Table of Contents

This document represents the work conducted, in response to the contracted scope of work, throughout the process of the Pace Bus Rapid Transit Initiative. The information contained in this document has been assembled in response to the contracted scope of work and incorporates comments from Pace staff and the project’s Technical Advisory Committee. Included are all required submittals, as identified below:

- **Section I – Literature Search Report (Task 1)**, originally submitted as a draft on December 28, 2000

- **Section II – Universe of Location Report (Tasks 0 & 2)**, originally submitted as a draft on December 28, 2000

- **Section III – Concept Design Report (Tasks 3 & 4)**, originally submitted as a final report on May 24, 2002

The following document is also included in response to Pace’s request:

- **Appendix - Glossary of Bus Rapid Transit Terms and Concepts**

*Each section contains its own detailed table of contents.*
Task 1 – Literature Search
This document fulfills the requirements of Task 1 in the study scope of work, which includes a domestic and international review of current operating and planning applications of bus rapid transit (BRT) that are analogous to Pace’s Bus Rapid Transit Initiative as discussed in the project Kick-Off Meeting. The literature review mainly focuses on projects in Europe, South America, Canada, and the United States, that have been planned and/or implemented.
# Table of Contents

1. **Introduction**  
   1.1. Definition of Bus Rapid Transit  
   1.2. Purpose of Report  
   1.3. List of Systems Reviewed  

2. **Bus Rapid Transit Features**  
   2.1. Separation from Traffic  
      2.1.1. Dedicated Busway  
      2.1.2. Buses in HOV Lanes  
      2.1.3. Bus Lanes on Arterials  
      2.1.4. Mixed Traffic  
   2.2. Station Location  
      2.2.1. Stop Spacing  
      2.2.2. Limited Stop Service  
      2.2.3. Relationship with Busway  
      2.2.4. Relationship with Intersection  
   2.3. Passenger Facilities  
      2.3.1. Weather Protection  
      2.3.2. Level Boarding  
      2.3.3. In-Station Passenger Information  
   2.4. Transit Signal Priority  
   2.5. Vehicle Design  
      2.5.1. Low-Floor Vehicles  
      2.5.2. Door Capacity  
      2.5.3. On-Board Amenities  
      2.5.4. Propulsion System  
      2.5.5. Automatic Guidance  
      2.5.6. Appearance  
   2.6. Fare Collection  
   2.7. Access to Transit
3. Experience with Bus Rapid Transit

4. Recommendations for Pace
   4.1. Features Recommended for All Routes
       4.1.1. Limited Stopping Patterns
       4.1.2. Off-Board Fare Payment
       4.1.3. Level Boarding
       4.1.4. High-Quality Passenger Facilities
       4.1.5. Passenger Information Systems
       4.1.6. Easy Access to Transit
       4.1.7. Distinctive Route Marketing
   4.2. Corridor-Specific Features
       4.2.1. Transit Signal Priority
       4.2.2. Tollway and Expressway Priority
       4.2.3. Arterial Bus Lanes
   4.3. Optional Features
       4.3.1. Exclusive Guideway
       4.3.2. Advanced Transit Vehicles

Works Cited

Appendix A – Citation for Bus Rapid Transit References
1. Introduction

1.1. Definition of Bus Rapid Transit

Bus Rapid Transit (BRT) is a combination of technologies, design features, operating practices, and marketing approaches that allow rubber-tired transit vehicles to approach the speed and service quality of light rail transit service. BRT systems are designed to reduce travel time, increase schedule reliability, and improve passenger comfort over traditional bus service on heavily traveled routes. In many cases, BRT allows rail-like service to be achieved at a fraction of the cost of constructing and operating a new rail line.

A central BRT concept involves giving priority to transit vehicles. This can be justified when BRT, through the use of vehicles with high occupancy, can result in higher passenger throughput in a corridor than would be possible with automobiles, which typically have a relatively low occupancy. The emphasis is thus on person throughput rather than vehicle throughput.

1.2. Purpose of Report

This report provides an overview of recent experience around the world with BRT systems. Special emphasis is placed on BRT systems that are currently operating (as opposed to in planning or under construction) and that are located in contexts similar to the suburban landscape of Pace. Through an examination of experience with other BRT systems already in operation, this report will make recommendations about the features of successful BRT systems that Pace should consider including in its BRT Initiative.

1.3. List of Systems Reviewed

More than 7 BRT systems currently in operation in 3 countries are reviewed in this report. To provide insight into emerging design trends and new technologies, 8 BRT systems currently in planning or under construction are also reviewed. Systems reviewed are listed in Table 1.1.
Table 1.1: BRT Systems Reviewed

<table>
<thead>
<tr>
<th>Transit System</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eugene, Oregon</td>
<td>planning</td>
</tr>
<tr>
<td>Orlando Lymmo</td>
<td>operating</td>
</tr>
<tr>
<td>Ottawa Transitway</td>
<td>operating</td>
</tr>
<tr>
<td>Honolulu H-1 Bus Rapid Transit</td>
<td>planning</td>
</tr>
<tr>
<td>Los Angeles Metro Rapid Bus</td>
<td>operating</td>
</tr>
<tr>
<td>Cleveland Euclid Avenue BRT</td>
<td>planning</td>
</tr>
<tr>
<td>Nashville Urban Core BRT</td>
<td>planning</td>
</tr>
<tr>
<td>Vancouver Rapid Bus</td>
<td>operating</td>
</tr>
<tr>
<td>Dulles Corridor BRT</td>
<td>planning</td>
</tr>
<tr>
<td>Hartford/New Britain Conn.</td>
<td>planning</td>
</tr>
<tr>
<td>Louisville River City BRT</td>
<td>planning</td>
</tr>
<tr>
<td>South Miami-Dade Busway</td>
<td>operating</td>
</tr>
<tr>
<td>Santa Clara Valley Rapid Bus</td>
<td>planning</td>
</tr>
<tr>
<td>Pittsburgh West Busway</td>
<td>operating</td>
</tr>
<tr>
<td>Seattle/King County</td>
<td>operating</td>
</tr>
</tbody>
</table>

In addition to these systems, references to more than 15 other systems in various countries in North America, South America, Europe, and Australia were reviewed. These systems are mentioned where they provide insight into the issues discussed herein, but were not reviewed at the same level of detail as the systems shown in Table 1.
2. **Bus Rapid Transit Features**

BRT consists of a combination of various technologies, design features, operating practices, and marketing approaches that allows public transportation service using rubber-tired vehicles to approach the speed, reliability, and passenger comfort of light rail transit. BRT features include exclusive guideways, limited stopping patterns, amenity-filled passenger stations, transit signal priority on arterial streets, rail-like vehicle designs, off-vehicle fare payment, and improved access to transit facilities.

However, not all systems employ all features. Systems reviewed in this report include a wide range of features, from limited-stop bus routes using standard shelters and traditional buses in mixed traffic to rail station-like passenger facilities served by articulated, self-steering vehicles running in dedicated guideways.

2.1. **Separation from Traffic**

BRT systems operate in a range of traffic conditions from full isolation in busways to mixed traffic. In general, increased separation results in greater operating speeds and schedule reliability, especially in congested areas. However, it also requires a larger physical roadway cross-section to accommodate all users and involves inherently higher construction and maintenance costs.

BRT systems can operate on a combination of roadway types, such as dedicated busways, HOV lanes on expressways, and mixed traffic lanes on arterials. In this manner, busways can be constructed one segment at a time as construction opportunities and funding permit. As traffic separation increases through a series of incremental improvements, BRT service quality may gradually increase over time.

The following sections discuss the range of levels of separation of buses from traffic used in BRT systems reviewed.

2.1.1. **Dedicated Busway**

The most isolated busways are fully grade-separated facilities on which only buses are permitted to travel. Overpasses or underpasses at intersections with other roads eliminate conflicts with other traffic. By running high-capacity transit vehicles at short headways, these types of busways can achieve passenger capacities per hour equal to or greater than that of many light rail transit systems.

Many of the dedicated busways in use today were constructed along railroad rights of way. The new Pittsburgh West Busway, completed in September 2000, includes sections of abandoned railbeds and tunnels. Likewise, the Ottawa Transitway was constructed in part in abandoned railroad corridors. It is possible to mix railroad and busway uses within the same corridor where space permits. For example, Pittsburgh’s East Busway is constructed in part on railroad right-of-way adjacent to active railroad tracks. A portion of Pittsburgh’s South Busway is shared with light rail vehicles.
In the 1970s, several communities developed busways in the medians of expressways. Examples include the Interstate 10 (El Monte) Freeway in Los Angeles and U.S. 101 in San Francisco. Both of these later reverted to HOV lanes, which allowed other traffic with sufficient occupancy levels to share the facility. BRT operations in mixed-traffic HOV lanes are discussed in Section 2.1.2.

Also during the 1970s, transit malls involving dedicated busways were implemented in several downtown areas in the United States. Locations included State Street in Chicago, the Transit Mall in Portland, Oregon, and the Nicollet Mall in Minneapolis. Each of these involved dedicating one or more streets to transit use only. In Seattle, a dedicated transit tunnel was constructed under 2nd Street to minimize interference with surface traffic. Dual-mode buses converted from internal combustion to electric trolleybus operation at the transition to the tunnel. The Seattle transit tunnel is now being converted to light rail operations. The State Street Mall has since been converted back to mixed traffic following concerns raised by merchants over reduced traffic.

A slightly lower degree of traffic separation exists on many busways that are constructed in the medians of arterial streets along which at-grade intersections exist. In this arrangement, busways mimic the operation of many light rail transit systems running in the center of boulevards. To enhance BRT average operating speeds, some form of transit signal priority is often implemented at intersections. The South Miami-Dade Busway is an example of a busway constructed in the median of a major surface street, U.S. Highway 1 in this case. The busway serves as an 8.2-mile extension of the Miami Metrorail system. Miami-Dade Transit uses the intersections as access points for 11 routes that feed the busway from surrounding areas.

Restriction of traffic to authorized transit vehicles can also allow the busway to be designed with a narrower cross section than a standard traffic lane if automatic guidance mechanisms are used on the vehicles. Some dedicated busways have curbs on both sides of the lane against which rollers on the bus steer the vehicle. Using this design, bus lane width can be reduced to 9 feet or less from the standard 11 feet. The O-Bahn Busway in Adelaide, Australia, is one of the most prominent examples of guided busways currently in operation. The O-Bahn is constructed with pre-cast roadway segments that include formed-in curbs. In some cases, vehicles designed for operation in dedicated busways may not be suitable for operation in mixed traffic.

Busways are often designed as low-cost precursors to future light rail corridors. The Seattle bus tunnel, for example, will form the downtown segment of the Link light rail system. In Ottawa, the Transitway was designed with the intention of upgrading to light rail in the future as ridership growth justified additional investment. However, the operational success of the BRT system convinced OC Transpo to maintain the existing rubber-tired system when conversion was recently considered.

2.1.2. Buses in HOV Lanes

Express bus operations in mixed traffic on expressways and tollways were one of the first forms of BRT implemented in the United States. Most systems serve the suburb to central business district (CBD) market.
One very successful HOV system is located in Houston, Texas. Beginning in the early 1980s, the Metropolitan Transit Authority of Houston (METRO), began to plan for and build an HOV system on six of the major freeway corridors that converge in the CBD. Today, these 6 corridors have over 70 miles of barrier-separated HOV lanes in use and extensions are being planned in every corridor with one corridor currently in construction. Each corridor has a minimum of three park & ride lots spaced between 3 and 6 miles apart. Most of the park & ride lots are connected directly to the HOV barrier-separated lanes via a T-ramp.

HOV systems have been implemented in many different design alternatives. They can be two-directional, or they can be single-direction, reversible facilities. Reversible facilities are applicable only in corridors with substantial imbalances between directions of flow. HOV lanes can be physically separated from other lanes, or they can be separated only with paint and signage. Concurrent flow lanes can either be on the left or on the shoulder.

According to the seminal work on the subject, the National Cooperative Highway Research Program Report 155 (Bus Use of Highways) and the newer HOV Systems Design Manual (NCHRP, 1998), it is desirable to locate HOV facilities on the median (inside) lanes of the highway to avoid conflicts with ramp movements and weaving traffic. Operation on the shoulder is undesirable due to the need to maintain a clear zone for disabled vehicles and as a safety buffer between traffic and the edge of pavement.

2.1.3. Bus Lanes on Arterials

Bus lanes are traffic lanes on a surface street reserved for the exclusive use of buses. Bus lanes on arterial streets provide the most effective means of improving bus speeds where it is not possible to construct busways or HOV facilities. Bus lanes provide priority to transit vehicles by minimizing conflicts with other vehicles. Bus lanes can be implemented as curbside lanes, median lanes, and contraflow lanes.

All bus lanes require dedication of limited cross section street width. The amount of street width needed to accommodate bus lanes, stations, barriers, through traffic, turning traffic, and parking varies. Bus lanes are frequently in effect only during the peak hours in the peak direction. At other times, bus lanes may serve as general-purpose travel lanes or as parking lanes.

**Curbside Lanes:** Curbside bus lanes typically require the least modification to existing street geometry during implementation. They conserve width by allowing bus stops to be located on the sidewalk. Curbside lanes are frequently shared with right-turning vehicles, thus also conserving width. However, curbside lanes are also the most difficult lanes to keep free of obstructions, such as illegal parking and standing and right-turning vehicles yielding to pedestrians. As a result, they tend to provide less priority to buses than median or contraflow lanes.

It is possible to mitigate these effects by prohibiting right turns, enforcing parking restrictions, providing two bus lanes to allow passing, or constructing right turn lanes between the bus lane and the curb. For example, on Madison Avenue in New York City, both the curb lane and the next lane over are designated as bus lanes. Right turns are prohibited and taxis are permitted in the lanes. This design permits buses to pass each other.
Median Lanes: Median lanes are much less likely to be congested by other traffic than curbside lanes. With traffic conflicts only at intersections, median bus lanes approach the performance of busways. However, the need for passenger loading areas in the center of the street can increase the cross section street width needed. Central stations also require passengers to cross traffic lanes to reach the sidewalk. Where there are several lanes of fast traffic, this can create safety problems, especially since passengers often are anxious to cross when they see a bus approaching. In addition, left-turning traffic conflicts with straight-through buses. Either left turns must be banned or they must be permitted only in a separate phase.

Median lanes are among the most common design alternatives for BRT systems on arterial streets. The Curitiba BRT system operates primarily in the medians of wide boulevards. The Euclid Corridor in Cleveland is being implemented as a median busway along Euclid Avenue. The Honolulu In-Town BRT is planned as an 11-mile busway located primarily at grade in the median of arterial streets.

Contraflow Lanes: Contraflow lanes are less common solutions for integration of BRT features with arterial streets. A contraflow lane is typically a bus lane in the opposite direction on what would otherwise be a one-way street. Contraflow lanes sometimes can provide more direct routing for buses when one-way street patterns create detours. Contraflow lanes, even when implemented along the curb, do not generally have the same enforcement problems as curbside concurrent lanes.

The Lymmo downtown circulator in Orlando is an example of contraflow bus lane design. For most of the route, the Lymmo travels on streets that were formerly three lanes in the same direction (one-way streets). After conversion to bus lanes, the right-most lane remains for general traffic use and provides access to on-street parking. The center lane was converted to a bus-only lane, with a raised curb separating it from the general traffic lane and providing space for loading. The left-most lane becomes a bus-only lane for opposite-direction bus traffic; loading is on the opposite sidewalk and there is no on-street parking on that side.

An alternative implementation of contraflow lanes on two-way streets is in use in Montreal. Contraflow lanes along the median of a boulevard were used to provide peak-hour service to stations with central platforms using standard right-side boarding buses.

2.1.4. Mixed Traffic

Few BRT systems operate exclusively in mixed traffic, but this is a component of parts of many systems. In these conditions, transit signal priority treatments become especially important for increasing bus speeds in relation to automobile traffic. Even in mixed traffic, special bus signals in combination with dedicated queue jump lanes may be used to give buses priority at intersections. Bus signals are typically implemented in the format of streetcar signals with white horizontal bars representing stop and vertical bars representing go. Signal priority treatments are described in Section 2.4.

2.2. Station Location

Station location and design has a substantial impact on BRT system performance.
2.2.1. Stop Spacing

Bus stop spacing affects both in-vehicle travel time and out-of-vehicle travel time by either requiring passengers to be delayed at more stops en route or by requiring passengers to walk further to reach the stop. Although analysis techniques based on acceleration rates, running speed, dwell time, etc. can determine optimal stop spacing, the most important criterion in selecting bus stop locations is proximity to major activity centers.

Bus stop spacing varies considerably between the systems reviewed. Bus stops tend to be farther apart in suburban areas than in urban areas. Even in suburban areas, bus stops tend to be further apart along expressways than along arterials. As a heavy rail transit extension route, the South Dade Busway in Miami operates in a suburban context along an arterial street and has bus stops spaced approximately every 0.5 mile. In Los Angeles, the Metro Rapid BRT system’s stop spacing focuses primarily on major destinations and transfer points, with stop intervals approximately every 0.8 to 1.0 miles in a low-density context similar in many places to the Pace service area. The proposed Dulles Corridor BRT project involves a 22-mile extension of the Washington Metro heavy rail system primarily in the median of an existing expressway and includes 11 stations (every 2 miles).

In more urban contexts, systems show similar variability. In Cleveland, the Euclid Corridor Busway has approximately 3 stations per mile (every 0.33 mile). The Ottawa Transitway has an average station spacing of approximately one station per kilometer (every 0.6 mile), with stops clustered closer together in the central city and farther apart in the suburbs. In Vancouver, British Columbia, the Rapid Bus running from the CBD to the University has 14 stations over an 11-mile route (every 0.8 mile).

2.2.2. Limited Stop Service

One way to maintain close station spacing and reduce travel time is to skip stops along the route. Some BRT systems, such as the Western Avenue X49 service in Chicago, operate as express routes overlaid on local routes. Likewise, the Los Angeles Metro Rapid BRT system replaces existing limited-stop service and leaves existing local bus service unchanged.

Some busways are constructed to allow buses to pass each other at stations, or even en route. Passing provisions are a necessary physical component of any skip-stop service pattern. For example, although skip-stop operations are not practiced, the Ottawa Transitway is constructed as a two-lane facility in each direction to allow for passing. In general, even one-lane busways physically accommodate passing vehicles to avoid delays associated with disabled vehicles.

2.2.3. Relationship with Busway

There are three basic types of stations used in BRT systems as differentiated by their relationship to the busway. Types of stations include on-line stations, bus turnouts, and off-street transit centers.

Most BRT systems use on-line stations or bus turnouts. On-line stations are suitable for application in busways, expressway medians, arterial medians, and arterial curb lanes. On-line
stations mimic the operation of rail stations where vehicles stop without leaving their line-haul right-of-way. Where on-line stations along a busway include passing lanes, bus turnouts result. The use of bus turnouts is generally avoided in mixed traffic applications to eliminate delays associated with buses merging back into traffic. Some jurisdictions, such as Washington State, Oregon, and Florida, have enacted priority merge rules for buses that require motorists to yield to buses re-entering the traffic stream.

Where bus lanes are provided with curbside parking or where buses operate in mixed traffic, bus bulbs can reduce merge delay and provide additional space for shelters and other amenities. Bus bulbs are extensions of the sidewalk through the parking lane. They prevent illegal parking in bus stops and can increase the amount of on-street parking by allowing parking in what would have been the taper areas of the bus turnout. In mixed traffic, however, they increase delays for cars waiting behind the stopped bus.

Off-street transit centers are used primarily at major transfer centers or terminals along a BRT route. On the South Dade Busway in Miami, off-street transit centers are provided at each end. In Houston, off-busway transit centers are provided to interface with park-and-ride lots. Off-street transit centers are also sometimes used, to provide more direct interfaces with suburban shopping malls and to improve physical integration with feeder bus services.

2.2.4. Relationship with Intersection

Bus stops can be located on the near side of an intersection, on the far side or at mid-block. In general far-side stops are preferable, especially when used with transit signal priority treatments. This allows much greater time for signal controllers to react to requests for priority. Far-side stops also reduce bus conflicts with right-turn movements that occur at near-side stops. Far-side stops also allow buses to use gaps in traffic created by the intersection for merging. The Los Angeles Metro Rapid Bus system uses far-side bus stops exclusively to accommodate signal priority.

TCRP Report 19 (Guidelines for the Location and Design of Bus Stops) provides considerable detail for the analysis of desired bus stop location.

2.3. Passenger Facilities

Premium passenger facilities are a major component of the premium transit service that BRT provides. Careful attention to passenger facility design can not only improve transit operations through reduced dwell times and lower operating costs, but can positively influence a customer's overall transit experience.

2.3.1. Weather Protection

Passenger shelters for BRT systems are generally upgrades over shelters used for standard bus service. Some passenger facilities approach the degree of enclosure, separation of pedestrian walkways and transit vehicles, and amenities typical of rail transit stations. For example, many stations along the Ottawa Transitway provide full overhead canopies, sheltered seating areas, and
pedestrian bridges with escalators and elevators over the busway. Likewise, the Dulles BRT Project, planned as an extension of the Washington Metro, includes rail-like stations in the median of the Dulles Access Road.

BRT systems that include at-grade bus lanes on arterial streets typically employ simpler shelter designs. Passengers cross the busway at grade to enter and exit the station. Shelters are generally larger than standard bus shelters, in part to accommodate higher passenger loads. Shelters typically include both roofs and walls for protection from the elements. Seating areas are not uncommon.

2.3.2. Level Boarding

Level boarding reduces boarding time for all passengers, but especially those with mobility impairments. Level boarding can be achieved by either lowering the floor of the bus (using low-floor vehicles), raising the level of the platform, or both. According to the *Transit Capacity and Quality of Service Manual* (TCRP, 2000), dwell times on low floor buses average 85% of the times on normal buses. When the need to cycle a wheelchair lift is avoided, more than 60 seconds can typically be saved.

The Curitiba BRT System pioneered level boarding with its innovative tube stations. Wheelchair lifts are provided at stations to assist the mobility impaired with the transition from sidewalk level to platform level (approximately 20 inches off the sidewalk). Buses are equipped with ramps that extend when the doors open to close the gap between the vehicle and the platform. The floor of the bus is at the same height as the platform.

With modern low-floor buses, level boarding can be achieved with platforms between 6 and 12 inches off the pavement (or zero to 6 inches off the sidewalk). Precision docking mechanisms are available to minimize the gap between the vehicle and the platform. For example, in 1997, New York City Transit successfully demonstrated low-floor buses with full automatic control. The buses were equipped with vision and radar sensors to control the bus in both lateral and longitudinal directions. The use of mechanical systems, such as the guide wheels used on some busways, is also an option, particularly at stations.

2.3.3. In-Station Passenger Information

Advanced Traveler Information Systems (ATIS), such as countdown signs displaying the time until the next transit vehicle arrives have been deployed on many rail transit systems around the world. These systems reduce passenger anxiety about how long the wait will be for the next vehicle and improve the transit experience.

The London Countdown system extended the technology to buses on key routes. With advances in automatic vehicle location (AVL) technology, countdown signs have begun to be applied to bus transit systems in the United States. The NextBus system in San Francisco and Oakland, California, provides real-time updates of bus location to displays located at bus stops and to wireless users via pager technology.
2.4. Transit Signal Priority

Transit signal priority involves giving special treatment to buses at intersections. This can be accomplished with green extension (holding a green light for a bus), red truncation (giving an early green signal to an approaching bus), or allowing buses to proceed first from the intersection using a special signal phase and a queue jumper lane.

There are two methods for triggering signal priority treatment in roadside traffic signal controllers. Passive priority gives priority to every bus approaching an intersection when timing of arrival permits. Active priority allows buses to only request priority treatment when they are running behind schedule and/or have full passenger loads. This approach requires automatic vehicle location (AVL) systems to determine schedule adherence. Both approaches require interfaces with central traffic signal control centers or dedicated short-range communications in the form of radio transponders, infrared emitters, or other means between the bus and the signal controller.

Pace is already a leader in the development of transit signal priority systems, having successfully demonstrated passive signal priority along Cermak Avenue in 1993. Pace’s Intelligent Bus System, in combination with traffic signal controller interfaces developed through RTA and IDOT initiatives, will allow for active transit signal priority in the future.

2.5. Vehicle Design

Innovative vehicle design provides a means to differentiate BRT service from traditional bus service. Curitiba’s BRT system is characterized by its bright red, double-articulated, level-boarding vehicles. The CIVIS system uses a sleek, futuristic-looking vehicle with extraordinarily large side windows, low-floor design, and electric propulsion. Each of these examples uses the design of the vehicle to create a large part of the identity of the system.

2.5.1. Low-Floor Vehicles

Low-floor vehicles are used in many of the existing and planned BRT systems in the United States. As described in Section 2.3.2, low-floor vehicles support level boarding, which reduces dwell time, with platforms typically lower than those used in Curitiba. Platforms can be only a few inches higher than normal curb height, which eliminates the need for Curitiba-style wheelchair lifts at stations. Low-floor vehicles are also popular with BRT systems because their availability from many vendors ensures price competition in procurement, both initially and in the future.

2.5.2. Door Capacity

BRT systems that use off-board fare payment methods are able to reduce dwell time by allowing passenger to board and alight through multiple side doors. Some vehicle designs include three doors in a standard 40-foot bus and more in articulated buses. In addition, wider doors, in some cases with more than 48 inches clear width, speed boarding and alighting by allowing passengers
to pass each other while entering and leaving the bus. Doors wider than 32 inches, the standard for rail vehicle doors, accommodate wheelchair boarding.

2.5.3. On-Board Amenities

BRT vehicles often offer upgraded interior materials and finishes, including upholstered seats and individual air vents. More comfortable seat designs are especially common on systems that provide serve long commutes, such as on the Houston HOV system. The use of AVL systems on BRT vehicles not only improves dispatching efficiency and supports passenger information systems at stations, but also can interface with next-stop annunciators and variable message signs on-board.

2.5.4. Propulsion System

BRT systems employ a range of propulsion technologies, from clean diesel to compressed natural gas (CNG) to hybrid electric systems to fully electric systems. Most systems in the United States use conventional diesel or CNG propulsion systems to avoid costs associated with building and maintaining power distribution along the guideway.

An alternative is hybrid electric propulsion systems. Hybrid propulsion reduces air and noise pollution by using an internal combustion engine on-board the vehicle to drive a generator that produces electric power to charge batteries. The batteries are also charged during braking by operating the motors as generators (regenerative braking), which converts the kinetic energy of the vehicle into electrical power stored in the battery. Current is drawn from the batteries to run electric motors that drive the wheels, and the internal combustion engine is not directly coupled to the wheels. The configuration is similar to diesel/electric locomotives that have been in service for years. Hybrid buses are under consideration in Honolulu.

Fully electric buses represent the quietest transit mode of all and produce no tailpipe emissions. Electric trolley buses, powered by catenary (overhead wires), are proven technology. They are currently used in the Seattle bus tunnel (dual-mode buses operate with internal combustion engines outside the tunnel) and are planned along the Euclid Corridor in Cleveland. Electric trolley buses require overhead wires along the route, which is considered by some to be unsightly. The CIVIS system selected for the Las Vegas BRT system and under consideration for Eugene, Oregon, uses electric propulsion with innovative hub motors in each wheel.

An Italian firm, Ansaldo Breda, has developed a segmented power strip that is embedded in the pavement. In the STREAM Embedded Plate System, each segment of the power strip is energized only when the power collector below the transit vehicle is in contact with the segment. At all other points, the power strip is not energized, posing no threat of electric shock if touched by persons or by crossing traffic. This system has not been deployed in North America.

2.5.5. Automatic Guidance

Automatic guidance in rubber-tired transit applications ranges from fully automated, driverless people mover systems commonly deployed at airports to automatically steered vehicles running
in dedicated busways to precision docking mechanisms that align doors with specific points on passenger platforms and minimize gaps between the platform and the vehicle. People mover systems are considered beyond the scope of the Pace BRT Initiative and are not reviewed in this document.

There are two methods for automatic guidance along busways in use today. The oldest and simplest system uses rollers that run along curbs on each side of the bus way. The rollers are connected to the steering mechanism of the vehicle and guide the bus without any input from the driver. The use of curbs allows the busway to be very little wider than the width of the bus, allowing the system to fit into some space-constrained contexts where normal bus lanes would be difficult or impossible to accommodate.

The CIVIS system uses an optical guidance system that employs a video camera and an image processing algorithm to follow special painted street markings designating the intended path. The effect is the same as with the curbs, but less guideway maintenance is required. In both cases, vehicles can leave the guideway for use in mixed traffic or feeder route applications if power is available.

2.5.6. Appearance

The striking design of the CIVIS system gives the BRT system a physical identity similar to light rail systems. The use of vehicle appearance to promote the marketing of the service is a component of many BRT systems. A notable recent example is the Los Angeles Metro Rapid Bus system, which began service on two routes in June 2000. The buses are painted in a special Rapid Bus Red color at the factory. Special MTA advertising is also used on the buses. Both the ‘king’ and ‘queen’ exterior advertisement spaces will have displays of the Rapid Bus routing and stations in a ‘Rail line’ – like stylized map. The exterior paint scheme is coordinated with the station design.

2.6. Fare Collection

Fare collection systems in use on BRT systems range from traditional bus fareboxes to proof-of-payment systems common on light rail systems to barrier systems common on heavy rail systems. The use of off-board fare payment significantly reduces dwell time at bus stops because passengers need not queue at the front door of the bus to pay their fares and board. According to the Transit Capacity and Quality of Service Manual (TCRP, 2000), pre-payment reduces per-passenger boarding times by 33% compared to systems that require cash payment on the bus.

The most common approach to fare pre-payment on LRT and BRT systems is proof-of-payment and the industry trend appears to be moving in this direction. Most of the new light rail systems in North America use proof-of-payment fare collection policies. The Ottawa Transiway and Vancouver Rapid Bus BRT systems already use proof-of-payment systems. The policy is being considered or will be implemented on near-future BRT systems in Cleveland, Louisville, and Eugene.

TCRP Report 10 (Fare Policies, Structures, and Technologies) ranked proof-of-payment highest among fare collection systems, including payment-on-entry and barrier systems. The only
criterion on which proof-of-payment was considered inferior to other systems was “impact on fare evasion or abuse.” Systems vary on the extent to which they use random fare checks to limit fare evasion.

Barrier systems are used in Curitiba. Passengers pay their fare at the station before entering the waiting area and boarding the vehicle. While dwell times are minimized by pre-payment of fares, cash handling systems and, in many cases, station attendants are required. The dispersion of cash collection points increases the operating costs associated with this system. This design has not been duplicated on any of the recent BRT systems in North America.

2.7. Access to Transit

Unlike traditional bus routes, BRT systems frequently accommodate multiple modes of access. BRT stations often accommodate bicycle parking, kiss-and-ride facilities, park-and-ride facilities. Kiss-and-ride and park-and-ride are especially common on systems in outlying areas, such as the Houston HOV system and the Dulles BRT project.

Station-area development is also important to enhancing ridership. Ottawa has achieved some success with integrating BRT stations with major shopping malls. The stations are built in the outlots of the property and infill development is constructed between the stations and the mall. This improves the pedestrian connection between the BRT station and the mall. In addition, malls frequently offer considerable unused parking that may be available for commuter parking.

Especially along arterial streets, many BRT customers will arrive by foot. Good pedestrian access, including complete sidewalk networks, marked crosswalks, and pleasant walking environments are important for promoting access between BRT stations and surrounding trip generators and attractors.
3. Experience with Bus Rapid Transit

The tables that follow summarize many of the key features of some of the BRT systems reviewed in this document. These tables allow for easy comparison of systems.

Table 3.1 shows basic system characteristics, including route length, service characteristics, and construction cost.

Table 3.2 shows physical characteristics of the infrastructure, including busway type, degree of separation from traffic, orientation of the route in relation to the central business district, use of transit signal priority treatments, station characteristics, and use of passenger information systems.

