

Developing Guidelines for Evaluating, Selecting, and Implementing Suburban Transit Services

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ABSTRACT

Across the country, metropolitan regions have continued to grow outward from their traditional urban cores. Populations in former city centers continue to decline while surrounding suburbs are often showing substantial growth. Furthermore, many traditional suburbs have become ethnically and economically diverse communities with extensive commercial and employment opportunities. What we are seeing today is a pattern with older suburbs mimicking former urban centers while newer suburbs develop, stretching the metropolitan regions even further.

This study is designed to advance the research initiated in *TCRP Report 55* (available online at http://trb.org/news/blurb_detail.asp?id=2563). What the industry is beginning to understand since the previous research is that there are no simple solutions for serving the suburban environs. Rather, a complex mix of conditions exist which lead to success and which need to be measured by reasoned expectations. This includes defining effective metrics of performance, as well as the institutional, organizational and financial characteristics which also support achievement.

This study produced a guide on suburban transit service with a refined view of the suburban environment. The guide has been published separately as *TCRP Report 116* (available online at http://trb.org/news/blurb_detail.asp?id=6525). We have reviewed services within a regional context, not looking at service types as stand alone features off the menu of transit services. The research recognizes that the provision of service is complicated by both the physical features of a region and also by the institutional characteristics which make up each transit system.

SUMMARY OF FINDINGS

The goals of this research were to examine the current status of suburban transit, both from operational and land-use perspectives, and develop guidelines for evaluating, selecting and implementing those services, which would be manifested in the form of a guidebook that would inform both technical staffs and policy boards. The research was conducted by a multidisciplinary team and included evaluation of approximately 30 preliminary and eight detailed case studies that included substantial communication and understanding of those preliminary and detailed case studies which was then compiled in the findings and conclusions of the research.

Unlike some research efforts that focus on the mathematical formulae associated with specific public transit issues, this research, as will be described more thoroughly below, reinforced the importance of public policy decisions within an area that is still developing. These policy-related perspectives combined with the other technical results to form the following summary of findings:

1. The state of suburban transit services continues to evolve just as the state of suburbs also evolves. For example, as suburbia extends into new areas the former suburban areas begin to more resemble the downtown areas of decades ago, thus further stretching the resources required to adequately connect those new suburban areas with public transit.
2. Although the menu of solutions, commuter, regional connection and local circulation, remains similar from prior studies, the decision making process to retain or withdraw these suburban services is primarily based on local policies, which are substantially influenced by the availability of local funding.
3. Measurement processes for these services can also vary from a relatively stringent quantitative analysis, e.g. meeting a minimum ridership per hour threshold, to a less stringent qualitative view, which could include maintaining community control of local circulators. Denver RTD does use a modified performance level evaluation for all of its family of suburban transit services that appears can serve as a model for other agencies to consider and will be described in detail in the guidebook.
4. Efforts by the research team to more specifically analyze the land-use connection with suburban transit services provide mixed results. On the one hand, the more general use of density, diversity and design components, as more thoroughly described herein, shows potential for assisting the local transit planning process at the local level.
5. However, the more detailed use of land-use data, as seen in some of the detailed case study results, did not assist in developing a comparative analysis that could be used in general throughout the country, in part because the land-use data were inconsistent and difficult to assemble into a uniform format, and, in part, because the attributes of the services varied greatly from location to location, making general comparisons difficult.
6. In fact, several research team members believed that further national collection of those specific land-use data, for example percentage of persons employed in manufacturing, would not expand the value of those data, and, perhaps the best incorporation of land-use data would be at the local level as recorded and analyzed at the local level.
7. It appears at the current time that more agencies are grappling with the issue of how to provide alternative services in those areas that cannot support fixed-route services. Some alternatives, such as point and route deviation, appear to be accepted by local

communities in some areas and not accepted in others. In addition, there are increasing examples of demand-responsive services, many of which require order taking and scheduling on the fly by operators, expanding their role.

8. It would also appear that many of these services are developed with the goal of expanding suburban transit service coverage, which is sometimes counter to the goal of fixed-route services to maximize productivity. Some of these services incorporate the responsibility to deliver ADA complementary paratransit services by blending in those ADA-eligible clients into the suburban service solutions, thus eliminating the need for the separate ADA service.
9. Additional research may prove beneficial by focusing on these non-fixed-route alternatives and the potential to incorporate the goal of coordinating human service transportation, as evidenced by the increasing emphasis on the Federal United We Ride program, as well as examining alternatives for ADA paratransit, which has increased significantly in demand in both urban and suburban locales, with costs outpacing the funding sources used to finance those programs.
10. Although the specificity of land-use data and uniformity of suburban transit data were not that as originally anticipated by the research team, there appear to be a variety of more general trends and conclusions that will move forward the understanding of the complexities of suburban transit services and underscore the importance of the local policy making process.

Not all research processes can result in easy to adapt findings. The state of suburban transit services indicates yet again that many aspects of public transit service delivery, whether from the planning or policy perspectives remains more art than science, but scientific developed findings can assist the informed policy boards based on an ongoing understanding of service alternatives and attributes.

The guidebook on suburban transit service has been published separately as *TCRP Report 116* (available online at http://trb.org/news/blurb_detail.asp?id=6525).

CHAPTER 1: INTRODUCTION AND RESEARCH APPROACH

OVERVIEW

An overriding thesis of the modern condition is the fact that mobility is becoming increasingly complex. Nationwide, economic growth has led to commercial expansion and activity reaching further and further out to suburbia, creating more settings to which the transit industry has been asked to respond. These suburban communities are creating less dense and more auto dependent environments. For the transit industry, historically, these types of communities have been most difficult to serve, not having the density to support fixed route, but neither having the fiscal support to sustain demand-responsive services. With the price of fuel continuing to increase and the demand from constituent groups, such as older adults, to provide more mobility options the opportunity to revisit the state of the practice regarding the ability to deliver suburban services appears particularly germane.

Through a series of research programs aimed at improving transit service in suburban land-use environments across the country, TCRP has begun the development of a process that transit operators can use to assist in the design of appropriate and effective transit services in the most challenging service areas. The goal of this research is to build upon those prior research efforts, including a new dynamic, the evaluation of the correlation of land use and transit, to determine if there are additional relationships that can be employed to further the potential that appropriate transit services can match concomitant land uses to improve public transportation efficiency and effectiveness.

