Hudson River Waterfront Transitway System

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A unique transitway has been proposed for New Jersey's Hudson River waterfront. A narrow strip of land is being converted from railroad yards to large-scale mixed use development. At 35 million ft^2 of commercial floor space and 35,000 dwellings, this new development requires a high-capacity transitway. Add to the trips generated by the new development nearly 200,000 peak period trips (7 to 10 a.m.) passing through the waterfront to the Manhattan central business district. At least 75,000 trips made by bus ultimately will find their way onto the transitway. The core of the proposed transitway is the state-of-the-art light rail transit (LRT) facility to carry intrawaterfront trips. A busway component and land access roadway have been designated to integrate with the LRT. Transitway design variations include LRT exclusive, busway exclusive, transit in street, bus and LRT sharing right-of-way, and, in one location, bus and LRT sharing travel lanes.

"RECYCLING" IS A POPULAR buzzword in our environmentally aware society. Along the Hudson River waterfront, the term is being applied in two unique ways: recycling waterfront land and recycling the concept of light rail transit (LRT) in support of development. Imagine the opportunities in a strip of land 18 mi long and never more than a mile wide, largely vacant, and 1,000 yd from Manhattan's central business district (CBD). Five years ago, when commercial rentals approached \$40/ft^2 in Manhattan, one perceptive

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developer was purchasing 370 contiguous acres of vacant railroad yard at $21,000/acre less than a mile away in Hudson and Bergen counties, New Jersey, along the Hudson River's west bank.

Development of the Hudson River waterfront renewed interest in LRT in New Jersey. It evolved from a unique combination of changing economic conditions, unusual topography, and dynamic transportation needs. Palisades 150 ft high parallel the river along the northern portion of the waterfront. These cliffs isolate the riverbank from the development on the heights to the west. The narrow strip of land along the base of the palisades is a meager 300 ft wide in some locations.

The first cycle of development commenced in the mid-1800s on reclaimed landfill on the New Jersey side of the Hudson River. Nine railroads established beachheads on the narrow strip of waterfront at the base of the palisades. For these railroads and Public Service Railways (the regional streetcar operator), marine fleets, car floats, and passenger ferries completed the vital trans-Hudson River link. The first development cycle peaked around the 1920s when over 2,000 acres of waterfront were devoted to railroad use. Eight railroad tunnels or cuts penetrated the palisades ridge to serve the waterfront. Public Service streetcars scaled the palisades by various means at eight separate locations. These crossings over, through, and under the palisades were to become strong determinants in sketch-planning LRT transitway alignments.

The first cycle of waterfront development declined when the palisades and river obstacles were overcome by vehicular tunnels and bridges in the 1930s. By the 1960s, waterfront railroad properties lay idle as a result of declining railroad traffic, financial failures, mergers, and abandonments. Five of the largest (and bankrupt) waterfront railroad property owners merged into the Consolidated Rail Corporation (Conrail) in April 1976. Rationalization of Conrail's yards and rights-of-way combined with sale of surplus land by the trustees of bankrupt railroads resulted in hundreds of waterfront acres going on the market. This opened a second cycle filled with land development and transportation opportunities despite the topographical limitations that remained.

Today the challenge facing transportation agencies and land developers is to provide new waterfront transportation overlaid on existing trans-Hudson transportation volumes. Since trans-Hudson services are presently operating at capacity and utilize the same corridors required for waterfront access, staff have concluded that the two markets must be considered together. Officials endorse this dual function concept. A multiagency approach was formed with the New Jersey Department of Transportation (NJDOT), NJ Transit, the Port Authority of New York and New Jersey (PA), and other organizations working together. Partnership with the land developers became a key strategy

for bringing transportation capability on line incrementally as development matures.

SOME UNIQUE OPPORTUNITIES

In 1984, a complex sketch-planning process revealed the grand scale of potential development. Even conservative estimates of commercial office space totaled over 30 million ft^2. Waterfront dwelling units at developer-planned build-out would hover near 35,000 units. Analysis confirmed that none of these plans and expectations are achievable absent a strong, visible, high-capacity transit presence.

If developers are to achieve their full build-out plans, the waterfront would have to host 64,000 parking spaces based solely on initial developer expectations. Even with restrained parking policies and high ratios of floor space to parking space (one space or less per 1,000 ft^2), total parking requirements would consume a huge amount of precious space. Nor is there enough roadway capacity to serve anticipated development. Compounding the problem are local land use regulations preserving, among other things, view corridors and view planes from the top of the palisades toward the Manhattan skyline. Placement of towers, size of development, and building height became critical calculations in developer return on investment. Infrastructure either did not exist or was in a state of overload and disrepair. With the exception of Port Authority Trans-Hudson Corporation (PATH), much of the total waterfront area is unserved, even by bus. Rush hour traffic is already congested at levels of service (LOS) D and E because of trans-Hudson and local growth.

The sketch-planning process concluded—and developers recognized—that growth could not be achieved nor could highest and best land uses be realized if automobiles were the primary means of waterfront access. Planning principles devised to guide policy included:

- Suppressed parking;
- Isolation of trans-Hudson and waterfront vehicular traffic flows as far inland as possible;
- Diversion of automobile users to transit in advance of congestion; and
- Trans-Hudson and local bus service and a waterfront transitway system on exclusive rights-of-way.

Fashioning an Alignment

Conrail currently operates its River Line, a freight trunk line, through the Weehawken Tunnel and along the waterfront. This line is of strategic importance to the light rail project because it is a waterfront access tunnel through the palisades and its right-of-way is strategically located at the base of the palisades. The line serves the waterfront from the Weehawken Tunnel south to its crossing of NJ Transit's commuter line into Hoboken. The total length of railroad that can be made available to the transitway system is 4.5 mi, or about 20 percent of the total right-of-way required (see Figures 1 and 2). Fortunately, physical and funding options are available to relocate Conrail to the parallel Northern Branch on the west side of the palisades.

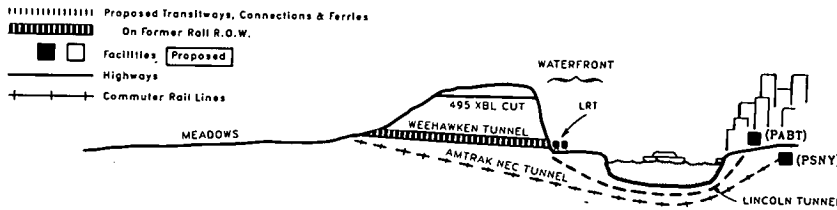


FIGURE 1 Hudson waterfront profile (scale exaggerated).

The state has entered into an agreement with Conrail that will yield benefits that include the relocation and betterment of Conrail's freight operations while vacating the existing River Line right-of-way for its use by the transitway system. The Port Authority's Bank for Regional Development is funding the Northern Branch upgrade and UMTA is funding the purchase of former Conrail waterfront tunnel and railroad alignment. Thus, NJ Transit falls heir to the vacated railroad line for its transitway and NJDOT for its Riverfront Boulevard.