Table 3.3 shows vehicle configuration characteristics, including vehicle type, level boarding, door capacity, seating capacity, propulsion technology, use of automatic guidance, and fare payment method.
<table>
<thead>
<tr>
<th>Transit System</th>
<th>Length</th>
<th>Vehicles</th>
<th>Peak Headway</th>
<th>Service Span</th>
<th>Construction Costs (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eugene, Oregon</td>
<td>4 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orlando Lymmo System</td>
<td>3 miles</td>
<td>10</td>
<td>5 min.</td>
<td>6am - 10pm</td>
<td></td>
</tr>
<tr>
<td>Ottawa Transitway</td>
<td>19 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honolulu H-1 Bus Rapid Transit</td>
<td>11.6 miles</td>
<td>2-4 min.</td>
<td></td>
<td></td>
<td>$660</td>
</tr>
<tr>
<td>Los Angeles County (LADOT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles to Santa Monica</td>
<td>18.5 miles</td>
<td>58</td>
<td>2 - 4 min.</td>
<td>5am - 11pm</td>
<td>Capital: $149</td>
</tr>
<tr>
<td>San Fernando Valley to Chandler</td>
<td>14.0 miles</td>
<td>58</td>
<td>2 - 4 min.</td>
<td>5am - 11pm</td>
<td>Ann. Op.: $17.9</td>
</tr>
<tr>
<td>Cleveland Euclid Avenue BRT</td>
<td>5 miles</td>
<td>6 min.</td>
<td>4am - 1am</td>
<td></td>
<td>$205.4</td>
</tr>
<tr>
<td>Nashville Urban Core BRT</td>
<td>4.2 miles</td>
<td>7 - 9 min.</td>
<td>5am - 1am</td>
<td></td>
<td>$53.5</td>
</tr>
<tr>
<td>Vancouver RapidBus</td>
<td>11 miles</td>
<td>26</td>
<td>4 min.</td>
<td>6am - 1am</td>
<td>$8.8</td>
</tr>
<tr>
<td>Dulles Corridor BRT</td>
<td>22 miles</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hartford/New Britain Conn.</td>
<td>9 miles</td>
<td>30</td>
<td>6 min.</td>
<td>6am - 12am</td>
<td>$82</td>
</tr>
<tr>
<td>Louisville River City BRT</td>
<td>16 miles</td>
<td>22</td>
<td>5 min. trunk</td>
<td>6am - 1am</td>
<td></td>
</tr>
<tr>
<td>South Miami-Dade Busway</td>
<td>8.5 miles</td>
<td>49</td>
<td>3 min.</td>
<td>6am - 1am</td>
<td>$32.5</td>
</tr>
<tr>
<td>Santa Clara Valley Rapid Bus</td>
<td>27 miles</td>
<td>40</td>
<td>10 min.</td>
<td>24 hr.</td>
<td>$32.5</td>
</tr>
<tr>
<td>West Busway - Pittsburgh</td>
<td>16.1 miles</td>
<td>16 routes</td>
<td>5 min.</td>
<td>5am - 1am</td>
<td>$326.8</td>
</tr>
<tr>
<td>Seattle/King County</td>
<td>1.2 miles</td>
<td>70</td>
<td>5 min.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.2: BRT System Physical Characteristics

<table>
<thead>
<tr>
<th>Route Characteristics</th>
<th>Signal Priority</th>
<th>Station Configuration</th>
<th>Station Enclosure</th>
<th>Level Boarding</th>
<th>Passenger Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial Suburb to CBD</td>
<td>Yes</td>
<td>Off-Street</td>
<td>High</td>
<td>Low Floor Bus</td>
<td>In Station</td>
</tr>
<tr>
<td>Downtown Area</td>
<td>Yes</td>
<td>Off-Street &amp; On-Line</td>
<td>High</td>
<td>Low Floor Bus</td>
<td>Electronic Kiosks</td>
</tr>
<tr>
<td>Radial Suburb to CBD</td>
<td>Yes</td>
<td>On-Line</td>
<td>Low</td>
<td>Not Level</td>
<td>On Bus</td>
</tr>
<tr>
<td>Radial Suburb to CBD</td>
<td>Yes</td>
<td>On-Line</td>
<td>High</td>
<td>Level Boarding</td>
<td>In Station &amp; On Bus</td>
</tr>
<tr>
<td>Mix of corridors</td>
<td>Yes</td>
<td>Off-Street</td>
<td>High</td>
<td>Raised Platform</td>
<td>In Station</td>
</tr>
<tr>
<td>Radial Suburb to CBD</td>
<td>Yes</td>
<td>On-Line</td>
<td>Low</td>
<td>Low-level Platform</td>
<td></td>
</tr>
<tr>
<td>CBD to University</td>
<td>Yes</td>
<td>Off-Street</td>
<td>High</td>
<td>Level Boarding</td>
<td>In Station</td>
</tr>
<tr>
<td>CBD to University</td>
<td>Yes</td>
<td>Off-Street</td>
<td>High</td>
<td>Kneeling Bus</td>
<td>On Bus</td>
</tr>
<tr>
<td>Dulles Airport Corridor</td>
<td>n/a</td>
<td>In Median</td>
<td>Low</td>
<td>Slightly raised</td>
<td>On-Bus</td>
</tr>
<tr>
<td>Radial CBD to CBD</td>
<td>Yes</td>
<td>On-Line</td>
<td>Low</td>
<td></td>
<td>On-Bus</td>
</tr>
<tr>
<td>Radial Suburb to CBD</td>
<td>Yes</td>
<td>On-Line</td>
<td>Low</td>
<td></td>
<td>On-Bus</td>
</tr>
<tr>
<td>Radial Suburb to Rail Line</td>
<td>No</td>
<td>Off-Street &amp; On-Line</td>
<td>Low</td>
<td>Not Level</td>
<td>On-Bus</td>
</tr>
<tr>
<td>Radial Suburb to CBD</td>
<td>Yes</td>
<td>On-Line</td>
<td>Low</td>
<td>Slightly raised</td>
<td>On-Bus</td>
</tr>
<tr>
<td>Radial Suburb to CBD</td>
<td>Yes</td>
<td>On-Line</td>
<td>Low</td>
<td>Not Level</td>
<td>On-Bus</td>
</tr>
<tr>
<td>Downtown Area</td>
<td>n/a</td>
<td>On-Line</td>
<td>Level Boarding</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Table 3.3: BRT System Vehicle Characteristics

<table>
<thead>
<tr>
<th>Transit System</th>
<th>Low Floor</th>
<th>Vehicle Type</th>
<th>Door Capacity</th>
<th>Seating Capacity</th>
<th>Propulsion System</th>
<th>Automatic Guidance</th>
<th>Fare Collection</th>
<th>Vehicle Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eugene, Oregon</td>
<td>Yes</td>
<td>40'</td>
<td>2</td>
<td>50</td>
<td>Diesel</td>
<td>No</td>
<td>Off-Vehicle</td>
<td></td>
</tr>
<tr>
<td>Orlando Lynmo</td>
<td>Yes</td>
<td></td>
<td>2</td>
<td>50</td>
<td>CNG</td>
<td>No</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>Ottawa Transitway</td>
<td>No</td>
<td>Artic</td>
<td>2</td>
<td>65</td>
<td>Diesel</td>
<td>No</td>
<td>Proof-of-Payment</td>
<td></td>
</tr>
<tr>
<td>Honolulu H-1 Bus Rapid Transit</td>
<td>Yes</td>
<td>Artic</td>
<td>3</td>
<td>150</td>
<td>Diesel/Electric</td>
<td>No</td>
<td>Proof-of-payment</td>
<td></td>
</tr>
<tr>
<td>Los Angeles Metro Rapid Bus</td>
<td>Yes</td>
<td>Artic</td>
<td>2</td>
<td>65</td>
<td>Diesel</td>
<td>No</td>
<td>Off Vehicle</td>
<td>Special Red Color</td>
</tr>
<tr>
<td>Cleveland Euclid Avenue BRT</td>
<td>Yes</td>
<td>Artic</td>
<td>3 per side</td>
<td>90</td>
<td>Electric</td>
<td>No</td>
<td>Proof-of-payment</td>
<td>Special Red Color</td>
</tr>
<tr>
<td>Nashville Urban Core BRT</td>
<td>Yes</td>
<td>Artic</td>
<td>2</td>
<td>65</td>
<td>Electric</td>
<td>No</td>
<td>Off Vehicle</td>
<td>Electric Trolleybus</td>
</tr>
<tr>
<td>Vancouver Rapid Bus</td>
<td>Yes</td>
<td>Mix</td>
<td>2</td>
<td>70</td>
<td>Diesel</td>
<td>No</td>
<td>Proof-of-payment</td>
<td></td>
</tr>
<tr>
<td>Dulles Corridor BRT</td>
<td>Yes</td>
<td>Artic</td>
<td>2</td>
<td>65</td>
<td>Diesel</td>
<td>No</td>
<td>On-Vehicle Electronic</td>
<td>BRT paint scheme</td>
</tr>
<tr>
<td>Hartford/New Britain Conn.</td>
<td>Yes</td>
<td>Mix</td>
<td>2</td>
<td>45-60</td>
<td>Diesel</td>
<td>No</td>
<td>Proof-of-payment</td>
<td>BRT paint scheme</td>
</tr>
<tr>
<td>Louisville River City BRT</td>
<td>Yes</td>
<td>Artic</td>
<td>2</td>
<td>60</td>
<td>CNG/Diesel</td>
<td>No</td>
<td>Proof-of-payment</td>
<td></td>
</tr>
<tr>
<td>South Miami-Dade Busway</td>
<td>No</td>
<td>Mix</td>
<td>1</td>
<td>60</td>
<td>Diesel</td>
<td>No</td>
<td>On Bus</td>
<td></td>
</tr>
<tr>
<td>Santa Clara Valley Rapid Bus</td>
<td>Yes</td>
<td>Artic</td>
<td>2</td>
<td>60</td>
<td>Diesel</td>
<td>No</td>
<td>Off-Vehicle</td>
<td></td>
</tr>
<tr>
<td>West Busway - Pittsburgh</td>
<td>No</td>
<td>Mix</td>
<td>1</td>
<td>45-60</td>
<td>Diesel</td>
<td>No</td>
<td>On Bus</td>
<td></td>
</tr>
<tr>
<td>Seattle/King County</td>
<td>Yes</td>
<td>Artic</td>
<td>1</td>
<td>65</td>
<td>Electric/Diesel</td>
<td>No</td>
<td>On-Bus</td>
<td></td>
</tr>
</tbody>
</table>
4. Recommendations for Pace

This section interprets some of the key findings from the review of the systems described above. Nothing in the literature describes each BRT feature in terms of its relative cost effectiveness, such as cost per new rider. Such a measure, while providing a good indicator of which features to include or not include, would be difficult to measure in isolation and has not been the focus of any research reviewed herein.

In the absence of this information, this report takes a slightly less rigorous, but similarly intentioned, approach. Experience with each of the BRT features described in Section 2 is reviewed in terms of its applicability to the Pace operating environment, in terms of its relative contribution to the success of the BRT systems that employ the feature, and in terms of its relative cost of implementation. The objective is to identify those features that would be highly desirable, cost-effective components of any Pace BRT Initiative. Desirable features are grouped into those that should be part of any Pace BRT project and those that may be applicable in some corridors but not others, and those that would provide additional benefits if substantial additional resources could be mobilized.

4.1. Features Recommended for All Routes

The most desirable features to include in the Pace BRT Initiative are those that provide the greatest improvements in speed, schedule reliability, and passenger convenience at the least cost. One of the most effective means of achieving the speed and schedule reliability associated with BRT involves minimizing dwell time at stops. There are several approaches to minimizing dwell time, including minimizing the number of stops, minimizing the boarding time required by each passenger, and minimizing the boarding time associated with wheelchair users and others with mobility impairments.

Increasing the speed of the transit vehicle relative to traffic also reduces travel time and improves schedule reliability, but techniques for achieving this tend to cost more to implement.

4.1.1. Limited Stopping Patterns

It is recommended that Pace develop a network of limited stops no less than 1/2 mile apart along BRT routes. This would require abandoning Pace’s current operating policy of making flag stops at any safe location – at least along BRT routes. This provides an opportunity, however, to concentrate resources on the construction of high-quality passenger facilities at key intersections and major activity centers.

4.1.2. Off-Board Fare Payment

It is recommended that Pace adopt a proof-of-payment fare collection system for its BRT routes. This method is currently being used on the majority of light rail systems in North America, is a component of several BRT systems, and is also in use on traditional bus systems in Vancouver and New Jersey. Systems interviewed report that the operating costs are generally lower than for
traditional on-board farebox systems because the burden of fare payment is placed on the passenger. There is some added cost due to the need for personnel to conduct random fare checks and slightly higher fare evasion, but that increased ridership due to improved passenger convenience and reduced travel times justifies the expense.

Pace currently uses a magnetic farecard developed by Cubic Transportation Systems. The farecard format is shared with the Chicago Transit Authority. The farecard stores the remaining cash value on the card and the time and location of most recent use. The system allows unlimited riding and discounted transfers for a period of two hours after initial use. Proof-of-payment could be implemented by equipping passenger facilities with validation devices that would deduct the fare and record the time and location, much like that on a bus farebox or a CTA turnstile. By eliminating queuing at the front door of the bus as customers handle cash and pay their fares and by allowing entry through any door on the bus, dwell times could be substantially reduced at busy stations.

Customers needing to add value to farecards could do so at vending machines on board the vehicle. This would allow all cash handling to remain on the bus, as is the case with traditional fareboxes in use today. Fare evasion would be minimized by equipping personnel with farecard readers that check the time and location of the last validation stamp and by performing random, but sufficiently frequent, on board checks.

4.1.3. Level Boarding

It is recommended that Pace employ vehicles that allow level or nearly level transitions between the floor of the vehicle and the passenger platform. This can be achieved by using low-floor vehicles, raised boarding platforms, or both. Level boarding reduces boarding times per passenger by approximately 15% for able-bodied passengers. By eliminating the need for wheelchair lift deployment, boarding times for the mobility impaired can be substantially reduced as well. For example, a bus driver can deploy a short flip-type ramp across the gap between a bus and the curb in less than 30 seconds, compared to the more than 60-second cycle time associated with lifts. Automatically deploying ramps used at each station for all users, such as in Curitiba, would be even faster. In addition, low floor buses are available from many vendors.

4.1.4. High-Quality Passenger Facilities

As discussed above, part of the premium service provided by BRT is experienced in the passenger facilities. Pace BRT stations should consist of large, distinctively designed passenger shelters that provide not only ample overhead weather protection, but also vertical windscreens. Roofs should be extended over the vehicle boarding areas. Ample station amenities should be provided, including lighting, trash receptacles, seating, and newspaper vending machines. Platforms should be raised slightly above sidewalk level to allow for level boarding. Raised platforms also allow for distinctive floor design treatments. Wheelchair ramps should be provided where needed to make the transition between sidewalk and platform level. Designs will vary from location to location, such as expressway median to dense neighborhood.

To accommodate proof-of-payment fare collection, each station should be equipped with a farecard reader, much like the mechanism used on board current Pace buses. This reader would
allow customers to validate their farecards before boarding the bus. For those who need to recharge their cards or purchase a single use ticket, vending machines would be located on board the bus.

### 4.1.5. Passenger Information Systems

Stations should also make use of the capabilities of the Pace Intelligent Bus System (IBS). This includes passenger information displays showing the time until the next bus in countdown format. Since communications will be needed from a central control center to each station for the fare collection and passenger information systems, the use of remotely monitored security cameras should also be considered.

### 4.1.6. Easy Access to Transit

There are numerous locations in Pace’s suburban environment where continuous sidewalk networks are lacking. High-quality pedestrian connections between BRT stations and adjacent traffic generators will be required to maximize ridership. Likewise, good connections between Pace BRT stations and intersecting Pace bus routes will be required. To support bicycle access, bicycle racks should be provided at each station. At major off-street facilities or where space permits, park-and-ride and kiss-and-ride facilities should be integrated. Coordination of development of BRT facilities with outlot development at major shopping centers has been successful in Ottawa and merits further investigation in Chicago.

### 4.1.7. Distinctive Route Marketing

Highly recognizable physical facilities, signage, and vehicle graphics should be used to raise the visibility of Pace BRT systems. It is recommended that Pace develop a coordinated, innovative graphics program and integrate it with widespread marketing activities. Color coded buses, such as in Pace yellow and blue, used in conjunction with color-coordinated shelters. Vehicle graphics, signage, schedules, web sites, marketing materials, and other printed matter should be coordinated to exhibit a cohesive look and feel.

### 4.2. Corridor-Specific Features

Some features apply only to certain types of routes. It is envisioned that Pace BRT systems will operate in mixed environments including arterial streets, expressway and tollways, HOV facilities, and potentially busways. Where applicable the following technologies and design approaches should be used.

#### 4.2.1. Transit Signal Priority

Pace has expressed the desire to make maximum use of transit signal priority treatment for both BRT routes and regular routes. The Study Team fully supports this position. Pace BRT projects should be selected to operate on designated high-priority signal priority corridors as defined by
the Illinois Department of Transportation (IDOT) and the Regional Transportation Authority (RTA). In general, transit signal priority works best with far-side bus stops. In arterial streets locations where signal priority is used, it is recommended that BRT stations be located on the far side of intersections.

4.2.2. Tollway and Expressway Priority

Pace express bus routes already use I-PASS transponders to gain priority treatment at toll plazas on the Illinois State Toll Highway Authority (ISTHA) system. Where available, Pace buses use I-PASS Express lanes to avoid stopping at toll plazas. It is recommended that this practice be continued.

Where tollways or expressways are scheduled for reconstruction, it is recommended that Pace coordinate with ISTHA or IDOT to integrate bus priority features into new designs. Priority features that may be applicable in Northeast Illinois include HOV lanes, dedicated median bus lanes that could eventually be converted to rail, bus-only T-ramps to serve stations at cross-streets, and ramp metering bypass lanes. Dedicated bus-only access routes may also be possible at toll plazas and tollway oases using transponder technology. Shoulder use of expressways and tollways is not recommended because of the conflicts created with merging vehicles and disabled vehicles.

4.2.3. Arterial Bus Lanes

The use of dedicated bus lanes, especially along the curb of arterial streets, should be investigated. These solutions are available at relatively little cost compared to other forms of busways. Although the fact that they often share space with right-turning vehicles reduces their effectiveness, there may be opportunities where bus lanes could increase the person throughput of intersections or roadway links. The selection of curbside bus lanes, and queue jumper lanes will be made on a case-by-case basis considering site-specific physical and operational constraints.

4.3. Optional Features

4.3.1. Exclusive Guideway

No single feature could do more to improve the speed and schedule reliability of BRT in the most congested corridors than fully separating the transit vehicle from traffic. This can be accomplished using a combination of dedicated bus lanes in the median of expressways, dedicated bus lanes in the median of arterials, unused rail corridors, or other rights of way. These features often require a substantial portion of the available cross section of a roadway and require significant capital costs for street reconstruction. For this reason, it is recommended that Pace identify opportunities for integration of exclusive bus lanes and busways in future highway and road construction projects, where costs can be shared with other implementing agencies. As a precursor to dedicated facilities, less expensive approaches, such as transit signal priority and curbside bus lanes may be used before facilities are reconstructed.
4.3.2. Advanced Transit Vehicles

BRT networks that include fully dedicated guideways allow for application of more advanced technologies that more closely imitate the operating characteristics of light rail systems. Multiple-articulated vehicles with guidance mechanisms become possible when BRT vehicles are fully separated from traffic. This technology allows for higher vehicle capacities, precise docking that eliminates the need for wheelchair ramps, and narrower lane widths, but requires considerably more infrastructure construction. Such systems have been most frequently deployed in the central areas of cities without other forms of fixed-guideway transit. In general, Chicago suburbs do not have the central business district population and employment density to justify investments in such high capacity transit systems. However, the rail-like image that these systems project could be an important component of attracting ridership to the BRT system.
Works Cited


Appendix A  Citation for Bus Rapid Transit References

Appendix A of the Draft Phase I Report contained a copy of the Bus Rapid Transit Reference Guide, which is available on the Federal Transit Administration website, www.fta.dot.gov. The Study Team found this to be among the best, concise references on the subject of BRT systems. The reference for the guide is provided for the benefit of the reader here in the final report rather than the full document due to the volume of other material in this final report.
Task 2 – Universe of Locations
This document fulfills the requirements of Task 1 in the study scope of work, which includes a domestic and international review of current operating and planning applications of bus rapid transit (BRT) that are analogous to Pace’s Bus Rapid Transit Initiative as discussed in the project Kick-Off Meeting. The literature review mainly focuses on projects in Europe, South America, Canada, and the United States, that have been planned and/or implemented.
BUS RAPID TRANSIT INITIATIVE

Task 2 Technical Memorandum 1: Universe of Locations

1. Introduction

This technical memorandum summarizes work conducted in accordance with Task 2 in the study scope of work. Task 2 includes the selection of a location for concept design of an initial Bus Rapid transit (BRT) project by Pace. The universe of potential locations was discussed in Task 0 at the first meeting of the Study Technical Committee (STC) in November 2000. This report summarizes the first phase of the screening process of those locations for the selection of the single concept design location. The first phase of the screening reduces the Universe of Locations to a subset of up to seven facilities at which more detailed analysis of physical and operational characteristics will be conducted. The physical and operational analysis will be documented in Task 2 Technical Memorandum 2.

2. Universe of Facilities from Task 0

The STC suggested that the first Pace BRT project should have one or more of the following characteristics:

- Component of the Strategic Regional Transit (SRT) system as defined by the Chicago Area Transportation Study (CATS). The SRT system includes the most important regional rail and bus routes as defined by ridership and network connectivity. The SRT system includes the entire CTA and Metra rail systems and a group of the most heavily used CTA and Pace bus routes in the region. More information about the SRT system is available in

- Construction as a precursor to rail service on one of the two circumferential rail routes included in the CATS Destination 2020 Regional Transportation Plan.

- Location in the Interstate 90 Northwest Corridor, which is already under consideration for one of several transit improvements, including Bus Rapid Transit.
• Location in the IL-53 – I-290 – I-355 North South Corridor between Lake-Cook Road and Interstate 55, which includes the major suburban centers of Schaumburg / Rolling Meadows / Elk Grove Village and Downers Grove / Lisle / Naperville.

The STC also requested that the universe of locations include at least one representative from each of the six counties in which Pace provides service.

2.1. Pace Strategic Regional Transit Routes

The CATS SRT system includes more than 60 existing and planned fixed route bus corridors served by Pace. Some routes are currently in service. The SRT system also includes 18 express routes identified in the 1992 Pace Comprehensive Operating Plan document. Pace currently provides service along some of these routes.

Table 1 shows the SRT routes included in the Universe of Locations. The transit facilities in this section include fixed Pace SRT routes that are considered good candidates for BRT due to their high ridership and locations along strategic arterials. Expressway and tollway routes that are listed in Pace’s Comprehensive Operating Plan are also included in the table.

Table 1: Pace Strategic Regional Transit Routes

<table>
<thead>
<tr>
<th>Route Number</th>
<th>Road From</th>
<th>To</th>
<th>Road From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>COP-1</td>
<td>I-94</td>
<td>Gurnee</td>
<td>Lake Cook Rd.</td>
<td></td>
</tr>
<tr>
<td>COP-2</td>
<td>Lake Cook Rd.</td>
<td>IL-43</td>
<td>IL-53 Extension</td>
<td></td>
</tr>
<tr>
<td>COP-3</td>
<td>I-294</td>
<td>Lake Cook Rd.</td>
<td>I-290</td>
<td></td>
</tr>
<tr>
<td>COP-4</td>
<td>Proposed Elgin-O'Hare</td>
<td>O'Hare Airport</td>
<td>Elgin</td>
<td></td>
</tr>
<tr>
<td>COP-6</td>
<td>IL-53, I-355, I-55</td>
<td>Lisle</td>
<td>Wilmington</td>
<td></td>
</tr>
<tr>
<td>COP-7</td>
<td>I-88</td>
<td>Plainfield Rd.</td>
<td>Sugar Grove</td>
<td></td>
</tr>
<tr>
<td>COP-8</td>
<td>I-80</td>
<td>I-294 in Hazel Crest</td>
<td>Joliet</td>
<td></td>
</tr>
<tr>
<td>COP-9</td>
<td>COP-12</td>
<td>IL-120</td>
<td>Waukegan</td>
<td></td>
</tr>
<tr>
<td>COP-13</td>
<td>COP-13</td>
<td>IL-25, Kirk Rd.</td>
<td>Elgin</td>
<td></td>
</tr>
<tr>
<td>COP-14</td>
<td>COP-14</td>
<td>I-394, I-294, I-88</td>
<td>Sauk Village</td>
<td></td>
</tr>
<tr>
<td>COP-15</td>
<td>COP-15</td>
<td>Busse, Higgins</td>
<td>Franklin Park</td>
<td></td>
</tr>
<tr>
<td>COP-16</td>
<td>COP-16</td>
<td>I-355, I-53</td>
<td>Elk Grove Village</td>
<td></td>
</tr>
<tr>
<td>COP-17</td>
<td>COP-17</td>
<td>I-90</td>
<td>Rosemont</td>
<td></td>
</tr>
<tr>
<td>COP-18</td>
<td>COP-18</td>
<td>Cicero, I-290, I-53</td>
<td>Cicero &amp; Ogden</td>
<td></td>
</tr>
<tr>
<td>COP-19</td>
<td>COP-19</td>
<td>I-90</td>
<td>Schaumburg</td>
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<td>COP-20</td>
<td>COP-20</td>
<td>US-34, I-88</td>
<td>Oak Brook</td>
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<tr>
<td>COP-21</td>
<td>COP-21</td>
<td>IL-53 Extension</td>
<td>Grayslake</td>
<td></td>
</tr>
<tr>
<td>COP-22</td>
<td>COP-22</td>
<td>IL-53</td>
<td>Bolingbrook</td>
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Wilbur Smith Associates
Table 1 (cont’d): Pace Strategic Regional Transit Routes

<table>
<thead>
<tr>
<th>Route Number</th>
<th>Road</th>
<th>From</th>
<th>To</th>
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</thead>
<tbody>
<tr>
<td>208</td>
<td>Church St.-Golf Rd</td>
<td>Davis Station</td>
<td>Des Plaines Metra</td>
</tr>
<tr>
<td>209</td>
<td>Golf Rd-Woodfield</td>
<td>Harlem Station</td>
<td>Woodfield Mall</td>
</tr>
<tr>
<td>210</td>
<td>Lincoln Ave</td>
<td>Glenview</td>
<td>Downtown Chicago</td>
</tr>
<tr>
<td>212</td>
<td>Evanston-Glenview-Northbrook</td>
<td>Foster Station</td>
<td>Northbrook Court</td>
</tr>
<tr>
<td>213</td>
<td>Green Bay Rd</td>
<td>Davis Station</td>
<td>Highland Park Metra</td>
</tr>
<tr>
<td>215</td>
<td>Crawford-Howard</td>
<td>Old Orchard Mall</td>
<td>Howard Station</td>
</tr>
<tr>
<td>223</td>
<td>Elk Grv-River Rd Station</td>
<td>Elk Grove Industrial Area</td>
<td>River Road Station</td>
</tr>
<tr>
<td>226</td>
<td>Oakton St</td>
<td>Oakton/Hamilton</td>
<td>Jefferson Park Station</td>
</tr>
<tr>
<td>240</td>
<td>Dee Rd</td>
<td>Golf Mill Mall</td>
<td>Cumberland Station</td>
</tr>
<tr>
<td>250</td>
<td>Dempster St</td>
<td>Evanston</td>
<td>Des Plaines</td>
</tr>
<tr>
<td>270</td>
<td>Milwaukee Ave</td>
<td>Glenbrook Hospital</td>
<td>Jefferson Park Station</td>
</tr>
<tr>
<td>290</td>
<td>Touhy Ave</td>
<td>Howard Station</td>
<td>Cumberland Station</td>
</tr>
<tr>
<td>301</td>
<td>Roosevelt Rd</td>
<td>Des Plaines Station</td>
<td>Hillside (Wolf/Harrimoon)</td>
</tr>
<tr>
<td>303</td>
<td>Madison St-19th Ave</td>
<td>North/9th</td>
<td>Forest Park Transit Station</td>
</tr>
<tr>
<td>304</td>
<td>Cicero-LaGrange</td>
<td>54th Station</td>
<td>LaGrange/Hillgrove</td>
</tr>
<tr>
<td>305</td>
<td>Cicero/River Forest</td>
<td>Trinity H.S.</td>
<td>Morton College</td>
</tr>
<tr>
<td>307</td>
<td>Harlem</td>
<td>Grand/Thatcher</td>
<td>Argo (63rd/Archer)</td>
</tr>
<tr>
<td>309</td>
<td>Lake St</td>
<td>Elmhurst Metra Station</td>
<td>Lake/Austin</td>
</tr>
<tr>
<td>310</td>
<td>Madison St-Hillside</td>
<td>Hillside (Wolf/Harrimoon)</td>
<td>Forest Park Transit Station</td>
</tr>
<tr>
<td>311</td>
<td>Oak Park Ave</td>
<td>North/Narragansett</td>
<td>Lawndale/Joliet</td>
</tr>
<tr>
<td>313</td>
<td>St. Charles Rd</td>
<td>Lake/Austin</td>
<td>Yorktown Center</td>
</tr>
<tr>
<td>318</td>
<td>West North Ave</td>
<td>North/Wolf</td>
<td>Forest Park Transit Station</td>
</tr>
<tr>
<td>319</td>
<td>Grand Ave</td>
<td>Wolf/North</td>
<td>Brickyard Mall</td>
</tr>
<tr>
<td>322</td>
<td>Cermak Rd-22nd St</td>
<td>54th Station</td>
<td>Yorktown Center</td>
</tr>
<tr>
<td>330</td>
<td>Mannheim-LaGrange Rd</td>
<td>O'Hare Airport</td>
<td>Archer/Harlem</td>
</tr>
<tr>
<td>331</td>
<td>Cumberland-5th Ave</td>
<td>Cumberland Station</td>
<td>Brookfield Metra</td>
</tr>
<tr>
<td>349</td>
<td>S. Western</td>
<td>Western/79th</td>
<td>154th/Park</td>
</tr>
<tr>
<td>350</td>
<td>Sibley</td>
<td>Hammond Transit Center</td>
<td>154th/Park (Harvey)</td>
</tr>
<tr>
<td>352</td>
<td>Halsted</td>
<td>95th/Dan Ryan</td>
<td>Chicago Heights Terminal</td>
</tr>
<tr>
<td>353</td>
<td>95th-Riverdale</td>
<td>95th/Dan Ryan</td>
<td>Homewood P-N-R</td>
</tr>
<tr>
<td>357</td>
<td>Lincoln Highway</td>
<td>Lincoln Hwy/Woodlawn</td>
<td>Southwick Dr</td>
</tr>
<tr>
<td>359</td>
<td>Robbins/S. Kedzie Ave</td>
<td>Grenoble Square</td>
<td>119th/Halsted</td>
</tr>
<tr>
<td>364</td>
<td>159th St</td>
<td>Hammond, Indiana</td>
<td>Tinley Park</td>
</tr>
<tr>
<td>379</td>
<td>W. 79th St</td>
<td>Moraine Valley College</td>
<td>Midway Station</td>
</tr>
<tr>
<td>381</td>
<td>95th St</td>
<td>88th/110th</td>
<td>95th/Dan Ryan</td>
</tr>
<tr>
<td>383</td>
<td>S. Cicero</td>
<td>Midway CTA Station</td>
<td>Oak Forest Hospital</td>
</tr>
<tr>
<td>386</td>
<td>South Harlem</td>
<td>Midway CTA Station</td>
<td>Moraine Valley &amp; 127/Homai</td>
</tr>
<tr>
<td>411</td>
<td>Niles Local Service</td>
<td>Niles</td>
<td>Niles</td>
</tr>
<tr>
<td>568</td>
<td>Lakehurst</td>
<td>Washington/Genesee</td>
<td>Lakehurst Mall</td>
</tr>
<tr>
<td>569</td>
<td>Lewis</td>
<td>VA Hospital</td>
<td>Lewis/Edgewood</td>
</tr>
<tr>
<td>572</td>
<td>Waukegan-Hawthorn Center</td>
<td>Washington/Genesee</td>
<td>Hwys. 45 and 60</td>
</tr>
<tr>
<td>606</td>
<td>Northwest Limited</td>
<td>River Road Station</td>
<td>Woodfield Corporate Center</td>
</tr>
</tbody>
</table>

2.2. Circumferential Rail Corridors
The 2020 Regional Transportation plan prepared by CATS included two circumferential rail corridors linking suburbs around Chicago. Metra is currently studying the feasibility of providing rail service in these corridors. Table 2 lists these corridors.

The Outer Circumferential Service runs from Waukegan to Joliet along the single-track Elgin, Joliet & Eastern railroad. The possibility of providing service beyond Joliet through Will County has been studied, but is not considered to be as feasible as the northern portion of the route and is not included in the Universe of Locations.

Four alternatives for the Inner Circumferential service, which runs between O’Hare and Midway airports, are currently under consideration. All run in various railroad rights of way. The Universe of Locations includes all four proposed alignments.