This report will document the research efforts beginning with the literature search and working through the detailed case studies to the results. As will be described, although there has been much work in the transit industry to wrestle with the difficulties of suburban transportation issues, including developing a long list of innovative, technology enhanced services, there are no “one size fits all” solutions. With regard to land-use connections, there are emerging data bases and resources that can be used to assist transit agencies in planning, but, to date, the lack of availability and lack of consistency of these resources limit their applicability. Further, in the detailed case studies, neither the land use, nor the transit data suggest specific approaches to predicting efficiency or effectiveness, though there are some trends worth reporting. Finally, the policy perspective regarding the success or failure of many suburban services is often not based on typical quantitative performance measurement factors, but more on qualitative concepts, such as value added to the community. These findings suggest that suburban transit service delivery remains more of an art than a science, but that the combination of innovation and technology, including the use of GIS incorporating land-use data, may lead to more uniform solutions in the future.

To recapitulate, the methodology for this study is based on four fundamental efforts, described below:

- **Background research and preliminary analysis** focused on reviewing previous studies in the area of suburban transit service, defining land-use components, describing the characteristics of transit services, and exploring the relationships between land-use and activity patterns, and how they relate to various types of transit service.

-
- **Preliminary case studies** generated a wealth of information on a wide range of agencies, identified common issues and trends faced by these agencies, and elucidated how agencies make decisions about what service to implement and how its performance will be measured. This effort also helped identify which agencies operate a variety of service types, which were willing to participate more heavily in the study, and what land-use and operating data they have available.
 - **Detailed case studies** offered the opportunity to follow-up with a limited number of agencies to better understand their operating environment, transit services, and political and funding situation, among others. Nine sites were selected and visited by a team member to collect various data, explore the service area, and meet with agency representatives. Qualitative information was synthesized for each site while the land-use data was used to generate an activity surface for the region or develop specific land-use statistics for the service areas of selected services. This information, along with service operating statistics and ridership data, was used to evaluate the relationship between land-use attributes or activity patterns and transit service.
 - **Guidelines** are the final component of the work. This step synthesizes findings from the detailed case studies and develops guidelines for operators and policy makers that can be used to inform their choice of transit service. The guidelines have been published separately as *TCRP Report 116* (available online at http://trb.org/news/blurb_detail.asp?id=6525).

UNDERSTANDING REGIONAL ACTIVITY PATTERNS

The urban form of modern cities and contemporary suburbia is increasingly characterized by multiple activity centers. The polycentric city is a complex hierarchy of centers, corridors, and areas in between. Whereas a large share of trips in the pre-automobile city was focused radially on the downtown, the modern city is characterized by dispersed travel patterns in all directions. This is evidenced by the continuous rise in suburb-to-suburb travel over the last few decades.

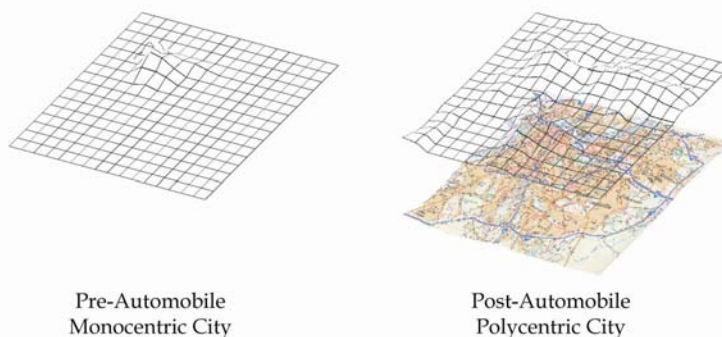
Recognizing that traditional downtown-oriented transit services no longer align with most trips being made, *TCRP Report 55* recommended that suburban transit services be developed around focal points and link to a broader regional network of line-haul transit services. In this manner, transit centers can be located near concentrations of trip origins and destinations, minimizing the need for transfers.

The initial step in designing such a regional transit system involves understanding the intrinsically related patterns of development and travel demand. Travel demand is the sum of the individual trip origins and destinations of every traveler in the region. While this information can be represented in large trip matrices, as used in travel demand models, a useful method for visualizing regional development patterns and travel demand is the activity surface.

As illustrated in Figure 1-1, an urban area can be thought of as a surface that represents the relative importance of each point across the metropolitan region. The relative importance of a point is a function of the number of activities that serve as the ends of trips, such as jobs, shopping, medical care, recreation, and housing. The activity surface of a pre-automobile city was a relatively simple convex surface with a noteworthy peak over the downtown, a single mountain in a large plain. The modern, polycentric city has a much more complex, bumpy

activity surface characterized by peaks of various heights over the traditional downtown and outlying centers, ridges connecting peaks along major corridors, and plains in between, where people live in sprawling subdivisions.

Figure 1-1: Conceptual Activity Surfaces by Urban Form



Supported by tools such as the activity surface, this project explores the relationship between the land-use characteristics and travel patterns of the service area, the operating characteristics of the service, and the service's performance on a range of suburban transit services. These relationships provide guidelines that transit operators and policy makers may use to inform their decisions on where to operate service and what characteristics the service should have, given different performance expectations.

TCRP Report 55 identified six types of suburban land-use environments based on their diversity of uses and how the intensity of their development (density) relates to that of the surrounding area. These environments included residential suburbs, balanced mixed-use suburbs, suburban campuses, edge cities, suburban corridors, and exurban corporate enclaves. Thinking back to the discussion of the activity surface, each topographical feature of the activity surface corresponds to one or more of these suburban environments:

- **Peaks** represent the major activity centers, such as downtowns, shopping centers, edge cities, and community business districts. In a polycentric city, peaks have various heights based on their relative share of the region's total residential, employment, commercial, medical, and recreational activity. Edge cities and downtowns of balanced mixed-use suburbs are examples of peaks. Peaks generally have urban characteristics – a diversity of uses, higher densities, and perhaps deterrents to driving.
- **Ridges** represent the major travel corridors in a region. These corridors frequently connect peaks and are often lined with higher density residential, employment, or commercial uses. Suburban corridors are examples of ridges. Ridges have more suburban qualities – less diversity and design conditions where there are large gaps in the street wall, although there may well be deterrents to driving in the form of traffic congestion.
- **Points** represent places in the region that are destinations for trips, but that do not necessarily fall on peaks or ridges. Suburban areas are characterized by a relatively high share of destinations that are not located within walking distance of other major activity centers or on major transportation corridors. Suburban campuses and exurban corporate

enclaves are examples of points. Points are largely characteristic of suburbs, without the qualities of urban areas.

- **Plains** represent the large areas of relatively low density residential, office or industrial development that frequently serve as one end of a trip. Residential suburbs are examples of plains. Again, plains are largely a phenomena of suburbia and do not have high diversity, density, design, or deterrents to driving.

Appendix A contains more detailed and supplemental information regarding the potential use of land-use data to look at framing the connection with transit. The next section continues this discussion of development patterns and appropriate transit services with a discussion of the types of transit services that are available to improve mobility in suburban environments.