The project has also been fortunate in obtaining a number of easements from private developers who will benefit from the transitway system. Although the construction of the system is some years away, staff approached developers early to ensure that the right-of-way will be available. The first transitway easements were obtained in 1984 from Arcorp. The easement covered nearly a mile of abandoned rail right-of-way north of the Weehawken Tunnel. The agreement was precedent setting, signaling developers' commitment to the transitway concept. Subsequent to that initial acquisition, negotiations with other developers have provided the project with significant amounts of right-of-way in areas where high-density development is taking place. The following rights-of-way have been, or are being, secured without cost to the project:

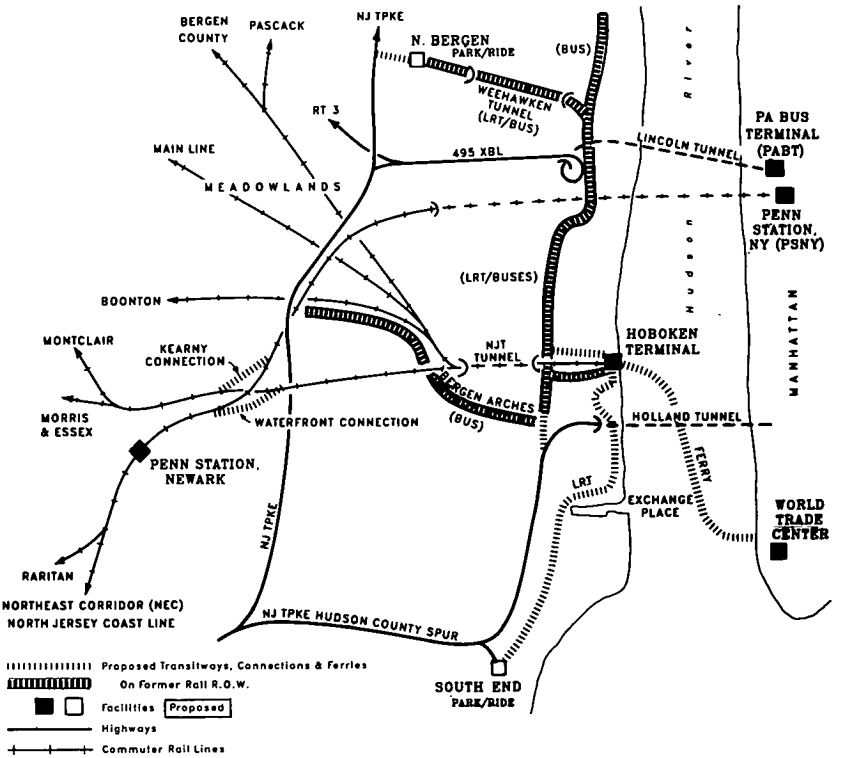


FIGURE 2 Hudson waterfront: existing and proposed transportation.

- Newport Centre—Direct negotiations with this developer yielded a right-of-way across the entire development for a distance of approximately 0.8 mi.
- Lincoln Harbor—Hartz Mountain has provided an additional 30-ft-wide corridor paralleling both its development and the Conrail right-of-way.
- Harborside/Liberty Center/Evertrust—It is anticipated that negotiations with these developers will result in securing a right-of-way in the area immediately north of Exchange Place in Jersey City.
- Lever Brothers Research Center—An agreement has been concluded substituting frontage for former railroad right-of-way as a transit easement.
- Harsimus Cove—Negotiations with this developer anticipate providing rights-of-way to connect the easements furnished by Harborside et al. and Newport Centre.

The combination of the Conrail acquisition with the developer-granted easements is expected to provide the exclusive right-of-way needed for the

transitway system where development is densest. Securing transitway easements continues vigorously.

Development Initiative

Development of the Hudson west bank waterfront is on a particularly large scale, although it represents only a modest percentage of the total 775 mi of New York/New Jersey harbor shoreline:

- 18 mi of shoreline,
- 40-plus private and public developers participating,
- 34,900 new dwellings,
- 2,700 acres,
- 32.5 million ft^2 of commercial office space,
- 3.2 million ft^2 of retail commercial space,
- 3,200 hotel rooms, and
- 10-plus marinas.

Heightening the complexity of waterfront development are the institutional involvements. The Jersey waterfront spans two counties and eight separate municipalities, each with its own land use regulations and planning mechanisms. Local jurisdictions successfully defeated attempts to establish a waterfront regional planning institution. To promote development and liaison with developers, the Governor's Policy Office established a Hudson River Waterfront Office. Other state government participants include the Community Affairs, Environmental, and Transportation departments.

Complementary Programs

All transportation programs in the region aggregate to around $14 billion. Several projects are expected to alter dramatically travel patterns feeding to and crossing through the Hudson waterfront. The centerpieces of New Jersey's transportation capital program are two short inland rail connections to unify the two now separate operating segments of NJ Transit's commuter rail system. These connections act like a double slip switch at Kearny Meadows where the Northeast and Morris and Essex commuter rail corridors cross (see Figures 1 and 2). One of these, appropriately called "Waterfront Connection," enables the North Jersey Coast, Northeast Corridor, and Raritan Valley rail services to enter the waterfront directly at Hoboken. Existing and proposed rail services at Hoboken could thereby total 11 distinct rail lines. This, in combination with a Port Authority trans-Hudson ferry

proposal, an upgrade of PATH, and the light rail transitway system, creates a waterfront transportation gateway through Hoboken. Prior to the Waterfront Connection, only former Erie-Lackawanna rail services in the northern third of New Jersey accessed Hoboken and the waterfront directly.

One of the major features of the waterfront LRT is the integration of its service with the high-capacity bus, rail, and, eventually, marine modes that surround it. Unlike most other new initiatives, where the LRT is the line-haul service exclusively, this light rail will be designed to perform feeding and distribution for the existing fixed-guideway modes as well as line-haul functions.

WATERFRONT TRANSITWAY SYSTEM CONCEPT

The concept of a joint transitway system that meets the waterfront's transportation needs with LRT and local bus, and trans-Hudson needs with express bus, was based on the planning principles detailed earlier. The transitway experiences in other cities demonstrated a number of options for consideration. Notable is Pittsburgh, where both busways and LRT operate jointly on open right-of-way and through a major tunnel facility. Busways as rapid transit/LRT substitutes in Ottawa service a high-density market, highlighting the capacity and flexibility of this particular mode. Visits to a number of the new LRT properties showed how this mode can be fitted compatibly into various environments.

Existing Highway Transportation

As the map and profile in Figures 1 and 2 indicate, there are exceedingly few access points to the Hudson River waterfront. The mature palisades communities, Hoboken and downtown Jersey City, create effective street barriers of urban density to the west. The principal access routes through the palisades and these communities include I-495, US-1, US-9, and the Hudson County spur of the New Jersey Turnpike. Unfortunately, these access roadways are also the same roadways that are heavily used by vehicles destined to cross the Hudson. These crossing approaches are operating at capacity during the peak hour period.

