliff and South Oak Cliff lines. Completion of the Oak Cliff line is on schedule, and revenue service is expected to begin in June 1996.

The OC-1 line section extends from Houston Street at the edge of the CBD Mall south 2.9 km (1.8 mi) past Dealey Plaza on the Triple Underpass and through the railroad Right-of-Way District behind Union Station. The alignment turns east to go under the expanded Dallas Convention Center and then turns southeast along the old City Spur of the Atchison, Topeka, and Santa Fe Railroad to cross the R. L. Thornton Freeway (I–30) on an existing Santa Fe Railroad bridge. Following the Atchison, Topeka, and Santa Fe corridor, the line joins the OC-2 line section between The Cedars Station and the Yard Lead. Stations are located at Union Station, Dallas Convention Center, and The Cedars (Lamar). The Convention Center Station will have provision for three bus bays and no parking. The Cedars Station will have no parking and three bus bays. The OC-1 alignment was selected because the City Spur was very lightly used by the Atchison, Topeka, and Santa Fe Railroad and was clear of the Right-of-Way District, which was still heavily used. Union Station was the only logical choice for a station, and the alignment could be acquired at a reasonable price and provided the needed connection with the south side of Dallas.

The 4.3-km (2.8-mi) OC-2 line section continues from east of The Cedars Station over Lamar Street to the Yard Lead, where it turns to the north to enter the Service and Inspection Facility and to the south as a new double-track aerial structure over the main lines of the Right-of-Way District and then over the Trinity River and its floodplain. After crossing the Trinity River, the line crosses Eighth Street at grade and continues to Corinth Street, which it crosses on a grade-separated structure. There is one station on this section, Corinth Station, which is located between Corinth and Eighth streets. Initially, this station will have 86 parking spaces, with the potential of expanding to approximately 500 parking spaces, and three bus bays.

Trinity River Bridge

The 1.6-km (1-mi) Trinity River Bridge is part of the 4.3-km (2.8-mi) OC-2 line section from Moore Street east of the Texas Utilities Electric (TUE) right-of-way. A new double-track aerial structure was constructed over the river and its floodplain between the levees and the main lines of the Right-of-Way District south of the CBD. The right-of-way and existing single-track bridge were purchased from the Santa Fe Railroad (along with the yard for the Service and Inspection Facility and the West Oak Cliff line) to provide a river crossing. To facilitate the sale, DART entered into agreements with the railroad to allow the displaced trains to use other DART-owned rail right-of-way and paid for connections to those lines. DART had originally considered utilizing the existing one-track bridge. This option was discarded early on because of the heavy use the corridor would receive as the trunk line of the system with frequent headways. The single-track bridge would have restricted operations below DART service standards. As a result, a new double-track bridge was approved. As it crosses the river, the alignment is entirely within the former Santa Fe Railroad except for a short 152.5-m (500-ft) section that spans a portion of the TUE easement of Trinity Park (part of the city of Dallas Greenbelt). The alignment then crosses the existing underpass at Lamar Street before returning to grade. The bridge and yard lead have been used as an on-site test track for new LRVs. The bridge was completed in July 1995.

Union Station

Two at-grade rail platforms are located at Union Station between the Reunion Boulevard bridges. The first platform (nearest to Union Station) will be used exclusively by northbound LRT passengers. The second platform will be shared by RAILTRAN commuter-rail passengers and southbound LRT passengers. Also serving the station on a third platform is Amtrak. Mainline freight traffic will be situated west of the three platforms.

West Oak Cliff Line

The West Oak Cliff corridor extends from the South Oak Cliff—Oak Cliff junction along the former Atchison, Topeka, and Santa Fe right-of-way to the Westmoreland Station, passing the Dallas Zoo en route. The right-of-way was purchased from the railroad in 1992. This corridor was considered the easiest to plan and construct within the starter system primarily because of the existing right-of-way and the high potential for ridership. Aside from a problem with contaminated soil on city-owned property at one station, this branch has encountered few difficulties. Development in the area is primarily older, single-family residential units with limited industrial activity. Completion of the West Oak Cliff line is on schedule with revenue service expected in June 1996.