FEATURES OF SUBURBAN TRANSIT SERVICES

As suburbs expand and the suburban population grows, it is increasingly apparent that traditional transit service is often not suited to meet suburban mobility and accessibility needs. In spite of significant investments in transit services, transit's mode share is challenged overall, even for commute trips - transit's biggest market. As discussed previously, the private automobile offers the convenience and flexibility that many people often take for granted in their daily travels. However, congestion, fuel costs, mobility needs of the transportation disadvantaged and environmental concerns require that alternatives to private automobiles and driving alone be viable and available.

With a commitment to providing transportation alternatives in suburban locations comes the understanding among public decision makers and transit agencies that traditional transit paradigms may not be an effective alternative and must be redefined to better serve suburban markets. Traditional, fixed-route may not meet passengers' mobility and accessibility needs. Therefore, there needs to be a commitment to try new things – to develop new ways to provide transit such that it offers benefits similar to automobiles. Benefits of private cars, and consequently desirable attributes of suburban transit, include:

- Near door-to-door service
- Flexible routing and scheduling
- Service on demand
- Relatively fast trips
- Real-time information
- Comfort
- Convenience

In order to provide these attributes in suburban transit service, transit agencies must develop transportation solutions that are tailored to the specific circumstances of their service area. Services must reflect the transportation needs of the community, the operating environment, and demographics.

The research has indicated the types of transit services that operate within a range of suburban environments. These are briefly discussed here and more thoroughly described in Appendix B.

Established Suburban Transit Services

Fixed Routes

Among the most commonly deployed transit service, fixed routes are those which follow a predetermined alignment and schedule. Fixed routes may operate more frequently than other service forms, providing service during peak hours or all day. These include:

- Trunk
- Express
- Limited Service
- Circulators
- Shuttles and Feeders

Deviated Fixed Routes

In deviated fixed-route service, vehicles have the flexibility to move within a given service area as long as they arrive on schedule at various time points. Often the time points are located at transit hubs where passengers can transfer to trunk or express service. Deviated fixed-routes frequently use smaller vehicles, whether they are small buses or large vans. It is also common for these routes to have their own identities, with unique logos and color schemes.

Deviated routes generally take one of three forms. The most flexible form of deviated fixed-route is essentially a demand-response service that has two time points, one on each end of a service area. A slightly more restricted service might have a vehicle running along a route between 4 or 5 time points, but deviating as necessary for passengers to board and alight. Another common variation is to have a vehicle follow a fixed route, but allow it to deviate up to a given distance (typically $\frac{1}{2}$ or $\frac{3}{4}$ mile) from the route to pick-up or drop-off passengers. Examples of these services include:

- Circulators
- Shuttles

Demand Responsive Services

Demand responsive service, also called “dial-a-ride,” schedules vehicles to pick-up and drop-off passengers throughout a service area, providing high quality, curb-to-curb service for the general public and persons with disabilities. These services are particularly effective in areas with low-density development and/or widely dispersed trip generators that are hard to serve with a fixed-route or full-size coach. All of these trips require a call-in request. Advance notice requirements vary from days in advance to the actual time of the desired trip. Demand response services use smaller vehicles, whether they are small buses, large vans or taxis, which can navigate residential neighborhoods and narrow streets.

Due to smaller passenger loads vehicles can follow more direct routes between origins and destinations, reducing trip travel times. Technological advances, including improved dispatching capabilities and real-time information, should allow transit systems to significantly reduce advance reservation requirements.

Similar to the deviated fixed-route service described above, demand-response service is generally provided as either shuttle, feeder or circulator service. Demand response service is probably most commonly associated with social service transportation and is also utilized to

meet the paratransit requirements of the Americans with Disabilities Act (ADA). In the private sector, airport shuttles are probably the most common application of demand-response service. In the overall network of suburban transit services, demand-response service plays a critical role in serving niche markets that are not well served by fixed-route service and appears to be positioned to increase its relative profile in coming years.

Subscription Services

Subscription service offers a tailored transit service to specific individuals when they have paid a subscription fee. Many subscription services originated as private enterprises and have transitioned to public operation, although they may also be the result of a public/private partnership. Subscription vehicles, whether they be coaches or smaller vehicles, collect passengers at predetermined times and locations. Trips are scheduled to best meet the needs of a particular trip's passengers in terms of the origin, destination and pickup and drop-off times. Subscription services tend to operate from residential environments that have low average densities but have concentrations of residents who have similar work locations. Subscription services often experience farebox recovery ratios much higher than other transit services because the demand for service is known in advance and because such a premium service demands higher fares.

For the purposes of this document, the discussion of subscription services is limited to commute service, as this is the market upon which most public and public/private partnerships focus. However, it is worth noting that other subscription services exist for markets such as childcare, sporting events, and travel to airports. The most common examples of public subscription services are commuter buses and vanpools. Although some ADA trips are called "subscription" trips, in reference to a standing reservation for a particular trip made by a specific passenger, they are not included in this discussion. Rather these trips are classified as being part of demand-responsive service. Examples include:

- Subscription Commute Buses
- Vanpools

Innovative Suburban Transit Service

Innovations in technology have also led to innovations in various aspects of suburban transit services. These include the availability of real time information to assist both customers and service providers regarding schedule adherence, operating conditions, etc. In demand-response services, real time scheduling and dispatch programs can improve efficiency and effectiveness. Some systems have employed the use of cell phones to ensure more direct communication between customers and operators. Smart cards have become another means of improving transfers between systems and services plus reinforce the goal of seamless travel. In addition, vehicle design, such as low floor buses, have made accessing the vehicles easier for all age groups and automated stop announcements have assisted in the consistent availability of this information for people with disabilities. Examples include:

Technology and Infrastructure Improvements

- Real-Time Information
- Transit Preferential Treatment

-
- Vehicle Modifications
 - Fare Technology

Transit Services and the Activity Space

The activity surface provides the basis for relating the spatial distribution of travel demand and the optimal arrangement of transit centers, line-haul routes, and other transit services. All transit services can be organized around the topographical features on the activity surface, as shown below:

- **Peaks** are the largest destinations for travel by all modes and are generally served by the highest frequency, highest capacity transit services in a region. They are also generally the best locations for transit hubs because the concentration of routes serves travel demand from all directions and the concentration of trip ends minimizes the need to transfer.
- **Ridges** generally represent the best locations for traditional line-haul transit services, including rail and fixed-route bus services, since they have a relatively high number of trip ends within walking distance and the mix of uses provides a source of relatively high, all-day travel demand.
- **Points** are among the most difficult locations to effectively serve with fixed-route transit. Not only are points geographically dispersed, but their travel demand also tends to be concentrated at certain times of day. As a result, these places tend to be poorly served by transit. Frequently they receive little or no service at non-peak times, are served by dedicated trips or scheduled route deviations that can confuse customers, or require customers to walk a long distance to a mainline bus route. Defining strategies to effectively serve points is one of the major objectives of this research.
- **Plains** are also notoriously difficult to serve with fixed-route transit because of the low density, coarsely grained mix of land uses, and lack of well-connected pedestrian facilities frequently found in suburban residential areas. As with points, identifying strategies to effectively serve plains is one of the major objectives of this research.