Local streets through the palisades are other alternatives for reaching waterfront destinations. These streets and boulevards are congested in developed areas. Further local roadway expansion and greater use would only degrade the quality of life in waterfront communities that are in the process of gentrification.

Existing Transit

NJ Transit operates rail commuter services to the Hoboken Terminal from seven rail lines now and may increase that number to 12 in the future. The local bus service operates in a radial fashion from two principal points on the waterfront, Hoboken and Exchange Place in downtown Jersey City. These routes bring riders from locations remote from the immediate waterfront area. With the exception of PATH between Hoboken and Jersey City, these transit services do not now distribute riders along the waterfront. Relying only on PATH raises concerns that it will not have the capacity to service the intrawaterfront market while absorbing more trans-Hudson growth.

Parking

Suburban developers traditionally provide four or five parking spaces per 1,000 ft^2 of office space. These parking ratios are not being incorporated in the waterfront developments. The initial developments along the waterfront have been located near established transportation linkages or planned linkages to New York City. Given this accessibility, the parking ratio at the initial developments has been held down to one or less per 1,000 ft^2 of office space.

Trans-Hudson Perspectives

The trans-Hudson bus system is operating over 700 buses during the peak hour through the contraflow I-495 express bus lane (XBL) and the Lincoln Tunnel to the Port Authority Bus Terminal in New York. This is beyond the practical capacity of the XBL. The ability to provide additional capacity in the I-495 corridor for bus operations is at best temporary. To improve the reliability of trans-Hudson bus service, to reduce total travel time, and to provide capacity for future growth, buses must access their own rights-of-way at some point in advance of the existing congestion. Additionally, the exclusive transitway must be two-way to recycle peak period bus runs, reduce deadhead hours, and handle an expected surge in reverse peak commuting to the new employment generators along the waterfront and other regional attractions.

Functional Requirements

Any waterfront transit plan fulfilling trans-Hudson and waterfront requirements must address four functional roles exemplified by the following trip-end pairs:

- Suburb-waterfront,
- Suburb-Manhattan CBD,
- Waterfront-Manhattan CBD, and
- Waterfront-waterfront.

The lack of good automobile access routes, the inability to make capacity improvements, limited parking, and capacity shortfall of the local street network create a need for fringe park-and-ride facilities. These parking facilities must be located where space, highway access, and direct transit links to the waterfront can be provided. The links to the waterfront also have to perform a distribution function so that persons using the fringe parking facilities have access to virtually all of the developing areas.

Early System Conclusions

A common solution for trans-Hudson problems and the developing waterfront areas was required. These dual needs dictate the nature of transit access to the conceptual Hudson River waterfront transportation system shown in Figure 3. The core right-of-way ingredients that fulfill these combined needs are Conrail's River Line, the associated Weehawken Tunnel, and a back-up penetration of the palisades further south called Bergen Arches (another former rail right-of-way). The Weehawken Tunnel links the waterfront to the Meadowlands, itself a major development area where sufficient land is available for a major park-and-ride facility. Because the Meadowlands area is bisected by both spurs of the New Jersey Turnpike and five state arterials, excellent automobile access will be provided to any park-and-ride facility.

Trans-Hudson bus routes utilizing the New Jersey Turnpike from Passaic, Bergen, and other counties will be afforded easy access to the transitway system by connecting the bus element of the transitway to the New Jersey Turnpike. The specific alignments to accomplish all this are detailed in a following section. A South End park-and-ride is fed off the Hudson County spur of the turnpike. The two park-and-ride lots at the outer extremities of the transitway are expected to provide a viable automobile intercept system. They also feed trips bidirectionally on the transitway.

Initial System Definition

The demand levels and trip concentrations associated with waterfront access needs and intrawaterfront and distribution functions led to the conclusion that a high-capacity LRT would be appropriate for certain portions of the transitway system. This conclusion was reinforced by the high person/trip turnover

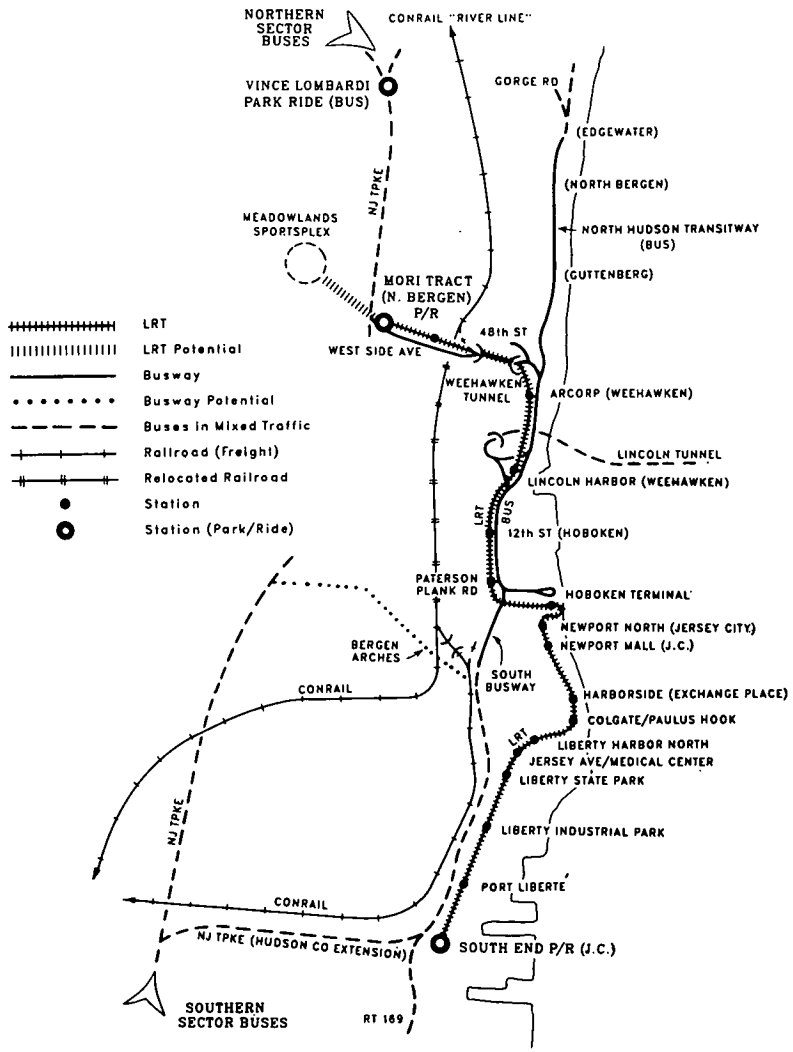


FIGURE 3 Hudson waterfront transitway services and stations.

rate expected at gateway points along a waterfront transit system. Developers were clamoring for a tangible commitment by the public sector to waterfront transportation. They wanted fixed-guideway, permanent, modern, high-capacity transit to complement their "world class" developments—and they appeared willing to help provide for transit that would be uniquely "waterfront."