The 4.0-km (2.5-mi) WOC-1 line section includes the segment between the junction of the West Oak Cliff and South Oak Cliff lines and the Dallas Zoo and Tyler/Vernon stations. The Dallas Zoo Station will serve the regional population by providing direct access to a popular destination in the area. The station has five bus bays and no parking. The Tyler/Vernon Station is located adjacent to a former industrial site. This site has a tremendous opportunity for redevelopment with direct access to the station. Like the Zoo Station, park-and-ride spaces are not provided.

The WOC-2 line section extends from Polk Street west along the Atchison, Topeka and Santa Fe right-of-way corridor 3.4 km (2.1 mi) to Westmoreland Road. Stations are located at Hampton and Westmoreland roads. The Hampton Station opened as a bus transit center in January 1995. The station has 550 parking spaces and five bus bays. The Westmoreland Station will have over 1,000 parking spaces and six bus bays.

South Oak Cliff Line

The South Oak Cliff corridor extends from the junction of the Oak Cliff and South Oak Cliff lines to the Ledbetter Station just beyond Loop 12. This corridor utilizes three distinct rights-of-way in its 6.4-km (4-mi) length. Construction of the South Oak Cliff line is on schedule with revenue service expected on SOC-1 in June 1996 and SOC-2 in May 1997.

The SOC-1 line section extends from the Atchison, Topeka and Santa Fe right-of-way along the TUE transmission line right-of-way (formerly the Texas Electric Railroad right-of-way) 2.4 km (1.5 mi) to Illinois Avenue. Stations are located at Morrell Street and Illinois Avenue. The Morrell Station does not provide parking and has two bus bays. The Illinois Station opened as a transit center in July 1994. The Illinois Station will have approximately 350 parking spaces (with an additional capacity of 260 spaces) and nine bus bays.

Below the Illinois Station, the SOC-2 line section extends from Illinois Avenue south 4.7 km (2.9 mi) to Arden Road in the Lancaster Avenue median past Ledbetter Drive, where it veers onto an exclusive guideway to the terminus at Ledbetter Station. Stations are located at Kiest Boulevard, Veterans Administration Hospital, and Ledbetter Drive. The Kiest Station will have 474 parking spaces and two bus bays, Ledbetter Station will have 400 parking spaces and six bus bays. The VA Hospital Station will have no parking or bus bays.

Utility Corridor

The SOC-1 section line begins at the junction with the Oak Cliff line and continues south along the former Texas Electric Railroad right-of-way shared with relocated TUE high-tension transmission towers. The Texas Electric Railroad alignment was acquired by TUE during the 1940s. During construction of the DART system in this corridor, the utility lines were relocated onto new poles spaced closer together and placed off to one side. The alignment is partially flanked by Moore Street on the west and Woodbine Street on the east. The alignment from Iowa Avenue to Compton Street is at-grade construction.

From Iowa Avenue, the alignment parallels the west side of the relocated TUE transmission towers. The existing towers were removed and replaced with poles that have the capability to provide the same capacity in less space. The required horizontal and vertical clearances of the rail line to the poles and the final typical section were developed with the approval of the local TUE authority. A new 106.8-km (350-ft) long street on the west side of the alignment required additional right-of-way between Stella Road and Edgemont Avenue. This alignment was selected because of the availability of the corridor and lower cost associated with development of light rail in the right-of-way. Because of the alignment, three streets end in cul-de-sacs on the east side of the TUE right-of-way. At-grade crossings are provided at Stella Road and Edgemont Avenue.

The next at-grade crossing is at Lynn Haven Avenue. Proceeding northward, at-grade crossings are provided at Waco Street and Morrell Avenue, and three streets—Galloway, Strickland, and Hendricks—are closed at the DART/TUE right-of-way and the final grade crossing at Compton Street.

Lancaster Road

The area between the Illinois and Ledbetter stations is an automobile- and bus-oriented commercial corridor along both sides of Lancaster Road and is referred to as the Lancaster Commercial District. A few residences and several public facilities including the Kiest Library and the Veterans Administration Hospital are located within the district. The median of Lancaster was selected during the planning phase for several reasons. The former Texas Electric Railroad right-of-way was not selected because the line did not go through the commercial area (it was located several blocks west) nor was it close enough to the VA Hospital.