At this juncture in the process the research team convened and, based on the background information gathered regarding land-use and service attributes, developed a candidate list of preliminary case study locations.

PRELIMINARY CASE STUDIES

This section outlines the findings from preliminary case studies completed for twenty-eight transit operators. These initial case studies served multiple roles, including to:

- Confirm the range of transit service formats operating in suburban environments,
- Understand how agencies evaluate the performance of their transit services,
- Identify key issues and trends facing suburban transit, and
- Compare the characteristics of transit service with aspects of the suburban land form as described with the activity surface concept.

A number of techniques were used to select sites for the initial case studies. The techniques used included reviewing transit agency websites, identifying appropriate sites from

the literature search, requesting information via a list serve, and applying our professional knowledge of transit properties. The final choice of case study locations was done to balance the size and geographical coverage of agencies, while ensuring that unique programs were also included.

The following is the list of the twenty-eight transit agencies that were part of the initial case studies. The list is organized first by geographic region (West, Midwest, South, and East) and then by agency size (starting with the smallest agencies).

West

- Livermore Amador Valley Transit Authority (LAVTA)
- South Metro Area Rapid Transit (SMART)
- Eastern Contra Costa County Transit Authority (Tri Delta Transit)
- Orange County Transportation Authority (OCTA)
- Pierce Transit
- Valley Metro
- Metropolitan Transit Development Board (MTDB)
- King County Metro (Metro)
- Denver Regional Transit District (Denver RTD)
- Tri-County Metropolitan Transportation District (TriMet)

Mid-West

- Champaign – Urbana Mass Transit District (C-UMTD)
- Des Moines Metropolitan Transit Authority (DMMTA)
- Madison Metro
- Suburban Mobility Authority for Regional Transportation (SMART)
- Toledo Area Regional Transit Authority (TARTA)
- Kansas City Area Transportation Authority (KCATA)
- Metropolitan Council
- Pace, Suburban Bus Division of the Regional Transportation Authority (Pace)

South

- Broward County, Florida and municipalities within the County
- Fort Worth Transportation Authority
- Charlotte
- Dallas Area Rapid Transit (DART)

East

- Potomac and Rappahannock Transportation Commission (PRTC)
- Merrimack Valley Regional Transit Authority (MVRTA)
- Capital District Transportation Authority (CDTA)
- Transportation District Commission of Hampton Roads (HRT)
- Rhode Island Public Transportation Authority (RIPTA)
- New Jersey Transit (NJ TRANSIT)

In addition to accumulating a wealth of information on a wide range of agencies, it has become clear that there are many common issues and trends faced by these agencies, but there are diverging conclusions being made about their services. The following section discusses these issues and trends in greater detail. Appendix C provides the analysis of the initial case studies. Case study methodology is discussed in detail in Appendix D.

Key Issues and Trends

A number of key issues and trends emerged from the analysis of the initial case studies. The range of services offered by the agencies included in the case studies can be grouped into the following categories:

- Commuter
- Route deviation
- Demand response
- Circulators
- Shuttles
- Vanpools

The commuter services are typically premium operations designed to attract a higher income market through various service attributes, or reverse commute operations, which usually operate during non-traditional hours and are often funded by Job Access Reverse Commute (JARC) funds. Another trend is that premium commuter services require a higher farebox recovery ratio than standard fixed routes to be considered successful. Using an employee from the job site as the driver, creating a “bus-pool” is one innovation observed at a case study site.

Success with route-deviation services, sometimes in concert with demand-responsive service, has been mixed. Several areas have abandoned or greatly reduced this type of service based on a variety of difficulties, including schedule adherence, customer complaints about advance scheduling and lack of buy-in by operational personnel. Some properties believed that mixing a fixed schedule with demand-responsive routing was a conflict in philosophies. However, other properties appeared to successfully combine these concepts, especially when they were implemented as a substitute for existing service (as opposed to a standalone, new service). Some agencies considered route-deviated services successful if they exceeded the productivity rate of the local demand-responsive service, while others considered route deviation successful if their productivity was comparable to the fixed-route average.

Among demand-responsive services, zone systems that capture internal trips or link passengers to fixed routes have been successfully implemented. The size of the zone (including the number of attractions) and the availability of other services appeared to significantly affect productivity. The standards used to rate success varied by agency.

Some services named “shuttles” by their operating agency are similar to the demand-responsive services described above, while others were more fixed in nature, connecting neighborhoods or providing service to employment centers through connections at rail stations or transit hubs. Employer shuttles appeared to perform best with sustained employer participation.

The information collected thus far on vanpools and ridesharing also varies by agency, with a key factor in agency participation being the ownership of the vehicles. In addition, one innovative service used by Pace is to keep vans at Metra stations to connect workers to their place of employment. This also resembles a car sharing methodology, sometimes termed station cars, that has been employed in more urban areas of the country.

In addition to these observed services, there are several other issues that are worth additional discussion, such as:

- Performance measurement
- Funding
- Community interaction

With regard to performance measurement, one of the most thorough efforts to quantify service performance was completed by Pierce Transit (WA). The performance criteria and standards for one of Pierce Transit’s services are shown in Table 1-1.

Table 1-1: Performance Criteria and Standards

	Passengers per Vehicle Hour	Cost per Boarding Passenger*
New Routes (less than one year old):		
Satisfactory	>3.0 pass/hr	<\$11.30/pass
Unsatisfactory	<3.0 pass/hr	>\$11.30/pass
Routes one to two years old:		
Satisfactory	>4.0 pass/hr	<\$8.50/pass
Unsatisfactory	<4.0 pass/hr	>\$8.50/pass
Routes more than two years old:		
Satisfactory	>5.0 pass/hr	<\$6.80/pass
Unsatisfactory	<5.0 pass/hr	>\$6.80/pass
*All costs are in 2003 dollars. They should be indexed for inflation.		

Other performance measurement systems of note are the Met Council’s (Twin Cities) thorough review of zones every three years and the MTDB’s (San Diego) combination of quantity and quality of service goals. The quantitative criteria include: passengers per revenue mile, passengers per revenue hour and subsidy per passenger. The qualitative criteria can be grouped into three categories: transit supportive land uses, regional transportation priorities and quality of service. Denver RTD also uses performance measurement extensively for all types of services that they provide.