Next came the determination of which segments would support LRT operations, which would justify busway operations, and which would require joint bus/rail operation. Where joint operations were to take place, staff considered European and North American experiences with various forms of transitways. Pittsburgh's transitway proved the viability of treatments where bus and LRT modes mingle on the same roadway, and where separated modes run parallel within the same right-of-way. But how to adapt joint operation through the Weehawken Tunnel on tight headways proved a challenging traffic management task.

The waterfront system also had to deal simultaneously with express and local service. Both the distributive and waterfront access services are predominantly local-stop in nature. The trans-Hudson services, on the other hand, would stop only at one major interface facility and then operate express to the Lincoln Tunnel portal. This type of operation dictated bypasses for the express trans-Hudson buses skirting station platforms for local transit vehicles.

Based on the vehicles and service types to be blended on the transitway, the following functions and mode pairings were devised:

- LRT Local Services—LRT waterfront services between northern park-and-ride and southern park-and-ride facilities providing local access to the waterfront and an intrawaterfront distributive function en route;
- Busway Express—Trans-Hudson, from northern turnpike connection to Lincoln Tunnel;
- Busway Express—Trans-Hudson, from southern turnpike connection to Lincoln Tunnel (South Transitway);
- Busway Semiexpress—Trans-Hudson, from entrances at Gorge Road and 48th Street to Lincoln Tunnel (North Hudson Transitway);
- Busway Local—from Gorge Road and 48th Street (bus lines servicing northern Hudson County and southern and eastern Bergen County) to Hoboken.

Plotting these functions and modes on a map (Figure 3) reveals a core transitway at the central portion of the waterfront containing joint LRT and bus and joint express and local service. Exclusive bus and exclusive LRT appendages diverge from the core to serve the rest of the waterfront and upland areas.

System Refinement

A conceptual engineering effort further refined a number of issues relating to this project. The major issues included:

- Alignment—What specific alignment should the transitway system follow and what should its specific terminal points be? Where are grade separations required? Are street operations warranted in certain areas?
- Joint Operation—If selected, should LRTs and buses operate in the same pavement area or should they be immediately parallel to one another? What volume and type of joint operation can the Weehawken Tunnel sustain?
- Technology Application—What state-of-the-art bus and LRT technology should be applied to this system?

DESCRIPTION OF THE TRANSITWAY SYSTEM

As presently envisioned, the transitway alignment totals 22 route mi. The total is composed of approximately 13 mi of LRT, 9 mi of busway, and approximately 4.5 mi of joint operation (only in the Weehawken Tunnel do bus and LRT share lanes). This system is depicted in Figure 3. The LRT service will originate at a major Meadowlands park-and-ride facility located on the turnpike either at the existing Vince Lombardi park-and-ride site or at a new site immediately north of Harmon Meadow at what is referred to locally as the Mori Tract. If the former site is chosen, alignment will be oriented north/south, paralleling the New York Susquehanna & Western Railroad. At the south end of Conrail's North Bergen Yard the transitway will turn east to the Weehawken Tunnel. The Mori Tract alignment would originate near the turnpike and proceed east over Westside Avenue to the Weehawken Tunnel. In this instance, provisions would be made for a future extension westward to the Meadowlands Sports Complex about a mile distant.

At the east portal of the tunnel, the alignment would turn south following Conrail's River Line right-of-way along the west side of Hoboken to the Hoboken/Jersey City boundary. At this point, it would turn east to parallel NJ Transit's existing commuter rail line to access Hoboken Terminal.

Leaving Hoboken, the alignment will turn west on an elevated structure for a short distance and then south to serve the Newport, Harsimus Cove, Liberty Center, and Evertrust developments. This will bring the LRT to the Exchange Place area on the surface where access will be afforded to the major Harborside and Colgate developments (12 million commercial ft^2). Continuing south, it will skirt the established Paulus Hook residential area (and historic district) with some street running and provide access to a number of new residential developments along the old Morris Canal basin. South of the west end of the basin, the alignment generally will follow one of several alternative routes parallel to the turnpike to a southern terminus in the Greenville section of Jersey City. En route, the LRT will provide access to a proposed

technology center and museum, Liberty State Park, and several residential and industrial areas.

Trans-Hudson buses bound for New York from the northern sector of the commutershed will get new transitway access from the turnpike with an interchange to be built adjacent to the Mori Tract station. Buses would then share the transitway right-of-way with LRT (lanes shared only in the Weehawken Tunnel) to the vicinity of the Lincoln Tunnel. A bus-only link would then be provided for access to the Lincoln Tunnel. In a similar fashion, trans-Hudson buses originating from the southern sector would be diverted initially to the turnpike's Hudson County spur and then operate over the South Busway and shared transitway system to the Lincoln Tunnel. A somewhat longer-range proposal is to build a connection from the turnpike for buses to use the existing Boonton Line and Bergen Arches rights-of-way to connect with the transitway near the Hoboken/Jersey City line.

A busway branch will also be provided along the east palisades north of the Weehawken Tunnel. This North Hudson transitway facility will extend north to Gorge Road and will improve trans-Hudson services for communities in northern Hudson and southeastern Bergen counties. It will also provide a way for closer-in communities to access the waterfront area through the operation of direct local bus service on the transitway to the Hoboken area. The transitway system will provide direct busway access to a new Hoboken bus terminal separate from the LRT. Other local bus routes would utilize portions of the transitway to access the Hoboken Terminal.

System Costs

The conceptual engineering effort nearing completion has generated an estimate of system costs. As described above, the light rail system will cost approximately $638 million; the busway system, $265 million. Table 1 indicates a breakdown of these costs by some of their major components. These costs represent a per-mile cost of approximately $50 million for light

TABLE 1 PROJECT COSTS

Component	Cost ($ thousands)
LRT	410,162
Busway	38,165
LRT/busway	295,249
Roadway	225,948
Right-of-way	89,591
Engineering	154,299
Total	1,213,414

rail and $30 million for busway. A review is being made at this time of various design criteria and assumptions that have been made in order to highlight areas where project costs can be reduced.

Ridership

Table 2 indicates the p.m. peak hour ridership for each segment of the line. Maximum peak hour boardings are expected to be 16,379, with 4,163 passengers riding past the maximum load point between the Hoboken Terminal and Paterson Plank Road Station in the northbound direction. The intercept parking facilities accommodate 1,660 riders/hr at the northern facility and 2,847 riders/hr at the southern facility. This table also indicates that one of the prime functions of the LRT is as a distributor, particularly between the Liberty Harbor North station and the Arcorp south station. This table also indicates the major interfaces between the LRT system and the existing bus, PATH, and rail commuter systems.

Table 3 shows the heavy trans-Hudson busway volumes expected on the system in 1995. This level of patronage will compel peak hour bus headway of 9 sec on both the northern and southern approaches to the Lincoln Tunnel. (Present XBL bus headway is less than 5 sec.)