Table 2: Circumferential Rail Corridors

<table>
<thead>
<tr>
<th>Route</th>
<th>Name</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer</td>
<td>EJ&amp;E</td>
<td>Waukegan</td>
<td>Joliet</td>
</tr>
<tr>
<td>Inner Alt. 1</td>
<td>IHB/BRC</td>
<td>O’Hare</td>
<td>Midway</td>
</tr>
<tr>
<td>Inner Alt. 2</td>
<td>MDW/BRC</td>
<td>O’Hare</td>
<td>Midway</td>
</tr>
<tr>
<td>Inner Alt. 3</td>
<td>CSX/BRC</td>
<td>O’Hare</td>
<td>Midway</td>
</tr>
<tr>
<td>Inner Alt. 4</td>
<td>CCP/BRC</td>
<td>O’Hare</td>
<td>Midway</td>
</tr>
</tbody>
</table>

EJ&E = Elgin, Joliet & Eastern  
IHB = Indiana Harbor Belt Railroad  
MDW = Milwaukee District West  
CSX = CSX Transportation  
CCP = Chicago Central & Pacific Railroad  
BRC = Belt Railway Company of Chicago

2.3. Requested Interstate Corridors

For various reasons, the STC and Pace staff have requested that the universe of Locations include the expressway and tollway corridors shown in Table 3. The Interstate 90 corridor is currently under consideration by the Regional Transportation Authority as a potential location for Bus Rapid Transit to be implemented by Pace. Other transit alternatives are also under consideration, including a heavy rail extension of the CTA Blue Line and a commuter rail line constructed as a spur of the Metra North Central Service or the Metra Milwaukee District West Line.

The IL-53 – Interstate 290 – Interstate 355 corridor connects some of the largest and fastest growing suburban activity centers in the region, including the Schaumburg – Rolling Meadows – Elk Grove Village area and the Downers Grove – Lisle – Naperville area. A north-south BRT service in this corridor could provide needed inter-suburban transportation.
Table 3: Requested Interstate Corridors

<table>
<thead>
<tr>
<th>Route</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-90</td>
<td>Rosemont</td>
<td>Elgin</td>
</tr>
<tr>
<td>IL-53 - I-290 - I-355</td>
<td>Lake-Cook Road</td>
<td>I-55</td>
</tr>
</tbody>
</table>

2.4. Other Considerations

The Universe of Locations described in the previous three sections does not include any facilities in McHenry County. The Study Team proposed adding a suburb-to-suburb BRT route between Fox Lake and Woodstock. The proposed alignment approximately follows Pace Route 806 between Fox Lake and McHenry. Between McHenry and Woodstock, the alignment follows IL-120.

3. Initial Screening of Universe

The Universe of Locations described in Section 2 was screened in a 2-part process to identify segments that could represent the best, near-term opportunities for BRT improvements. It is important to distinguish this process from a research design that would identify the best locations region-wide for BRT service. Because of the desire to implement a prototype BRT demonstration project in the near-term, emphasis was given to corridors in which road improvements were already planned or in which some of the required features were already in place.

3.1. Near-Term Opportunities for Improvements

Locations where the Illinois Department of Transportation (IDOT) or the Illinois State Toll Highway Authority (ISTHA) are planning road improvements in the next 5 to 10 years represent opportunities to integrate BRT features into the construction project. This strategy is consistent with a recommended long-term BRT implementation strategy in which Pace would coordinate with IDOT and ISTHA design engineers to include BRT features in future road improvement projects as they are designed.

Arterial streets which IDOT has identified as potential transit signal priority corridors also represent opportunities where some of the infrastructure required for BRT may already be in place. Locations where these conditions overlap with the Universe of Locations were given priority as potential near-term BRT corridors.

3.1.1. Future Road Construction Locations

The map below shows roads, expressways and highways in the 6-county region that are targeted for infrastructure improvements between 2001 and 2005, according to information from IDOT.
and ISTHA. Some of the data used to create this map was obtained from the IDOT blue book titled, “FY 2001-2005 Proposed Highway Improvement Program.” High priority tollway improvements were identified through discussions with ISTHA staff. Implementation schedules for tollway projects will be based on funding availability.

**Figure 1: Future Road Construction Locations**

![Map showing future road construction locations with IDOT and ISTHA routes highlighted.](image-url)
3.1.2. IDOT Signal Priority Corridors

The figure on the following page lists potential signal priority corridors as identified by the Illinois Department of Transportation.

Figure 2: IDOT Signal Priority Corridors
Segmentation of Corridors

Each of the corridors that remained after the initial screening was divided into segments between major activity centers or intermodal transportation facilities, such as Metra stations. With an average length of approximately 4.2 miles, segments represent more manageable initial BRT projects than the numerous lengthy corridors that resulted from the initial phase of the screening.

3.1.3. Arterial Streets

Table 4 includes a list of arterial streets that was produced from an overlay function performed in the ArcView Geographic Information System (GIS). A file consisting of Pace COP and SRT routes was overlaid with a file of IDOT and ISTHA 2001-2005 road improvements and IDOT signal priority corridors. The following table of arterial segments was common to both files. Several segments were excluded because of their location in the City of Chicago or because of their adjacency to Metra or CTA rail lines.

The table also includes projected population and employment quarter-section data for the year 2010 developed by the Northeastern Illinois Planning Commission (NIPC) for each street segment as well as population and employment data per mile. The population and employment data was calculated by dividing the total population and employment in quarter sections within 1/4 to 1/2 mile of each arterial segment by the length in miles of each segment.
### Table 4: Arterial Street Segments

<table>
<thead>
<tr>
<th>Street</th>
<th>From</th>
<th>To</th>
<th>Pop+Emp</th>
<th>Length (mi.)</th>
<th>Pop+Emp/mi.</th>
</tr>
</thead>
<tbody>
<tr>
<td>79th</td>
<td>Harlem</td>
<td>88th</td>
<td>11,164</td>
<td>2.01</td>
<td>5,554</td>
</tr>
<tr>
<td>79th</td>
<td>Cicero</td>
<td>Harlem</td>
<td>21,755</td>
<td>3.01</td>
<td>7,228</td>
</tr>
<tr>
<td>95th</td>
<td>Western</td>
<td>Oak Lawn</td>
<td>48,855</td>
<td>3.51</td>
<td>13,919</td>
</tr>
<tr>
<td>95th</td>
<td>Oak Lawn</td>
<td>Harlem</td>
<td>26,271</td>
<td>2.05</td>
<td>12,815</td>
</tr>
<tr>
<td>159th</td>
<td>Halsted</td>
<td>I-294</td>
<td>19,940</td>
<td>2.31</td>
<td>8,632</td>
</tr>
<tr>
<td>159th</td>
<td>Torrence</td>
<td>Halsted</td>
<td>20,804</td>
<td>3.78</td>
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<tr>
<td>Cermak</td>
<td>Harlem</td>
<td>Tristate</td>
<td>39,105</td>
<td>5.97</td>
<td>6,550</td>
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<tr>
<td>Cermak</td>
<td>Tristate</td>
<td>Highland</td>
<td>60,070</td>
<td>4.71</td>
<td>12,754</td>
</tr>
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<td>Cicero</td>
<td>63rd</td>
<td>127th</td>
<td>86,734</td>
<td>8.06</td>
<td>10,761</td>
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<tr>
<td>Cicero</td>
<td>127th</td>
<td>163rd</td>
<td>27,337</td>
<td>4.05</td>
<td>6,750</td>
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<td>Dempster</td>
<td>Evanston</td>
<td>Skokie Swift</td>
<td>42,861</td>
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<td>12,040</td>
</tr>
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<td>Dempster</td>
<td>Skokie</td>
<td>Des Plaines</td>
<td>82,381</td>
<td>6.45</td>
<td>12,772</td>
</tr>
<tr>
<td>Golf</td>
<td>Arl Heights</td>
<td>Woodfield</td>
<td>36,353</td>
<td>2.67</td>
<td>13,615</td>
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<td>Golf</td>
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<td>Arl Heights</td>
<td>49,239</td>
<td>7.62</td>
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<td>Milwaukee</td>
<td>35,675</td>
<td>4.71</td>
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<td>151st</td>
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<td>Fullerton</td>
<td>Lake</td>
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<td>Harlem</td>
<td>Lake</td>
<td>I-290</td>
<td>18,361</td>
<td>1.03</td>
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<td>Harlem</td>
<td>I-290</td>
<td>43rd</td>
<td>46,853</td>
<td>3.44</td>
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<td>IL-120</td>
<td>Fox Lake</td>
<td>McHenry</td>
<td>11,318</td>
<td>10.91</td>
<td>1,037</td>
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<tr>
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<td>McHenry</td>
<td>Woodfield</td>
<td>22,042</td>
<td>10.67</td>
<td>2,066</td>
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<tr>
<td>Lake</td>
<td>1st</td>
<td>Harvard</td>
<td>38,761</td>
<td>3.67</td>
<td>10,562</td>
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<tr>
<td>Madison</td>
<td>Oak Park</td>
<td>Lathrop</td>
<td>18,361</td>
<td>1.03</td>
<td>17,826</td>
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<tr>
<td>Madison</td>
<td>Lathrop</td>
<td>25th</td>
<td>31,824</td>
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<tr>
<td>Mannheim</td>
<td>Balmoral</td>
<td>Madison</td>
<td>55,578</td>
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</tr>
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<td>Madison</td>
<td>Cermak</td>
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<td>7,645</td>
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</tr>
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<td>Devon</td>
<td>Golf</td>
<td>31,342</td>
<td>4.73</td>
<td>6,626</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>Golf Mill</td>
<td>Lake</td>
<td>16,515</td>
<td>2.77</td>
<td>5,962</td>
</tr>
<tr>
<td>North</td>
<td>Harlem</td>
<td>1st</td>
<td>17,869</td>
<td>1.51</td>
<td>11,834</td>
</tr>
<tr>
<td>North</td>
<td>1st</td>
<td>Harvard</td>
<td>44,540</td>
<td>3.50</td>
<td>12,726</td>
</tr>
<tr>
<td>Oak Park</td>
<td>North</td>
<td>Lake</td>
<td>29,582</td>
<td>1.40</td>
<td>21,130</td>
</tr>
<tr>
<td>Oak Park</td>
<td>Lake</td>
<td>I-290</td>
<td>15,696</td>
<td>1.11</td>
<td>14,141</td>
</tr>
<tr>
<td>Oak Park</td>
<td>I-290</td>
<td>Pershing</td>
<td>59,833</td>
<td>3.53</td>
<td>16,950</td>
</tr>
<tr>
<td>Oak Park</td>
<td>Pershing</td>
<td>51st</td>
<td>7,122</td>
<td>0.83</td>
<td>8,581</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>Laramie</td>
<td>1st</td>
<td>54,120</td>
<td>4.07</td>
<td>13,297</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>1st</td>
<td>Wolf</td>
<td>41,322</td>
<td>3.54</td>
<td>11,673</td>
</tr>
<tr>
<td>Touhy</td>
<td>Kedzie</td>
<td>Cicero</td>
<td>21,667</td>
<td>2.01</td>
<td>10,780</td>
</tr>
<tr>
<td>Touhy</td>
<td>Cicero</td>
<td>Cumberland</td>
<td>47,190</td>
<td>4.22</td>
<td>11,182</td>
</tr>
<tr>
<td>Western</td>
<td>131st</td>
<td>151st</td>
<td>15,731</td>
<td>2.29</td>
<td>6,869</td>
</tr>
</tbody>
</table>
### 3.1.4. Circumferential Rail Routes

Table 5 lists the CATS Inner and Outer Circumferential Rail routes divided into smaller segments between major activity centers or junctions with other commuter rail or rapid transit lines. The four alternatives for the Inner Circumferential Rail routes from O’Hare to Midway are included. Several segments were excluded because they are shared between alternatives. For example, all alternatives use the Metra NCS service between O’Hare and the Milwaukee District West Line. Several segments were eliminated along Cicero Avenue because they are either located entirely in the City of Chicago or parallel service already provided by CTA Bus Routes 54 or 54B along Cicero Avenue (these would be more logically developed as CTA BRT Initiatives). Several segments that run on or adjacent to existing Metra or CTA lines were also excluded.

Again, NIPC population and employment data for the year 2010 within quarter-sections located within 1/4 to 1/2 mile of each rail segment were used to produce the population and employment per mile figures.

#### Table 5: Circumferential Rail Route Segments

<table>
<thead>
<tr>
<th>Street</th>
<th>From</th>
<th>To</th>
<th>Pop+Emp</th>
<th>Length (mi.)</th>
<th>Pop+Emp/mi.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Rail</td>
<td>Waukegan</td>
<td>MD-N</td>
<td>23,102</td>
<td>4.88</td>
<td>4,734</td>
</tr>
<tr>
<td>Outer Rail</td>
<td>MD-N</td>
<td>NCS</td>
<td>15,966</td>
<td>5.30</td>
<td>3,012</td>
</tr>
<tr>
<td>Outer Rail</td>
<td>NCS</td>
<td>UP-NW</td>
<td>27,346</td>
<td>11.13</td>
<td>2,457</td>
</tr>
<tr>
<td>Outer Rail</td>
<td>UP-NW</td>
<td>MD-W</td>
<td>21,558</td>
<td>11.59</td>
<td>1,860</td>
</tr>
<tr>
<td>Outer Rail</td>
<td>MD-W</td>
<td>UP-W</td>
<td>16,138</td>
<td>10.38</td>
<td>1,555</td>
</tr>
<tr>
<td>Outer Rail</td>
<td>UP-W</td>
<td>BNSF</td>
<td>30,800</td>
<td>7.52</td>
<td>4,096</td>
</tr>
<tr>
<td>Outer Rail</td>
<td>BNSF</td>
<td>Joliet</td>
<td>36,292</td>
<td>18.87</td>
<td>1,923</td>
</tr>
<tr>
<td>Inner Rail1</td>
<td>MD-W</td>
<td>UP-W</td>
<td>31,309</td>
<td>2.14</td>
<td>14,630</td>
</tr>
<tr>
<td>Inner Rail1</td>
<td>UP-W</td>
<td>BNSF</td>
<td>34,862</td>
<td>2.98</td>
<td>11,699</td>
</tr>
<tr>
<td>Inner Rail1</td>
<td>BNSF</td>
<td>Midway</td>
<td>55,241</td>
<td>8.52</td>
<td>6,484</td>
</tr>
<tr>
<td>Inner Rail3</td>
<td>MDW</td>
<td>UP-W</td>
<td>23,921</td>
<td>2.52</td>
<td>9,492</td>
</tr>
<tr>
<td>Inner Rail3</td>
<td>UP-W</td>
<td>Forest Park</td>
<td>17,659</td>
<td>0.92</td>
<td>19,195</td>
</tr>
<tr>
<td>Inner Rail4</td>
<td>MD-W</td>
<td>UP-W</td>
<td>31,309</td>
<td>2.17</td>
<td>14,428</td>
</tr>
<tr>
<td>Inner Rail4</td>
<td>UP-W</td>
<td>Broadview</td>
<td>16,585</td>
<td>1.52</td>
<td>10,911</td>
</tr>
<tr>
<td>Inner Rail4</td>
<td>Broadview</td>
<td>BNSF</td>
<td>29,295</td>
<td>3.16</td>
<td>9,271</td>
</tr>
<tr>
<td>Inner Rail4</td>
<td>BNSF</td>
<td>Cicero</td>
<td>28,336</td>
<td>2.21</td>
<td>12,822</td>
</tr>
</tbody>
</table>

### 3.1.5. Expressways and Tollways

Table 6 lists expressway and tollway segments containing the PACE COP and SRT routes that were also scheduled for highway improvements by IDOT or ISTHA. The I-90 and IL- / I-290 / I-355 corridors were also included. Population and employment figures were calculated as above.
### Table 6: Expressway and Tollway Segments

<table>
<thead>
<tr>
<th>Street</th>
<th>From</th>
<th>To</th>
<th>Pop+Emp</th>
<th>Length (mi.)</th>
<th>Pop+Emp/mi.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-53</td>
<td>Lake Cook</td>
<td>I-90</td>
<td>43,776</td>
<td>7.32</td>
<td>5,980</td>
</tr>
<tr>
<td>I-88</td>
<td>Midwest</td>
<td>IL-53</td>
<td>38,333</td>
<td>4.42</td>
<td>8,673</td>
</tr>
<tr>
<td>I-90</td>
<td>Rosemont</td>
<td>Elmhurst</td>
<td>39,470</td>
<td>4.44</td>
<td>8,890</td>
</tr>
<tr>
<td>I-90</td>
<td>Elmhurst</td>
<td>Woodfield</td>
<td>64,480</td>
<td>6.24</td>
<td>10,333</td>
</tr>
<tr>
<td>I-90</td>
<td>Woodfield</td>
<td>Roselle</td>
<td>16,708</td>
<td>1.82</td>
<td>9,180</td>
</tr>
<tr>
<td>I-290</td>
<td>I-90</td>
<td>I-355</td>
<td>43,846</td>
<td>6.58</td>
<td>6,664</td>
</tr>
<tr>
<td>I-294</td>
<td>Dempster</td>
<td>Foster</td>
<td>44,622</td>
<td>4.54</td>
<td>9,829</td>
</tr>
<tr>
<td>I-294</td>
<td>95th</td>
<td>159th</td>
<td>48,753</td>
<td>11.13</td>
<td>4,380</td>
</tr>
<tr>
<td>I-294</td>
<td>159th</td>
<td>Halsted</td>
<td>18,298</td>
<td>3.77</td>
<td>4,854</td>
</tr>
<tr>
<td>I-294</td>
<td>Halsted</td>
<td>I-394</td>
<td>12,626</td>
<td>2.82</td>
<td>4,477</td>
</tr>
<tr>
<td>I-355</td>
<td>I-290</td>
<td>I-88</td>
<td>46,964</td>
<td>12.34</td>
<td>3,806</td>
</tr>
<tr>
<td>I-355</td>
<td>I-88</td>
<td>I-55</td>
<td>39,162</td>
<td>7.57</td>
<td>5,173</td>
</tr>
</tbody>
</table>

### 3.2. Ranking of Segments

Each of the segments described in Section 3.2 was ranked in terms of its combined population and employment density per mile, as projected for 2010 by NIPC. All else being equal, those corridors with the greatest density represent the best candidates for BRT improvements in the near-term.

Table 7 shows the highest ranking segments. The top 21 segments include all segments with densities above 12,000 residential dwellers or jobs per route-mile within 1/2 mile of the facility. Most of the segments fall in the 12,000 to 15,000 residents/employees per mile range. Because many of the segments have relative similar densities from a regional perspective, comparing locations within this group of the highest ranked facilities is not considered to be fruitful. The Study Team recommends considering each of the facilities that merit inclusion in this list relatively equal in terms of density and making further selections based on more detailed site-specific criteria.
Table 7: Highest Ranking Segments

<table>
<thead>
<tr>
<th>Street</th>
<th>From</th>
<th>To</th>
<th>Pop+Emp</th>
<th>Length (mi.)</th>
<th>Pop+Emp/mi.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak Park</td>
<td>North</td>
<td>Lake</td>
<td>29,582</td>
<td>1.40</td>
<td>21,130</td>
</tr>
<tr>
<td>Inner Rail3</td>
<td>UP-W</td>
<td>Forest Park</td>
<td>17,659</td>
<td>0.92</td>
<td>19,195</td>
</tr>
<tr>
<td>Harlem</td>
<td>Fullerton</td>
<td>Lake</td>
<td>45,271</td>
<td>2.44</td>
<td>18,554</td>
</tr>
<tr>
<td>Harlem</td>
<td>Lake</td>
<td>I-290</td>
<td>18,361</td>
<td>1.03</td>
<td>17,826</td>
</tr>
<tr>
<td>Madison</td>
<td>Oak Park</td>
<td>Lathrop</td>
<td>18,361</td>
<td>1.03</td>
<td>17,826</td>
</tr>
<tr>
<td>Oak Park</td>
<td>I-290</td>
<td>Pershing</td>
<td>59,833</td>
<td>3.53</td>
<td>16,950</td>
</tr>
<tr>
<td>Inner Rail1</td>
<td>MD-W</td>
<td>UP-W</td>
<td>31,309</td>
<td>2.14</td>
<td>14,630</td>
</tr>
<tr>
<td>InnerRail4</td>
<td>MD-W</td>
<td>UP-W</td>
<td>31,309</td>
<td>2.17</td>
<td>14,428</td>
</tr>
<tr>
<td>Golf</td>
<td>Crawford</td>
<td>Skokie</td>
<td>13,933</td>
<td>0.98</td>
<td>14,217</td>
</tr>
<tr>
<td>Oak Park</td>
<td>Lake</td>
<td>I-290</td>
<td>15,696</td>
<td>1.11</td>
<td>14,141</td>
</tr>
<tr>
<td>95th</td>
<td>Western</td>
<td>Oak Lawn</td>
<td>48,855</td>
<td>3.51</td>
<td>13,919</td>
</tr>
<tr>
<td>Harlem</td>
<td>I-290</td>
<td>43rd</td>
<td>46,853</td>
<td>3.44</td>
<td>13,620</td>
</tr>
<tr>
<td>Golf</td>
<td>Arl Heights</td>
<td>Woodfield</td>
<td>36,353</td>
<td>2.67</td>
<td>13,615</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>Laramie</td>
<td>1st</td>
<td>54,120</td>
<td>4.07</td>
<td>13,297</td>
</tr>
<tr>
<td>InnerRail4</td>
<td>BNSF</td>
<td>Cicero</td>
<td>28,336</td>
<td>2.21</td>
<td>12,822</td>
</tr>
<tr>
<td>95th</td>
<td>Oak Lawn</td>
<td>Harlem</td>
<td>26,271</td>
<td>2.05</td>
<td>12,815</td>
</tr>
<tr>
<td>Dempster</td>
<td>Skokie Swift</td>
<td>Des Plaines</td>
<td>82,381</td>
<td>6.45</td>
<td>12,772</td>
</tr>
<tr>
<td>Cermak</td>
<td>Tristate</td>
<td>Highland</td>
<td>60,070</td>
<td>4.71</td>
<td>12,754</td>
</tr>
<tr>
<td>North</td>
<td>1st</td>
<td>Harvard</td>
<td>44,540</td>
<td>3.50</td>
<td>12,726</td>
</tr>
<tr>
<td>Madison</td>
<td>Lathrop</td>
<td>25th</td>
<td>31,824</td>
<td>2.55</td>
<td>12,480</td>
</tr>
<tr>
<td>Dempster</td>
<td>Evanston</td>
<td>Skokie Swift</td>
<td>42,861</td>
<td>3.56</td>
<td>12,040</td>
</tr>
</tbody>
</table>

Several segments in or near Oak Park rank very highly, including segments along Oak Park Avenue, Harlem Avenue, and Madison Street.

Several segments of the Inner Circumferential Rail alternatives also rank very highly, including the Wisconsin Central Limited railroad right-of-way between the Forest Park CTA Blue Line station and River Forest, the Indiana Harbor Belt railroad between Franklin Park and Melrose Park, and the Chicago Central & Pacific Railroad between Berwyn and Sportsman’s Park.

Two segments of 95th Street from the Chicago city limits at Western Avenue through Oak Lawn to Harlem rank near the top as well. These segments rank slightly higher than the segment of 95th Street between the city limits and the 95 / Dan Ryan CTA terminal (not shown).

Two noncontiguous segments of Golf Road between Evanston and Skokie and between Arlington Heights and Schaumburg rank among the densest segments.

The Dempster Street corridor between Evanston and Des Plaines ranks highly.

A segment of North Avenue through Melrose Park, Stone Park, and Northlake ranks highly.

A segment of Cermak Road and Butterfield Road between Oak Brook and Yorktown also ranks highly.
4. **Recommendations for Pace**

The next step in the screening process is to conduct more detailed analysis of physical conditions, operating conditions, and opportunities for integration of BRT features in a group of up to seven corridors. Pace staff has requested that these seven corridors specifically include four corridors:

- **Northwest Corridor between Rosemont and Schaumburg:** This corridor is already a candidate for BRT improvements as a result of studies being conducted by the RTA. The Northwest Corridor Transit Feasibility Study, completed in May 2000, made no selection of a preferred alternative, although BRT in the I-90 median had the lowest capital cost per new transit wider of the eight alternatives considered. No selection of a preferred transit technology and specific alignment is expected during the timeframe of this study.

  This corridor includes one of the highest ranking arterial segments – Golf Road between Arlington Heights Road and Woodfield Shopping Center. The Interstate 90 segment between Elmhurst Road and Woodfield is also the highest ranking expressway corridor under consideration, although its density of 10,300 falls short of the threshold for inclusion among the highest ranked segments.

  It is recommended that Pace consider this corridor a top candidate for its BRT Initiative. It is also recommended that the Pace study include the combination of arterial and tollway BRT components.

- **North-South Corridor between Lake-Cook Road and Bolingbrook:** This corridor, especially the portion between the Schaumburg – Rolling Meadows – Elk Grove Village area and the Downers Grove – Lisle – Naperville area connects some of the most significant and fastest growing major activity centers in the region. Although no major highway reconstruction projects are planned for I-290 or I-355 in this area in the next 5 to 10 years, a combination of BRT services on key arterial streets and mixed-traffic use of the expressway and tollway could result in a successful BRT project for Pace. Two arterial street corridors in this area, Golf Road between Arlington Heights Road and Woodfield Shopping Center and Cermak Road between Oak Brook Shopping Center and Yorktown Shopping Center, rank among the top segments. If these segments could be linked with a high-speed tollway/expressway link, a 25-mile horseshoe-shaped circumferential alignment could be created.

  It is recommended that at least some segment of this corridor be carried forward for further consideration as a candidate for the first project in Pace’s BRT Initiative.

- **Outer Circumferential Corridor:** No segment of this corridor exceeds a density of 5,000 residents or jobs per route mile within 1/2 mile of the route. Because of the low density in this corridor, BRT may be a preferred alternative as a precursor to rail service. However, these densities are far less than some of the other BRT corridors under consideration. The low density would limit the potential for walk-up access to BRT services, although a park-and-ride or feeder bus-based access system could allow the system to draw riders from a wider area.

  The typically 100-foot wide right-of-way of the single-track EJ&E Railroad may be able to accommodate a busway, even if existing freight operations must be maintained.
However, new bridges and culverts may be required at numerous locations to accommodate a parallel busway.

It is recommended that Pace coordinate with Metra and EJ&E to determine the feasibility of constructing a busway along portions of the Outer Circumferential Corridor. Because of the low density, however, this corridor should not be considered a top candidate for the first BRT project in the region.

- **Inner Circumferential Corridor:** Development of a busway between O’Hare and Midway airports along any of the four proposed Inner circumferential alignments would likely pose greater challenges than along the Outer Circumferential Corridor, especially if relatively heavier existing freight and commuter rail operations are to be maintained. In general, there are more mainline tracks, more sidings, more crossings, and more structures within the same 100’ right-of-way (or in some cases a narrower 66’ right-of-way).

However, it may be possible to use some shorter segments for busways linking suburbs. For example, the highest ranked rail segment along the Wisconsin Central Limited railroad right-of-way between the Forest Park CTA Blue Line station and downtown River Forest could form part of a CTA rail line extension BRT route.

It is recommended that high-ranking segments of proposed rail corridors be considered as components of a Near-West Suburban BRT project. Selection of segments in coordination with Metra could support BRT feeder service to potential future Inner Circumferential rail service.

If several of these four segments are carried forward, there remain several slots for other corridors to be considered in more detail. The preceding population and employment density analysis suggests the following top candidates:

- **Near-West Suburban BRT:** Several segments of major arterial streets in the Oak Park and Forest Park areas ranked among the densest segments under consideration. It may be possible to link several major activity centers, including two CTA Rail Lines with some of these segments. It is recommended that a corridor from Brickyard Mall along Harlem Avenue to the CTA Green Line terminal to the CTA Blue Line terminal at Forest Park be evaluated in more detail. A southern extension to North Riverside Park Mall or Riverside or Berwyn could also be considered. An alternative alignment could include Oak Park Avenue between the Brickyard Mall and Berwyn. Either alignment would form a suburb-to-suburb circumferential route in the near-west suburbs. Integration with one or more Inner Circumferential Rail alignments should also be studied.

- **95th Street BRT:** A 5.5-mile segment of 95th Street between the Chicago city limits and Harlem Avenue via the Oak Lawn Metra station ranks among the densest corridors in the region. Coordination with the CTA could result in an extension to the 95 / Dan Ryan Red Line terminal. 95th Street is a Strategic Regional Arterial (SRA) and an IDOT Signal Priority corridor. It is recommended that this corridor be carried forward for more detailed consideration.
• **Dempster Street BRT**: The segment of Dempster Street between the Metra UP-North and the CTA Purple Lines in Evanston and downtown Des Plaines ranks among the densest corridors in the region. The majority of this corridor is an SRA and an IDOT Signal Priority corridor. The changing cross section of this corridor could accommodate a mix of BRT operating conditions from mixed traffic to curbside bus lanes. Median bus lanes may be possible in certain sections. It is recommended that this corridor be considered for further analysis.

• **North Avenue BRT**: The segment of North Avenue between 1st Avenue and the Tri-State Tollway (I-294) ranks among the densest corridors in the region. North Avenue is an SRA and an IDOT Signal Priority corridor. Like Dempster Street and 95th Street, curbside bus lanes or median bus lanes may be possible along substantial portions of this corridor. North Avenue is also recommended for further consideration.
Tasks 3 & 4 – ITS Review & Concept Design
This document fulfills the requirements of Task 4 in the study scope of work, which includes a concept design for the Cermak Road BRT corridor. This concept design is intended to exemplify typical improvements that may be implemented on various Pace BRT corridors around the region. The concept design includes discussion of the proposed service plan, rolling stock, passenger facilities, technology elements, capital and operating costs, and ridership forecasts. This report also addresses requirements associated with the review of relevant ITS technologies in Task 3.
BUS RAPID TRANSIT INITIATIVE

Concept Design

Table of Contents

1. Introduction 1

2. Design Overview 3
   2.1. Project Corridor 3
   2.2. Station Locations 5
   2.3. Existing Ridership 7
   2.4. Exclusive Bus Lanes 9

3. Operating Plan 11
   3.1. BRT Service 11
       3.1.1. Service Characteristics 12
       3.1.2. Fare Collection 14
   3.2. Traditional Bus Service 15
       3.2.1. Service Characteristics 16
       3.2.2. Fare Collection 16
   3.3. Flex-Route Bus Service 17
       3.3.1. Route-Deviation Flexible Route 17
       3.3.2. Service Characteristics 19
       3.3.3. Fare Collection 19
   3.4. Community Van Service 20
       3.4.1. Demand-Response Service 20
       3.4.2. Service Characteristics 21
       3.4.3. Fare Collection 21
4. **Rolling Stock**
   4.1. BRT Service
      4.1.1. System Capacity
      4.1.2. Fleet Composition
      4.1.3. Hybrid Propulsion
      4.1.4. Technology
      4.1.5. Image
   4.2. Traditional Bus Service
   4.3. Flex-Route Service
   4.4. Demand-Response Service
   4.5. Summary of Fleet Requirements

5. **Passenger Facilities**
   5.1. Station Types
      5.1.1. BRT Stop
      5.1.2. Superstop
      5.1.3. Community Transportation Center
      5.1.4. Regional Transportation Center
   5.2. Typical BRT Stop Design
   5.3. Station Design Typologies
      5.3.1. Bus/Rail Terminal Interchange Facility
      5.3.2. BRT Stop in a Traditional Urban Commercial Context
      5.3.3. BRT Stop in a Typical IDOT Corridor Context
      5.3.4. Superstop in a Typical IDOT Intersection Context
      5.3.5. Community Transportation Center at Commercial Center
      5.3.6. Regional Transportation Center

6. **Technology Elements**
   6.1. BRT Service
      6.1.1. Intelligent Bus System
      6.1.2. Traffic Signal Priority
      6.1.3. Automatic Fare Collection System
      6.1.4. Transfer Connection Protection
   6.2. Traditional Fixed-Route Services
   6.3. Flex-Route Services
      6.3.1. Intelligent Bus System
      6.3.2. Itinerary Management System
      6.3.3. Automatic Fare Collection System
   6.4. Demand-Response Service
   6.5. Passenger Facilities
      6.5.1. Active Transit Station Signs
      6.5.2. Automatic Fare Collection
      6.5.3. Security
7. **Financial Considerations**
   7.1. Capital Cost Estimates
   7.1.1. Capital Costs for BRT Stations
   7.1.2. Capital Costs for Rolling Stock
   7.2. Operating Cost Estimates
   7.3. Ridership Forecasts

8. **Next Steps**
   8.1. Market Research
   8.1.1. Traditional Transit Market Analysis
   8.1.2. Non-Traditional Transit Market Data
   8.2. Detailed Design
   8.2.1. Passenger Facilities
   8.2.2. Intersection Modifications
   8.2.3. Traffic Signal Priority
   8.2.4. Interagency Coordination
1. Introduction

This study explores how Bus Rapid Transit (BRT) could be applied in Pace’s suburban service area. The majority of BRT implementations have been in dense urban corridors where bus technology was used to provide service capacity and/or service quality similar to rail transit, but at less cost. Pace’s service area, dominated by low-density, automobile-oriented development provides challenges that other BRT systems do not have. As a result, the concept design for Pace’s BRT Initiative places somewhat different emphasis on key components than other systems have. The design concept is driven by three goals:

- Pace’s BRT system will place great emphasis on the flow of real-time service information between vehicles, control centers, and customers.

- Pace’s BRT system will be supported by innovative transit services that serve the widely distributed trip origins and destinations typical of suburban land uses.