Funding sources also appeared to influence both service availability and, to some degree, the productivity analysis. For example, a number of non-traditional services were funded by JARC or CMAQ, while several locales either had passed dedicated local funding taxes or were funded as a result of “opting out” of the transit district. In several instances, the lack of sustained funding from JARC or CMAQ determined if the service continued beyond the demonstration period. Similarly, those services with dedicated funding are often held to different performance standards.

Another apparent trend was the interaction between local communities and transit agencies, where several programs were considered to be successful when transit dollars were

added to community dollars for the provision of services designed by the community. In other instances, lack of continued community enthusiasm was cited as a factor in discontinuing or reducing service.

Assessment of Practices

Interviews with representatives from the transit agencies from around the country revealed that many agencies use quantitative performance standards as they decide how to serve suburban areas that have uneven and relatively low demand. However, it was also evident that other factors heavily influence service design and provision decisions.

A weak economy in many areas of the country has resulted in lower than usual farebox and sales tax revenues, thereby limiting funds available to transit systems. When faced with limited resources, many agencies have chosen not to invest operating funds in areas of relatively low transit demand. Instead, they have strategically invested their limited resources in areas of higher density, where the highest ridership and revenues can be realized. Alternatively, some agencies provide service in lower density suburban areas only when there is a funding source or partner that will pay for the many of the service's expenses. For instance, in the Pace service district, no new suburban shuttle services are put in operation unless there is a major employer or a transportation management association (TMA) that will subsidize the cost of its operation. Hence, some of the services are being put into place not as the result of anticipated service performance, but as the result of dedicated funding.

A number of the agencies interviewed stated that they simply do not use service guidelines or standards to inform their decisions on where and how to serve lower density suburban areas. Among these agencies, service changes tend to be very incremental. Service planners within these transit agencies are very familiar with their communities and the changes that are taking place. The transit planners use their professional judgment, based on their local experience and understanding what kinds of development are likely to attract transit users, and allocating their resources accordingly. This professional judgment is often augmented by new service requests and political influence, expressed as interest in service by transit board members or other politicians.

In the majority of cases reviewed, newer, more flexible forms of transit have been substituted for unproductive fixed-route service. Transit agencies are realizing that traditional, fixed-route services are no longer viable in certain areas, or for certain bus routes, due to extremely low ridership. However, they still want to provide mobility options to expanded service areas. Route deviated service, point deviation service, or some form of demand-response call and ride service have a number of advantages under these circumstances:

- The transit agency does not leave former fixed-route passengers stranded without any service. This is important to the passengers, but also to the transit boards who see themselves as providers of mobility options.
- The sense of equity is maintained by providing broader coverage service throughout the area that supports the transit agency with taxes. Equity is a rationale used by transit agencies looking for political support at upcoming referenda for continued or expanded transit services.
- New, flexible service is often less expensive than traditional, fixed-route service since it is sometimes contracted out and provided with smaller vehicles. The savings are

increased with flexible services because complementary paratransit service is not required where flexible, accessible transit is equally available to all passengers.

- Smaller vehicles are often more compatible with the sensitivities of suburban neighborhoods, which are often sensitive to the noise and pollution generated by full-sized transit buses. These smaller vehicles are better able to negotiate crowded shopping centers, narrow residential streets, or the turns necessary to accommodate deviation requests.

These reasons for using more flexible service to substitute for traditional fixed-route service are generally sufficient justification for a transit agency, leaving it without a pressing need to develop separate standards or guidelines. However, there are a number of agencies that measure the performance of new, flexible services. Generally this is done because the agency has very limited financial resources and might have to cut even these less expensive services (as has happened in Ft. Worth, Texas where eight different flex routes were tried and terminated), or because the agency regards these services as any other, and they need to be continuously reviewed to ensure that they are being used in the most appropriate locations (as in Tacoma, Washington).

The specific performance standards used to judge these newer services vary dramatically, though there is some agreement on the general expectations of flexible services. The most commonly used quantitative performance measure is passengers per hour. Virtually all transit agencies expect flexible services to perform better than standard paratransit service, but worse than traditional fixed-route service. Most agencies are satisfied with service that carries between four and eight passengers per hour. Some perform slightly worse than this, but are maintained as “lifeline” services, while a few others have performed better than eight passengers per hour. The Tri Met system in the Portland, Oregon area requires its local suburban circulators to maintain a productivity level of 15 passengers per hour.

Some agencies include the subsidy per passenger as another quantitative performance measure. Once again, the specific standard varies due to different cost structures around the country and different budget constraints, but at first blush the range of values is between \$4.50 and \$11.30. Less often, transit agencies use the farebox recovery ratio as a primary determinant of whether the new transit service is viable. A minimum standard between 20 and 25 percent is the typical threshold for continued service. It should also be noted that agencies often provide different “probationary periods” during which they expect these new services to become established. The standard time frame ranges from one to three years, with 18 months as an average.

In addition to the quantitative measures that drive service decisions, there are often qualitative reasons. As noted earlier, many of new, flexible services are started as substitutes for unproductive fixed-route service. In areas where flexible transit is introduced as a new service, the qualitative factors influencing the decision to provide the service have included:

- Specific requests from major employment centers or communities, many of whom offer to help pay for the expense of providing the service.
- Strategic placement of service within communities to build support for transit referendums.
- Geographic or topographic characteristics that make the provision of regular fixed-route service impractical.

-
- A residential community’s proximity to premium transit service, such as rail or BRT stations.
 - A regional transit agency’s desire to provide faster, more direct service. This is often accomplished by straightening trunk-line routes on major arterials and creating feeder routes to serve areas once served by the fixed route.
 - A priority to minimize traffic congestion and air pollution by providing a transit link between premium transit services and major employment centers.
 - An interest to provide mobility services to residents of areas with relatively high unemployment to support their entry into the workforce.
 - A goal to provide for internal community trips with vehicles that can easily access shopping centers and other areas with relatively crowded and/or tight lane conditions.
 - Providing service with smaller vehicles that are more acceptable to certain neighborhoods.
 - A policy that all residents within a service area will have access to some form of public transit, even if it is limited service, as a “lifeline” for those with no other affordable mobility options.
 - Regional policies that call for a relationship between different densities of land uses and levels of transit availability.
 - The availability of funds from sources such as Congestion Mitigation and Air Quality Improvement Program (CMAQ), Job Access Reverse Commute (JARC), or state grant programs for experimental services.
 - Providing different services at times or on days that normally see less transit demand.

The specific quantitative and qualitative measures being used by the interviewed agencies are summarized in two appendices, which are described below.

- Appendix F – the quantitative factors decision matrix lists each of the case study agencies and notes which performance measures they employ and the relevant standard (if available).
- Appendix G – the qualitative factors decision matrix lists the case study agencies and notes which factors influence their decision to implement new service.