The 4.7-km (2.9-mi) alignment consists of at-grade double track located within the rebuilt median of Lancaster Road with one aerial crossing at Illinois Avenue. Between Illinois Avenue and Ledbetter Road, Lancaster Road has been transferred from the state highway system to the city of Dallas. South of Ledbetter Road, Lancaster Road is a state highway (SH–342). Both sections have a narrow median. Numerous driveways and median crossings provided local access across Lancaster Road, which is striped for four lanes; two parallel parking lanes provide width capacity for six lanes. The median will be widened to accommodate the double-track rail line, and Lancaster Road will retain the same number of traffic lanes that are presently provided; however, on-street parking has been eliminated on both sides of Lancaster Road to preserve as much of the commercial development as possible and to provide for the rail right-of-way. At-grade crossings are provided at all major and secondary thoroughfares crossing Lancaster Road. Certain median openings at minor-street crossings are closed because of safety and access concerns. Eight major cross streets will remain open. Additional right-of-way is required along some sections of the street adjacent to signalized intersections to provide separate left-turn lanes for Lancaster Road approaches.

Proceeding southward from Illinois Station, the at-grade alignment parallels Denley Drive adjacent to the TUE substation. Continuing southward, the alignment becomes aerial as it crosses Illinois Avenue and turns to cross the southbound lanes of Lancaster Road at the point where Lancaster Road splits right to meet Corinth Street Road and left to meet Montana Avenue. The alignment returns to grade and continues in a new median with two lanes of traffic in each direction. The alignment remains within the median south to the Ledbetter Station passing the Kiest and VA Hospital stations. After crossing Ledbetter Drive, the alignment turns to the west, crosses the southbound lanes of Lancaster Road, and enters an exclusive right-of-way.

LRVs

A contract was awarded to Kinki-Sharyo for 40 LRVs. Given the choice between a futuristic design and a more conventional one, the DART Board chose the former, with end caps sloping back at a much greater angle than is the case in most other North American LRVs. The LRVs were specifically designed to function in the wide range of operating environments found within the DART system. The cars are double ended, articulated, with six axles, high floors, and four sets of sliding doors per side. Each car measures 28.2 m (92 ft 8 in.) over coupler faces, with a width of 2.7 m (8 ft 10 in.) and a height of 3.8 m (12 ft 6 in.) from the top of the rail. The car body is lightweight welded steel. The vehicles weigh no more than 49 940 Mg (110,000 lb) without passengers, making them the heaviest LRVs to be delivered in North America. The articulated section is weatherproof and does not degrade lighting or air-conditioning or heating performance in the interior. Seating capacity is provided for 76 persons with an additional 76 standing. Each car can accommodate a crush load of 200 persons. Power is provided by a 750-volt DC overhead catenary system. The cars are designed for speeds of 105 km/hr (65 mph), with an average of 40 to 56 km/hr (25 to 35 mph). Final assembly is taking place at a facility in the Dallas area. The cost per car is $2,500,000. About 21 percent of the vehicle cost will be funded by the Federal Transit Administration. The complete system will require 125 cars.

The first two LRVs were delivered in mid-1995 for testing. Each car will accumulate 6,440 km (4,000 mi) during the testing phase running up to the 105 km/hr (65 mph) top speed on 4 km (2.5 mi) of track. The test track consists of the yard lead for the Service and Inspection Facility, a portion of the light-rail system in Oak Cliff that runs over the Trinity River Bridge to the Corinth Station. Forty light-rail cars will be tested during 1995 and 1996, arriving in increments of four per month.

Station Facilities

Twenty-one stations will be built along the initial 32.2-km (20-mi) starter system. Light-rail station facilities range from individual shelters along the transit mall to major subway stations. The CBD stations consist of an 8-in. raised platform (sidewalk extension) with shelters for weather protection. These shelters are easy and inexpensive to maintain, and in all cases, security is heightened because of the visibility provided. Away from downtown, the station design includes arching canopies over both tracks. Platforms are designed for either side of the tracks or center placement. The typical side platform measures 91.5 m (300 ft) long and is 5.2 m (17 ft) wide; center platforms are 8.5 m (28 ft) wide. Both station types are equipped with a 30.5-m (100-ft) canopy. Additional space is provided at all non-CBD station platforms to accommodate a future 30.5-m (100-ft) length extension. Finishes include wind screens, benches, landscaping, and artwork. Landscaping will be employed to enhance the appearance, to control and passively direct the movement of patrons within station sites, and to enhance or improve microclimates at the stations. High-level platforms for the mobility impaired are located at the forward end of each platform.