- Pace’s BRT system will provide passenger facilities that achieve a high level of comfort, protection from the elements, and access to adjacent land uses. At major activity centers, transit facilities will be closely integrated to make transit as competitive as possible with automobile access.

This report fulfills requirements associated with Tasks 3 and 4 in the Pace BRT Initiative Study scope of work. This report presents a concept design and a discussion of relevant ITS technologies for a corridor selected in Task 2. The concept design applies the BRT features identified as relevant to Pace in the international literature search conducted in Task 1. The Cermak Road corridor between the 54/Cermak CTA rail station in Cicero and Yorktown Mall in Lombard is used to illustrate how BRT service could be implemented in many corridors throughout Pace’s suburban service area. The Cermak Road corridor was selected for several reasons:

- The Cermak Road BRT corridor is envisioned as an enhanced bus service extension of the CTA Blue Line Douglas Branch rapid transit line, which terminates at 54/Cermak in Cicero, with improved travel times in the corridor.

- Pace’s traffic signal priority demonstration project was implemented in the portion of the corridor in Berwyn and Cicero and may be used to support on-street BRT operations.
• The land use in the corridor transitions from walkable commercial and residential development typical of the inner-ring suburbs in the east to low-density, automobile-oriented development typical of Interstate-era suburbs in the west and thus represents a cross section of the environments in which Pace operates.

• Reconstruction of the Blue Line is scheduled for completion in 2005 and provides an opportunity for Pace to time its introduction of BRT service with the reopening of the line.

The Cermak Road BRT Service will incorporate many of the BRT features described in the Task 1 report, including limited stopping patterns, off-board fare payment, level boarding, high-quality passenger facilities, passenger information systems, transit signal priority, pedestrian and bicycle access enhancements, park-and-ride and kiss-and ride facilities where applicable, and highly recognizable physical facilities, signage, and vehicle graphics.

The primary objectives of BRT systems are to improve bus operating speed and schedule adherence on heavily traveled routes. The BRT service is expected to include relevant ITS technologies at various stages of deployment in the region that support the vision for Pace BRT in the Cermak Road corridor.
2. **Design Overview**

2.1. **Project Corridor**

Cermak Road and State Route 56 between Farnsworth/Kirk Road in Kane County and Cicero Avenue in the town of Cicero in Cook County was identified as a Strategic Regional Arterial (SRA) route by the Illinois Department of Transportation (IDOT). The SRA system was intended to serve as a second tier mobility network to supplement the expressway and toll way systems. Pace Route 322 corresponds closely to the proposed BRT service in terms of its alignment along Cermak Road and its termini at 54/Cermak and Yorktown Mall.

For the purpose of this study, the Cermak Road corridor was divided into three segments based on the characteristics of surrounding land uses:

- **Eastern Segment**: Between 54/Cermak and Harlem Avenue, the corridor is characterized by walkable commercial development along Cermak Road with multi-family and single-family residential uses. This area has a population density of 12,400 persons per square mile. The employment density in this area is 2,900 jobs per square mile. This segment passes through the municipalities of Cicero and Berwyn. As shown in Table 2.1, 61% of the boarding and alighting activity on Pace Route 322 in the corridor occurs in the Eastern Segment. Transfers to CTA rail at 54/Cermak representing approximately 28% of total corridor activity.

- **Central Segment**: Between Harlem Avenue and the DuPage County Line, the corridor is characterized by single-family residential development with concentrations of commercial development at major intersections. There are large areas of land uses that produce few transit trips, such as forest preserves, cemeteries, and golf courses. This area has a population density of 3,500 persons per square mile. The employment density in this area is 2,800 jobs per square mile. This segment includes the municipalities of North Riverside, Forest Park, Broadview, and Westchester. According to Pace’s ridership statistics, 15% of the boarding and alighting activity in the corridor occurs in the Central Segment.

- **Western Segment**: In DuPage County, large-parcel commercial and office development predominates. This development is characterized by large setbacks and an orientation to automobile access. This area has a population density of 1,900 persons per square mile. The employment density in this area is 7,700 jobs per square mile. This segment includes the municipalities of Oak Brook, Oakbrook Terrace, and Lombard. According to Pace’s ridership statistics, 24% of the boarding and alighting activity in the corridor occurs in the Western Segment.
Figure 2.1: Corridor Overview

Proposed Services
- Off-Street Transportation Center
- On-Street Bus Station
- Future Passenger Facility

Existing Features
- CTA Rail Line
- Interstate Highway
- Pace Bus Route
- CTA Bus Route

Western Segment
- BRT + Demand-Response

Central Segment
- BRT + FlexRoute
- Future Passenger Facility

Eastern Segment
- BRT + Fixed Route

Future Passenger Facility

Demand-Response Van Service Area
Figure 2.1: Corridor Overview
Figure 2.1 shows the layout of the Cermak Road BRT project. The BRT service is envisioned as an extension of the CTA Blue Line west from 54/Cermak. The figure shows a backbone of BRT service with 15 stations.

- Stops are spaced every ½ to 1 mile in the Eastern Segment, with stops at 54/Cermak, Austin Boulevard, Ridgeland Avenue, and Oak Park Avenue. Many of these intersections correspond with locations served by the limited-stop Pace Route 767.

- In the Central Segment, stops are spaced every ½ to 1 ½ miles, corresponding with major intersections. Stops include North Riverside Mall, First Avenue, Ninth Avenue, Broadview Square, Mannheim / LaGrange, Mayfair Avenue, and Wolf Road. The longer station spacing is a result of express operations through forest preserves and other open areas and the provision for a future station near 25th Street. This station would serve the proposed Metra Inner Circumferential Service commuter rail line.

- Because of the long distances to many potential trip origins and destinations from Cermak or Butterfield Road in the Western Segment, stops occur primarily at major activity centers. Stops are located at York Road, Oakbrook Center, Butterfield Road, and Yorktown Mall. The average stop spacing is between 1 ½ and 2 miles. This long spacing makes bus speeds more competitive with the automobile, but requires supporting transit services as described in Section 3.

### 2.2 Station Locations

Proposed station locations between 54/Cermak and Yorktown Mall are shown in Figure 2.1 and include:

**54/Cermak:** BRT buses will connect with the CTA rail system at the relocated CTA station at 54/Cermak. A dedicated passenger boarding area will be provided for BRT vehicles. BRT vehicles will enter and leave the station along the same path as other buses. The station is to be relocated one block east of the existing station after the Douglas Branch reconstruction. A concept design for this location is presented in Section 5.3.1.

**Austin Boulevard:** A pair of far-side BRT stops will be provided at Austin Boulevard. These bus stops will also be served by traditional Pace and CTA bus routes. Existing Pace bus stops on Austin Boulevard will remain.

**Ridgeland Avenue:** A superstop-type BRT station will be provided at Ridgeland Avenue to support future development of BRT services along Ridgeland Avenue. A superstop includes boarding areas on each leg of the intersection, integrated passenger information systems providing real-time information on connecting services, and enhanced pedestrian crosswalks and signal clearance intervals as required. The design of the station will be coordinated with the streetscape design of the surrounding business district. The Ridgeland BRT station will be shared with the Pace 767 express route and other routes in the corridor.

**Oak Park Avenue:** A pair of far-side BRT stops will be provided at Oak Park Avenue. Because of constrained site conditions associated with narrower clearances between the curb and building facades, a BRT stop configuration that is compatible with urban environments will be provided.
The proposed concept design is presented in Section 5.3.2. The Oak Park BRT station will also be shared with Pace Route 767 and other routes in the corridor.

**North Riverside Park Mall:** A Community Transportation Center will be provided at North Riverside Park Mall. Community transportation centers provide off-street bus boarding and layover facilities, which support multiple terminating routes. A concept design for this facility located near the east entrance of North Riverside Park Mall just north of 25th Street and west of the railroad tracks is presented in Section 5.3.5. This facility will consolidate all transfer activity between bus services on Cermak Road and Harlem Avenue at one location that offers enhanced passenger amenities. Also, a direct pedestrian connection with the mall will be provided.

**First Avenue:** A superstop-type BRT station will be provided at First Avenue to support future development of BRT services along First Avenue. The stops on Cermak Road will include a turnout to allow flex-route service to meet BRT vehicles. A concept design for this location is presented in Section 5.3.4.

**Ninth Avenue:** A pair of far-side BRT stops will be provided at Ninth Avenue. A turnout will be provided to allow flex-route service to meet BRT vehicles.

**Broadview Village Square:** A pair of BRT stops will be provided on Cermak Road at Broadview Village Square. The westbound BRT stop will be located on the far side of the 14th Avenue intersection. The eastbound stop will be located between 17th Avenue and 14th Avenue. A turnout will be provided to allow flex-route service to meet BRT vehicles.

**Metra Inner Circumferential (future):** Depending on development of the Inner Circumferential Service commuter rail line proposal by Metra, the BRT project will include a bus-stop-type BRT station at the Indiana Harbor Belt (IHB) Railroad. Cermak Road crosses the IHB on an overpass. To minimize travel time penalties associated with serving the Metra station, it is recommended that the bus station be constructed on the overpass and connected with the Metra station with sidewalks, ramps, and elevators as necessary. The presence of a grade separation allows for a pedestrian crossing under Cermak Road at this mid-block location.

**Mannheim / LaGrange:** A superstop-type BRT station will be provided at the intersection of Mannheim and LaGrange Roads. A combination of far-side stops and nearside stops will be used at this location to avoid conflicts with existing conditions and to provide same-quadrant interchange between bus routes.

**Mayfair Avenue:** A pair of far-side BRT stops will be provided at Mayfair Avenue. A turnout will be provided to allow flex-route service to meet BRT vehicles. The Mayfair Avenue stops would also serve Immaculate Heart of Mary and St. Joseph High Schools. A concept design for this location is presented in Section 5.3.3.

**Wolf Road:** A pair of BRT stops will be provided at Wolf Road in both directions. A far-side stop will be provided in the westbound direction. A stop between Enterprise Drive and Wolf Road will be provided in the eastbound direction. Both stops will include turnouts to allow flex-route service to meet BRT vehicles.

**York Road:** A superstop-type BRT station will be provided at York Road. Because of turning movements made by various other Pace routes at this intersection, a combination of nearside and
far-side stops will be used. A turnout for flex-route and demand-response vehicles will be provided to support feeder services to the BRT.

**Oakbrook Center:** A regional transportation center will be provided at Oakbrook Center. This off-street facility will accommodate transfers between more than 10 existing and planned expressway and tollway BRT routes, arterial BRT routes, community-based fixed-route bus routes, community-based flex-route services, area circulators and shuttles, and demand response services. The facility will offer high-quality passenger amenities, park-and-ride, kiss-and-ride, and bicycle storage facilities, and a direct, architecturally integrated connection with Oakbrook Center. A concept design for this regional transportation center is presented in Section 5.3.6.

**Butterfield Road:** A pair of BRT stops will be provided on Butterfield Road between 22nd Street and TransAm Plaza Drive. A turnout for connecting shuttle vans will be provided at these bus stops. Sidewalk connections with surrounding properties will also be an important component of the passenger facility design.

**Yorktown Mall:** A community transportation center will be provided at Yorktown Mall. This off-street facility will accommodate transfers between several existing and planned expressway and tollway BRT routes, arterial BRT routes, community-based fixed-route bus routes, community-based point-and-route-deviation services, area circulators and shuttles, and demand response services. Like Oakbrook Center, the Yorktown Mall BRT station will offer high-quality passenger amenities, dedicated boarding areas for connecting transit services, an architecturally integrated connection with the mall, and park-and-ride, kiss-and-ride, and bicycle storage facilities. Pace has developed a concept design for a transportation center at Yorktown Mall.

### 2.3. Existing Ridership

Pace Route 322 currently serves an average of 3,730 weekday trips with approximately 58 runs per day and 15-minute peak-period headways (not including several school trips). This compares to approximately 4,300 trips (2,150 daily boardings) on the CTA Blue Line at 54/Cermak that currently operates on eight-minute headways during the limited daily peak periods.

Existing bus operations in the Cermak Road corridor were evaluated using sample ridership data provided by Pace. In general, the ridership information available to date provides a snapshot of a portion of one day’s activity. The information would need to be expanded in order to represent a random, comprehensive sample from which conclusions about all-day or all-week travel patterns can be drawn. However, the observations described below provide an initial picture of transit ridership patterns in the corridor.

Boarding and alighting (on/off) counts were reviewed for each stop along Pace Route 322. The current routes have several stops in the vicinity of North Riverside Park Mall / Harlem Avenue, Broadview Plaza / 17th Street, Oakbrook Center, Cermak Road / Butterfield Road, and Yorktown Mall. For the purpose of this analysis, the data for these stops were aggregated to correspond more closely with potential BRT limited-stop service patterns.

Passenger boardings are summarized in Table 2.1. Passenger boardings and alightings are greatest at Oak Park Avenue, North Riverside Park Mall, Broadview Village Square, Mannheim Road, and Oakbrook Center. Ridgeland Avenue, First Avenue, and Yorktown Mall represent a...
second tier of boarding locations. These locations correspond very closely to the largest activity centers and the connecting bus routes along the corridor. The BRT stations proposed serve approximately 87% of total boarding and alighting activity in the Eastern Segment and the Central Segment of the corridor. Because of the more dispersed activity centers in the Western Segment, the BRT stops serve approximately 62% of observed boarding and alighting activity. On a corridor-wide basis, BRT stops serve 89% of the boarding and alighting activity observed on Pace Route 322.

### Table 2.1: Pace Route 322 Boarding and Alighting Activity

<table>
<thead>
<tr>
<th>Eastern Segment</th>
<th>Central Segment</th>
<th>Western Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Stop</td>
<td>Activity Level</td>
<td>Bus Stop</td>
</tr>
<tr>
<td>54th</td>
<td>51.0</td>
<td>21st</td>
</tr>
<tr>
<td>Central</td>
<td>2.0</td>
<td>Northgate</td>
</tr>
<tr>
<td>58th</td>
<td>2.0</td>
<td>Norfolk</td>
</tr>
<tr>
<td>Austin</td>
<td>5.5</td>
<td>Portsmouth</td>
</tr>
<tr>
<td>Lombard</td>
<td>3.0</td>
<td>Newcastle</td>
</tr>
<tr>
<td>Highland</td>
<td>0.0</td>
<td>Hull</td>
</tr>
<tr>
<td>Ridgland</td>
<td>5.0</td>
<td>Broadway</td>
</tr>
<tr>
<td>East</td>
<td>2.5</td>
<td>Mannheim</td>
</tr>
<tr>
<td>Riverside</td>
<td>1.5</td>
<td>Bellevue</td>
</tr>
<tr>
<td>Oak Park</td>
<td>2.0</td>
<td>Hawthorne</td>
</tr>
<tr>
<td>Home</td>
<td>2.0</td>
<td>Stratford</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1.5</td>
<td>Sunnyside</td>
</tr>
<tr>
<td>North Riverside</td>
<td>29.5</td>
<td>Buckingham</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Downing</td>
</tr>
<tr>
<td></td>
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<td>Kensington</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mayfair</td>
</tr>
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<td></td>
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<td>Boeger</td>
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<tr>
<td></td>
<td></td>
<td>High Ridge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Downing</td>
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<tr>
<td></td>
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<tr>
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<td>Mandel</td>
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<td></td>
<td>Enterprise</td>
</tr>
<tr>
<td></td>
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<td>I-294</td>
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</table>

<table>
<thead>
<tr>
<th>Segment</th>
<th>Percent of Total</th>
<th>Percent at BRT Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Segment</td>
<td>61%</td>
<td>87%</td>
</tr>
<tr>
<td>Central Segment</td>
<td></td>
<td>87%</td>
</tr>
<tr>
<td>Western Segment</td>
<td></td>
<td>62%</td>
</tr>
</tbody>
</table>

**Bold type** denotes proposed BRT station.

Passenger loadings along the route are summarized in Figure 2.2. Passenger volume levels generally coincide with boundaries between corridor segments, with the greatest ridership observed in the Eastern Segment.
The central segment of the BRT Corridor along Cermak Avenue presented a significant challenge. The land use in the central corridor includes several commercial and institutional centers that may be the origin and destination for BRT transit riders if the first/last mile of the trip is effective for individual BRT passengers. The design team envisioned trip request information that could be used to modify transit vehicle routing on existing future flag stop routes that traverse and parallel the BRT Corridor. The vehicle routing would be accomplished by integrating scheduled and real-time travel information. Additional investigation of this service would be necessary as the investigation and design of BRT in the region is undertaken. The service is named FlexPace, and is described further in Section 3.3.

Figure 2.2: Average Passenger Load by Bus Stop

2.4. Exclusive Bus Lanes

Exclusive bus lanes or dedicated guide ways represent one of the most effective BRT features in terms of their ability to increase bus speeds and schedule reliability. Exclusive bus lanes on Cermak Road were considered early in the study. They were deferred in this study due to the expected roadway constraints. There are few locations along Cermak Road where sufficient
right-of-way exists for an additional lane dedicated to buses. Moreover, the forecast demand for BRT services in the corridor (approximately 243 passengers per hour per direction during the peak period as described in Section 7.3) is a small fraction of the person-capacity of a single travel lane, even with single-occupant vehicles (between 1,500 and 2,000 vehicles per hour per lane). This suggests that taking a lane from traffic would not be warranted.

Queue jumpers are a technique for permitting buses to pass through an intersection before general-purpose vehicular traffic. Figure 2.3 is a graphical representation of a queue jumper lane. Near side roadway treatment involves an exclusive lane for buses to move to the head of the line (or queue) at an intersection. The principle is that buses advance past backed-up traffic in the through lanes to the front of the intersection. Early green signal phases with special bus indications are sometimes provided to allow buses to proceed through the intersection before general-purpose traffic. Queue jumper lanes can work with near-side and far-side stops, but are especially well suited to near-side stops. At near-side stops, they allow a bus to reach the stop quickly, avoid the need to merge back into traffic after transferring passengers, prevent buses from blocking traffic while stopped, and work well with transit signal priority treatments triggered automatically by door closures. The concept designs developed in this study accommodate queue jumper lanes in concept. Queue jumper lane locations have yet to be specifically identified due to limited traffic volume and turning movement data to support a detailed analysis of the location of these improvements. It is recommended that the use of queue jumper lanes be evaluated during the implementation phase of the project.

**Figure 2.3: Queue Jumper Lane Configuration**
3. Operating Plan

The success of the BRT will depend on how well it provides access to the many trip origins and destinations in the Cermak Road corridor. Because many activity centers are located a considerable distance from Cermak Road, there is a need for a service that solves this “last mile” problem. However, the classical tradeoff in transit planning applies: high access is achieved at the cost of high speed and vice versa.

The BRT Initiative could solve this problem by supporting the high-speed BRT service with three types of high-access transit services: traditional fixed-route bus services, flex-route bus services, and demand-response van services. The selection of service type will be based on the land use characteristics of the surrounding area. All three support services will be closely coordinated with the BRT service and transferring passengers will be provided with real-time information on connection status. The mix of transit services proposed herein for the Cermak Road corridor was based on a preliminary field investigation and is intended to represent a range of solutions that may be applicable in various corridors throughout Pace’s service area. The final selection of supporting transit services along Cermak Road should be based on more detailed market analysis as described in Section 8.1.

The Cermak Road BRT corridor is envisioned as a route extension of the CTA Douglas Branch rapid transit line (Blue Line), to major activity centers in Cook and DuPage counties. The CTA Blue Line currently terminates at 54/Cermak in Cicero. The BRT route will overlay and modify existing local service bus routes in the Cermak Road corridor and will integrate with routes that cross the corridor. Pace Route 322 will be replaced with a combination of BRT service, reconfigured traditional fixed route service in the Eastern Segment of the study corridor, flex-route service between North Riverside Mall and Oakbrook Center, and demand-response service at Oakbrook Center and Yorktown Mall.

3.1 BRT Service

The BRT service will provide a limited-stop, high-speed backbone transit service for the Cermak Road corridor. Strong and consistent presentation of a positive image is an important part of attracting potential riders to use the BRT system. It may be appropriate to consider a BRT service name that complements and recognizes the service from which it was born while distinguishing BRT service from its local service counterpart. The BRT system’s marketing and brand identity should emphasize speed. It may extend the use of existing Pace identity elements, such as the rhythm of yellow dots found on many Pace shelters. This rhythm connotes speed, service reliability, and the limited stop nature of the service. The logo may be used on route schedules, maps, websites, marketing materials, bus designs, and transit station and shelter designs.
3.1.1. Service Characteristics

BRT runs will coincide with CTA rapid transit runs on the Douglas Branch of the Blue Line. Shortly after each outbound train arrives at 54/Cermak, a westbound BRT bus will depart. Likewise, BRT buses will be timed to arrive at 54/Cermak shortly before each train departs. The amount of time between train arrivals and BRT departures and between BRT arrivals and train departures will be established based on schedule reliability and the approximate time it takes the average person to make the transfer. The scheduled transfer time will probably be approximately 2 to 3 minutes, with an allowance for flexibility in departure times to protect this important interagency transfer. The Transfer Connection Protection (TCP) system that may be used to coordinate this transfer is discussed in more detail in Section 6.1.4.

The BRT vehicles are to be operated on a train-headway based schedule. The schedule may vary by time of day but is expected to coincide with the CTA Blue Line operations as a minimum. A 10-minute average headway is projected for the peak hour. During the midday and most of the day on Saturdays, 15-minute headways are assumed, based on current Blue Line schedules. Hours of operation would be from approximately 4:30 a.m. to midnight on weekdays and from 5:30 a.m. to 11:30 p.m. on Saturdays, which are similar to current Pace Route 322 hours of operation. Precise schedule times will be coordinated with the Blue Line timetable. It should be noted that the Forest Park Branch of the Blue Line runs all night and that if every other train serves the Douglas Branch after reconstruction, approximately 17 runs in each direction every weeknight will not be met with BRT service.

The BRT service is expected to have approximately 78 round-trips per weekday and 70 round-trips per Saturday. This compares to 58 weekday round-trips and 30 Saturday round-trips on Pace Route 322. It is assumed that Sunday service will be reinstated on the Douglas Branch following reconstruction. Based on the current Sunday Blue Line schedule and the assumption that trains will alternate between terminals at Forest Park and 54/Cermak, this will total 50 round-trips at 20-minute headways during most of the day. Sunday service hours are assumed to be between 7:00 a.m. and 11:00 p.m., which is similar to current Pace Route 322 hours of operation.

Approximately 40 of the 58 weekday round trips on Pace Route 322 run the entire length of the BRT corridor between 54/Cermak and Yorktown Mall. North Riverside Park Mall is the terminus for the majority of trips that do not extend to Oakbrook Center and Yorktown Mall. BRT service each day is assumed to start from either 54/Cermak or Yorktown Mall each day, with partial runs beginning at an intermediate point enroute from the Pace Melrose Park Garage. All buses will complete runs to either terminus before deadheading back to Melrose Park.

Running times were estimated using an average of three weekday peak-period bus runs on the existing Pace Route 322. During the period of data collection, the Traffic Signal Priority system was not in operation in the Eastern Segment because of a recent repaving project that destroyed detector loops in the pavement. For each run, the time spent stopped at bus stops (dwell time), the time spent stopped in traffic, and the time spent moving were recorded. The average speed (not including dwell time) was computed for each direction in each of three segments of the corridor. The running time of the proposed service was computed by estimating the total distance in each segment, applying the existing average speed and reducing the result by 15% to account for traffic signal priority treatment. This timesavings is consistent with the experience of Pace’s traffic signal priority demonstration project on Cermak Road between 54/Cermak and Harlem Avenue. The proposed running time also reflects a reduction in dwell time due to the limited
stopping pattern. An average dwell time of 10 seconds per bus stop and 30 seconds per transportation center was used. This reflects the use of off-board fare payment and level boarding.

Estimated travel times on the BRT route are summarized in Table 3.1. Using traffic signal priority to reduce traffic delays and various features to reduce dwell time, the BRT service will make the 14.7-mile run between 54/Cermak and Yorktown Mall in 43 minutes. The 14.5-mile eastbound run will take 42 minutes. The difference in distance reflects minor differences in off-street routing through transportation centers. The travel times represent a savings over the existing Pace Route 322 of 15% and 19%, respectively. Including layover at each end, the 110-minute (1:50:00) peak-period round-trip running time represents a 23% savings over the existing schedule.

Table 3.1: Cermak Road BRT Round-Trip Travel Time

<table>
<thead>
<tr>
<th></th>
<th>Schedule (Pace Route 322)</th>
<th>Existing (average of 3 runs)</th>
<th>Proposed (Mixed-Traffic BRT)</th>
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<tbody>
<tr>
<td><strong>Westbound</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Time</td>
<td>2,750</td>
<td>2,420</td>
<td></td>
</tr>
<tr>
<td>Dwell Time</td>
<td>293</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (seconds)</strong></td>
<td>3,480</td>
<td>3,043</td>
<td>2,600</td>
</tr>
<tr>
<td><strong>Subtotal (minutes:seconds)</strong></td>
<td>58:00</td>
<td>50:43</td>
<td>43:20</td>
</tr>
<tr>
<td><strong>Yorktown Recovery</strong></td>
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</tr>
<tr>
<td>Base</td>
<td>540</td>
<td>840</td>
<td>260</td>
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<tr>
<td>Railroad Delay</td>
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<td><strong>Subtotal (seconds)</strong></td>
<td>540</td>
<td>840</td>
<td>729</td>
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<td><strong>Subtotal (minutes:seconds)</strong></td>
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<td><strong>Eastbound</strong></td>
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<tr>
<td>Running Time</td>
<td>2,702</td>
<td>2,339</td>
<td></td>
</tr>
<tr>
<td>Dwell Time</td>
<td>425</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (seconds)</strong></td>
<td>3,540</td>
<td>3,127</td>
<td>2,519</td>
</tr>
<tr>
<td><strong>Subtotal (minutes:seconds)</strong></td>
<td>59:00</td>
<td>52:07</td>
<td>41:59</td>
</tr>
<tr>
<td><strong>54/Cermak Recovery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>960</td>
<td>840</td>
<td>252</td>
</tr>
<tr>
<td>Railroad Delay</td>
<td></td>
<td></td>
<td>469</td>
</tr>
<tr>
<td>Clockface Schedule</td>
<td></td>
<td></td>
<td>671</td>
</tr>
<tr>
<td><strong>Subtotal (seconds)</strong></td>
<td>960</td>
<td>1,511</td>
<td>752</td>
</tr>
<tr>
<td><strong>Subtotal (minutes:seconds)</strong></td>
<td>16:00</td>
<td>25:11</td>
<td>12:32</td>
</tr>
<tr>
<td><strong>Total Round-Trip Cycle Time</strong></td>
<td>8,520</td>
<td>8,520</td>
<td>6,600</td>
</tr>
<tr>
<td><strong>Total Round-Trip Cycle Time</strong></td>
<td>2:22:00</td>
<td>2:22:00</td>
<td>1:50:00</td>
</tr>
<tr>
<td><strong>Savings over Schedule</strong></td>
<td></td>
<td></td>
<td>23%</td>
</tr>
</tbody>
</table>

The travel time estimate includes an allowance of nearly 8 minutes in each direction to allow for railroad crossing delays near First Avenue. According to IDOT statistics, 12 trains per day use the Canadian National / Illinois Central Railroad through North Riverside. During running time
observations conducted for this study, a delay of 469 seconds was observed waiting for a freight train at this crossing. While this introduces a degree of uncertainty to BRT operations, the train volume is insufficient to justify a grade separation at this location, especially considering the substantial engineering complexity and expense associated with its proximity to the Des Plaines River. The total number of buses required for BRT operation is discussed in Section 7.2 of this report.

At off-peak times on weekdays and on Saturdays, the BRT will operate on 15-minute headways. It is assumed that round-trip running time will be scheduled at 105 minutes (1:45:00) at these times. Early in the morning, late at night, and on Sundays, the BRT will operate on 20-minute headways. This is based on the assumption that one-half of the CTA Blue Line trains currently scheduled will terminate at 54/Cermak. In this case, round-trip running time will be scheduled at 100 minutes (1:40:00).

### 3.1.2. Fare Collection

Off-board fare collection has been shown to reduce dwell times at bus stops by allowing passengers to board through any door. Some BRT systems, such as Curitiba, Brazil, use traditional barrier fare collection with turnstiles at bus stops, but the trend in light rail systems and many bus systems has been toward proof-of-payment fare collection. This method is currently being used on the majority of light rail systems in North America, is a component of several BRT systems, and is in use on traditional bus systems in Vancouver and New Jersey. Systems interviewed report that the operating costs are generally lower than for traditional on-board fare collection systems because the burden of fare payment is placed on the passenger. There is some added cost due to the need for enforcement personnel to conduct random fare checks and slightly higher fare evasion, but that increased ridership due to improved passenger convenience and reduced travel times likely more than offsets the expense.

The use of off-board fare payment significantly reduces dwell time at bus stops because passengers need not queue at the front door of the bus to both pay their fares and board. According to the *Transit Capacity and Quality of Service Manual* (TCRP, 2000), pre-payment reduces per-passenger boarding times by 33% compared to systems that require cash payment on the bus. TCRP Report 10 (Fare Policies, Structures, and Technologies) ranked proof-of-payment highest among fare collection systems, including payment-on-entry and barrier systems.

It is proposed that Pace introduce proof-of-payment fare collection to the Northeast Illinois region as part of its BRT Initiative. The existing Automatic Fare Collection (AFC) system used by Pace and CTA is well suited to this form of payment. When boarding a bus or entering a rapid transit station, the AFC system deducts a full fare ($1.50 regular) from the value stored on the magnetic farecard or smart card. It then writes the remaining value and the time and location of fare payment onto the card. If a second bus is boarded or a second station is entered within two hours, a transfer is deducted ($0.30 regular). One subsequent boarding within the two-hour window is free.

The time and date stamp can be queried at any time with the appropriate reader device. It is proposed that a hand-held unit be developed that can be carried by Pace personnel for random checks on BRT vehicles. Any passenger on a BRT vehicle who does not have a farecard showing time remaining would be assessed a fine.
Proof-of-payment will require that farecard validators be installed at each BRT station. To minimize security requirements, cash will be accepted only at Pace transportation centers or CTA rail stations where attendants are on duty. Typical BRT stops would be equipped only with farecard validators, which accept magnetic farecards or smartcards only. Credit card readers may be appropriate at BRT stops as a partial substitute for cash acceptance. Advances in wireless credit card acceptance technology provide an opportunity to expand on-bus and off-bus payment options. Pace is currently testing a prototype transit pass vending machine that accepts credit cards (see Figure 3.1). Similar technology has been implemented by various other transit properties for the payment of individual fares as well.

For simplicity, it is recommended that BRT services adopt the same fare structure as is used for the rest of the system. This means that transfers from other bus routes or rail lines would be accepted and that the base fare would be equivalent to other bus or rail services. However, it may be desirable to provide free transfers to passengers transferring from rail to BRT at 54/Cermak. This would improve passenger convenience by streamlining the rail-to-bus transfer, strengthen the psychological connection between the rail line and its BRT extension, and potentially reduce the time between train arrival and BRT departure at 54/Cermak. As a practical consideration, it would also eliminate proof-of-payment enforcement challenges associated with ensuring that rail passengers pay the transfer at 54/Cermak before boarding the BRT. In the other direction, the transfer fee from BRT to rail should also be free.

3.2. Traditional Bus Service

In the Eastern Segment, existing fixed-route bus services will continue to provide local service between BRT stops. CTA Routes 21, 21X, and 25 and Pace Routes 304 and 322 currently provide combined service between approximately 4:30 a.m. and midnight on weekdays, between approximately 5:30 a.m. and 11:30 p.m. on Saturdays, and between approximately 7:00 a.m. and 11:00 p.m. on Sundays. Weekday service frequency varies from approximately 5 buses per hour between 5:00 a.m. and 8:30 a.m., 4 buses per hour until 2:30 p.m., 6-8 buses per hour until 4:30 p.m., 6 buses per hour until 6:00 p.m., and 4-6 buses per hour until 11:00 p.m. Saturday service frequency is approximately 3 buses per hour between 7:30 a.m. and 8:30 p.m. and 4 buses per hour until 10:30 p.m. Sunday service frequency is approximately 3 buses per hour between 8:30 a.m. and 7:30 p.m. tapering to 2 buses per hour between 8:30 p.m. and 10:30 p.m.