RECOMMENDATION OF DETAILED CASE STUDY SITES

Following the gathering of the above information, the research team then convened several times via conference call to discuss recommendations for detailed case studies. Those calls focused on the group’s desire to balance the geographic distribution and agency size, including sites from larger and more rural areas of the country, while representing transit properties that have specific policies guiding service implementation and those whose service choices appear to be more politically motivated. Other considerations were: the availability of land-use, demographic, and operations data to facilitate the development of the land-use analysis, and that the range of suburban transit services be represented by the sites.

With these goals in mind, the team collectively decided that it would be of more value to select sites that operate a number of different types of services over those which only feature a small number of varied services (which would typically be replicated in other places with multiple services). The rationale was that this approach would allow showcasing and ultimately detailing more types of services through site visits. There was a discussion that there might be a

perception that the study highlights larger markets while omitting some smaller, rural sites because larger areas are more likely to offer more extensive and varied services. Similarly, preliminary work indicated that more robust land-use data may exist in some of the medium and larger transit properties. Because one of the goals is to illustrate the nexus between land use and suburban transit services, sites with more extensive data were given priority. To combat the perception that the guidebook is geared to larger transit agencies, the analysis will include discussions that focus on how our findings relate to all areas, especially transit agencies which operate in smaller metropolitan environments.

The locations listed below are our final recommendation of sites and represent the team's consensus, based on a thorough discussion of all the above factors and the preliminary case study locations. The recommended sites are:

- King County Metro (Seattle, Washington)
- Tri-Met (Portland, Oregon) and South Metro Area Rapid Transit (Wilsonville, Oregon)
- Regional Transit District (Denver, Colorado)
- Metropolitan Council (Minneapolis area, Minnesota)
- Charlotte Area Transit System (Charlotte, North Carolina)
- Suburban Mobility Authority for Rapid Transportation (Suburban Detroit, Michigan)
- Broward County Transit (Broward County, Florida)
- Capital District Transportation Authority (Albany, New York)

As indicated in the following tables, the recommended sites provide broad geographical coverage, vary in size, and offer a wide range of service alternatives.

Table 1-2: Case Study Sites by Agency Size (number of buses)

Small (Less than 100 buses)	Medium (100 – 600 buses)	Large (More than 600 buses)
South Metro Area Rapid Transit, SMART (OR)	Capital District Transportation Authority, CDTA (NY) Charlotte Area Transit System, CATS (NC) Broward County Transit, BCT (FL) Suburban Mobility Authority for Regional Transportation, SMART (MI)	Denver Regional Transit District, Denver RTD (CO) King County Metro, Metro (WA) Metropolitan Council, MetCouncil (MN) Tri-County Metropolitan Transit District, TriMet (OR)

Table 1-3: Case Study Sites by Agency Location

East	South	Midwest	West
CDTA (NY)	CATS (NC) BCT (FL)	SMART (MI) MetCouncil (MN)	SMART (OR) TriMet (OR) Metro (WA) Denver RTD (CO)

Table 1-4: Case Study Sites by Transit Services Offered

Transit Services	BCT (FL)	CDTA (NY)	Denver RTD (CO)	MetCouncil (MN)	Metro (WA)	SMART (OR)	SMART (MI)	TriMet (OR)
Fixed Route - Circulator/Shuttle	✓	✓	✓	✓	✓	✓	✓	✓
Demand Response	✓		✓	✓	✓	✓	✓	✓
Flexible -Route Deviation -Point Deviation	✓	✓			✓ ✓		✓ ✓	✓
Commuter -Bus -Vanpool			✓ ✓			✓		✓

Through the detailed case studies of the eight sites listed above and the mini service evaluations, the team will cover the range of services that operate in suburban environments. These services include: commuter, trunk, shuttles, route deviation, and demand response. Although the research proposal called for the study of six sites, the scope was expanded to provide more geographic coverage.

CASE STUDY RESEARCH METHODOLOGY

Overview

Once the case study sites were approved by the TCRP Panel, the research team developed a detailed data and information request form as shown in Appendix E. The form included both transit and land-use characteristics as summarized below:

- **Transit Characteristics**
 - *Service Characteristics*
 - % of households or jobs within service area; Response time (DAR); Number of vehicles in peak service; Intermodal hubs; Technology (Signal preemption/Next bus)

-
- *Vehicle Characteristics*
 - Vehicle type; Capacity (seats/wheelchair positions); Technology (Annunciators, AVL, Smart Cards)
 - **Route Characteristics**
 - Headway (Peak/Off peak); Average speed; Trips per (Weekday/Saturday/Sunday); Route length (mi/hr); Service span (Weekdays/Saturday/Sunday)
 - **Performance**
 - Annual passengers; Revenue hours; Revenue miles; Vehicle hours; Vehicle miles; Cost/passenger; Cost/hour; Cost/mile; Subsidy/passenger; Farebox recovery ratio
 - **Funding Sources**
 - **Transit Policy**
 - Board role and involvement; Decision-making process; Guidelines; Performance Measurement System (describe); Organizational model; Other unique characteristics
 - **Land Use & Travel Patterns**
 - *Key Attractions*
 - (Large employers, schools, shopping centers, medical centers, museums, arenas, hotels)
 - *Land Use by Parcel*
 - Residential (dwelling units by parcel or block); Commercial (square footage of leasable space)
 - *Travel Behavior*
 - Origin-Destination Travel Patterns; Trip Purposes; Trip Frequency;
 - **Demographics**
 - Household income; Car ownership; Age composition; Unemployment rate; Non-English speaking populations; Average household size;
 - **Street Network Characteristics**
 - Street width; Number of lanes; Speed limit; Signal spacing; ADT; V/C or LOS; Connectivity; Distance between bus stops
 - **Transit Priority Features**
 - Traffic signal priority; Queue jump lanes; Exclusive lanes
 - **Parking Cost or Scarcity**
 - Average cost of parking, metered parking, structures, etc.

Although the transit service data were typically available from the affected agencies, due to the level of detail requested, it proved quite time consuming to interact with agency staff to acquire and refine data on a line by line basis. In addition, the coupling of the request for land-use information proved to take more time and often involved multiple agencies at the city, county and regional level. Further, there was a considerable lack of consistency between the data available at the various case study sites. During this period of the research, several issues became evident. First, based on a variety of factors, there was agreement to delete Charlotte from the list of case studies. Second, due to the inconsistency of land-use data and the time and resources

necessary to process that data into the full land-use analysis, the number of the studies in the category of highly available land-use data was reduced to four sites, Detroit, Minnesota, Portland and Wilsonville. Third, it was apparent from the level of inconsistency and availability of land-use information that developing sufficient linkages with transit services on a line level was logically going to be difficult.

Appendix H contains the results from the case studies.