TABLE 2 LRT PASSENGER ESTIMATES: P.M. PEAK HOUR, MORI TRACT PARK-AND-RIDE TERMINAL

	Northbound			Southbound		
	On	Off	Thru	On	Off	Thru
Mori Tract	0	1,660	0	1,065	0	1,065
West Side Avenue	0	1,214	1,660	236	0	1,301
Arcorp	667	1,848	2,874	2,135	663	2,773
Lincoln Harbor	1,052	509	4,055	1,190	327	3,636
12th Street	263	562	3,512	449	277	3,808
Paterson Plank Road	237	589	3,811	255	293	3,770
Hoboken Terminal	2,238	266	4,163	325	1,496	2,599
Newport[a]	968	777	2,191	368	1,060	1,907
Harborside	794	104	2,000	1,315	502	2,720
Colgate/Paulus Hook[b]	864	120	1,310	1,327	656	3,391
Liberty Harbor North	111	24	566	18	234	3,175
Liberty State Park/Jersey Avenue	41	1	479	1	30	3,146
Liberty Industrial Park	40	7	439	3	68	3,081
Port Liberté	78	6	406	5	239	2,847
South End Park and Ride	334	0	334	0	2,847	0
Total	7,687	7,687	N/A	8,692	8,692	N/A

[a]Includes Newport North and Newport Mall.
[b]Includes added trips from Colgate redevelopment.

TABLE 3 PEAK HOUR BUS DEMAND—LINCOLN TUNNEL/XBL

	XBL Approaches					
	Tpke./17	Route 3	Tpke./16E	XBL Total	Local Approaches	Total Through Lincoln Tunnel[a]
1983	235	154	281	670	109	779
1986	266	174	317	757	123	880
1987	272	178	324	774	126	900
1988	278	182	331	791	129	920
1989	284	186	339	809	131	940
1990	290	190	346	826	134	960
1991	296	194	353	843	137	980
1992	302	197	360	859	140	999
1993	308	202	367	877	142	1,019
1994	314	206	374	894	145	1,039
1995	320	209	381	910	149	1,059
2005	368	241	439	1,048	170	1,218

[a]NJ Transit/PA joint venture forecast for bus ridership growth through the Lincoln Tunnel is 36 percent. PA estimate for total trans-Hudson growth from 1995 to 2005 is 10 percent. Anticipated growth for bus ridership is 15 percent owing to the inability of automobile crossing traffic to grow in the same time period.

Stations

As presently planned, there will be 17 or 18 stations on the light rail system. Figure 3 indicates their general locations.

The stations are intended to serve a number of users. Mori Tract and South End stations are primarily intended for park-and-ride patrons and possible transferees. Other stations, such as Arcorp, Lincoln Harbor, Newport North, Newport Mall, and Harborside, are in direct proximity to the residential and commercial developments currently being constructed or planned.

Hoboken Terminal will provide interchange with the commuter rail network, with the Port Authority's planned ferry, and with the existing PATH system. The Hoboken Terminal station hosts bus routes that originate in the palisades communities and can use the transitway. The station at Newport Mall will serve the large 1.5-million ft^2 retail development recently opened. The Harborside station will serve an area in common with PATH's Exchange Place station, a focal point for local bus routes serving the downtown and southern portions of Jersey City. Finally, West Side Avenue, 12th Street, Paulus Hook, Liberty Harbor North, and Port Liberté stations will provide access to both the established and the developing residential and recreation areas along the LRT line.

Three typical station types are being considered, although there will be variations on these schemes to adapt stations to their particular environments.

An LRT station at grade is shown in Figure 4. Platform lengths would initially be 200 ft with expansion capabilities up to 300 ft. Pedestrian crossing would be allowed at controlled points and a station track fence would be installed to prevent random intrusions into the track area. The architectural treatments will support full station accessibility for the disabled.

An elevated station is shown in Figure 5. Dimensions and amenities are similar to the at-grade station. Access to the platform is provided through four stairways located at both the fore and aft portions of the platform. Track fences are placed to discourage intrusions into the track area. The station is fully accessible to the handicapped and includes elevators on each platform.

Figure 6 shows a station designed to handle both bus and LRT vehicles. Light rail vehicles (LRVs) would service joint stations in a manner similar to the LRT-only station except for a merge point between buses and LRVs immediately outside of each station area. Buses would be required to move from the inside lane to access the LRT station platform lane. Express buses would use the inside lanes exclusively and avoid conflicts with LRVs making local stops. Due to the high volumes of buses expected during the peak hours, passenger access to the vehicle lanes is discouraged by design. A center pedestrian barrier stretches the full length of the station to discourage patrons from entering the vehicle lanes. Crossing between platforms will be accomplished by stairways, elevators for the handicapped, and an elevated walkway.

In those areas of the transitway system served solely by buses, station facilities will consist of 10-ft-wide platforms that will vary in length from 80 to 120 ft. Passenger circulation to and between station platforms will utilize at-grade pedestrian crossings as a result of the anticipated lower volume of buses and good sight lines in these areas.

Construction Types

The construction of the waterfront transitway system features several cross-section types to blend it with its environment and to accommodate joint bus/rail operation. In those areas where the LRT operates on its own separate right-of-way, a 50-ft right-of-way will be required as shown in Figure 7. The addition of a busway component requires a total of 60 ft of cross-section (Figure 8). As initially designed, both LRT and busway would share the same roadway in all instances of joint right-of-way use. Based on comments from a peer group review and an in-depth review of the dynamics of accommodating in excess of 400 buses and up to 30 light rail movements in a peak hour, it was decided to separate the bus and rail on a common right-of-way (Figure 9), with one exception.