The BRT service will replace Pace Route 322 and operate as a limited-stop express route overlaid on the other existing local services. Pace Route 767 currently operates in this manner during peak periods. Route 767 makes three stops in the proposed BRT corridor before turning north on Desplaines Avenue to the Forest Park Transportation Center and the Eisenhower Expressway. Although the multiplicity of routes appears to provide excess capacity in this corridor for local trips, it may be necessary to adjust some schedules to accommodate the replacement of local service provided by Pace Route 322 with limited-stop BRT service in the central segment as discussed in Section 2.3.
In the Western Segment between Oakbrook Center and Yorktown Mall, Pace operates two express bus routes. Routes 877 and 888 run from the Yorktown Mall area via Oakbrook Center and the Tri-State toll way (I-294) to Harvey and Homewood, respectively. Together, they add approximately 10 westbound trips in the morning and 13 eastbound trips in the afternoon to the Cermak corridor in this segment. These services will continue to operate and will be adjusted as necessary to coordinate with BRT service at the transportation centers at Oakbrook Center and Yorktown Mall. Traffic, roadway conditions and the varying number of flag stops per transit vehicle trip introduce a measure of uncertainty for the schedule, particularly in the peak hours. In addition to the Oak Brook area, Harlem Avenue traffic introduces similar schedule uncertainty. As such, these services will provide limited local service along Cermak Road and Butterfield Road between Oakbrook Center and Yorktown Mall, an area that will also be served with demand-response vans.

Eight Pace bus routes intersect Cermak Road between 54/Cermak and Yorktown Mall. These routes include Pace Route 305 on Austin Avenue, Pace Route 315 on Ridgeland Avenue and Austin Avenue, Pace Route 311 on Oak Park Avenue, Pace Route 307 on Harlem Avenue, Pace Route 311 on First Avenue, Pace Route 325 on 25th Avenue and Cermak Road between 25th and Broadview Square, Pace Route 330 on Mannheim Road / LaGrange Road, Pace Route 332 on York Road and Cermak Road between York Road and Oakbrook Center. It is not expected that significant service changes will be required on these routes as part of BRT implementation on Cermak Road. However, Pace Route 307 will need to be realigned slightly to serve the North Riverside Mall transportation center.

In addition, Oakbrook Center and Yorktown Mall are transfer points between other Pace routes. Oakbrook Center is an interchange point between Pace Routes 322, 332, 703, 747, 877, and 888. Yorktown Mall is an interchange point between Pace Routes 322, 313, 715, 834, 877, and 888. Some of these routes share relatively minor segments of Cermak Road with the proposed BRT corridor. Although service plans for these routes were not prepared for this study, it is expected that minor changes will be made to improve coordination and timing of transfers at Oakbrook Center and Yorktown Mall.

### 3.2.1 Service Characteristics

Service hours for this combined fixed-route service (not including 322) are between approximately 4:30 a.m. and midnight on weekdays, between approximately 5:30 a.m. and 11:30 p.m. on Saturdays, and between approximately 7:00 a.m. and 11:00 p.m. on Sundays. Weekday service frequency varies from approximately 5 buses per hour between 5:00 a.m. and 8:30 a.m., 4 buses per hour until 2:30 p.m., 6-8 buses per hour until 4:30 p.m., 6 buses per hour until 6:00 p.m., and 4-6 buses per hour until 11:00 p.m. Saturday service frequency is approximately 3 buses per hour between 7:30 a.m. and 8:30 a.m. and 4 buses per hour until the end of service at 11:30 p.m. Sunday service frequency is approximately 3 buses per hour between 8:30 a.m. and 10:30 p.m. It is expected that these services will remain largely unchanged with the introduction of BRT service and the elimination of Pace Route 322.

### 3.2.2. Fare Collection

Fare collection methods and fare policies will remain unchanged.
3.3. Flex-Route Bus Service

In the Central Segment, there are a number of major activity centers located some distance from Cermak Road. To effectively serve as many of the trips in the corridor as possible, feeder service that links these trip generators with the BRT service is needed. Furthermore, the limited stopping pattern reduces access for approximately 13 percent of customers on the existing Pace Route 322. In order to avoid the travel time penalties that local stops or deviations would impose on the BRT service, an innovative type of supplemental transit service is proposed.

3.3.1. Route-Deviation Flexible Route

Route deviation services have been implemented in suburban and small-town settings throughout the United States, and have been very successful where trip origins and destinations are not primarily located along a major street. Most implementations build extra time into the route to allow for deviations. Deviations are typically requested by telephone to a central dispatch center, but some properties allow walk-up requests for drop-offs if there is time available. Because of communications limitations between the scheduling system and the vehicle operator, many services require an advanced notice of one day or more before the request is served. Using real-time scheduling software, automatic vehicle location (AVL) systems, and advanced wireless communications, this lead-time has been reduced to as little as one hour by some services.

A notable example is the OmniLink system operated by the Potomac and Rappahannock Transportation Commission (PTRC) in Northern Virginia. OmniLink is a local weekday bus service operated on three routes that were designed to meet the transportation needs of the entire community, including individuals who may have difficulty walking to established bus stops. Unlike a traditional public bus service that operates only along a designated route, OmniLink buses have a limited amount of time available within each trip when, providing time is available, the bus can be rerouted to pick up and drop off passengers at locations that are not on the route. Three types of stops are served: posted bus stops, on-demand stops and scheduled pick up or drop off locations. Posted bus stops are spaced every ¼ to ½ mile and are served by all runs. Flag stops between these locations may be served, but are not guaranteed. In addition to the posted bus stops, some locations are on-demand bus stops. Passengers wanting to be dropped off at an on-demand bus stop may request the deviation service when they board the bus. To be picked up from and on-demand bus stop, one must call the OmniLink travel center and the next available bus will be rerouted to serve the request.

Deviations to other locations within ¾ mile of the regular route are also available by reservation on a first-come, first-served basis and are limited to trips that ensure the bus service is reliable for all customers. Trips may be scheduled with as little as 2 hours notice, but for best results, reservations should be made 1 to 2 days in advance. Scheduled pick-up or drop-off locations are established on a case-by-case basis and some customers may be asked to board or alight at a location that is within a few blocks of their origin or destination. Some locations are not accessible to OmniLink buses. OmniLink buses meet customers at the curb of the prearranged...
pickup location. Buses do not wait for late passengers. PRTC recommends that passengers arrive at the pickup location 5 minutes before the scheduled time.

The service has been very successful. Twelve vehicles are now in use serving the general public along three flex-route corridors. Ridership averages 1,150 boardings per day at 45-minute headways. By combining fixed-route and paratransit services, operating costs have been reduced by one-third. Five out of six riders find the flexible aspect of the service understandable and rate the service good or excellent, noting that it has made it “easier to get around” than before the service was introduced.

It is suggested that Pace implement a similar system to serve as a feeder service to the Cermak Road BRT. A local bus route between North Riverside Mall and Oakbrook Center will form the basic route, but the operator will be empowered to deviate on request to certain major activity centers not located near BRT stations. The route will include posted stops at all BRT stops and at certain intermediate locations spaced every ¼ to ½ mile. The initial phase of implementation could include only a small number of on-demand stops, such as the Kohl’s Department Store at North Riverside Mall, Cermak Plaza, Morton West High School, Loyola University Hospital, Hines VA Hospital, and the K-Mart Department Store at Broadview Plaza. It is recommended that on-demand stops be equipped with kiosks that allow pick-up requests to be made without access to a telephone. Kiosks are described in more detail in Section 6.3.1. To minimize left-turn and weaving movements, deviations to the north of Cermak Road will be made by westbound buses and deviations to the south will be made by eastbound buses.

On Route 322, Pace defines 65 possible stop locations between North Riverside Mall and Oakbrook Center, including 9 BRT stops. If necessary, the flex-route could serve all flag stops along Cermak Road, but this would require deviations to return to the route at or before the point where they turned off (route deviation versus point deviation). Longer deviations that may include backtracking reduce the number of requests that could be served in each run. The BRT stops represent 89% of all Pace Route 322 boarding and alighting activity between the flex-route termini, suggesting that guaranteed service to all flag stops might not be justified, especially at the expense of compromised deviation operations. A policy decision on this issue will be needed during implementation.

Following successful testing of this system, it may be possible to offer additional deviation destinations, potentially including curbside service at private residences. However, this would significantly complicate the scheduling problem and would require a more robust customer interface, perhaps using telephone or Internet technology. A phased introduction of this curbside service could include the integration of the paratransit service that is required to be provided for persons with mobility impairments within ¼ mile of any fixed-route bus service under the American with Disabilities Act (ADA). In this manner, the number of potential requests for curbside service could be increased in stages over time.

The lead-time between when a request is received and when it can be served on the OmniLink service is limited by the need to establish the schedule and itinerary before a run begins. Much of OmniLink’s required minimum lead-time is driven by the headway of 45 to 60 minutes. Service that is more frequent could reduce lead times without changes to this policy. However, using wireless communications and an in-vehicle navigation system with turn-by-turn directions, it may be possible to revise itineraries while a run is in progress. Of course, changes would be subject to the vehicle’s ability to serve pick-up requests within the range of times promised when the
reservation was made. This could substantially reduce lead times, make the service more convenient, and increase efficiency making all available time in each run available for utilization as late as possible.

3.3.2. Service Characteristics

The demand for deviations will not be known until detailed market research is conducted or actual operating experience in the corridor is available. For the purposes of this study, it was assumed that the flex-route would require 40 minutes to travel between Oakbrook Center and North Riverside Mall in the peak period. This assumes the same travel time between Oakbrook Center and Wolf Road as Pace Route 322 and double the existing travel time between Wolf Road and North Riverside Mall. This is approximately 60% longer than the 25-minute average observed travel time for the existing Pace Route 322 between Oak Brook and North Riverside. The 40-minute one-way trip time amounts to a 90-minute round-trip running time, including layover.

Because the flex-route will provide essential feeder functions to the BRT line, frequent service is important. It is expected that many passengers will make transfers to BRT vehicles at stations along the route. To facilitate these transfers, an on-board visual and audible next-stop announcement system will notify passengers of approaching BRT stations and the estimated time until the next BRT vehicle. The wait time until the next flex-route vehicle will also be provided to the driver for those times when drop-off requests cannot be accepted.

For the purpose of this preliminary concept design, it is proposed that headways be established that correspond to the BRT service. The frequent headway minimizes lead-time for deviation requests and allows for timed transfers with BRT service at North Riverside Mall and Oakbrook Center. Frequent service also maximizes opportunities for transfers to and from BRT service en route. Assuming 10-minute peak-period headways, four BRT vehicles will pass through the corridor during each flex-route run, allowing at least several opportunities for connections to BRT service.

3.3.3. Fare Collection

It is proposed that regular service on the flex-route be treated like any other service in terms of fare policy. Under this scenario, passengers would pay when entering the vehicle using a standard Pace farebox administered by the bus operator.

A premium fare or deviation fee also works well with fare prepayment, a policy that minimizes the risk of abuse. People requesting trips that they do not make would impose substantial travel time costs on passengers and operating costs on the transit property when needless diversions are made. Because value is stored on the farecard, the existing AFC does not support remote debiting of transit fares. It would thus be impossible to collect a fare from a person who does not board a bus. However, a credit card, debit card, or other charge account could be debited by telephone, Internet, or at a kiosk when a request is made. Drop-offs could be served at no charge or by manually collecting a higher fare at the farebox when a passenger makes a deviation request on boarding. In a conversation with Cubic Transportation Systems, manufacturer of Pace’s AFC system, this would require only a minor software change to the fareboxes on the flex-route.
vehicles. The operator would need to manually distinguish passengers requesting a deviation by pressing a button on the farebox. At kiosks located at on-demand stops, customers could request deviation service using a farecard or a credit/debit card. Credit/debit card users would be issued a receipt that would serve as proof-of-payment when boarding the bus. Persons who have not requested a pick-up would also be allowed to board at a deviation stop and would be charged the deviation fee at the farebox. Frequent users could establish a FlexPass account with Pace that would be linked to a smart card and/or a credit card account and would streamline the process of reserving and paying for trips.

3.4. Community Van Service

A demand-response van or small bus service will be provided in the Western Segment to serve the widely distributed trip generators typical of DuPage County. Vans will be based at the Oakbrook Center and Yorktown Mall transportation centers. In addition to service the general public, this service could meet the requirements of the ADA for supplemental transit services within ¾ mile of a fixed route.

3.4.1 Demand-Response Service

The demand-response van or small bus service will operate much like the deviation feature of the flex-route service, except that there will be no normal route. The route will serve a designated area centered on a base transportation center. All passengers will make requests for pick-up or drop-off. The itinerary for each run will be planned and modified in real-time as requests are received.

Requests for pick-up will be taken at a central dispatch center with a telephone bank and an Internet interface. The customer interface will provide an estimated time until arrival of the demand-response vehicle at the time the request is made. This estimate will be expressed as a range of five to ten minutes to provide some flexibility for traffic delays and for serving drop-off requests. A pre-stored meeting place description will also be identified from a database containing each potential pick-up address. Standing reservations may also be accepted.

Like the flex-route service, a limited number of fixed pick-up locations may also be defined. These locations would offer kiosks that allow customers to make pick-up requests at major activity centers without the need for a telephone or an Internet connection. Potential locations for such kiosks include the entrances to office towers and anchor stores at strip-type shopping centers.

Requests for drop-off will be made at the time of boarding. A certain amount of time will be reserved in the schedule as pick-up requests are received to accommodate drop-off requests. Drop-offs will be scheduled in real-time with pick-ups using a shortest travel time algorithm. However, drop-offs will not be scheduled that make it impossible to meet pick-up time estimates made to passengers who made requests over the telephone or Internet.
3.4.2 Service Characteristics

Two demand-response service areas will be served. For the service based at Oakbrook Center, assumed service area boundaries include Roosevelt Road, Midwest Road, 31st Street, and the DuPage County Line. However, locations within ¼ mile of Cermak Road east of Oakbrook Center would be served by walk access to the flex-route for persons without disabilities. For the service based at Yorktown Mall, assumed service boundaries include Roosevelt Road, Interstate 355, 31st Street, and Midwest Road. Larger service areas could be defined, but may require additional rolling stock. For additional passenger convenience, the Midwest Road boundary between service areas could be blurred to allow eastbound passengers located just west of Midwest Road to use the Oakbrook Center service and avoid backtracking to Yorktown Mall.

3.4.3 Fare Collection

The fare structure for demand-response service will be the same as for deviations on the flex-route service. As with flex-route service, the final selection of fare policy should be based on more detailed analysis of the travel market, including a stated preference survey, focus groups, and/or other consumer input, and a financial analysis that assesses projected recovery ratio.
4. **Rolling Stock**

The package of BRT and its supporting transit services will require a variety of vehicle types. To minimize requirements for maintenance training and spare parts storage, the vehicle types selected should match vehicles currently in use by Pace as much as possible. This section describes some of the considerations that govern vehicle selection and makes recommendations regarding general vehicle specifications.

4.1. **BRT Service**

It is proposed that the BRT service employ vehicles that are as similar as possible to those used elsewhere in Pace’s fleet. Because the BRT system will operate primarily on street in mixed traffic, the use of advanced transit vehicles that offer such features as automatic guidance systems, multiple articulations, and two-sided boarding is not warranted. The success of the Los Angeles Metro Rapid BRT system shows that an innovative and effective BRT service can be implemented using standard low-floor transit buses.

4.1.1. **System Capacity**

At the 10-minute peak headways established by the Blue Line, the BRT system could serve 240 passengers per hour per direction (pphpd) using 40-foot low-floor buses. This is 50% more peak-hour capacity than Pace Route 322, which operates at 15-minute peak headways (not including several school trips). Using 40-foot low-floor buses, such as the Orion VI, with a capacity of 40 persons per vehicle (32 seated passengers and 8 standees), the current peak-hour supply is 160 pphpd. Both capacities assume a 125% load factor, which corresponds to LOS D in the *Transit Capacity and Quality of Service Manual* (Transit Cooperative Research Board, 1999).

This capacity would meet more than double the observed peak-period demand on the existing Pace Route 322. Peak-hour runs on Pace Route 322 were observed to have an average occupancy of 26 passengers at the maximum load point (54/Cermak). At 15-minute peak headways, this amounts to a peak-hour demand of approximately 104 pphpd. Insufficient data on ridership patterns by time of day was available for this study to support a detailed peak-period capacity analysis. A standard peak-hour factor of 10% (one tenth of daily boardings occur during the busiest 60 minutes of the day) was used. This may represent a conservative assumption, since many regional transit services experience somewhat more constant ridership throughout the day.

The preliminary projections of daily ridership prepared for this study suggest that the BRT service will attract approximately 30% more ridership than the current route. Based on the ridership forecast discussed in Section 7.3 and assuming that 10% of those passengers ride during the peak-hour, 243 pphpd are expected in the peak hour. At 40 passengers per vehicle, this amounts to just over six vehicles in each direction needed to meet projected demand. This suggests that using normal 40-foot buses at the proposed 10-minute headways would fall just short of projected demand in the first year of operations.

As ridership grows beyond the initial capacity of the system, it is recommended that capacity be added in the form of articulated buses and/or increased frequency. Low-floor articulated buses
currently on the market can accommodate 56-seated passengers or a schedule load of 70 passengers. At the same 10-minute headways, this amounts to 420 pphpd. Adding peak-hour BRT runs between trains could significantly expand capacity, but would reduce convenience for some passengers transferring between BRT and rail and would substantially increase operating costs. For example, 5-minute headways using 40-foot vehicles would increase capacity to 480 pphpd.

If required in the future, an alternating mix of 60-foot low-floor articulated buses timed to meet trains and 40-foot low-floor buses timed to arrive and depart 54/Cermak between trains could provide a capacity of 660 pphpd. This would provide greater seat capacity for passengers transferring to or from rail while also meeting demand elsewhere in the corridor. Table 4.1 shows various service options and their associated capacities.

Table 4.1: Service Options and Line Capacity

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Seated Capacity</th>
<th>Schedule Capacity</th>
<th>Headway (minutes)</th>
<th>Capacity (pphpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40' low-floor bus</td>
<td>32</td>
<td>40</td>
<td>10</td>
<td>240</td>
</tr>
<tr>
<td>60' low-floor articulated</td>
<td>56</td>
<td>70</td>
<td>10</td>
<td>420</td>
</tr>
<tr>
<td>40' low-floor bus</td>
<td>32</td>
<td>40</td>
<td>5</td>
<td>480</td>
</tr>
<tr>
<td>Alternating Mix (1)</td>
<td>32</td>
<td>40</td>
<td>5</td>
<td>660</td>
</tr>
<tr>
<td>60' low-floor articulated</td>
<td>56</td>
<td>70</td>
<td>5</td>
<td>840</td>
</tr>
</tbody>
</table>

Notes: (1) Mix includes alternating 40-foot and 60-foot buses with 60-foot buses timed to meet trains.
(2) Schedule capacity assumes 25% standees at peak (LOS D).

4.1.2. Fleet Composition

A fleet of 14 buses can serve the current demand estimates on opening. This corresponds to a peak-period requirement of 11 vehicles plus 3 spares, which is consistent with Pace’s 19% system-wide spare ratio. The off-peak requirement is 7 buses plus two spares. Because the ridership forecast suggests that 40-foot buses alone will not meet projected demand, it is suggested that a mixed fleet of 40-foot buses and 60-foot buses be used. The fleet could consist of 7 40-foot Orion VI or newer buses plus two spares and four 60-foot articulated buses plus one spare. The 60-foot buses would be used only during peak periods. At six runs per hour during the peak period, this mixed fleet would have a capacity of approximately 360 pphpd, which exceeds projected first-year demand by 48%. It would thus probably provide for seated load service during most of the peak period.

Bike racks should be provided on all BRT vehicles, similar to other Pace services.
4.1.3. Hybrid Propulsion

The introduction of an innovative BRT service provides an opportunity to package the introduction of many innovations and to capitalize on the publicity associated with the new line to enhance the image of Pace as a leader in transit technology. There is a movement in the bus transit industry toward hybrid diesel-electric propulsion systems. Hybrid systems have been shown to increase fuel efficiency by 50% over normal diesel buses, reduce emissions to levels lower than buses powered by compressed natural gas, and significantly lower noise. Cleaner, quieter buses would be an additional means to distinguish BRT service from traditional bus services. Less fuel consumption reduces operating costs.

The Orion VI is available with a hybrid diesel-electric power system. Because Orion VI hybrid buses share many components with the diesel versions currently in use by Pace, the need for additional maintenance training and parts stocking would be minimized.

It is recommended that Pace consider the use of hybrid buses on the BRT system. They have been shown to reduce operating costs and provide an opportunity to enhance the image of the transit property with environmental sensitivity and technological innovation.

4.1.4. Technology

The BRT vehicle will include the Intelligent Bus System (IBS), which is currently being deployed by Pace under contract with Siemens. The vehicle will be outfitted with a Mobile Data Terminal (MDT), a GPS-based Automatic Vehicle Location (AVL) system, an Automatic Passenger Counter, an on-board next-stop display with audible announcements, and an upgraded digital radio communication system. Technology features are described in more detail in Section 6.

4.1.5. Image

A highly recognizable paint scheme will be used for BRT vehicles. The paint scheme will be used to distinguish BRT vehicles from regular transit buses. The Los Angeles County Metropolitan Transportation Authority (LACMTA) has used a bright red paint scheme to great effect on its Metro Rapid bus program. A distinctive shade of red automobile lacquer has been used consistently in the image development and marketing of the Metro Rapid bus service. As shown in Figure 4.1, the red paint is applied to the front of the buses to distinguish them from other buses as they approach the bus stop. The red color is also used on the upper sides and rear of the vehicles. Standard white paint is used on the lower side panels to simplify routine maintenance.
Pace should conduct a more detailed marketing study, including focus groups, during the development of a comprehensive system identify for the BRT service. This marketing identity should also include the supporting flex-route and demand-response service services with the goal of presenting all three services as a coordinated package. Coordination will be an important concept to communicate to the traveling public because easy transfer between feeder services and BRT will be an important part of the system’s success.

4.2. Traditional Bus Service

It is assumed that traditional bus services that parallel or intersect the BRT corridor will continue to operate with the mix of vehicles currently deployed. Pace Route 322 will be eliminated and replaced with a combination of BRT service and diversion to other parallel bus routes in the Eastern Segment of the Cermak Road corridor. The elimination of Pace Route 322 service will save approximately nine 40-foot buses plus two spares in the peak period. It is assumed that diversions to other routes will have no effect on vehicle requirements for traditional bus services in the corridor.

4.3. Flex-Route Service

Assuming a 40-minute one-way running time and a 5-minute layover at each end, the flex-route will operate on a 90-minute round-trip cycle time, including 15 minutes of diversions in each direction. To provide the most effective feeder services to the BRT, this route is assumed to operate on the same frequency as the BRT service. At 10-minute headways, this will require a total of 9 flex-route vehicles in the peak period. Including two spares, this amounts to 11 vehicles.

Depending on ridership, it is expected that 23- or 29-foot buses will be used for flex-route service. To minimize maintenance costs, they should be consistent in make and model with other vehicles in Pace’s fixed-route fleet. Because of the on-board hardware and software requirements to support real-time scheduling and navigation, the vehicles assigned to flex-route service will
need to be dedicated to the Cermak Road corridor. It is recommended that buses used for flex-route service be equipped with bike racks to the extent possible.

4.4. Demand-Response Service

It is assumed that demand-response services will operate in 20-minute loops during peak periods from their bases of operation at Oakbrook Center or Yorktown Mall. During off-peak periods, 15-, 20-, or 30-minute loops may be operated such that a multiple of BRT headways is achieved. This headway coordination is important to allow the demand-response service to function as a timed-transfer feeder system with BRT.

Detailed market information was not available for this study to support an analysis of travel demand for this service or its associated vehicle requirements. For the purpose of this initial feasibility study, it is assumed that two vehicles will meet each BRT bus at Oakbrook Center and one vehicle will meet each BRT bus at Yorktown Mall. Because the round-trip loop time is assumed to be two BRT headways (20 minutes) during peak periods, a total of 6 demand-response vehicles will be required. Including two spares, this amounts to 8 vehicles.

Depending on ridership, it is expected that 19- or 23-foot wheelchair-accessible buses will be used for the demand-response service. To minimize maintenance costs, they should be consistent in make and model with other vehicles in Pace’s Para transit fleet. Because of the on-board hardware and software requirements to support real-time scheduling and navigation, the vehicles assigned to demand-response service will need to be dedicated to the Oakbrook Center and Yorktown Mall service areas.

4.5. Summary of Fleet Requirements

Table 4.2 summarizes the fleet requirements for the BRT and supporting transit services. These rolling stock estimates were based on preliminary ridership analyses for the BRT route and general assumptions about the level of demand for supporting transit services. Supporting transit services require more vehicles (and generally have proportionally higher operating costs) than the BRT service or the existing Pace Route 322. Of the 26 vehicles in peak service, 11 are BRT vehicles, 9 are flex-route buses, and 6 are demand-response buses. This level of service is needed to support timed-transfer feeder services to the BRT that open markets not served by the existing fixed route. Because BRT stops serve more than 87 percent of existing boarding and alighting activity in the Cermak Road corridor, such service may have stronger justification in other corridors. Lower vehicle requirements and operating costs could be achieved by meeting every second or third BRT vehicle, for example. More detailed assessment of travel patterns and potential ridership is recommended during the implementation phases of the project.
<table>
<thead>
<tr>
<th>Service</th>
<th>Round-Trip Cycle Time</th>
<th>Service Headway</th>
<th>Vehicles Required</th>
<th>Spare Vehicles</th>
<th>Vehicle Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday Peak</td>
<td>1:50:00</td>
<td>10</td>
<td>11</td>
<td>3</td>
<td>60’ and 40’ buses</td>
</tr>
<tr>
<td>Weekday Off-Peak</td>
<td>1:45:00</td>
<td>15</td>
<td>7</td>
<td>2</td>
<td>40’ low-floor buses</td>
</tr>
<tr>
<td>Saturday</td>
<td>1:45:00</td>
<td>15</td>
<td>7</td>
<td>2</td>
<td>40’ low-floor buses</td>
</tr>
<tr>
<td>Sunday</td>
<td>1:40:00</td>
<td>20</td>
<td>5</td>
<td>1</td>
<td>40’ low-floor buses</td>
</tr>
<tr>
<td>Traditional Bus (322 eliminated)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday Peak</td>
<td>2:22:00</td>
<td>15</td>
<td>-9</td>
<td>-2</td>
<td>40’ low-floor buses</td>
</tr>
<tr>
<td>Weekday Off-Peak</td>
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<td>20</td>
<td>-6</td>
<td>-2</td>
<td>40’ low-floor buses</td>
</tr>
<tr>
<td>Saturday</td>
<td>2:00:00</td>
<td>30</td>
<td>-4</td>
<td>-1</td>
<td>40’ low-floor buses</td>
</tr>
<tr>
<td>Sunday</td>
<td>2:00:00</td>
<td>60</td>
<td>-2</td>
<td>-1</td>
<td>40’ low-floor buses</td>
</tr>
<tr>
<td>Flexible Route</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday Peak</td>
<td>1:30:00</td>
<td>10</td>
<td>9</td>
<td>2</td>
<td>23’ or 29’ buses</td>
</tr>
<tr>
<td>Weekday Off-Peak</td>
<td>1:30:00</td>
<td>15</td>
<td>6</td>
<td>2</td>
<td>23’ or 29’ buses</td>
</tr>
<tr>
<td>Saturday</td>
<td>1:30:00</td>
<td>15</td>
<td>6</td>
<td>2</td>
<td>23’ or 29’ buses</td>
</tr>
<tr>
<td>Sunday</td>
<td>1:20:00</td>
<td>20</td>
<td>4</td>
<td>1</td>
<td>23’ or 29’ buses</td>
</tr>
<tr>
<td>Demand Response - Oakbrook</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday Peak</td>
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<td>10</td>
<td>4</td>
<td>1</td>
<td>19’ or 23’ buses</td>
</tr>
<tr>
<td>Weekday Off-Peak</td>
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<td>15</td>
<td>2</td>
<td>1</td>
<td>19’ or 23’ buses</td>
</tr>
<tr>
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<tr>
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<td>20</td>
<td>2</td>
<td>1</td>
<td>19’ or 23’ buses</td>
</tr>
<tr>
<td>Demand Response - Yorktown</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday Peak</td>
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<td>10</td>
<td>2</td>
<td>1</td>
<td>19’ or 23’ buses</td>
</tr>
<tr>
<td>Weekday Off-Peak</td>
<td>0:15:00</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>19’ or 23’ buses</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>19’ or 23’ buses</td>
</tr>
<tr>
<td>Sunday</td>
<td>0:20:00</td>
<td>20</td>
<td>1</td>
<td>1</td>
<td>19’ or 23’ buses</td>
</tr>
</tbody>
</table>

| Net Total Vehicles Required  |                       |                  |                   |                |                    |
| Weekday Peak                 | 17                    | 5                |                   |                |                    |
| Weekday Off-Peak             | 10                    | 4                |                   |                |                    |
| Saturday                     | 12                    | 5                |                   |                |                    |
| Sunday                       | 10                    | 3                |                   |                |                    |
5. Passenger Facilities

High-quality passenger facilities will provide much of the distinction between traditional bus services and BRT. Passenger facilities will provide a degree of protection from the elements that are appropriate for Chicago’s climate. Passenger facilities will also communicate the availability and status of transit services to customers. Through their permanent appearance, passenger facilities will illustrate the route of the BRT to those not familiar with the system, much like stations do for rail lines. Passenger facilities will also be integrated with adjacent land uses to reduce impediments to transit access.

Pace BRT stations are proposed to consist of large, distinctively designed passenger shelters that provide not only ample overhead weather protection, but also vertical windscreens. Roofs will be extended over the vehicle boarding areas. Ample station amenities will be provided, including lighting, trash receptacles, seating, and newspaper vending machines. Platforms should be raised slightly above sidewalk level to allow for level boarding. Raised platforms also allow for distinctive floor design treatments. Wheelchair ramps will be provided where needed to make the transition between sidewalk and platform level. Designs will vary from location to location, but should share visual elements to the extent possible to reduce costs and to project a consistent system image. To accommodate proof-of-payment fare collection, each station will be equipped with a farecard reader, much like the mechanism used on board current Pace buses. This reader will allow customers to validate their farecards before boarding the bus. Ticket vending machines will be provided at Superstops, and Community and Regional Transportation Centers.

Pedestrian and bicycle access will be important components of facilitating ridership at all stations. It is recommended that gaps in the sidewalk network within at least ¼ mile of each station be filled during BRT implementation. Improvements to roadways and trail systems that facilitate bicycle access in the area are also recommended.

5.1. Station Types

There are four distinct types of passenger facilities used in the BRT system, each with its own level of complexity and physical design program: the BRT Stop, the Superstop, the Community Transportation Center, and the Regional Transportation Center.

5.1.1. BRT Stop

The BRT Stop is the simplest and most common type of passenger facility on the BRT system. Stops are typically located along the BRT route at or near an intersecting street on which no connecting BRT service is planned. The physical design program includes a heated waiting area enclosed on three sides and a sheltered boarding area. In general, far-side stop locations will be preferred, given their advantages in terms of enhanced traffic signal priority operations and reduced traffic impacts. At a minimum, these on-street stops will accommodate one 40-foot BRT vehicle with simple upgradeability to 60-foot articulated BRT vehicles. Based on preliminary ridership estimates, it is recommended that all stops on Cermak Road accommodate 60-foot vehicles on opening. Where supporting transit services are provided that need to make
connections with BRT at these locations, a bus bay will be added to accommodate one 23- or 29-foot bus.

5.1.2. Superstop

A Superstop is an on-street BRT Stop location along a corridor at which another BRT route intersects. This essentially results in a four-way bus stop at one intersection. Generally, the program is no more complex than that of the BRT Stop, although there are several design issues that may result in a variety of forms, given the specific physical and operational characteristics of an intersection. In general, emphasis will be given to placing connecting bus stops as close to each other as possible. In urban settings, stops on adjacent corners with or without a combined waiting area may be used. In this manner, one route would have nearside stops and the other route would have far-side stops. At major intersections with continuous right-turn lanes, nearside stops may be placed on modified islands. This has the effect of making large intersections more pedestrian-friendly. The appropriate design will be selected based on intersection-specific traffic volumes, turning movements, transit services, roadway geometry, physical conditions, and adjacent development.

5.1.3. Community Transportation Center

Community Transportation Centers serve as the origin point for community-based services and provide comfortable, convenient locations for customers to make connections between various transit services. Community-based services include a full gamut of service types from demand-response in some markets to fixed routes in others, with a customized mix of service types in each community. Transportation centers are typically located at and integrated with rail stations, community downtowns, shopping centers, and other major activity centers, and offer community transit-oriented development opportunities.

Community Transportation Centers provide off-street bus boarding areas and layover facilities. Wherever possible, they provide direct and safe access to commercial centers. The philosophy is similar to that of providing close access to commercial centers in urban areas that exist around primary road intersections. However, in many suburban shopping center contexts, close proximity can be achieved only by leaving the public street domain. In these cases, integration can sometimes be achieved by constructing transportation centers in the outlots or parking lots of shopping centers, including retail uses and replacement parking in the facility, and creating a pleasant, continuous pedestrian experience between the transportation center and the shopping center. Otherwise, the enhanced sensitivity to pedestrian access that is so important for the BRT concept may be lost, as users may find themselves several hundred feet away from any potential commercial destination.