CHAPTER 2: FINDINGS

The purpose of this chapter is to organize that information and data into the findings of the research. To assist in the organization, three perspectives of the analysis of the information and data will be used:

- Land-Use Assessment
- Performance Measurement
- Pearson Correlation Matrix

These analyses will indicate whether the information and data can be aggregated into findings that appropriately generalize the results, or whether disaggregated use of the data and information may be of more value regarding other areas potential to use this research.

LAND-USE ASSESSMENT

In assessing the land-use conditions within the transit service areas, we considered “four D’s:” Density, Diversity, Design and Deterrents to driving. These measures were chosen in order to evaluate the level of transit-supportiveness of each service area. The methodology for calculating these indicators is described below.

In order to calculate the measures, we first determined the service area of a given suburban transit service. In most cases, it was possible to obtain Geographic Information System (GIS) files of the routes directly from the transit provider. In other cases, we developed GIS files of the service areas based on published bus schedules. A few assumptions were built into the definition of service areas. In the case of fixed routes, we buffered the centerline of the route by $\frac{1}{2}$ mile, which is the distance we considered to be walkable. For deviated fixed routes, we buffered the fixed route by the distance that the driver was allowed to deviate to pick up or drop off passengers. For example, in Minneapolis, one fixed-route service deviates up to $\frac{3}{4}$ mile based on passenger requests, and therefore we buffered $\frac{3}{4}$ of a mile around the fixed route. In the case of point deviation service, we included the entire zone that included the collection points and the area covered by the service. In the case of demand-responsive service, the entire service area was selected for study. Park-and-ride lots were assumed to have a 5 mile radius catchment area.

Density

The Density indicator was measured by calculating the number of people, households and employment in the study area. Data was most often available at the traffic analysis zones (TAZ) level provided by the metropolitan planning organization (MPO) in that region. In some cases, particularly for population and households, data was provided in different units of geography, such as census tracts.

In order to calculate population, household and employment for each service area, we assumed that development was uniformly distributed throughout each zone. In GIS, zones were spliced based on the boundaries of the transit service area. The population, households and employment related to the zones and the fractions of zones that fell within the service area were summed to arrive at the service area totals.

To determine population, household and employment densities, we then divided the totals for population, households and employment by the number of square miles contained by the

service area. This uniform measure enabled us to compare service areas within the regions and across the country. With the number of jobs and population per square mile, we were also able to calculate the service area's jobs/housing ratio.

Diversity

To assess the Diversity of activities occurring in each service area, we evaluated the mix of industries and land uses present. Industry data on employment in each service area, where available from MPOs or other sources, was summarized and presented. Land-use data in GIS format was also obtained from MPOs, at times at the parcel level. We then determined which parcels were in the service area and summed the areas of all the parcels by land-use type. Some land-use categories were aggregated for sake of simplicity (e.g. wetlands, wooded areas, and parks all comprise open space). Once we determined the area for each land-use type, we divided the subtotals by the total service area to determine the proportion of each land use. For detailed case studies, we reported these percentages. In cases where we did not have sufficient data for this level of detail, we reported the dominant land use.

Design

Design was measured in terms of sidewalk and street connectivity and whether the area would qualify as an "urban place." Sidewalk connectivity was chosen as an indicator of the ability for pedestrians to walk to transit stops. This was evaluated on a scale of 1 to 5, with five indicating the highest level of sidewalk coverage. As shown in the chart below, the numerical measures are correlated with descriptions from the perspective of a pedestrian or a planner, depending on the training level of the rater.

Table 2-1: Rating System for Sidewalk Coverage

Rating System for Sidewalk Coverage			
For Planners		For Laypersons	
1	Most streets do not have sidewalks	1	A person cannot walk there; he/she must use the street
2	Many streets do not have sidewalks – there are many gaps in sidewalks	2	It is difficult to walk there – there are lots of gaps in the sidewalk
3	There are sidewalks on at least one side of most streets	3	A person could walk there but it would not be very easy or pleasant
4	There are sidewalks on nearly every street, but not always on both sides	4	It is fairly easy to walk there but there are some places where it could be improved (e.g. crosswalks, lighting needed)
5	There are sidewalks on both sides of nearly every street	5	It is very easy to walk there (extensive sidewalks, crosswalks, pedestrian crossing lights)

The street network was evaluated for its level of connectivity to determine whether transit riders would have options for direct routes to transit stops. This rating was also done on a scale of 1 to 5, with greatest connectivity being a 5. Images of sample street networks for each of the five levels were chosen to give raters a visual reference. Additionally, a text description characterizing each level of connectiveness was used as a guide, as shown below.






The final element of the Design measures was evaluating whether a suburban service area included any places that could be characterized as urban in terms of development patterns, street space, or walkability. This was a yes/no evaluation of whether the study area has a place with buildings fronting on the street and defining a strong public space, such as a traditional “Main Street.” If the person evaluating the area could answer “yes” to all of the following questions, the area was determined to have a place with “urban” characteristics.

- Does the service area include a place where most buildings are adjacent to the sidewalk, not set back from the sidewalk?
- Does the service area include a place where there are few if any parking lots in front of buildings?
- Does the service area include a place where there is high street wall continuity – a place where buildings are lined up next to each other with few gaps, providing a vibrant place for pedestrians to walk?

Deterrents to Driving

Deterrents to driving are characteristics of a service area that have the potential to encourage more people to choose transit over driving. We evaluated two measures: parking costs and transit priority features. Parking costs were defined in terms of average daily cost of off-street parking. If the study area included a place where free parking is generally not available, the value of this binary value was defined as “yes”. Transit priority features include traffic signal priority, queue jump lanes, exclusive transit lanes, or busways. The transit priority features measure was reported as either “yes” or “no” depending on whether the suburban transit service makes use of any of these features.

Table 2-2: Rating System for Street Connectivity

Rating System for Street Connectivity		
Rating	Description	Aerial View
1	Very low level of street coverage; mostly a few collectors or arterials with a few cul-de-sacs	
2	Cul-de-sacs and curvilinear roads predominate; there are few areas with grid coverage	
3	Significant grid coverage but also a number of areas with cul-de-sacs/dead ends	
4	Extensive grid network with a few cul-de-sacs and dead ends	
5	Complete grid network with no cul-de-sacs or dead ends	

RELATIONSHIPS OF LAND-USE SERVICE AREA CHARACTERISTICS TO TRANSIT SERVICE AND PERFORMANCE

In the section below, a series of graphics, first used at a presentation for the APTA Bus and Paratransit Conference in May 2005 at Columbus, Ohio, indicate the relationships and findings from a land-use assessment perspective.