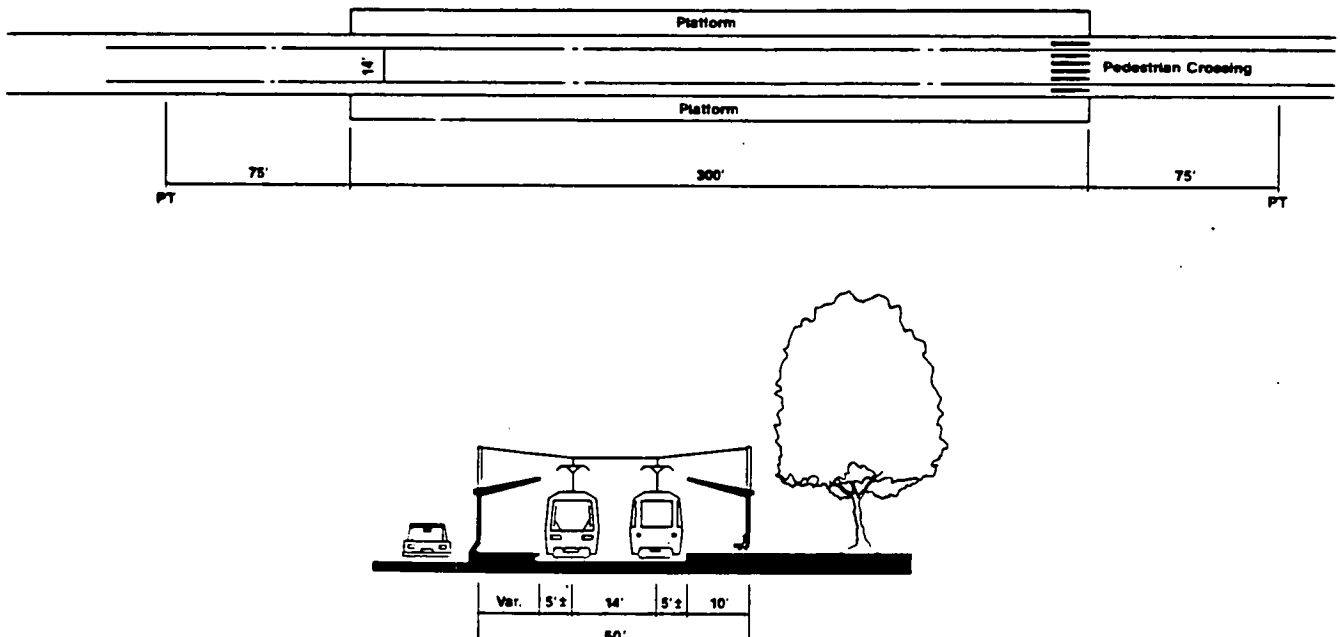


FIGURE 4 Typical station configuration: at grade.

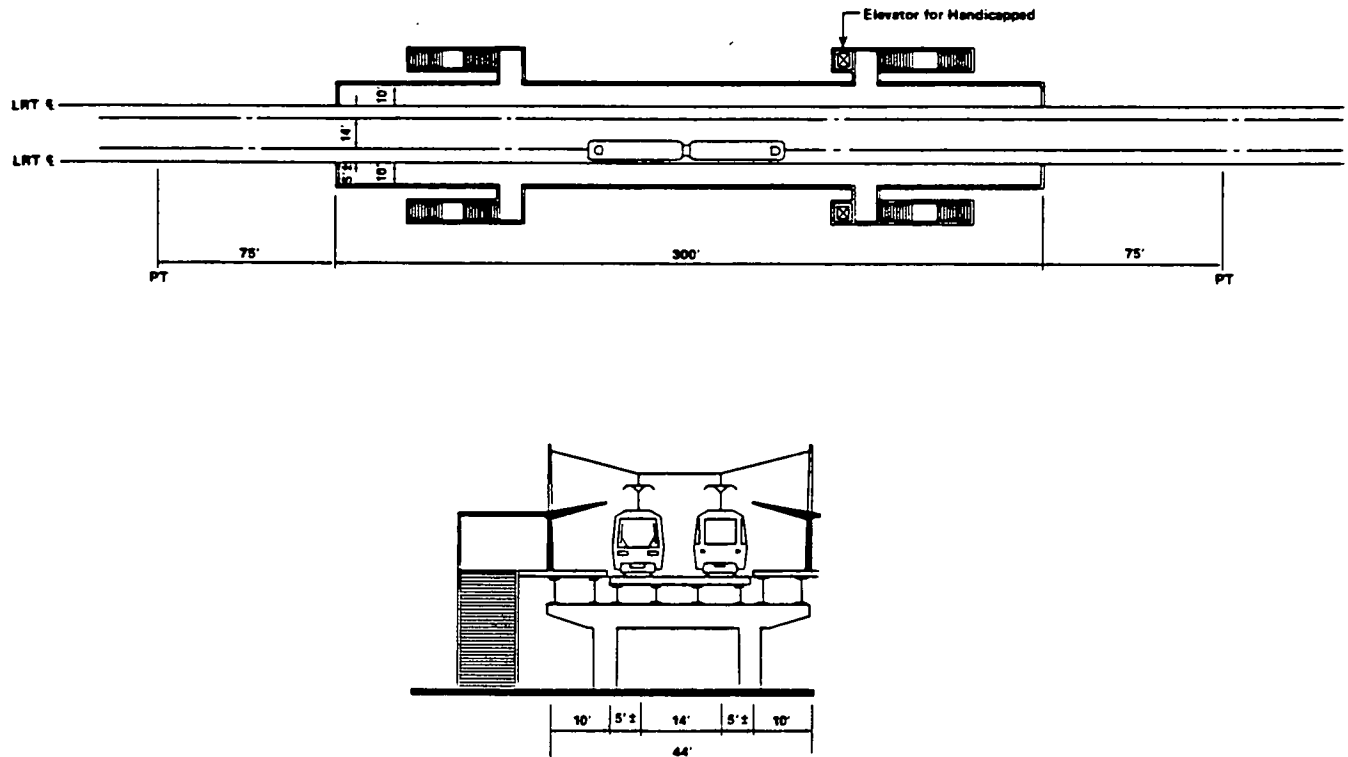
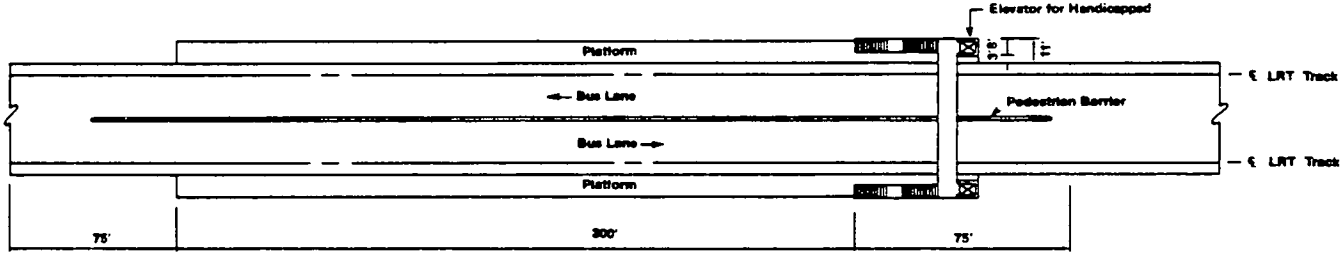


FIGURE 5 Typical station configuration: elevated.



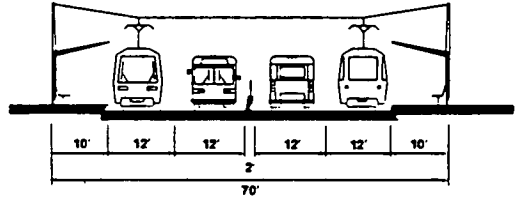


FIGURE 6 Typical station configuration: combined bus and LRT.