The design program for the Community Transportation Center is more elaborate than that of the BRT Stop or Superstop. It will accommodate more buses simultaneously, since several routes may terminate and layover before their next departure. The appropriate number of bus loading areas will be determined by the nature and number of routes connecting at any specific location. Transportation centers are designed to support efficient bus operations, including flow-through circulation, one-way directional traffic, easy access to and from the BRT corridor, segregation of buses from other traffic, and minimized local traffic conflicts. Transportation centers include
provisions for kiss-and-ride and park-and-ride access. Additionally, it will include amenities that address the needs of the local market, such as bicycle storage facilities, kiss-and-ride lanes, park-and-ride lots, farecard vending machines, driver washrooms, newspaper stands, coffee shops, dry cleaners, and other businesses that cater to the commuting public.

Off-street transportation centers are proposed for the following locations.

- 54/Cermak
- North Riverside Park Mall
- Oakbrook Center
- Yorktown Center

### 5.1.4. Regional Transportation Center

Pace has identified 16 locations throughout the region where major concentrations of employment, industrial, retail, and/or residential development will be served by a relatively large number of BRT routes and community-based services. Regional Transportation Centers will be constructed at these locations. These facilities are similar to Community Transportation Centers, but accommodate a larger number of people, and higher bus volume and frequency. Among transportation centers in the Cermak Road corridor, only Oakbrook Center is considered to be a Regional Transportation Center.

In the case of both the Community and Regional Transportation Centers, it is important to conceive of them as a complement to the existing development. Much of the ridership at these points will come from the centers themselves. Likewise, the BRT system offers great potential to link these major nodes and feed employees and patrons to these areas of higher intensity development. Therefore, they must be sited and designed in such a way as to allow for easy and direct movement between the bus area and the commercial areas. The issues and concerns of the commercial areas will likely play a major role in the physical design of the transportation centers.

Ottawa, Ontario has had success with siting busway stations in existing shopping malls as part of the regional commitment to integrate transit and land use. Over time, surface parking was converted to increased development, facilitated by the accessibility provided by the BRT system. Locating a station adjacent to existing development makes the station a destination even before new development arrives. Passengers waiting to transfer can also make use of their transfer time in adjacent shops.

Coordination of development of BRT facilities with outlot development at major shopping centers is recommended for further study in Pace’s BRT Corridors. An example is included as part of the Oakbrook Transportation Center concept design described in Section 5.3.6.
5.2. Typical BRT Stop Design

The most recognizable physical design feature of the BRT system will likely be the on-street structures that will exist at BRT Stops and Superstops. A consistent formal design is recommended for use at most intersections, although it may be adapted to meet specific local physical conditions or streetscape design standards. The recommended design represents a significant upgrade from bus shelters that are typically in use along traditional bus routes and integrates many BRT features.

The design is adaptable to reflect streetscape contexts characteristic of individual communities. This may be accomplished in part by applying various palettes of materials to the basic formal design. For example, while one neighborhood may have a shelter with a granite masonry base and dark bronze metalwork, another may be founded on a site-cast concrete base with painted metalwork, since it is more appropriate given the architectural vocabulary of that neighborhood or commercial district. In any environment, careful consideration must be given to each site and the way that its architectural influence is applied to the general form of the passenger facility.

The typical BRT stop has been designed to include the following program elements:

- **Waiting Area Enclosure:** It is recommended that a 3-sided enclosure be provided to protect from harsh winds and temperatures. The waiting shelter includes direct lighting and a display field for backlit signage showing the Pace BRT logo, the route name, and the station name. The waiting shelter will provide space for up to two leased 4' x 6' advertising panels. A bench will also be provided.

- **Boarding Area Shelter:** An overhead canopy at the boarding area shall be provided for shelter from precipitation. The roof is constructed of transparent fiberglass to admit daylight while providing shade from direct sunlight. At night, the roof is illuminated from underneath to provide ambient lighting and a distinctive glowing appearance on approach. The structure will be implemented in a modular manner to accommodate 40-foot or 60-foot buses, with the possibility of adding modules when ridership growth requires larger vehicles. The boarding area canopy will form the most recognizable visual element of the BRT system and should thus be repeated wherever possible.

- **Raised Platform:** The boarding area will be raised approximately 3 to 6 inches above sidewalk grade to allow level boarding with low-floor buses. This feature, when combined with flip-type hydraulic ramps on the BRT vehicle, can significantly speed boarding and alighting, especially for the mobility impaired. The flip-type ramp can be deployed much faster than conventional wheelchair lifts, and could be used at every stop to close the gap between the platform and the bus. At the street, this creates a barrier curb between 9 and 12 inches in height. Although a skilled operator can safely dock at barrier curbs without body damage, it may be desirable to include small horizontally mounted wheels near the front of BRT vehicles to reduce risk. It is recommended that a contrasting pavement material, such as brick, stone, or tile, be used at BRT boarding locations to distinguish them from the sidewalk.

- **Active Transit Station Signs:** Two types of variable message signs are recommended. Inside the waiting area, a full-matrix text display will be provided to communicate advisory messages. This feature may be combined with an audio public address system.
for communicating advisory messages. Most of the time, however, this sign will display the estimated time until arrival of the next BRT vehicle. On the ends of the waiting area enclosure, variable message signs will count down the number of minutes until the next BRT vehicle arrives in large numerals visible to approaching pedestrians. This information is sometimes more useful when viewed across the intersection from a bus stop than while at the bus stop.

- **Service Information:** A route map showing the coverage area of the BRT service and any connecting services available at the station will be provided as a static display. Service information including schedules and hours of operation will also be provided. It is recommended that a vicinity map showing the street network and points of interest within a ¼- to ½-mile walking distance also be provided.

- **Heat:** Because of Chicago’s harsh winters, it is recommended that enclosed waiting areas include infrared heat lamps and/or an electrically heated bench. Heat lamps are a common feature on rail platforms in the region.

- **Farecard Validation Machine:** A device for validating magnetic farecards or smartcards is required to support off-board fare payment and proof-of-payment fare collection. This device will consist of a simplified version of a bus farebox. It will not accept cash, but may accept credit or debit cards. Cash acceptance would require additional security measures that would substantially increase operating costs. A display will show the value remaining on the farecard. This device will be sturdily integrated with the structure of the waiting area enclosure.

- **Security:** The boarding area and waiting area will be remotely monitored by surveillance camera and/or microphone on a random basis. Security requirements and management would be explored on a location specific basis. The security discussion is expected to be an element of service coordination with communities and with Pace’s operating and maintenance program.

- **Bicycle Storage:** A ribbon-style bicycle storage rack will be provided. This tubular steel object may be integrated with lean bars in the boarding area.

- **Pedestrian Access:** There are numerous locations in Pace’s suburban environment where continuous sidewalk networks are lacking. High-quality pedestrian connections between BRT stations and adjacent traffic generators will be required to maximize ridership. Likewise, good connections between Pace BRT stations and intersecting Pace bus routes will be required. It is recommended that gaps in the sidewalk network within ¼ mile of each BRT station be filled as part of the BRT implementation program.

It is recommended that design elements be shared between larger transportation centers and the standard shelter design where possible. This will create a consistent and more recognizable design language across the corridor, and across the region in the areas served by BRT routes. Capital cost savings may also be introduced through economies of scale with shared elements. Examples of this will be shown in the design concepts of Community and Regional Transportation Centers.

Figure 5.1 shows the design concept for the typical BRT Stop.
Typical Shelter Design

**Shelter Plan**
Scale: 3/16" = 1' 0"

Legend:
1. Public Sidewalk
2. Landscaping/Existing Sidewalk
3. Ramp to Bus Platform
4. Bus Platform
5. Shelter Canopy Above
6. Bench
7. Knee Wall & Glass Enclosure
8. Concrete Pad on Street
9. 2'6" Curb Setback at Bus Bay
10. Bus Location at Stop

**Elevation & Section**
Scale: 3/16" = 1' 0"

Legend:
1. Overhead Canopy
2. Canopy Break-Away Safety Section
3. Shelter Roof
4. Canopy Structural Column
5. Advertising Panel
6. Knee Wall
7. Exterior VMS
8. Interior VMS
9. Shelter Lighting
10. Infrared Heater
11. Bench
12. Glass
13. Route/Scheduling Information Panel

WILBUR SMITH ASSOCIATES
Figure 5.1: Typical BRT Stop

Include Station Drawings-Plans, Section, Elevations, Perspective Sketch
5.3. Station Design Typologies

This section presents design concepts that apply the general design philosophy to specific BRT Stop, Superstop, and Community Transportation Center, and Regional Transportation Center locations in the Cermak Road corridor. While they reflect responses to specific conditions, these locations were selected to illustrate how the BRT system could look at a variety of locations throughout Pace’s service area. The following will serve as models:

- **Bus/Rail Terminal Interchange Facility:**
  54/Cermak Blue Line Station

- **BRT Stop in a Traditional Urban Retail Context:**
  Oak Park Avenue

- **BRT Stop in a Typical IDOT Intersection Context:**
  Mayfair Avenue

- **Superstop in a Typical IDOT Intersection Context:**
  First Avenue

- **Community Transportation Center at Commercial Center:**
  North Riverside Mall

- **Regional Transportation Center:**
  Oak Brook Center

5.3.1. Bus/Rail Terminal Interchange Facility

The relationship between the end of a rail line and the beginning of a BRT line is a crucial one. Seamless transfer from the CTA rail system to the Pace BRT will enhance BRT’s role as a rubber-tired extension of the rail line and will enhance the user-friendliness of the BRT system. As part of the Douglas Branch reconstruction project, the CTA is planning to build a new 54/Cermak rail station in the block between 54th Avenue and Laramie Avenue, directly east of the existing station site. Final design has already been substantially completed on the new station. The rail platform will be located slightly above grade with buses separated from trains by vehicle barriers and fencing. Integrating the BRT service with the already-designed station with as little need for modification as possible was a major design goal.

Two important design considerations include allowing quick bus access to the station from the Cermak Road corridor and providing a direct connection with the rail platform. It is recommended that BRT buses follow the same pattern as the local bus service, entering from Laramie Avenue and exiting on 54th Avenue. It is expected that bus delays associated with long traffic queues on Central Avenue that impede buses’ left turn movements from the station toward Cermak Road will be alleviated by the lighter traffic volumes on 54th Avenue. It is also recommended that the BRT bus platform be located at the beginning of the western bus boarding area nearest to the turnstiles. The BRT boarding area should be marked by the canopy used at the typical BRT Stop. This will give it a distinct architectural character that distinguishes it from
both the CTA and Pace local bus service-boarding areas and associates it with the rest of the BRT route. No enclosed waiting area has been included because of the tight integration of BRT departures with train arrivals. If demand requires that BRT runs be scheduled between trains, consideration may be given to a heated waiting area, although the CTA fare payment area could serve this purpose.

Figure 5.2 shows the station plan and circulation diagram. It is recommended that further coordination take place with CTA during the implementation process to refine this design, which was based on preliminary designs provided by the CTA before Blue Line reconstruction commenced.
54/Cermak Train/Bus Station

Circulation Diagram
Scale: 1" = 100'

BRT Area Site Plan
Scale: 1" = 60'

Legend
1. Stationhouse Area
2. Canopied BRT Area
3. Local Bus Area
4. CTA Rail Platform
Figure 5.2: 54/Cermak Concept Design

Insert 54/Cermak Station Plan and Circulation Diagram
5.3.2. BRT Stop in a Traditional Urban Commercial Context

The Oak Park Avenue / Cermak Road intersection represents a physical condition that is found in many of Chicago’s older neighborhoods and suburbs: buildings constructed to the property line without setback, moderate to heavy pedestrian traffic, and on-street parking. Narrow sidewalks at this intersection leave insufficient space to accommodate the typical shelter and canopy. This location was selected to show how the general design could be adapted to areas with limited right-of-way.

Pace Route 311 currently operates on Oak Park Avenue and the corridor has been identified in Pace’s Comprehensive Operating Plan as a potential future BRT route. Even if the Oak Park Avenue BRT Route is not implemented for some time, Pace Route 311 represents an important connecting service. At this location, one desirable layout involves placement of nearside and far-side bus stops such that bus stops are grouped on adjacent corners on opposite sides of the intersection. This layout is particularly well suited to Oak Park Avenue because of the configuration of buildings around the intersection.

The concept design includes far-side stops on Cermak Road and nearside stops on Oak Park Avenue. Along Cermak Road, sidewalk width is approximately 11 feet from building face to curb, with similar dimensions along Oak Park Avenue. An abbreviated version of the boarding area canopy is used at the BRT Stops. The waiting area enclosure is replaced with a panel version that incorporates the farecard validator, a lean bar, the ATSS advisory sign, service information, a vicinity map, and two advertising panels. The sidewalk is raised at the boarding areas and pedestrians who are passing through would simply walk over the raised area.

There are several elements unique to this intersection that may be used to unify the appearance of the intersection. The retail buildings on the northwest and southeast corners of the intersection mirror each other with their curved facades turning the corner. This curvature strengthens the formal relationship between the bus stop canopies. Extending a canopy from one bus stop to the other across the storefront entrances would further strengthen this connection, provide shelter for transferring passengers, and create additional advertising space for the retailers. In combination with contrasting pavement materials in the pedestrian crosswalks and minor streetscape improvements, the intersection could become a transit space linking retail services in a unified urban space. This is a unique and wonderful opportunity that should be taken advantage of wherever possible.

Figure 5.3 shows the station design plan and perspective for the Oak Park Avenue BRT Stop.
5.3.3. BRT Stop in a Typical IDOT Corridor Context

The Mayfair Avenue BRT Stop represents a typical condition where a pair of far-side BRT stops are located in the right-of-way of a major state highway. Cermak Road in this section is a six-lane divided roadway with sidewalks on both sides that are consistent with IDOT design practice in many parts of the suburbs. Land use and zoning regulations require large setbacks, minimizing physical constraints to station design. Mayfair Avenue is a signalized intersection.

Because the flex-route supporting transit service is available in this corridor, a bus turnout for one 25-foot bus will be provided in addition to the BRT platform. This turnout allows flex-route vehicles that arrive one minute or so before the BRT vehicle to wait for connecting passengers. This will be the standard operating practice for flex-route vehicles so that they can most effectively provide a feeder / distributor function for the BRT service. The turnout will be located behind the BRT platform so that the flex-route vehicle can arrive while the BRT vehicle is in the station. To minimize right-of-way requirements for turnouts and to facilitate faster reentry into traffic, BRT vehicles will stop in the traffic lane.

Figure 5.4 shows the station design plan for the Mayfair Avenue BRT Stop.
Figure 5.4: Mayfair Avenue Concept Design

Typical Far-Side Bus Bay
Scale: 1" = 30'

Legend

1. Typ. BRT Platform & Shelter
2. Feeder Bus Boarding Area
3. Landscaping
4. Bicycle Storage Area
5. New Sidewalk
5.3.4. Superstop in a Typical IDOT Intersection Context

Because BRT routes are typically located along major arterial corridors, superstops will commonly occur at major arterial intersections. Standard IDOT design practice includes five or more lanes on each leg and, in many cases, free-flow right turn lanes with or without pedestrian refuge islands. Because of the size of these intersections, far-side stops would create very long transfer distances between BRT boarding areas. It is desirable to make the pedestrian transfer between bus routes as short as possible and to balance the needs of automobile traffic with the greater pedestrian presence at these intersections created by BRT transfers.

There is a trend in the roadway geometric design community to replace free-flow right turn lanes with more pedestrian-friendly right-angle configurations that allow a right turn on red after stop. This modification also creates additional space on islands for pedestrian refuges and nearside bus stops.

Nearside bus stops minimize the transfer distance between bus stops. Nearside bus stops are somewhat less effective for traffic signal priority, since buses can only receive priority treatment at the beginning of the green phase (as opposed to early green and extended green at far-side stops). At nearside stops, buses cannot effectively request extended green because the window of time during which they could request it and have it granted would be very short. Islands reduce the crosswalk length and help to make an intersection less intimidating to pedestrians.

First Avenue provides an example of how a Superstop could be implemented at a major arterial intersection. Cermak Road is three lanes in each direction, plus right- and left-turn lanes. First Avenue carries Pace Route 331 and has been designated a potential future BRT corridor. First Avenue is two lanes in each direction with right and left turn lanes.

Along Cermak Road, BRT stops are designed to accommodate one 60-foot BRT vehicle and one 23- or 29-foot flex-route vehicle in a turnout. Both vehicles stop at an enlarged island that includes an enclosed waiting area, a sheltered boarding area, and a raised platform similar to a typical BRT stop. The landscaped islands segment the street crossing, reduce the perceived width of the intersection, and provide a safer and more comfortable place to wait. Although the rider is waiting on an island, the enclosure provides some isolation from surrounding traffic.

The waiting area enclosure includes end-mounted ATSS countdown signs that are visible from other BRT boarding areas at the intersection. The enclosure is transparent and setback sufficiently from the intersection to provide drivers in the right turn lane with a clear line of sight to oncoming traffic. The boarding area canopy is located 13½ feet above the pavement, set back two feet from the traffic lane, and includes break-away roof support ends to minimize risk of damage from tall vehicles. A bicycle storage area with integrated lean bars is located behind the canopy extension used for 60-foot buses. The boarding area for the flex-route turnout is at normal curb height and transitions to the raised boarding platform throughout the taper. A fence separates the backside of the island from moving vehicles in the right turn lane. The right turn lane provides a minimum 160-foot queue length.

Along First Avenue, the BRT stops are designed to accommodate one 40-foot BRT vehicle only. The smaller vehicle is currently indicated by the lower relative ridership on Pace Route 331 as compared to Pace Route 322. No flex-route service is currently envisioned for First Avenue, but
could be accommodated in the future by constructing longer islands. This study makes no recommendation on the degree of provisions to make for future intersecting BRT services, since the implementation timetable is not known.

The concept design illustrated in Figure 5.5a shows the site plan for the First Avenue Superstop, while 5.5b is a ground level perspective of the near-side island design concept. Bus queue jumper lanes are shown as an illustrative example, although sufficient traffic data was not available to justify their use in this situation on technical grounds. The design also shows a special island configuration in the northeast quadrant that may be used where there is heavy demand for deviations. Flex-route vehicles making deviations will normally proceed to the next major intersection after the stop before turning right to serve the deviation. They will return to Cermak Road before the next posted bus stop. (If a policy decision in favor of flag stop service were made, buses would return to Cermak Road at or before the point where they turned off.) However, where the size of the superblock necessitates long travel times or where the demand for deviations is expected to be high, an alternative island configuration could allow flex-route vehicles to turn right from the turnout before the intersection. The westbound BRT boarding area at First Avenue provides an example of this condition. To serve a request at the Hines VA Hospital or Loyola Medical Center after First Avenue, the flex-route vehicle would need to travel on a 3-mile loop along Ninth Avenue and Roosevelt Road, which could take as much as 10 minutes at 20 m.p.h. average speed. A right-turn from the BRT island onto First Avenue would provide a much more direct route and would reduce the deviation time to 4-6 minutes.

Although not necessarily required for the First Avenue location, Figure 5.6 also shows an alternative that groups bus stops into nearside and far-side locations. This allows physical constraints in certain quadrants of the intersection to be accommodated. Figure 5.7 details alternative island configurations that may be applied at various locations throughout the region. Variations support various BRT vehicle sizes, accommodations for supporting services, and responses to physical constraints.
Near-Side Superstop Configuration

Near-Side Superstop Design
Scale: 1" = 50'

Legend
1. Typical 40' BRT Near-Side Island Stop
2. 60' BRT/Feeder Bus-Through Near-Side Island Stop
3. 60'/Feeder Bus-Through Near-Side Island Stop
   with Queue Jumper Bus Lane

*See Figure 5.7 for island details
Near-Side Island Configuration

Near-Side Island Perspective

Proposed Intersection Configuration with Near-Side Bus Island

Existing Intersection Configuration
Near-Side Island/Far-Side Bus Bay Superstop Configuration

Near-Side/Far-Side Superstop Design
Scale: 1" = 50'

Legend

1. Typical 40' BRT Near-Side Island Stop
2. Typical 40'/60' BRT Far-Side Bus Bay Stop
3. Unmodified Intersection Quadrants

*See Figure 5.7 for Near-Side Island Details & Figure 5.4 for Far-Side Bus Bay Details
Figure 5.5: First Avenue Superstop Concept Design

Insert First Avenue intersection design plan.
Figure 5.5b: Near-Side Island Perspective

Insert nearside island perspective
Figure 5.6: Nearside – Far-Side Combination Superstop

Insert nearside island configurations and near-side/far-side island configuration
Figure 5.7: Alternative Superstop Island Configurations

Insert nearside island configurations and near-side/far-side island configuration
5.3.5. Community Transportation Center at Commercial Center

When a commercial center provides a large enough attraction for customers, removing the BRT from the street to provide better access to the activity center is warranted. When a commercial center can serve as the focal point of a Community Transportation Center, an off-street bus facility where multiple routes can connect and lay over may be warranted. North Riverside Mall provides an excellent example of these conditions. The mall is the main attraction in a large shopping area that spans to the east side of Harlem Avenue. The mall is currently the terminal for two existing CTA routes and is a stop on three existing Pace routes. Harlem Avenue has been designated as a future BRT corridor. An off-street transportation facility designed to connect all of these services would serve as a community hub for public transit.

Two key design issues influenced the selection of a recommended site for the transportation center: the need to minimize travel time between Cermak Road and Harlem Avenue and the passenger facility, and the desire to integrate as fully as possible with North Riverside Mall. The existing transit facility location was not selected because of its poor access to the mall and its need for more circuitous movement through the mall parking lot. A lightly utilized parking area and an undeveloped patch of green space adjacent to the abandoned railroad tracks and in line with the east entrance to the mall was selected as providing the greatest benefits to the BRT system with the least negative impact on exiting conditions.

Bus access is relatively direct from Cermak via a signalized intersection at the mall entrance or a right-turn-only driveway. Bus access from Harlem is relatively direct along 25th Street. Both routes are currently used by Pace buses. Minor improvements to intersection and roadway geometry may be made to speed BRT access between these streets and the transportation center.

The North Riverside Mall Transportation Center serves as the terminal for the flex-route service along Cermak Road. Because of the dispersion of activity centers in this large shopping district, the flex-route will provide limited circulation services between major attractions in this area.

The Community Transportation Center accommodates five buses up to 60 feet in length and provides three layover spaces. Two waiting area enclosures and an extended boarding area canopy protect transit customers from the elements. These elements share many design features with the typical BRT Stop. A kiss-and-ride lane provides direct access to the bus-boarding platform. A landscaped pedestrian concourse links the transit facility with the mall entrance via two road crossings with contrasting pavement and speed tables to reduce automobile traffic conflicts.

The concept design consumes approximately 96 existing parking spaces. No replacement parking was included in the concept design given the lightly used nature of existing parking areas. In addition, the transportation center may reduce parking requirements at the shopping center by increasing transit’s share as a mode of access.

The concept design for the North Riverside Mall Community Transportation Center is shown in Figure 5.8. A circulation diagram and a station design plan are included.
North Riverside Transportation Center

Circulation Plan
Scale: 1" = 300'

Legend
- Existing Eastbound Route (#322)
- Existing Westbound Route (#322)
- Future Eastbound BRT Route
- Future Westbound BRT Route

Station Site Plan
Scale: 1" = 100'

Legend
1. Bus Platform Area
2. Landscaped/Canopied Pedestrian Walkway
3. Speedtable at Raised Walkway
4. Landscaped Area
5. Landscaped Buffer Along Railroad Tracks
6. Bus Layover Area
7. Canopy Over Platform
8. Kiss-N-Ride Area
9. Existing Buildings

W I L B U R S M I T H A S S O C I A T E S
Figure 5.8: North Riverside Mall Transportation Center Concept Design

Insert diagram showing the mall circulation patterns from Cermak and Harlem and station area plan for transportation center.
5.3.6. Regional Transportation Center

The Oak Brook area is a major regional employment center, with more than 50,000 jobs located in the eight square miles bounded by the Cook County line on the east, Roosevelt Road on the north, Meyers Road on the west, and 31st Street on the south. Its location at the crossroads of several major expressways, tollways, and arterial streets makes it one of the most accessible places in the region. Within this area, the Oakbrook Center shopping center represents the major focal point of activity. The development of a transportation center at this location would serve as a stop or terminal point for several toll way, expressway, and arterial BRT routes. In Pace’s Comprehensive Operating Plan, the Oakbrook Transportation Center is envisioned as a terminal or stop for toll way / expressway BRT routes to Harvey, Willow Springs, Forest Park, Rosemont, Schaumburg, and Aurora, a terminal or stop for arterial BRT routes on Cermak Road, Roosevelt Road, Cass Avenue, Garfield Avenue, Plainfield Road, York Road, and IL-83, and a timed-transfer pulse point for a network of community-based fixed routes, flex-routes, or demand-response services serving Oakbrook Terrace, Oakbrook, and other surrounding communities. All of these factors make Oakbrook Center one of the most desirable locations in the region for the development of a Regional Transportation Center.

Based on site investigations and consideration of the access routes to each of the BRT routes proposed to serve this transportation center, the best location for the facility was identified as being along Cermak Road between the two mid-block driveways to the shopping center. A location in the outlot bounded by Cermak Road, the mall ring road, and the two driveways, provides the most direct access to routes approaching or departing the center via Cermak Road, I 88, IL-83, and Spring Road. Access to eastbound I-88 could be enhanced with a bus-only lane through the toll plaza delivery driveway on Jorie Boulevard. A gate activated by an I-PASS transponder on board the bus could limit toll way access to Pace BRT vehicles. The site located on an axis between the Lord & Taylor department store at Oakbrook Center and the Marriot Hotel across Cermak Road.

The design program for this facility includes:

- **BRT Bus Bays:** 12 bus bays for 40-foot or 60-foot buses, minimum
- **Community Transit Service:** 4 bus bays for fixed-route, flex-route and demand-response vehicles, minimum
- **Replacement Parking:** structure to compensate for the surface parking consumed by the transportation center,
- **Park-and-Ride:** commuter parking for 100 cars, minimum
- **Kiss-and-Ride:** Wait / drop-off area for 12 cars, minimum
- **Bicycle Storage:** Lockers for 12 bicycles and racks for 40 bicycles, minimum
- **Pedestrian Access:** connection across Cermak Road, grade separated if possible
• Retail Space: divisible retail space to connect the transportation center with the rest of the shopping center. Retail uses may include services oriented to the commuting public, such as newspaper stands, coffee shops, dry cleaners, concierge services, and convenience stores. Retail uses closer to the mall may include anything appropriate for the rest of the shopping center.

The proposed design is driven by the desire to accommodate a substantial transportation program while improving pedestrian circulation in the area around Oakbrook Center and creating positive value for the shopping center. A major concern in the retail industry is the visibility of the anchor stores from the street. Special design consideration was given to minimize the visual impact of the transportation center in order to allow for an amiable coexistence with the existing commercial center.

A change in grade of approximately 10 feet between Cermak Road and the mall ring road was used to minimize the impact on sight lines of the anchor stores from the street. This involves placing the parking entrance in a depressed section of the ring road approximately 13½ feet below current grade. The clearance is adequate for delivery trucks below 11 feet in height. A pedestrian bridge connects a new section of shopping center concourse surrounded by one-story retail buildings with the transportation center across the ring road. This minimizes pedestrian conflicts with mall traffic. The pedestrian concourse continues across the bus boarding area to the parking structure and under Cermak Road to the hotel. Along Cermak Road, a parking structure rises one story above ground and provides an opportunity to advertise the shopping center. Despite their impacts on shopping center visibility, it should be noted that parking structures in such outlots are not uncommon, including a recent example at Old Orchard Shopping Center in Skokie, Illinois (see Figure 5.9).

**Figure 5.9: Outlot Parking Structure at Old Orchard**

The Oakbrook Transportation Center design proposal is a response to many of the issues that may be faced throughout the region when placing such a facility in the context of a major regional commercial center. Special consideration is given to its relationship to the existing commercial storefronts and parking access. At the same time, the allowance for safe and easy pedestrian access between the mall, transportation center, and surrounding employment centers is a crucial element in assuring effective service and transferability. Four major elements come together to influence the design and behavior of the transportation center. These include bus service.
operation, pedestrian access, automotive circulation to the mall and transportation schematic center, and parking to be used by both mall patrons and commuters. Figure 5.10 is an aerial view of the transportation center concept, while Figure 5.11 is an architectural perspective that presents the pedestrian bridge concepts.

**BRT Bus Operations**

Easy access into and efficient circulation throughout the transportation center is essential in the operation of buses serving the Oakbrook area. Therefore, it is recommended that a dedicated bus lane be provided on Cermak Road for the entire length of the RTC site. This will allow buses unobstructed access into the center at the west end of the site and easier merging back into traffic from the east end of the site. The bus lane flanks the transportation center on the east and west sides of the site to create a separation between bus traffic and automobile traffic on entering the mall property. The buses in this lane follow the existing grade to the level of the bus pick-up and drop-off areas. Upon entering the platform area, there are two lanes with a total of 14 bus bays. At the east end of the north lane, space has been provided for local shuttle or demand-response vehicles. The buses exit the station area at the east end, and may continue east on Cermak via the left-hand turn lane or west by using the dedicated bus lane to accelerate and merge with automotive traffic.

**Pedestrian Access**

Pedestrian access must be a driving force in the layout of the station circulation and its relationship to surrounding land uses. In the case of Oakbrook Center, it is vital to consider the employment centers across Cermak Road as well as the shopping center. The existing grade conditions of the transportation center site allow for a pair of options for crossing Cermak Road. First, a tunnel may be provided at the level of the bus platforms. This axis goes from the platform station area south along a corridor with access to parking and commercial space, and under the roadway to the south side of Cermak Road and an existing hotel. It also provides points of access to the street-level sidewalk on each side of Cermak Road.

A second option is to go over Cermak Road on a pedestrian bridge running from the top level of the parking deck. Given potential utility and infrastructure conflicts under Cermak Road, this could provide a feasible alternative to an underground tunnel, and an opportunity to create an Oakbrook Center icon at Cermak Road.

The other key pedestrian connection to be considered is from the transportation center north to the shopping center. A pedestrian bridge at platform level over a depressed mall circulation ring road is proposed. This provides the safest possible crossing, and offers benefits to automotive circulation that will be discussed in the following section. Once crossing over the ring road, a pedestrian boulevard lined with new retail space provides an environment similar to the existing outdoor mall context of Oakbrook Center. The boulevard opens up to a plaza at the corner of the Lord & Taylor department store, an already prominent feature of the mall when approaching from the south. Additional new retail space is proposed running northwest from this plaza, parallel to the existing tenant space. This completes the formal pedestrian connection between the transportation center and the commercial center, since it defines an extension of the new pedestrian plaza, leading the user to the interior courtyard of the existing mall. It may be possible
to reorient the entrance to the department store to the corner of the building on this axis to greater
architectural and circulation effect.

Automotive Circulation / Kiss-N-Ride

It is crucial that impacts on automotive circulation be mitigated as much as possible, and, where
opportunities exist, improvements may be made for the benefit of mall circulation and its
integration with a major transportation center. The impact of the RTC has been localized to the
mall ring road, an interior access road off the northwest corner of the transportation center, and an
interior access road where the new pedestrian boulevard is proposed. The most significant
gesture is the depression of the ring road. This serves two purposes. First, it allows safe
pedestrian crossing at grade with the bus platforms. Second, it provides access to the station’s
parking garage through an entry underneath the bus area. The primary negative impact is that it
severs a small number of the connections from the ring road to the parking lots that flank the new
pedestrian boulevard.

A second move that influences the circulation around the mall site is the relocation of the interior
access road going northwest from the transportation center. As it exists, it turns south upon
entering the parking area from the mall interior. However, an opportunity to improve circulation
may exist. By continuing it on its southeast bearing, it can create a four-way intersection with the
mall ring road and the western entrance from Cermak Road. This provides for a localized point
of traffic, a more efficient pattern for automobile circulation, and it minimizes the impact of the
grade-separated ring road by providing interior access closer to the point of grade separation.

The final impact on automotive circulation is the introduction of the pedestrian boulevard from
the transportation center to the mall. While it provides direct and undisturbed pedestrian access,
it severs the interior east-west automotive connection that currently exists. As a result, all east-
west traffic must use the ring road accessed from the parking lots on either side of the pedestrian
boulevard.

When locating the kiss-and-ride function that serves the transportation center, it is important that
it is as close to the station as possible, and any distance is mitigated by a safe pedestrian
connection to the platform area. The proposed kiss-and-ride area is located on the north side of
the existing mall ring road. It is at the existing grade, to allow for riders to be dropped off and
gain access to the station by crossing the pedestrian bridge over the depressed ring road.
Automotive access to the kiss-and-ride area is gained from the ring road before it becomes grade-
separated. It is a one-way lane in the westbound direction, and is canopied in the area adjacent to
the proposed retail space along the pedestrian boulevard.