Patron access and egress at stations vary by location because of site conditions. Eight stations will be built with integral park-and-ride facilities, providing an initial capacity of nearly 4,450 spaces. Kiss-and-ride facilities are provided at 13 of the stations. Generally, access and egress treatments are hierarchical. First priority is given to bus patrons using the drop-off lanes. Second priority is given to short- and long-term parking for mobility-impaired and kiss-and-ride patrons. Third priority is to long-term commuter parking patrons. Patrons accessing stations on foot are provided the most direct circulation available to the adjacent land uses.

Service and Inspection Facility

The heart of DART's light-rail system is the new, $30 million state-of-the-art Service and Inspection Facility, situated just south of the R. L. Thornton Freeway near Fair Park. The three-story, 8277-m^2 (89,000-ft^2) facility houses the staff and equipment necessary to test and maintain the forthcoming fleet of LRVs. The facility can be expanded to 14 973 m^2 (161,000 ft^2) to accommodate an increased fleet size. The building includes a down-draft paint booth equipped with lifts and fresh air supply, environmentally controlled work areas including electronics, and a brake shop designed to prevent contaminants and contains an integrated bus and rail operations control center. The 10.9-ha (27-acre) tract includes two-track servicing areas for interior and exterior cleaning.

Project Costs

The light-rail starter system is estimated to cost $840 million (inflated dollars) or approximately an average of $26 million/km ($42 million/mi). However, the tunnel and bridge construction contracts awarded by the DART Board are below estimates by several millions. The North Central Tunnel was bid at $86.8 million to construct—$35 million below staff estimates. The contractor for the Trinity River Bridge construction submitted a price of $18.6 million—5 percent under staff estimates. The Federal Transit Administration has agreed to reimburse 19 percent, or $160 million, of the total cost of the starter system. The starter system's 40 LRVs are being built for $105 million.

As of August 31, 1995, the LRT project was within budget overall, with approximately $811 million, or 94 percent, committed; approximately $544 million, or 63 percent, was expended as of July 31, 1995.

Summary

It should be apparent that a general discussion of the experience of one system cannot answer the many planning and design questions concerning a light-rail system and site-specific applications. DART evaluated numerous alternatives in each of the light-rail corridors and decided to use LRT because of its flexibility, versatility, and ability to be developed incrementally. In addition, this flexibility has had a direct impact on the design of the light-rail stations and the vehicle to be operated on the system.

DART's 32.2-km (20-mi) starter system presents a different operating situation in nearly every kilometer of its total length. DART has found that the light-rail mode fits the complex operating environments found within the region that require installation of a versatile fixed-guideway system. Light rail can effectively utilize six kinds of right-of-way, depending on cost, availability, and condition. It can be completely grade separated, segregated horizontally from other traffic, within a mixed-traffic stream, in a transitway mall, and designed to operate in power-line corridors. Because of cost, elevated systems, subways, and bridges must be limited to the highest-density locations or key bottlenecks. Light rail is intended to be a lower-cost alternative, and an excess of fully grade-separated structures or tunnels can quickly eliminate most of the cost advantage. However, there is no other practical way to cross a river, highway, or railroad of major importance.

DART is currently in the final months of a construction program to build the initial starter system. Vehicles are being tested, and revenue service is planned to begin in June 1996. DART intends to expand the service to the north and east within the next several years. Even then, the system will not be complete—several other extensions are being planned, grade-separation projects are being designed, and operating enhancements are to be implemented.

DART's starter system project is but an increment of a larger LRT plan. By incorporating the flexibility of LRT and the proven technical and operational experiences of other light-rail systems into the DART experience, a new direction for improved public transit service in the region has been provided.