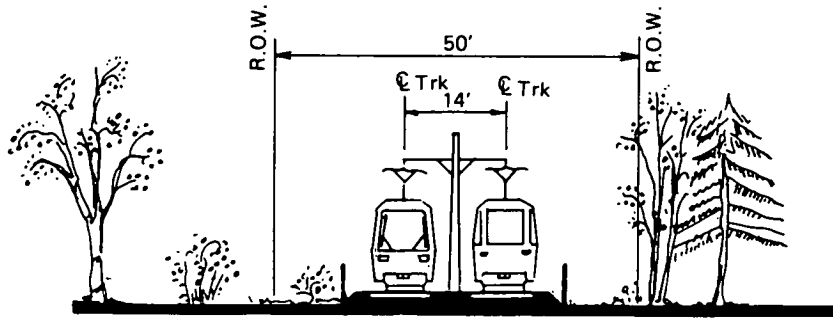


FIGURE 7 Typical cross section: LRT only.

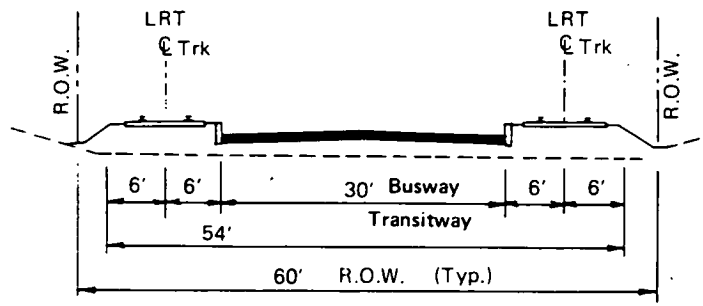


FIGURE 8 Typical cross section: LRT and busway.

Due to the limitation on right-of-way width available through the Weehawken Tunnel, which is only 27 ft wide, LRVs and buses will be mingled on the same roadway through the mile-long tunnel. The cross-section proposed in the Weehawken Tunnel is shown in Figure 10.

In those areas of busway-only operation, the typical cross-section consists of two 12-ft lanes provided together with 8-ft shoulders, and a 10-ft berm. This arrangement is adaptable, though, and could be reduced to 24 ft in areas of limited space.

To the greatest extent possible, the LRT/busway facility will be built at grade to reduce costs. However, there are certain locations along the line where conditions require elevated structures. Elevated locations are as follows:

- From the Mori Tract site to the east side of the Conrail right-of-way—Elevated structure in this area may be the most economical method of crossing the wetlands to avoid a costly earthen fill and accompanying mitigation requirements;

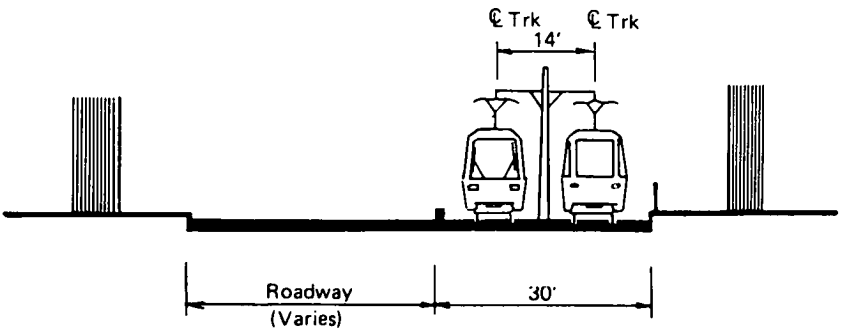


FIGURE 9 Typical cross section: LRT in street right-of-way.

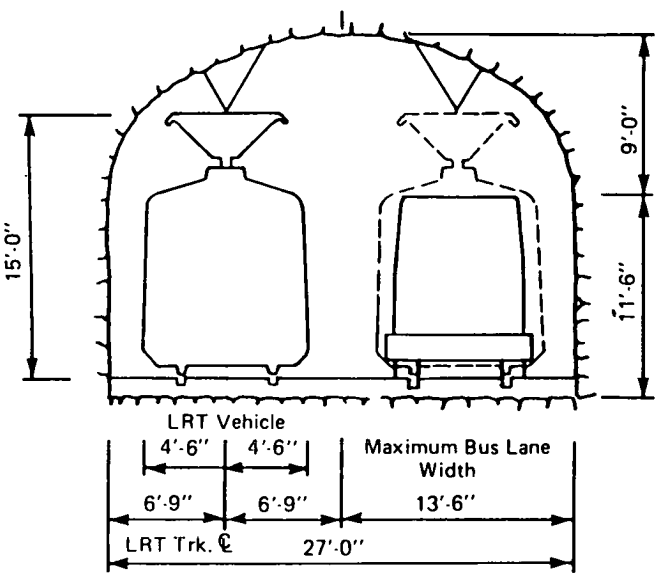


FIGURE 10 Typical cross section: Weehawken Tunnel.

- East of Weehawken Tunnel—An elevated transitway will be provided to grade separate the conflicting merging movements between the transitway routes and the busway from the north;
- Lincoln Tunnel Connector—The busways in this vicinity will be on a set of elevated ramps to sort trans-Hudson bus, local bus, rail, and vehicular movements;
- Crossing Paterson Plank Road and the Morris & Essex Rail Commuter Line;

- Newport—Current traffic projections indicate that grade separations may be required for crossing the major boulevards in the Newport area; and
- Additional elevated structures are being considered between Liberty State Park and the South End park-and-ride facility.

Each of these sections is being reviewed to minimize costs associated with special treatment.

Operating Parameters

Signals and Communications

The LRT system will use a conventional block signal system in those areas where it operates on its own exclusive right-of-way. Traffic signal preemption will be provided as necessary at major intersections. In those areas where both bus and light rail operate on the same roadway or where the light rail is operating within street rights-of-way, line-of-sight procedures will be practiced. The requirement for an on-line communication system will be met by piggybacking the transitway requirement onto the existing state-of-the-art bus radio system.

Transit Vehicles

At the present time the waterfront LRVs are planned to have the following features:

- Six-axle, articulated, double-end units with doors on both sides,
- Capacity for 73 people seated and about 120 standing, and
- 90-ft-long cars with the capability for coupling into two- or three-unit trains with a maximum speed of 45 to 50 mph.

Bus vehicles using the system will include conventional 40-ft transit buses, 60-ft articulated buses in both suburban and city configurations, and MCI commuter buses (intercity design).

Service Standards

During the peak hour, the LRT system will offer initial headways every 3 to 6 min depending upon the consists that are operated. Off-peak headways will be in the range of every 10 to 15 min. The span of service will be approximately between 5 a.m. and 1 a.m. initially, possibly expanded to 24 hours.

Maintenance Facilities

Because of limited available land in the heavily urbanized core of the system, the light rail maintenance center will be located near the northern or southern terminal. Investigations are under way to determine if storage facilities should be split between both ends of the line to minimize the amount of nonrevenue mileage required to set up the daily service pattern. The capabilities of the maintenance facility would be based on those activities already provided by other parts of the NJ Transit system. Integration of the light rail maintenance facility with existing NJ Transit maintenance functions will significantly reduce costs.

Weehawken Tunnel

The tunnel must accommodate both bus and light rail movements. Air circulation will be achieved through the installation of ceiling relay fans to avoid costly ceiling and floor plenums. The design volume for this facility will be approximately 300 buses in the peak hour.