Parking Access

Parking is an essential component of the success of the mall, and can greatly enhance the
performance of the BRT system by providing commuters with access to the starting point of a
route. Therefore, two primary parking issues exist with the siting of the transportation center.
First, there must not be a net loss in parking. In fact, in the case of Oakbrook Center, a 100%
replacement for mall parking and an additional provision of at least 100 commuter spaces were
determined to be a necessary piece of the proposal. Secondly, localizing the impacts of the new
parking configuration is necessary. This means that it may be harmful to replace the parking spaces on another part of the mall site, as it will have a secondary impact on the traffic patterns of those lots and the roads that serve the other parts of the mall. By replacing the spaces in the same area from which they were removed, minimum change is made to the overall transportation system.

As a result of these issues, a garage is proposed within the transportation center that replaces all lost parking, and provides enough on-site spaces for potential commuter riders. Table 5.1 quantifies the existing and proposed parking condition. The parking structure more than replaces the surface parking consumed by the improvements. A net gain of 118 spaces is available for commuter parking or additional shopping center parking.

Table 5.1: Oakbrook Transportation Center Parking

<table>
<thead>
<tr>
<th>Existing Parking Lost</th>
<th>New Parking Gained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Spaces</td>
</tr>
<tr>
<td>Outlot Site</td>
<td>405</td>
</tr>
<tr>
<td>Pedestrian Boulevard &amp; Retail Space</td>
<td>69</td>
</tr>
<tr>
<td>Parking Reconfiguration &amp; Kiss-N-Ride Area</td>
<td>121</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Parking Lost</strong></td>
<td><strong>595</strong></td>
</tr>
<tr>
<td><strong>Net Gain</strong></td>
<td></td>
</tr>
</tbody>
</table>

As previously discussed, an important issue is the visibility of the major anchor stores from the street. An alternative configuration that has more visual impact on sightlines could require less excavation and less capital expense. The alternative would have a very similar layout, but would include a pedestrian bridge over Cermak Road, no change in ring road elevation, a pedestrian bridge over the ring road, and a three-level above-ground parking structure along Cermak Road. This alternative configuration would have a higher profile along Cermak Road, but may be appropriate if underground utilities make a tunnel crossing prohibitive. The elevated pedestrian crossing would provide a more significant opportunity to advertise the shopping center and the surrounding Oakbrook area, but may be more difficult to integrate with the hotel. The pedestrian bridge over the ring road would provide an opportunity to develop two-story retail buildings between the transportation center and the Lord & Taylor department store.
Oakbrook Transportation Center

Site Plan
Scale: 1" = 100'

Legend
1. New Divisible Commercial Space
2. New Pedestrian Plaza Area
3. Pedestrian Canopy Area
4. Kiss-N-Ride Canopy Area
5. Reconfigured Parking & Circulation Area
6. Automotive Ramps to Lower Parking Level
7. Pedestrian Bridge to Shopping Center
8. Platform Canopies
9. Bus Platforms
10. Bus Level Parking Area
11. Street Level Parking Area
12. Cermak Road Pedestrian Tunnel to Station
13. Dedicated Bus Lane
14. Existing Cermak Road Curb Line
Oakbrook Transportation Center
Aerial Perspective

Legend

1. New Divisible Commercial Space
2. New Pedestrian Plaza Area
3. Kiss-N-Ride Canopy Area
4. Reconfigured Parking & Circulation Area
5. Automotive Ramps to Lower Parking Level
6. Pedestrian Bridge to Shopping Center
7. Platform Canopies
8. Bus Platforms
9. Multi-Level Parking Structure
10. Stair Tower to Station Level
11. Cermak Road Connection to Pedestrian Tunnel
12. Dedicated Bus Lane
Figure 5.10a: Oakbrook Transportation Center Site Plan

Insert Oakbrook Site Plan diagram
Figure 5.10b: Oakbrook Transportation Center Aerial Perspective

Insert Oakbrook Perspective
6. Technology Elements

The BRT service includes a package of Intelligent Transportation Systems (ITS) technologies selected to meet the criteria established by the Study Technical Committee. The committee established improving bus speed and reliability as a top priority for ITS systems. Providing real-time passenger information was also an important value. Given these considerations and the implementation status of related systems in the region, the following technologies were selected for the BRT service:

- **Traffic Signal Priority:** Initially demonstrated on Cermak Road in 1997, this technology gives transit customers priority at intersections by granting an early green phase or an extended green phase to approaching buses. The result is a significant savings of time spent stopped in traffic. The initial demonstration project gave all buses priority. To reduce impacts on cross-street traffic and to allow the system to be used to improve bus schedule reliability, the next phase of implementation will grant priority only to buses that are running behind schedule. This requires buses to have an awareness of their schedule adherence.

- **Automatic Vehicle Location:** Pace is implementing an AVL system that uses Global Positioning System (GPS) satellites to locate its buses and compare their locations with their scheduled location. This information can be used to limit traffic signal priority requests to only when the bus is behind schedule, give dispatching staff information about the progress of the run, and provide passengers with real-time information on the arrival of the next bus.

- **Automatic Fare Collection with Proof-of-Payment:** Prepayment of fares before boarding significantly reduces dwell time at bus stops by allowing customers to board through any door and preventing queues at the farebox. Proof-of-payment can be implemented with the current AFC system used by Pace and CTA.

- **Transfer Connection Protection:** The connection between rail and bus services at 54/Cermak is an important element in making the BRT service a seamless extension of the rail line. TCP will allow connections between bus and rail to occur despite minor travel time variations.

- **Passenger Information Systems:** Real-time transit service information will be communicated to customers using Active Transit Station Signs, audio announcements at passenger facilities, automated telephone- and Internet-based services, and next-stop announcements on BRT vehicles and supporting services.

- **Security Systems:** Remote monitoring and emergency notification devices will be installed on BRT vehicles, supporting transit service vehicles, and at BRT passenger facilities to protect customers and drivers. Video and audio technologies will be used and emergency events will be coordinated with local authorities. Security requirements and management would be decided on a location specific basis as discussed in section 5.2.

- **Flex-Route and Demand-Response Management:** Real-time technologies will be used to minimize lead times for flex-routes and demand-response vans that feed the BRT service. It will be possible to request curbside service within designated areas along the
corridor using a telephone, the Internet, or kiosks located at certain major activity centers not located at BRT stops.

Pace’s Intelligent Bus System (IBS) is the enabling technology that will make many of the advanced features of the BRT system possible. The IBS will serve as the central data collection, data processing, and information distribution system for the BRT. The IBS is currently in the process of implementation by Siemens Integrated Local Government division of Cedar Rapids, Iowa, and is expected to be in place by late 2003.

The plans for IBS include a control center at each Pace garage. It is assumed that the Cermak Road BRT service will be managed from Pace’s Melrose Park Garage. A call center for real-time flex-route and demand-response scheduling and for telephone and Internet communications with customers may be located at a remote location, such as Pace’s Headquarters or the facility of a third-party contractor.

A preliminary high-level system architecture for the ITS components of the BRT and related services is shown in Figure 6.1. This diagram shows the major technology components and communications linkages needed to expedite BRT vehicle progression on Cermak Road, coordinate BRT services with other transit services, communicate service status with customers, collect fares, and provide security.
Figure 6.1: High-Level System Architecture
6.1 BRT Service

6.1.1 Intelligent Bus System

The IBS will provide the digital radio communications, automatic vehicle location (AVL), schedule adherence monitoring, vehicle diagnostics, automatic passenger counting, security, on-board next-stop annunciators, and traffic signal priority interface features that will be used by the BRT service.

**Digital Radio Communications:** The BRT service will require nearly continuous communications with the Transit Management Center. Information flows include schedule adherence, incident management, silent alarm, emergency audio and/or video, voice communications, and transfer connection protection communications.

**Automatic Vehicle Location:** The IBS will include a Mobile Data Terminal (MDT) that processes satellite signals from the Global Positioning System (GPS) to locate the vehicle along its route. This information in combination with a Geographic Information System (GIS) and an electronic timetable stored on the bus will allow for real-time computation of schedule adherence. The IBS is currently planned to track schedule adherence at all timepoints per route. To improve the ability of the dispatch staff to track performance and to improve the accuracy of arrival time estimates communicated to customers, it is recommended that the BRT route be defined with additional timepoints, such as every stop or every other stop, or an interpolation algorithm to simulate this data. Each time a timepoint is reached, it is recommended that a schedule adherence update be transmitted to the Transit Management Center for dissemination to Active Transit Station Signs, connecting flex-route vehicles, traditional bus services in the Cermak Road Corridor, the Internet, and a telephone-based transit service status utility.

**Automatic Passenger Counting:** Pace is planning to equip a minimum of 20% of its fleet with automatic passenger counters (APCs) as part of the IBS implementation. It is recommended that every BRT vehicle be equipped with bi-directional APCs on all doors. This feature will allow Pace to quantify the effectiveness of its proof-of-payment fare collection system, provide very detailed information about travel patterns, and may be needed to support revenue sharing at the connection with the CTA Blue Line at 54/Cermak. Because it will be difficult to enforce the payment of a transfer when customers transfer from the Blue Line to the BRT, an accurate count of boardings at this location, less the number of farecard validations, will be needed to fairly distribute revenue between Pace and the CTA.

**Security:** All BRT vehicles will be equipped with silent alarms, as required by the *IBS Procurement Specification*. It is recommended that BRT vehicles also be equipped with on-board audio and video surveillance systems. These systems should have the capability for remote monitoring during emergencies.

**Next-Stop Annunciators:** Every BRT vehicle will be equipped with at least one variable message sign that displays the name of the next stop. On 60-foot articulated buses, two or more signs will be required. The visual displays will be accompanied by automated audio announcements of the same information. These displays will be driven by the AVL system, in accordance with the IBS Specification. Although it would require significantly more wireless communications and central processing, it may be desirable to announce the time until the next
traditional bus arrives at each stop in the Eastern Segment and the time until the next flex-route vehicle arrives in the Central Segment. In the Western Segment, timed transfers with demand-response vans will be available and will not require on-board notification, but connections on existing fixed routes, such as 877 and 888 may be displayed.

Traffic Signal Priority (TSP) Interface: The IBS supports an interface with three types of vehicle-to-roadside TSP communications. The Cermak Road TSP demonstration project uses loop detectors embedded in the pavement with transponders mounted on the underside of the bus to communicate requests for priority. Optical and video communications are also supported. It is recommended that all BRT vehicles be equipped with communications equipment to support TSP. It is expected that the loop- and transponder-based system will be extended to include the rest of the Cermak Road corridor, as opposed to other communications technologies.

6.1.2 Traffic Signal Priority

There are 44 signalized intersections along Cermak Road between 54/Cermak and Yorktown Shopping Center as shown in Table 6.1. These intersections are maintained by the Illinois Department of Transportation (IDOT). Two types of traffic signal controllers are in use in the corridor, including Eagle and Econolite isolated closed-loop controllers. Some of the signals are interconnected into coordinated signal systems between Yorktown and IL-56, near Oakbrook Center, York Road and I-294, Enterprise and Mannheim / LaGrange Road, and near Broadview Village Square. The signal at First Avenue and Cermak Road is part of a north-south interconnected system on First Avenue. The signals between Harlem and 54th Street are part of the Cermak Road Transit Signal Priority project described in more detail following the table.

Table 6.1: Signalized Intersections along Cermak Road

<table>
<thead>
<tr>
<th>Eastern</th>
<th>Central</th>
<th>Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment</td>
<td>Segment</td>
<td>Segment</td>
</tr>
<tr>
<td>Laramie Avenue</td>
<td>Shopping Center Entrance</td>
<td>Windsor Drive</td>
</tr>
<tr>
<td>54th Avenue</td>
<td>F</td>
<td>F York Road</td>
</tr>
<tr>
<td>Central Avenue</td>
<td>Desplaines Avenue</td>
<td>Jorie Boulevard</td>
</tr>
<tr>
<td>57th Avenue</td>
<td>I</td>
<td>McDonalds Drive</td>
</tr>
<tr>
<td>58th Avenue</td>
<td>12th Avenue</td>
<td>Spring Road</td>
</tr>
<tr>
<td>Austin Avenue</td>
<td>F</td>
<td>Oakbrook Centre East</td>
</tr>
<tr>
<td>Lombard Avenue</td>
<td>17th Avenue</td>
<td>Oakbrook Centre West</td>
</tr>
<tr>
<td>Ridgeland Avenue</td>
<td>F</td>
<td>Kingery Highway (IL-83)</td>
</tr>
<tr>
<td>East Avenue</td>
<td>Mayfair</td>
<td>Park View Drive</td>
</tr>
<tr>
<td>Wesley Avenue</td>
<td>Wolf Road</td>
<td>Oakbrook Place</td>
</tr>
<tr>
<td>Oak Park Avenue</td>
<td>F</td>
<td>Midwest Road</td>
</tr>
<tr>
<td>Home Avenue</td>
<td>Enterprise Drive</td>
<td>Butterfield Road</td>
</tr>
<tr>
<td>Wenonah Avenue</td>
<td>SB Tri-State Tollway (I-294)</td>
<td>Trans Am Plaza Drive</td>
</tr>
<tr>
<td>Harlem Avenue</td>
<td>I</td>
<td>Meyers Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fountain Square Drive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technology Drive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fairfield Avenue</td>
</tr>
</tbody>
</table>

I denotes interconnected traffic signal control system.
F denotes existing far-side bus stop.
Between 54/Cermak and Harlem Avenue, Pace and the Illinois Department of Transportation (IDOT) have installed a demonstration of transit signal priority (TSP) technology. The project involves the use of transponders mounted on the undercarriage of buses, loop detectors in the pavement, and signal priority programs in the traffic signal controllers to give buses extra green time at the beginnings or ends of signal cycles. TSP treatment has reduced bus travel times by approximately 15 percent in this segment.

This system will be extended to include intersections between Laramie Avenue and Fairfield Avenue. Detailed traffic volume information and turning movement counts were not available for this study to support a micro simulation traffic operations analysis of the effects of an extended TSP corridor on BRT performance. The preliminary running time estimates described in Section 3.1.1 were based on a similar level of performance as was realized during the Cermak Road TSP demonstration project.

The Cermak Road TSP prototype does not include the capability of granting conditional priority based on schedule adherence, which is a feature of more recent TSP implementations. This feature will be possible with implementation of Pace’s Intelligent Bus System (IBS), which will provide buses with on-board schedule adherence monitoring capability. It is recommended that conditional priority be implemented by selectively turning the transponder on and off depending on schedule adherence, with the primary goal of improving schedule reliability. Aggressive scheduling may be used to improve travel times to a limited extent with the assistance of TSP. However, because of the need to maintain timed transfers at both ends of the line, schedule reliability should take precedence over travel time minimization. This is an argument against using headway-based scheduling, which has proven very effective in reducing travel times and maintaining consistent headways (but not ensuring timepoint schedule adherence) on the frequent MetroRapid BRT service in Los Angeles, which operates at 3-minute peak headways.

Traffic Signal Priority is most effective when used with far-side bus stops because it can effectively provide either early green or extended green phases depending on the timing of bus arrival at the intersection. However, as discussed in Section 5, there are some locations where nearside stops may be required to improve pedestrian connections or to accommodate existing physical constraints. In these cases, it is recommended that TSP requests be triggered automatically by the closing of the bus doors after serving the BRT stop. If the request is received during the red phase of the signal cycle, an early green would be granted to the BRT vehicle. This may be accomplished by sensitizing detector loops at the bus stop to a special signal triggered by a door sensor on the bus. This may be accomplished by using the same transponder or a second transponder that is only sensed at intersections with nearside stops. At nearside stops with queue jumper lanes, this early green phase may be indicated by a special white bar bus priority signal, as shown in Figure 6.2.
6.1.3 Automatic Fare Collection System

As a result of the proof-of-payment fare collection system, BRT vehicles will not be equipped with fareboxes at the front door. Fares will be paid at validation machines located at each BRT Stop. Validation machines will accept magnetic farecards and smartcards. For security reasons, validation machines will not accept cash. However, it may be possible to integrate a credit card or debit card-based vending system with these machines that would distribute magnetic farecards or one-ride transfers.

Proof-of-payment fare collection will also require the development of a handheld device that can read the time stamps on magnetic farecards, transfers, and smartcards. Fare checkers making random inspections will use these devices.

6.1.4 Transfer Connection Protection

Timed transfers will be important at both ends of the route. The BRT service is designed to meet every train at 54/Cermak. Close coordination of this interagency transfer will be critical to the success of the system. The Regional Transportation Authority (RTA) has developed a preliminary design for a Transfer Connection Protection (TCP) system to protect important interagency transfers. This system involves schedule adherence communications of both connecting services to an automated coordination system. If a transfer is about to be missed because one vehicle is late, an electronic message will be sent to the operator of the waiting vehicle to delay departure for up to a pre-defined threshold of time. Even with relatively minor delay thresholds, this communications system can significantly reduce the probability that a missed transfer will occur. It is recommended that Pace work with the CTA and the RTA during implementation of the Cermak Road BRT to create transfer connection protection policies in both directions at 54/Cermak.

6.2 Traditional Fixed-Route Services

It is understood that the IBS will be deployed on traditional bus services that parallel or cross the Cermak Road corridor. No significant changes are expected to the IBS system for these routes, except for modifications to the schedule adherence subsystem associated with minor changes in route to serve new transportation centers.

However, to support the function of these routes as a feeder system to BRT, it is proposed that Pace explore the feasibility of providing on-board next stop annunciators with real-time BRT arrival time information so that they can display the time until the next BRT vehicle as the bus approaches a BRT Stop. Key considerations include the central control system’s ability to accurately query and distribute this information and bandwidth availability for additional control center-to-bus communications.
6.3 Flex-Route Services

6.3.1 Intelligent Bus System

The communications required to support real-time scheduling of deviations on the flex-route service will require more advanced capabilities than provided by the IBS as is currently being implemented. However, the IBS will form an important foundation on which to build the advanced scheduling functions. The IBS will provide the digital radio communications, automatic vehicle location (AVL), schedule adherence monitoring, security, and on-board next-stop annunciators that will be used by the flex-route service.

The flex-route service will be very similar to the OmniLink route deviation service operated by PTRC. OmniLink began operation in April of 1995, operating in a manual, non-ITS enhanced mode. In 1997, ITS technologies were introduced to improve on-street and in-office efficiencies, enhance vehicle tracking and communications capability, and offer real-time reservation options. ITS technologies include global positioning satellite-based (GPS) automated vehicle location (AVL) and a real-time call intake, scheduling, and dispatching system developed by Trapeze Software, Inc. The software integrates fixed route, flex-route, and Para transit modes and uses geographic information system (GIS) mapping. Digital dispatching and communication of ridership activity are handled through in-vehicle mobile data terminals (MDTs). ITS enhancements have reduced the minimum lead-time for deviation requests from 24 hours to two hours. The addition of in-vehicle navigation systems, including color moving map displays with turn-by-turn directions is currently in progress. Cellular digital packet data (CDPD) will be used for control center-to-vehicle communications. PTRC’s goal is to plans to further reduce the lead time to one hour or less.

The software program allows customer service agents to make real-time reservations and check the schedules, manifests, current vehicle loads, and on-time performance of various services to determine the best trip itinerary. The central control system tracks vehicle location, manages reservations, and can quickly determine the best times and vehicles to handle requested pick-ups and drop-offs. Customers can now make reservations and receive trip details in one phone call for both advanced and same day service. ITS enhancements allow PRTC to "fill in the holes" by scheduling trips when vehicles have excess time in the schedule.

In addition to capabilities provided by the IBS, the MDT on flex-route vehicles will have the following functional requirements:

- Present an ordered list of scheduled stops with turn-by-turn directions to the operator,
- Display a moving map image of the local area with the planned itinerary and stop points,
- Transmit drop-off requests to the central itinerary management system and receive confirmation or, if the run is fully scheduled, denial of requests with the time until the next run that can accommodate the request,
- Notify the operator when changes to the itinerary occur during the run,
• Cause the header sign on the front of the bus to flash “deviation service” or a similar message when the vehicle is traveling off of its normal route,

• Provide information on arrival time of connecting BRT services as the vehicle approaches a BRT station,

• Enforce collection of premium fares at on-demand stops, off-route stops, and/or when drop-off requests are entered, depending on fare policy,

The lead-time between when a request is received and when it can be served on the OmniLink service is limited by the need to establish the schedule and itinerary before a run begins. Much of OmniLink’s required minimum lead-time is driven by the headway of 45 to 60 minutes. More frequent service could reduce lead times without changes to this policy. However, using wireless communications and an in-vehicle navigation system with turn-by-turn directions, it may be possible to revise itineraries while a run is in progress. Of course, changes would be subject to the vehicle’s ability to serve pick-up requests within the range of times promised when the reservation was made. This could substantially reduce lead times, make the service more convenient, and increase efficiency making all available time in each run available for utilization as late as possible. The technology system capacity and information interconnectivity would be explored in subsequent design efforts as BRT is brought to implementation.

6.3.2 Itinerary Management System

The flex-route system will require a central Itinerary Management System similar to that used by the OmniLink service, at a minimum. The peak vehicle requirement of nine vehicles plus two spares for the Cermak Road flex-route is similar to that of OmniLink, which uses twelve vehicles on three routes.

The system will accept pick-up requests by telephone, Internet, and from kiosks located at on-demand stops. Information on the potential time until the next flex-route vehicle is available shall be available to persons requesting deviation service before a reservation is made. This information will be displayed on kiosks to provide information and to advertise the service. After a request is made, the kiosk display will show the time until the next vehicle arrives. The system will also accept drop-off requests from MDTs located on the vehicles. Subscriptions or standing reservations could also be accepted for recurring trips.

The Itinerary Management System will match requests with the next available vehicle. The system will estimate the total time to be spent off of the main route on Cermak Road using a travel time database as requests are received. Similar databases, which gather experience with travel times on each roadway link over time using a GPS-based automatic vehicle location system, are currently in use in the Para transit industry. After a certain deviation time allotment has been exceeded, any further requests for deviations on a given run will be denied.

The Itinerary Management System will transmit a planned itinerary to each vehicle before the start of each run. The itinerary will be modified in real-time during the run as drop-off requests and pick-up requests are received, if time is available.
6.3.3 Automatic Fare Collection System

The AFC system will be similar to that used on normal Pace buses. It will accept cash, transfers, farecards, and smartcards. If a premium fare policy is used for deviation service, the farebox will need to have a driver-actuated button to allow premium fares to be distinguished from normal fares. If fare prepayment is used for deviation service, the farebox will need to accept proof-of-payment (similar to transfers) from kiosks, and some form of identification from customers who make reservations by telephone or Internet. This may be a simple confirmation number keyed into the farebox by the driver that is checked against a manifest transmitted to the MDT.

6.4 Demand-Response Service

The demand-response service will use many of the same components of the Intelligent Bus System, Itinerary Management System, and Automatic Fare Collection System as the flex-route service.

6.5 Passenger Facilities

A number of information flows will be required between the central control center(s) and BRT passenger facilities, including BRT arrival time data, AFC fare collection data, text and audio advisory messages, and remote surveillance. Because of the multiple information flows, a trunked communications system may be appropriate. Depending on the availability of existing telephone lines to each station location, landline or wireless communications may be appropriate. In general, landline connections provide more reliable and secure communications, which may be preferred for fare collection and security applications. Cellular digital packet data (CDPD) is a wireless technology that has been applied successfully for countdown signs and other passenger information applications.

6.5.1 Active Transit Station Signs

Every BRT boarding area will be equipped with variable message signs (VMS) that display the estimated time until the next BRT vehicle arrives at the boarding area. The display will be presented in a countdown format in one-minute increments. An arrival message will be displayed shortly before the vehicle arrives. Displays will also have the capability of communicating text advisory messages about service disruptions or other events. These messages will be created and sent from the Transit Management Center. In accordance with the requirements of the Americans with Disabilities Act (ADA), all visual advisory messages will be accompanied with audible announcements. These messages may be pre-recorded electronic advisories with text and audio components or live messages communicated over a public address system. These passenger information systems may be part of the RTA Active Transit Station Signs (ATSS) initiative.
6.5.2 Automatic Fare Collection

Every BRT boarding area will be equipped with a farecard validation machine as described in Section 6.1.3. This machine allows passengers to pay their fares before boarding the BRT vehicle and thus reduces dwell time.

The validators will be integrated with the waiting area enclosure at typical BRT stops. At other locations, validation machines may be freestanding. At attended transportation centers, validation machines will be accompanied with farecard vending machines that accept cash. Farecard vending machines that accept credit or debit cards may be installed throughout the system at Pace’s option.

6.5.3 Security

In cooperation with local authorities and communities, Pace will employ such technologies as remote monitoring systems and emergency call boxes as appropriate. The emergency call box will open an audio channel with the Transit Management Center, or to a local authority, to allow passengers to report problems and to alert security personnel to begin remote monitoring. Microphones and/or a concealed video camera will capable of remote activation when a call is received and on a random basis. The security equipment will typically be mounted in the ceiling of the waiting area enclosure at BRT Stops. Transportation centers will have multiple security cameras and on-site security personnel. Hotlines will be established between the Transit Management Center and local authorities to respond quickly to any problems at unattended facilities.
7 Financial Considerations

7.1 Capital Cost Estimates

The capital costs for major components of the BRT system have been estimated. These costs are intended to provide a preliminary snapshot of the magnitude of probable system costs. The capital costs do not represent a comprehensive accounting of all pay items or development efforts that will be needed during implementation. More detailed cost estimates will be prepared in a later phase of the study. All costs are presented in year 2001 dollars.

7.1.1 Capital Costs for BRT Stations

The Cermak Road BRT includes fifteen geographic station locations along the length of the corridor beginning with the station at 54/Cermak and ending at Yorktown Plaza. Concept designs for representative station facilities are presented in Section 5 that are intended to meet the expected site conditions, passenger volumes and bus route interconnectivity while maintaining measures of standardized design wherever possible. These concept designs were used as a basis for the development of capital cost estimates. Cost estimates were based on industry standard unit costs, including those published in Means Construction Cost Data. Standard Means unit costs were inflated by 5% to reflect Chicago-area costs.

Three basic station configurations were estimated. The first station configuration was that of a curbside BRT Stop accommodating one 60-foot articulated bus. The estimated cost per stop is approximately $92,700, not including land, utilities and site development costs. This basic design will be used at the 54/Cermak, Austin Boulevard, Ridgeland Avenue and Oak Park Avenue stations. The second station configuration was that for an island BRT Stop accommodating a 60-foot bus and a feeder bus. These stations will be located at First Avenue, Ninth Avenue, Broadview Village Square, Mannheim Road, Mayfair Street, Wolf Road, York Road and Butterfield Road. The estimated cost per stop is $163,300, not including land, utilities and site development costs. The third station configuration is an island BRT Stop accommodating one 40-foot bus. These stations were assumed to be components of Superstops where intersecting north-south bus routes have lower ridership than Cermak Road. These facilities will be located at First Avenue and Mannheim Road. The estimated cost per stop is $133,000, not including land, utilities and site development costs.

At transportation centers, site-specific designs were prepared and associated cost estimates were developed. The minimal work at 54/Cermak was assigned the same cost as a 60-foot curbside BRT stop. The North Riverside Transportation Center was estimated to be approximately $500,000 and the Oakbrook Center capital cost was estimated to be approximately $26,000,000, including the transportation center, parking structure, retail space, and associated site improvements. An allowance of $1,000,000 was estimated for the Yorktown Mall station. Pace has developed a concept design for a transportation center at this location. In each case, the estimated capital costs do not include land, utilities, and site development costs.

Table 7.1 summarizes the cost estimates for each location.
Table 7.1: Station Capital Cost Summary

<table>
<thead>
<tr>
<th>BRT Station Location</th>
<th>60-foot bus only</th>
<th>60-foot bus plus feeder</th>
<th>40-foot bus only</th>
<th>Transport Center</th>
<th>Estimated Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>54th Street/Cermak</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>$92,700</td>
</tr>
<tr>
<td>Austin Boulevard</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$185,400</td>
</tr>
<tr>
<td>Ridgeland Avenue</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$185,400</td>
</tr>
<tr>
<td>Oak Park Avenue</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$185,400</td>
</tr>
<tr>
<td>North Riverside</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>$499,100</td>
</tr>
<tr>
<td>First Avenue</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>$592,500</td>
</tr>
<tr>
<td>Ninth Avenue</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$326,600</td>
</tr>
<tr>
<td>Broadview Village Square</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$326,600</td>
</tr>
<tr>
<td>Mannheim Road</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>$592,500</td>
</tr>
<tr>
<td>Mayfair Street</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$326,600</td>
</tr>
<tr>
<td>Wolf Road</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$326,600</td>
</tr>
<tr>
<td>York Road</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$326,600</td>
</tr>
<tr>
<td>Oakbrook Centre</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>$26,010,300</td>
</tr>
<tr>
<td>Butterfield Road</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>$326,600</td>
</tr>
<tr>
<td>Yorktown Mall</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>$1,000,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td><strong>16</strong></td>
<td><strong>4</strong></td>
<td><strong>3</strong></td>
<td><strong>$31,302,900</strong></td>
</tr>
</tbody>
</table>

Note: All costs include a 20% contingency.

The Oakbrook Transportation Center station represents 83% of the current total estimated capital cost for stations. The Oakbrook Transportation Center represents includes $20,394,400 for the parking structure that replaces existing ground level parking, provides bus shelter and ramp access as well as additional parking that complements the BRT service. The cost estimate includes $2,218,900 for bus related facilities, $2,323,200 for traffic circulation and $1,073,700 for pedestrian access and movement.

The cost estimates for BRT Stops located along Cermak Road do not include costs associated with the construction of exclusive bus lanes or queue jumper lanes. Exclusive bus lanes may be appropriate at certain locations near transportation centers where multiple routes converge. At this stage of preliminary design the exclusive use lanes were not included because the projected demand for the system is less than the capacity of a travel lane, even with single-occupant vehicles (1,500 to 2,200 vehicles per hour). Queue jumper lanes may be possible at certain locations, but additional data on traffic volumes, queue lengths, and turning movements is necessary to support a detailed justification of their use at a specific location at this time.

7.1.2. Capital Costs for Rolling Stock

Capital cost estimates for BRT rolling stock were developed for the proposed BRT service in the Cermak Avenue Corridor. The costs were estimated for each of the vehicle types including the BRT articulated bus, BRT single unit bus, flex route bus and demand responsive van.

Unit costs for vehicles are based on the American Public Transportation Association’s 2000-2001 Average New Bus and Van Costs for bus purchases by other transit properties plus a $20,000
allowance for Intelligent Bus System equipment, on-board passenger information systems, bus graphics and other BRT features. The summary of costs is shown in Table 7.2.

### Table 7.2: Rolling Stock Capital Cost Summary

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Fleet Size</th>
<th>Unit Cost</th>
<th>Subtotal Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRT Articulated Bus, 60-foot</td>
<td>5</td>
<td>$433,000</td>
<td>$2,165,000</td>
</tr>
<tr>
<td>BRT Single Unit Bus, 40-foot</td>
<td>9</td>
<td>$308,000</td>
<td>$2,772,000</td>
</tr>
<tr>
<td>Flex Route Bus, 29-foot</td>
<td>11</td>
<td>$76,000</td>
<td>$836,000</td>
</tr>
<tr>
<td>Demand Response Van, 23-foot</td>
<td>8</td>
<td>$43,000</td>
<td>$344,000</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td></td>
<td>$6,117,000</td>
</tr>
</tbody>
</table>

#### 7.3 Operating Cost Estimates

Operating costs were estimated on the basis of a simple resource build-up cost allocation model. Costs were calculated on the basis of revenue-hours of operation, revenue-miles of travel and per vehicle fixed costs. The BRT operations were estimated on the basis of $30.80 per revenue hour of operation, $0.77 per revenue mile traveled and $33,345 per vehicle. The flex route and demand responsive buses were estimated on the basis of $36.19 per revenue hour of operation, $0.12 per revenue mile traveled and $10,215 per vehicle. These unit costs are derived from the Pace’s Year 2000 costs for fixed-route and Para transit operations.

Annual operating costs were estimated on the basis of the expected operations described in Section 3 of this report. Table 7.3 presents a summary of the annual operating costs.

### Table 7.3: Operating Cost Summary

<table>
<thead>
<tr>
<th>Service</th>
<th>Revenue Hours</th>
<th>Revenue Miles</th>
<th>Fleet Size</th>
<th>Operating Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRT Service</td>
<td>39,076</td>
<td>297,840</td>
<td>14</td>
<td>$1,899,708</td>
</tr>
<tr>
<td>Fixed Route Service</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>Flex Route Service</td>
<td>30,570</td>
<td>142,800</td>
<td>11</td>
<td>$1,235,829</td>
</tr>
<tr>
<td>Demand Response Service</td>
<td>30,627</td>
<td>153,135</td>
<td>8</td>
<td>$1,208,487</td>
</tr>
<tr>
<td>Total</td>
<td>100,273</td>
<td>593,775</td>
<td>33</td>
<td>$4,344,024</td>
</tr>
</tbody>
</table>

The operating cost estimates that have been prepared to date have focused upon the vehicle operations. The actual roll out of BRT service would require additional management support and allocation of existing Pace resources in a manner that has not been identified at this level of conceptual development. The BRT passenger facilities, proof-of-payment fare collection, advanced ITS technologies, and other new components of the service will have operating and maintenance costs that as yet have not been identified.
7.4 Ridership Forecasts

This section summarizes the general approach and ridership potential for the proposed Pace BRT in the Cermak Corridor. Since regional travel forecasting model was not available for WSA to use, a spreadsheet type of model was developed using the existing available data sources. The theory behind this spreadsheet model is an incremental logit mode choice model. This model uses current mode shares and adjusts these mode share values based on changes in the characteristics of the transit network. This method has been used frequently by most transportation professionals because it requires only the differences of the transit network attributes resulting from improved transit services to estimate ridership.

The coefficients used in this incremental logit model are identical to those of the mode choice model used in the RTA Travel Demand Forecast Model. The RTA model was validated to replicate the transit travel patterns in Chicago region for both 1990 and 1995. The base year total trips and transit mode share information required by the incremental mode choice model were calculated from 1990 Census Transportation Planning Package (CTPP Journey-to-Work data), the only known and credible data source available in this region to permit this type of analysis. BRT level of service, vehicle running time and changes in access/egress services were based on the proposed BRT operation plan described in Section 3.

Figure 7.1 shows geography designed to forecast the proposed BRT ridership. The BRT catchment area was developed encompassing one mile on either side of the proposed BRT Route and was divided into six districts. Four districts were also created for capturing trips to/from the City of Chicago using CTA rail services. Travel volumes and mode shares between these districts were obtained from the Census CTPP data. Travel timesavings due to the replacement of BRT services with the existing Pace Route 322 were calculated from the BRT service-operating plan. Other assumptions used in the spreadsheet model was that access time to BRT route was assumed to be the same as that experienced on the existing Route 322. The rationale was that some riders would experience longer travel time due to fewer BRT stops and others would be shorter due to convenient flex-route and community van services. Headway was assumed to change from 15-20 minutes of the existing Route 322 to 10 minutes of the proposed BRT Route, resulting in shorter waiting times.

About 4,850 total daily boardings were estimated if the BRT system were operating today. This is an increase of 1,120 weekday boardings (above 30%) over the existing ridership of 3,730 on Route 322. Analysis of the existing bus route structure and ridership in the study area as seen in Figure 7.2 shows most of the potential BRT riders would come from the existing CTA and Pace parallel bus routes including Routes 301 and 25. Some diversions would also be anticipated from Routes 747, 304 and 302. Although the proposed BRT service would run faster and more frequently than these routes, most riders would still prefer not to transfer to BRT because they would rather have a one-seat ride to their destinations or to the rail stations either on Douglas or Congress Branches.
Figure 7.1: Districts Used for BRT Ridership Estimate
Figure 7.2: Pace and CTA Parallel Bus Routes
8  Next Steps

8.1.  Market Research

The proposed Pace BRT in the Cermak Corridor includes three distinct travel modes, Bus Rapid Transit, Flex Route and Demand-Response. None of these three types of service has received the attention and study that traditional bus and rail service have received in the Northeastern Illinois region or in the nation. The proposed BRT would also provide service across a diverse urban/suburban landscape each part of which is connected to a different travel market. Thus, in reviewing potential markets and the data needed to analyze them, it is necessary to move beyond the traditional transportation market analysis items to cover the issues raised by innovative transit service.

8.1.1 Traditional Transit Market Analysis

The logit model that was used to forecast trips for the proposed Pace BRT in the Cermak corridor incorporated traditional transportation data. This data included current ridership and trend data, on Metra, CTA, and Pace, transit service levels, operating times, and demographic data. If a detailed market analysis is conducted for the corridor, more detailed corridor-specific data will need to be collected and assembled. This data would expand upon the inputs used to develop the logit model to include:

- Land Use and Zoning maps where available from the western suburban municipalities that the BRT will serve, including Cicero, Berwyn, Broadview, Westchester, Oakbrook and Lombard;
- Survey data, where available, on non-work trips, including weekend trip making;
- Real estate data and projections including information on proposed residential, commercial, recreational and institutional projects;
- Information on special trip generators in the Cermak Corridor, for example the major commercial attractions of North Riverside and Oakbrook Malls, the VA Hospital, etc.;
- Transit transfer and potential transfer locations and number of transfers
- Future CTA Blue Line Operating Levels -- As the terminal station on the branch, 54/Cermak is directly impacted by service changes on the complimentary Forest Park branch and the O’Hare branch. Peak hour, midday, evening, and owl service availabilities and frequencies for weekdays, Saturdays and Sundays would be need to be reviewed. Over the next four years, the 54/Cermak Branch of the Blue Line will undergo a $482.6 million reconstruction resulting in faster trains, which will likely attract more riders.
8.1.2 Non-Traditional Transit Market Data

The list provided in the previous section provides a starting point for a detailed market analysis of the proposed Pace Cermak Corridor. The approach it embodies would serve mainly the Eastern Segment where the BRT service is similar to existing types of bus and rail service in the region. There are limitations to using traditional transit market data to study the emerging markets of flex-route and demand-response transit services which are proposed in the western two-thirds of the corridor. In this section, pertinent market data issues related to flex-route and demand-response service will be identified and then a short initial list of “non-traditional” transit data sources will be presented.

Issues related to flex route and demand response transit markets include:

- How can traditional predictors of transit attractiveness, such as frequency and span of service, wait time, and cost, be retrofitted to measure flexible and demand responsive service? Will transit vehicle availability, punctuality and convenience replace the former set?

- On the transit agency side, how will the farebox recovery ratio and the need to optimize use of the transit vehicle, impact the potential customer?

- How will the logistics of flexible and demand responsive services be customized to the potential users? How many riders and destinations are a full quota for any given run? What upper time limit is there to an efficient run? What is the optimum service area?

- Interplay -- how will traditional and flexible or demand responsive services interact to serve the customer?

- How many transfers will the rider tolerate?

- How do the traditional travel demand measures like trip purpose, trip time, trip length, time of day of trip, auto occupancy, and trip cost fit in the picture when flexible or demand responsive travel is analyzed?

- How important is the trip origin and destination to providing service to potential customers?

- What is the impact the wide range of the “values of time” of potential riders on the system?

- How do mobility-limited travelers fit into the picture – particularly those who do not qualify for ADA services?

- Will flexible and demand responsive services place bigger emphasis on weekend and non-work weekday travel?

- How comfortable are potential users with the technological changes needed to access the flexible and demand responsive parts of the system?
• Will qualitative information become more important than quantitative in assessing potential ridership?

• Will primary data collection, as opposed to using existing data to perform focused market analysis, become more critical to understanding the potential market?

The data sources that may be used to answer these questions include:

• Ridership information and trend data from all forms of CTA and Pace’s demand response services, including shared ride, dial-a-ride, commuter vans, shuttles, vanpools, and buspools;

• Northeastern Illinois and national suburban taxi ridership data and trends, including trip length, trip purpose, route, and cost;

• Current data from American with Disabilities (ADA) services on ridership and trends particularly in suburban and rural areas;

• Ridership information, trend data, and trip pattern information from municipal, employer, private, and community-based bus services, particularly suburban ones;

• Survey data from demand responsive or flexible bus service users in other U.S. suburban areas;

• Information on household, personal, and trip-making characteristics of shoppers and employees arriving at large suburban commercial destinations;

• Qualitative studies on issues directly and indirectly related to potential riders’ issues surrounding the BRT and supporting transit services, including the propensity of transit users to use mixed-traffic BRT services, the range of wait, ride, and transfer time that might be tolerated by the potential user, and the range of fares that might be acceptable to riders;

• Information on trip making patterns of persons in suburban households without automobiles or those with fewer automobiles than registered drivers.

8.2 Detailed Design

The various preceding sections of this report represent the concept design for BRT service along the Cermak Avenue corridor. The corridor was selected from several possible corridors due to a combination of unique and common characteristics present in the corridor. The concept design presented herein incorporates the results of several discussions with the Study Technical Committee and with Pace staff. The design has sought to capture those elements of a BRT system that generally represent expected conditions that may be found in other candidate corridors in the Pace service area.

The next level of detailed design for the Cermak Avenue corridor would include greater delineation of site conditions, examination of BRT service integration with Pace and CTA.
bus/rail service, integration of the regional transportation center with local land use and traffic circulation and interaction with adjacent communities and constituencies. The service and facility parameters and design features would be developed in sufficient detail in order to evaluate operational and cost factors in greater detail. Each of these items is discussed in greater detail below.

### 8.2.1 Passenger Facilities

The passenger facilities for the BRT system need to be integrated into the existing urban context to the maximum extent possible. The context sensitive design will minimize site constraints while increasing the contribution of the Pace riders and the presence of the BRT service to the localized area. In the case of the standard curbside BRT Stop, the passenger facilities are to be integrated with existing structures and streetscapes for both the Pace user and people visiting the area. The island configurations are also anticipated to merge with the site conditions while communicating the presence of the BRT service.

### 8.2.2 Roadway Modifications

Sufficient traffic volume, turning movement, and geometric data was not available to support detailed concept designs at each intersection. In combination with Traffic Signal Priority system implementation, it is recommended that more detailed traffic operations analysis, micro simulation, and geometric design be conducted to refine and finalize intersection designs. The development of queue jumper lanes and island BRT stops will require design review and approval by multiple agencies.

### 8.2.3 Traffic Signal Priority

The BRT requires that the existing Cermak Road Traffic Signal Priority demonstration project between 54/Cermak and Harlem Avenue be extended to Yorktown Mall. This involves installation of loop detectors, transponder signal receivers, and related controller upgrades at 30 intersections. Because of the relocation of the 54/Cermak station, extension of the system to Laramie Avenue to permit left turns with transit priority should also be explored. At nearside stops and where queue jumper lanes are constructed, the use of white bar bus priority signals is also proposed. While an industry standard, this traffic device is not in use in Northeast Illinois and may require special legislation.

### 8.2.4 Interagency Coordination

The construction of permanent BRT stations will require interagency coordination, community interaction, and public involvement. Issues include BRT stop locations, any associated losses in on-street parking, right-of-way needs, and utility relocations. Because of the electrical power and communications requirements of each station, intergovernmental agreements and/or other arrangements will be needed to secure utility connections. The development of queue jumper lanes, island stops, and other roadway geometric modifications will require coordination with
IDOT and the communities. Transportation centers require extensive coordination with landowners, developers, communities, IDOT, and other agencies.

The rail connection at 54/Cermak will require coordination with the CTA on BRT stop location, schedule coordination, Transfer Connection Protection, and revenue sharing. Because of the free rail-to-BRT transfer, Pace will need to work with CTA to develop a revenue sharing formula for BRT connection with rail, especially in the westbound direction. Automatic passenger counter data, less farecard validations at the 54/Cermak BRT boarding area, may be needed in the absence of controlled-controlled boarding data for this transfer.
Glossary of BRT Terms
APPENDIX – Glossary of Bus Rapid Transit Terms and Concepts

The following glossary of terms is being provided to establish a common baseline for the meanings and settings for terms used in describing BRT and transportation services, and includes terms used as both universally accepted BRT concepts and those introduced through Pace’s specific needs as identified in this report.
Pace BRT Glossary of Terms

Accessibility  the extent to which facilities are barrier free and usable by persons with disabilities, including wheelchair users and families using baby carriages.

Active Transit Station Signs  information system located at each facility to provide real-time travel information to passengers, including expected arrival time of next vehicle, unusual delay, etc.

Alighting  the act of getting off a bus, train, or ferry

Alternative Fuels  low-polluting fuels which are used to propel a vehicle instead of high-sulfur diesel or gasoline. Examples include methanol, ethanol, propane or compressed natural gas, liquid natural gas, low-sulfur or "clean" diesel and electricity

Area Pace  market name provisionally given to Pace’s local point deviation (see definition) bus service

Arterial Street  a major thoroughfare, used primarily for through traffic rather than for access to adjacent land, that is characterized by high vehicular capacity and continuity of movement

Articulated Bus  a bus usually 55 feet or more in length with two connected passenger compartments that bend at the connecting point when the bus turns a corner

Auto Restricted Zone (ARZ)  an area in which normal automobile traffic is prohibited or limited to certain times, and vehicular traffic is restricted to public transit, emergency vehicles, taxicabs and, in some cases, delivery of goods

Automated Guideway  an electric railway operating without vehicle operators or other crew on board the vehicle

Automatic Fare Collection System (AFC)  a system of controls and equipment that automatically admits passengers on insertion of the correct fare in coins, tokens, tickets or farecards; it may include special equipment for transporting and counting revenues

Automatic Vehicle Location System (AVLS)  technology that tracks the current location of fleet vehicles to assist in dispatching, maintaining schedules, answering specific customer inquiries, etc

Auto-Oriented Development  development that is designed with an emphasis on access and parking by personal vehicles. This type of development is characterized by large surface parking lots, wide streets, few or no sidewalks and long distances between buildings

Availability  the proportion of the public passenger vehicle fleet which is available to be used in service
Barrier Fare Collection  a fare payment system consisting of a secure facility to which a passenger is only allowed access upon fare payment

Base Fare  the price charged to one adult for one transit ride; excludes transfer charges, zone charges, express service charges, peak period surcharges and reduced fares

Base Period  the period between the morning and evening peak periods when transit service is generally scheduled on a constant interval. Also known as "off-peak period."

Bi-articulated Bus  a bus usually 75 feet or more in length with three connected passenger compartments that bend at the connecting point when the bus turns a corner. Bi-articulated buses have a seated and standing capacity of approximately 240 passengers

Boarding  the act of going aboard a bus, train, or ferry

Breakdown  a mechanical defect which immobilizes a vehicle

BRT Stop  any on-street BRT station location serving a single BRT route

BRT Superstop  any on-street designated BRT station location at which point two BRT routes intersect and allow for transfers

Bunching  the act of buses catching up with one another so that several run together, followed by a long interval before the next bus. Also known as platooning

Bus  a rubber-tired, self-propelled, manually-steered vehicle with fuel supply carried on board the vehicle. Types include advanced design, articulated, bi-articulated, circulator, double deck, express, feeder, intercity, medium-size, small, standard-size, subscription, transit and van

Bus Lane  a street or highway lane intended primarily for buses, either all day or during specified periods, but sometimes also used by carpools meeting requirements set out in traffic laws

Bus Rapid Transit  a combination of technologies, design features, operating practices, and marketing approaches that allow rubber-tired transit vehicles to approach the speed and service quality of light rail transit service

Bus Shelter  a building or other structure constructed near a bus stop, to provide seating and protection from the weather for the convenience of waiting passengers

Bus Stop  a place where passengers can board or alight from the bus, usually identified by a sign

Busway  exclusive freeway lane for buses and carpools

Cannibalization  the act of removing parts from one bus to use on another

Capital Costs  costs of long-term assets of a public transit system such as property, buildings, vehicles, etc
**Catchment Area**  
area from which primary transit ridership is drawn

**Central Business District (CBD)**  
the downtown retail trade and commercial area of a city or an area of very high land valuation, traffic flow, and concentration of retail business offices, theaters, hotels and services

**Circulator Bus**  
a bus serving an area confined to a specific locale, such as a downtown area or suburban neighborhood with connections to major traffic corridors

**Closed Door Operation**  
the prohibition of picking up and setting down passengers while operating a public transport vehicle along specified segments of a defined route

**Community Transportation Center**  
an off-road BRT facility which may serve as a terminal or point of transfer for one or several BRT and local service routes

**Commuter**  
a person who travels regularly between home and work or school

**Compressed Natural Gas (CNG)**  
an alternative fuel; compressed natural gas stored under high pressure. CNG vapor is lighter than air

**Contraflow Lane**  
reserved lane for buses on which the direction of bus traffic is opposite to the flow of traffic on the other lanes

**Corridor**  
a broad geographical band that follows a general directional flow connecting major sources of trips that may contain a number of streets, highways and transit route alignments

**Crew**  
the bus driver, train driver and conductor assigned to a bus or train

**Crosstown**  
non-radial bus or rail service which does not enter the Central Business District (CBD)

**Cutaway Van**  
a standard van that has undergone some structural changes, usually made to increase its size and particularly its height. The seating capacity of a cutaway van is approximately nine to 18 passengers

**Dead Mileage**  
the mileage (or kilometers) operated by buses not in revenue-earning service, most commonly between the depot and the point at which the bus takes up its route

**Deadhead**  
the movement of a transit vehicle without passengers aboard; often to and from a garage or to and from one route to another

**Dedicated Funding Source**  
a source of monies which by law is available for use only to support a specific purpose, and cannot be diverted to other uses

**Demand Responsive**  
non-fixed-route service utilizing vans or buses with passengers boarding and alighting at pre-arranged times at any location within the system's service area. Also called "Dial-a-Ride." Also, comparable transportation service for individuals with disabilities who are unable to use fixed-route transportation systems
**Depreciation**  a non-cash expense recognizing the cost of a capital asset distributed over the economic life of the asset

**Destination**  the point at which a journey or trip ends

**Dial-a-Ride**  see "Demand Responsive."

**Down Time**  the period of time when a bus is not available for service due to maintenance or repair

**Driver**  a person who acts as steersman or motorman of a public passenger vehicle in public transport service

**Dwell Time**  the scheduled time a vehicle or train is allowed to discharge and take on passengers at a stop, including opening and closing doors

**Early Shift**  a crew duty starting in the early morning and finishing around mid-day

**Electric Trolley Bus (ETB)**  an electric, rubber-tired transit vehicle, manually steered, propelled by a motor drawing current through overhead wires from a central power source not on board the vehicle. Also known as "trolley coach" or "trackless trolley."

**Elevated**  a fixed guideway built on bridge or other aerial support structures with stations located above grade

**Exclusive Right-of-Way**  a highway or other facility that can only be used by buses or other transit vehicles

**Express Bus**  a bus that operates a portion of the route without stops or with a limited number of stops. The express bus service is scheduled to operate faster than local service by limiting the number of stops the bus will make along the route

**Fare**  the approved sums payable in respect of a contract ticket for an individual passenger’s transport

**Fare Box Recovery Ratio**  measure of the proportion of operating expenses covered by passenger fares; found by dividing fare box revenue by total operating expenses for each mode and/or systemwide

**Fare Box Revenue**  value of cash, tickets, tokens and pass receipts given by passengers for transport services provided by the Operator as payment for rides; excludes charter revenue and revenue from advertising and concessions

**Fare Elasticity**  the extent to which ridership responds to fare increases or decreases

**Fare Evasion**  unlawful use of transit facilities by riding without paying the applicable fare

**Fare Structure**  the system set up to determine how much is to be paid by various passengers using a transit vehicle at any given time
**Fast Pace**  the market name provisionally given to Pace’s Bus Rapid Transit service

**Feeder Bus**  a bus service that picks up and delivers passengers to a rail rapid transit station or express bus stop or terminal

**“First Mile”/“Last Mile”**  the often unserved or neglected gap a transit user may experience between the closest point of transit access and the ultimate origin or terminus of a trip

**Fixed Cost**  an indirect cost that remains relatively constant, irrespective of the level of operational activity

**Fixed Guideway System**  a system of vehicles that can operate only on its own guideway constructed for that purpose (e.g., rapid rail, light rail). Federal usage in funding legislation also includes exclusive right-of-way bus operations, trolley coaches and ferryboats as "fixed guideway" transit

**Fixed Route**  service provided on a repetitive, fixed-schedule basis along a specific route with vehicles stopping to pick up and deliver passengers to specific locations; each fixed-route trip serves the same origins and destinations

**Fleet Number**  an identification number assigned to a bus by its Operator

**Flex Pace**  market name provisionally given to Pace’s local flex-route bus service (see definition)

**Flex-Route Bus Service**  local bus service which is not operated on a specific fixed guideway, but instead serves an area by diverting onto a local street network

**Force Majeure**  a disruptive event or effect that cannot be reasonably anticipated or controlled as in acts of war and civil strife, work stoppages resulting from labor disputes, or acts of terrorism but not acts of God

**Frequency**  the interval in minutes between buses operating on a route, or the number of buses per hour

**Fringe Parking**  an area for parking usually located outside the Central Business District (CBD) and most often used by suburban residents who work or shop downtown

**Headway**  time interval between vehicles moving in the same direction on a particular route

**High Occupancy Vehicle (HOV)**  vehicles that can carry two or more persons. Examples of high occupancy vehicles are a bus, vanpool and carpool. These vehicles sometimes have exclusive traffic lanes called "HOV lanes," "busways," "transitways" or "commuter lanes."

**Illegal Operator**  the person or organization to whom no license has been granted or issued or a license holder operating a public passenger vehicle outside the licensed area

**Infill Development**  in land-use and transit planning, development of vacant parcels in urbanized or suburbanized areas
Intelligent Transportation System (ITS)  automated systems of highway transportation designed to improve traffic monitoring and management. ITS includes: Advanced Public Transportation Systems (APTS), Automatic Vehicle Location System (AVLS) and "smart vehicles" which assist drivers with planning, perception, analysis and decision-making

Intercity Bus  a bus with front doors only, high-backed seats, separate luggage compartments, and usually with restroom facilities for use in high-speed long-distance service

Intermodal  those issues or activities which involve or affect more than one mode of transportation, including transportation connections, choices, cooperation and coordination of various modes. Also known as "multimodal."

Involuntary Stop  the stoppage of a bus caused by a breakdown

Joint Development  ventures undertaken by the public and private sectors for development of land around transit stations or stops

Kiss and Ride (K&R)  a place where commuters are driven and dropped off at a station to board a public transportation vehicle

Late Shift  a crew duty starting in the afternoon and finishing in the evening

Layover  the waiting time at the terminus between trips

Layover Time  time built into a schedule between arrival at the end of a route and the departure for the return trip, used for the recovery of delays and preparation for the return trip

Level Boarding  a physical transit facility feature which provides a raised boarding platform to enhance the speed and accessibility of boarding and alighting passengers

Level of Service (LOS)  a set of characteristics that indicate the quality and quantity of transportation service provided, including characteristics that are quantifiable and those that are difficult to quantify

Limited-stop Service  a service which is scheduled not to stop at all stops on a route, and which normally operates to a reduced running time

Linked Trip  a trip from origin to destination on the transit system regardless of the number of transfers a passenger must make during a journey. A complete one-way trip on the system

Liquefied Natural Gas (LNG)  an alternative fuel; a natural gas cooled to below its boiling point of -260 degrees Fahrenheit so that it becomes a liquid; stored in a vacuum bottle-type container at very low temperatures and under moderate pressure. LNG vapor is lighter than air

Livery  the color scheme and insignia applied to a bus or other public transport vehicle

Load Factor  the ratio of passengers actually carried versus the total passenger capacity of a vehicle
Market Rate or Market Value  the price agreeable to willing buyers and willing sellers

Mass Transit  see "Public Transportation."

Mass Transportation  see "Public Transportation."

Mean Distance Between Failures (MDBF)  the average distance in miles that a transit vehicle travels before failure of a vital component forces removal of that vehicle from service

Medium-Size Bus  a bus from 29 to 34 feet in length

Methanol  an alternative fuel; a liquid alcohol fuel with vapor heavier than air; primarily produced from natural gas

Missed Trip  a revenue trip not operated

Modal Split  a term which describes how many people use alternative forms of transportation. Frequently used to describe the percentage of people using private automobiles as opposed to the percentage using public transportation

Mode  types of transportation available for use, such as rail, bus, vanpool, personal vehicle or bicycle

Model  an analytical tool (often mathematical) used by transportation planners to assist in making forecasts of land use, economic activity, travel activity and their effects on the quality of resources such as land, air and water

Next-Stop Annunciators  on-board vehicle information system designed to inform passengers of upcoming stations and points of transfer

Off-Board Fare Payment  a fare payment system intended to accelerate bus boarding by providing a fare validation mechanism at an off-vehicle location

Off-Peak Period  non-rush periods of the day when travel activity is generally lower and less transit service is scheduled. Also called "base period."

On-time Performance  the proportion of the time that a transit system adheres to its published schedule times within stated tolerances

Operating Deficit  the sum of all operating expenses minus operating revenues

Operating Expense  monies paid in salaries, wages, materials, supplies and equipment in order to maintain equipment and buildings, operate vehicles, rent equipment and facilities and settle claims. This does not include depreciation

Operating Profit  the remainder of subtracting operating expenses from total revenue

Operating Revenue  receipts derived from or for the operation of transit service, including fare box revenue, revenue from advertising, interest and charter bus service and operating assistance from governments
**Operator**  the person or organization to whom a public transport license was granted and issued and who is providing a bus or rail service. This does mean “driver.”

**Ordinary Fare**  the fare paid for stage carriage service by all passengers who are not concessionaires.

**Overhaul**  the major maintenance work carried out on a vehicle or unit (such as an engine or gearbox), normally involving the removal and replacement of a large number of parts.

**Over-riding**  the traveling by a passenger further than the distance paid for.

**Paratransit**  informal transit services provided by operators who may or may not be licensed for public transport common carriage.

**Park and Ride**  designated parking areas for automobile drivers who then board transit vehicles from these locations.

**Passenger**  any occupant of a public transport vehicle (in or upon the vehicle) who is not the driver.

**Passenger Miles**  the total number of miles traveled by passengers on transit vehicles; determined by multiplying the number of unlinked passenger trips times the average length of their trips.

**Peak Period**  morning and afternoon time periods when transit riding is heaviest.

**Peak/Base Ratio**  the number of vehicles operated in passenger service during the peak period divided by the number operated during the base period.

**Point Deviation**  a type of transit service in which a vehicle stops at specified checkpoints (shopping centers, employment centers, etc.) at specified times, but travels a flexible route between these points to serve specific customer requests for doorstep pickup or delivery.

**Premium Fare**  the market rate fare paid for express bus or premium rail service.

**Premium Service**  a category of express bus or rail transit service that provides higher levels of comfort to passengers. These features may include air-conditioning, guaranteed seating or other comfort items and services.

**Preventative Maintenance**  the scheduled maintenance of vehicles to minimize the occurrence of mechanical failure, rather than only rectifying defects as they occur.

**Programmed Maintenance**  a planned maintenance program based on preventive maintenance principles and including other maintenance activities such as periodic repainting, chassis and body overhaul, etc.

**Proof-of-Payment Fare Collection**  a fare payment system in which a passenger pays the fare upon entry to the vehicle, and regulated by on-board personnel who may randomly check for proof of fare payment.
**Propane**  an alternative fuel; a liquid petroleum gas (LPG) which is stored under moderate pressure and with vapor heavier than air; produced as a by-product of natural gas and oil production

**Public Passenger Vehicle**  any mechanically propelled vehicle intended or adapted for use on the roads or on rails to carry passengers for hire or reward

**Public Transport System**  an organization that provides transport services owned, operated, or subsidized by any municipality, Emirate, regional authority, or other governmental agency, including those operated or managed by a private management firm under contract to the government agency owner

**Public Transportation**  transportation by bus, rail, or other conveyance, either publicly or privately owned, which provides to the public general or special service on a regular and continuing basis. Also known as "mass transportation," "mass transit" and "transit."

**Pull-in**  the arrival of buses or trains at the depot or yard at the end of the operating day

**Pull-out**  the departure of buses or trains from the depot or yards at the start of the operating day

**Queue Jumper Lane**  a near-side traffic lane, used in conjunction with traffic signal priority (see definition) which allows for transit vehicles to bypass queued automotive traffic and move through the intersection in order to maintain consistent headway operations and reduce trip delays due to traffic congestion

**Rapid Transit**  rail or motorbus transit service operating completely separate from all modes of transportation on an exclusive right-of-way

**Regional Transportation Authority (RTA)**  the Chicagoland metropolitan transportation authority (see definition) and primary funding source for regionally-allocated transit funding

**Regional Transportation Center**  a major off-road BRT facility which may serve as a terminal or point of transfer for one or several BRT and local service routes, as well as providing additional operator and passenger amenities with design and service features to compliment local land uses

**Revenue Service**  the time period when a public transport vehicle is available to the general public and there is a reasonable expectation of carrying passengers that either directly pays fares are assisted by public policy or provide payment through some contractual arrangement. Vehicles operated in fare-free service are considered to be in revenue service

**Reverse Commuting**  movement in a direction opposite the main flow of traffic, such as from the central city to a suburb during the morning peak period

**Ridership**  the number of rides taken by people using a public transportation system in a given time period
Ridesharing  a form of transportation, other than public transit, in which more than one person shares the use of the vehicle, such as a van or car, to make a trip. Also known as "carpooling" or "vanpooling."

Road Crew  the bus driver, train driver or motorman and conductor

Rolling Stock  the vehicles used in a transit system, including buses and rail cars

Roster  a list showing the allocation of crews to duties

Route Deviation  a type of transit service in which a vehicle travels a basic fixed route, picking up or dropping off passengers along the route. On request, and, perhaps, with additional charge, the vehicle will deviate a few blocks from the fixed route to pick up or deliver a passenger

Route Miles (kilometers)  the total number of miles (kilometers) included in a fixed route transit system network

Route Number  the identification number given to a bus route

Run Number  an identification number given to a Bus Duty

Run-out  the departure of buses from the depot at the start of the operating day

Schedule  a table of times giving details of bus or train crew duties

Service  public transport services performed, and the necessary workmanship and material furnished or used in performing the services

Service Area  a defined area from within which the majority of transit users will travel to a particular transit facility. A service area is influenced by the level of transit service provided, destinations served, availability of adequate parking, quality and convenience of vehicular access and intermodal transfers, and the relative location and quality of other nearby competing transit facilities

Shift  a crew duty

Short Turn  a trip that is scheduled to turn back short of the far end of the route

Shuttle  a public or private vehicle that travels back and forth over a particular route, especially a short route or one that provides connections between transportation systems, employment centers, etc

Small Bus  a bus 28 feet or less in length

Span of Service  the number of hours per day that transit service is available

Split Shift or Spreadover  a crew duty in two (occasionally more) parts separated by a break of several hours
**Stage Carriage** a category of local bus service that carries passengers for hire or reward at separate fares, stage by stage, and stopping to pick up or set down passengers at all bus stops along the line of route designated by the Transport Authority as such, and not being express carriages

**Standard-Size Bus** a bus from 35 to 41 feet in length

**Station** with respect to intercity and commuter rail, the portion of a property located appurtenant to a right-of-way on which intercity or commuter rail transportation is operated, where such portion is used by the general public and is related to the provision of such transportation, including passenger platforms, designated waiting areas, rest rooms and, where a public entity exercises control over the selection, the design, construction or alteration of the property

**Streetcar** a rail vehicle designed to operate in streets in general traffic

**Subscription Bus** a commuter bus express service operated for a guaranteed number of patrons from a given area on a prepaid, reserved-seat basis

**Subway** a fixed guideway system constructed in tunnels with underground stations

**Target Quality Standards** the caliber of service criteria specified in the operating plan

**Target Service Levels** the future bus or train kilometers, seated capacity and hours of service criteria specified in an operating plan

**Terminus** the point at the end of a route

**Timetable** the document showing all the times at which all bus trips on a route

**Transfer Center** a fixed location where passengers interchange from one route or vehicle to another

**Transit** see “Public Transportation.”

**Transit/Traffic Signal Priority** traffic signal technologies designed to expedite the movement of high-occupancy transit vehicles through intersections that may be difficult to navigate or access under normal traffic conditions

**Transit Bus** a bus with front and center doors, normally with a rear-mounted engine, low-back seating, and without luggage compartments or restroom facilities for use in frequent-stop service

**Transportation Authority** an autonomous statutory agency created by appropriate government decree

**Transportation Demand Management** program designed to maximize the people-moving capability of the transportation system by influencing either the time or need to travel
**Trip**  a single journey operated by a bus from one end of the route to the other, or to an intermediate point being used as the terminus for that journey

**Turning Point or Turnback**  an intermediate point on a route at which some trips are scheduled to short turn

**Undervalued Ticket**  a ticket issued for a value less than that paid by the passenger

**Unlinked Passenger Trip**  the number of passengers who board public transportation vehicles. A passenger is counted each time they board a vehicle even though they may be on the same journey from origin to destination

**Van**  a 20-foot long or shorter vehicle, usually with an automotive-type engine and limited seating normally entered directly through side or rear doors rather than from a central aisle, used for demand response, vanpool, and lightly patronized motorbus service

**Vanpool**  an arrangement in which a group of passengers share the use and cost of a van in traveling to and from pre-arranged destinations together

**Variable Cost**  a cost that varies in relation to the level of operational activity

**Vehicle Miles (kilometers)**  the total number of miles (kilometers) traveled by public transport vehicles. Commuter rail, heavy rail and light rail report individual car miles (kilometers) rather than train miles (kilometers) for vehicle miles (kilometers)

**Vehicle Trip**  a trip by a single vehicle regardless of the number of people in the vehicle