The large peak hour volume of buses through the tunnel, coupled with the difference in braking characteristics between LRVs and buses, requires a unique operating scenario. In the normal operating mode, buses will have free-flow entry into the tunnel. Their bidirectional flow rate will be monitored to prevent more than 22 vehicles occupying the tunnel at any one time. When an LRV is to enter the tunnel, the control system will interrupt bus flow, admit the LRV, and control the time and distance interval between the last bus and any following LRV.

Park-and-Ride Facilities

The terminal park-and-ride facilities are major components of the light rail system. The Mori Tract park-and-ride is being considered in two alternate configurations. The first would feature a five-level parking garage holding 2,860 automobiles. The facility would also enable a transfer between buses and the LRT for those patrons desiring to use the trans-Hudson bus routes in Bergen and Passaic counties to access the waterfront. The conceptual layout of this facility is shown in Figure 11. Another option is to have surface-only parking at a similar capacity. Ordinarily, unstructured parking is cheaper, but the cost of filling wetland areas and mitigation requirements may make surface parking the more costly alternative.

Several options are being considered for park-and-ride facilities adjacent to the southern terminus. In all cases, access would be provided to the Hudson County extension of the New Jersey Turnpike and other arterials.

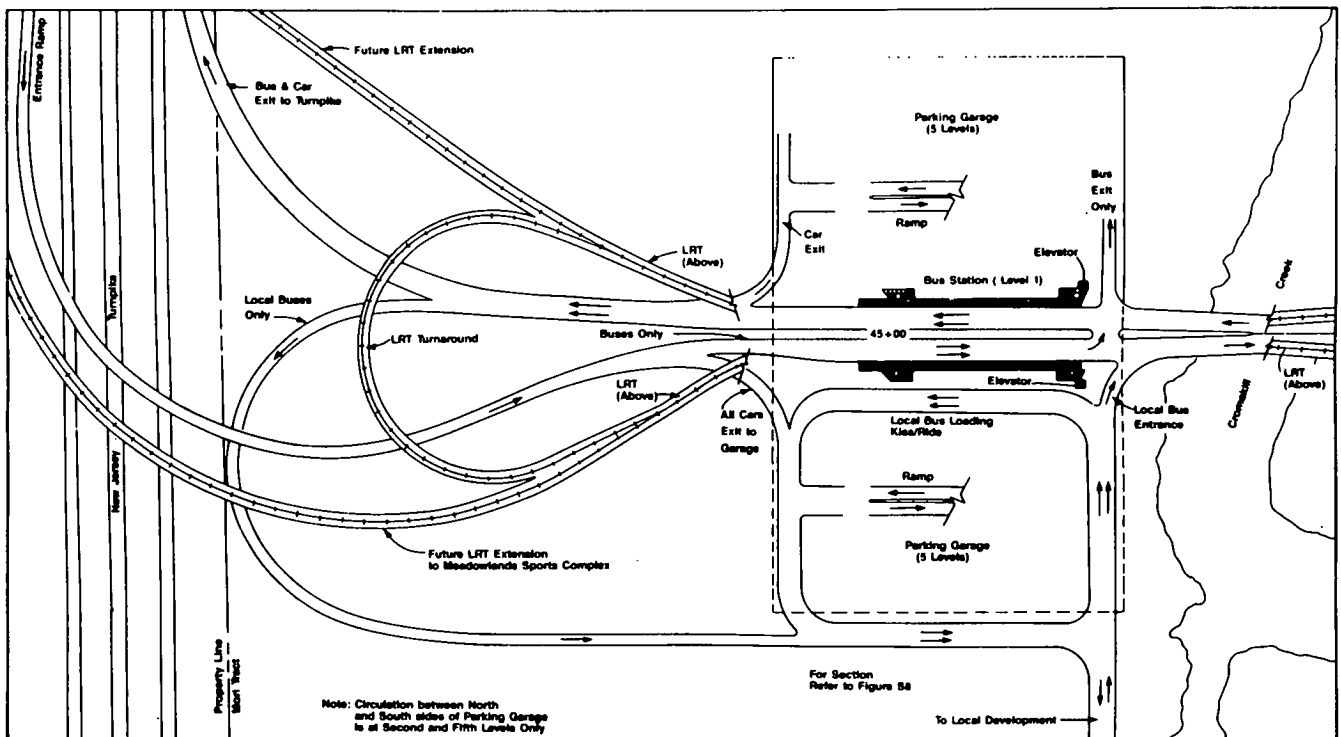


FIGURE 11 Mori Tract park-and-ride.

Funding and Institutional Roles

Funding initiatives and precedents are under way along several fronts. To meet its transportation capital needs, New Jersey has established a Transportation Trust Fund derived from gas tax revenues. This initiative, approved by the legislature in January 1988, is intended to address New Jersey's comprehensive travel needs, including the waterfront. Federal funds have already been applied to right-of-way acquisition along the waterfront. The Port Authority established two dedicated regional development funds from which New Jersey and New York each can draw at their discretion. New Jersey has already withdrawn funds for waterfront transit, highway, and pedestrian walkway projects. Finally, the developers have contributed rights-of-way and, in some cases, agreed to share the costs of transit improvements on the rights-of-way. The following institutions have already contributed to the study and design effort or supported right-of-way acquisition aggressively:

- NJ Transit Waterfront Office—Has been lead agency charged with overall responsibility for planning, design, and acquisition of the transitway system along with financial planning;
- New Jersey Department of Transportation—Provides engineering support for the planning and design effort; negotiates right-of-way acquisition with their consultant, Parsons, Brinckerhoff, Quade and Douglas; sponsors the initial study and design reports;
- Private Developers—Have granted dedicated right-of-way easements and other considerations through their properties and coordinated their designs;
- NJ Transit Bus Operations—Is proposed operator of the transitway property with major role in design standards and bus operations planning;
- Port Authority of New York and New Jersey—Has provided funding assistance for relocating Conrail off the waterfront, initiated consideration of several busway segments in sketch-planning phase, provided technical assistance on bus element of transitway and XBL bypass, and is providing funding assistance on South Busway segment of the transitway;
- Governor's Waterfront Office—Has played major institutional role in advancing the project and liaison with local jurisdictions, resolves land development and transportation issues, and participates in design;
- UMTA—Has provided funding for acquisition of Conrail's waterfront right-of-way to form the transitway core (further federal assistance is anticipated);

- Local Jurisdictions—Have adjusted plans and regulations and provided assistance through waterfront advisory body and directly on local problems; and
- Statewide Authorities and Private Institutions—Have provided other funds.

CONCLUSIONS

The last major addition to the North Jersey rail transit system occurred on May 26, 1935. On that date, Newark's City Subway opened as a light rail operation and closed an era of rail transit expansion. The City Subway, as a concept, an institution, and a light rail property, survived while other rail services in the New York/New Jersey region were discontinued. It is significant that this last new addition in 1935 and the anticipated future addition, the waterfront transitway of the 1990s, are both light rail.