Figure 2-1: Research Objective

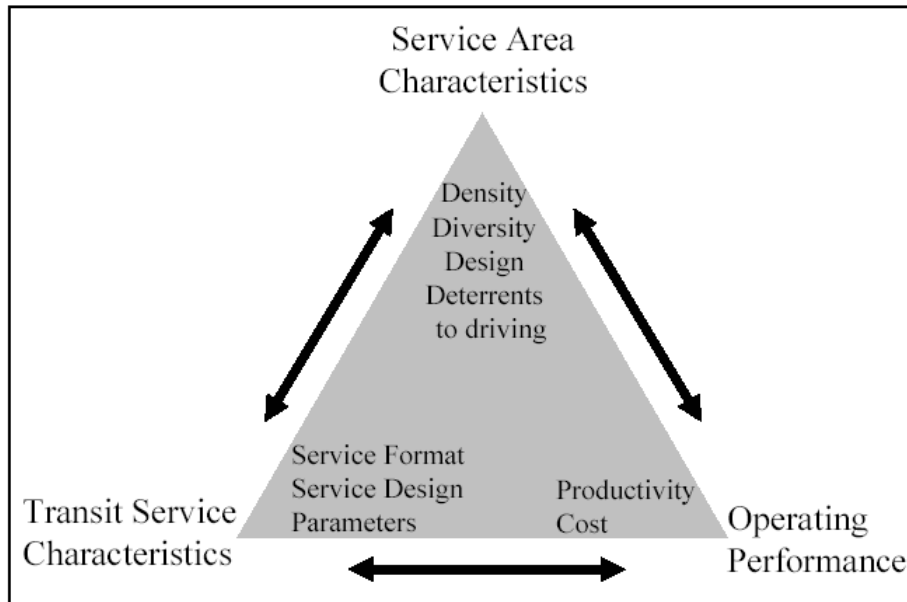
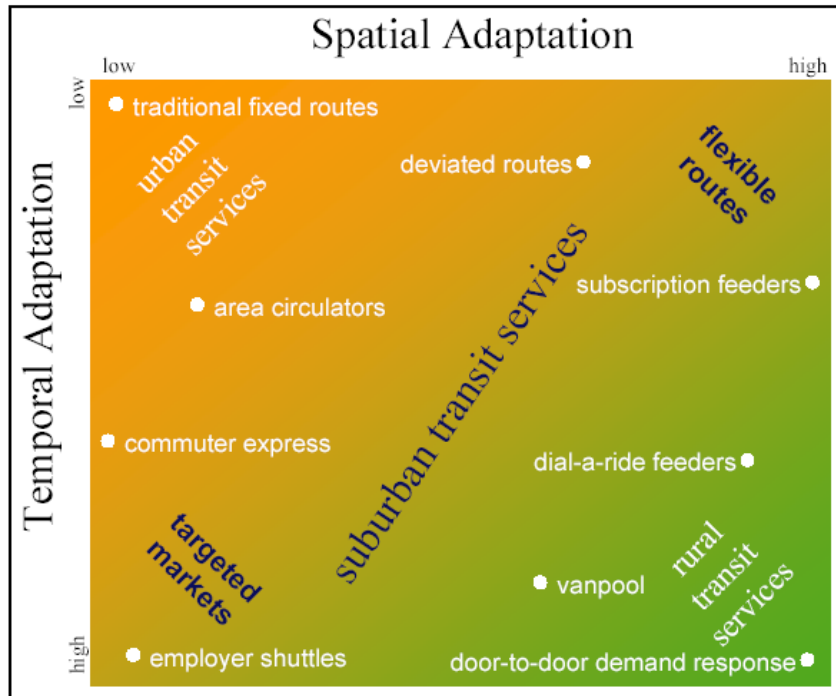


Figure 2-2: Typology of Services



The routes that were analyzed for this portion of the report are indicated below:

Figure 2-3: Case Study List of Services

Albany	Detroit	Minneapolis	Portland
SB ShuttleBug	TB Troy-Birmingham DAR	224 224 Shoreview	CM Cedar Mill Shuttle
SF ShuttleFly	BB Big Beaver Job Express	421 421 Burnsville	201 201 Barbur
	OM Oakland Mall Job Shuttle		
	LS Lakeside Job Express		
	FL Fairlane Job Express		
	GB Groesbeck Flex Route		
		● Fixed Route	
		● Route Deviation	
		● Point Deviation	
		● Zone Circulator	
		● Demand Response	

The routes displayed the following characteristics:

Figure 2-4: Spatial Adaptation

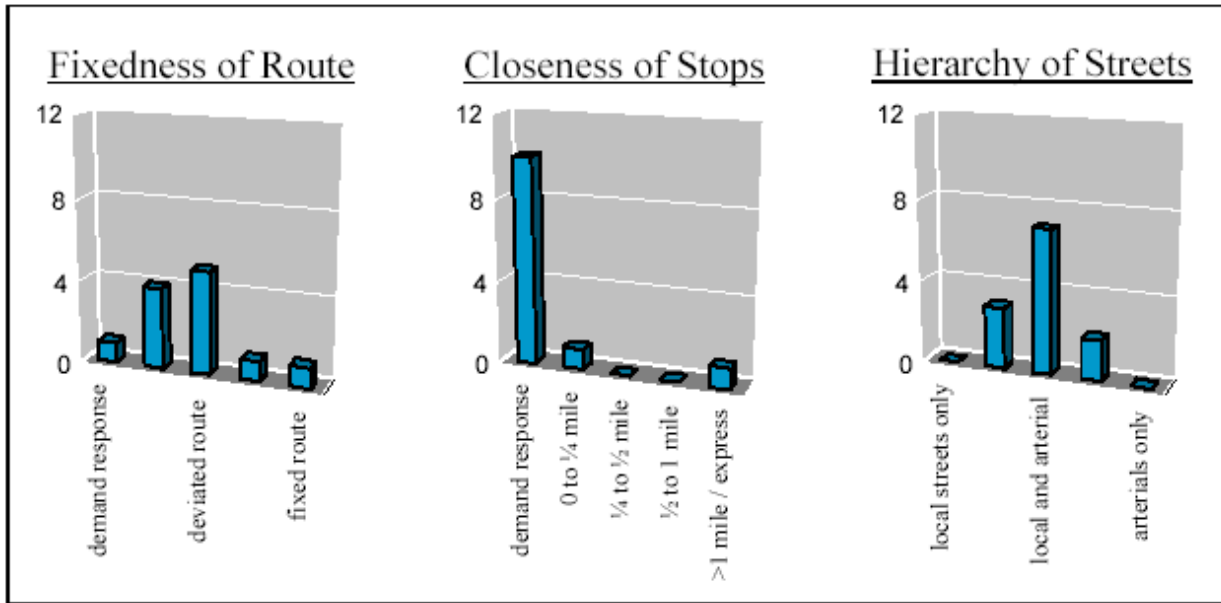


Figure 2-5: Temporal Adaptation

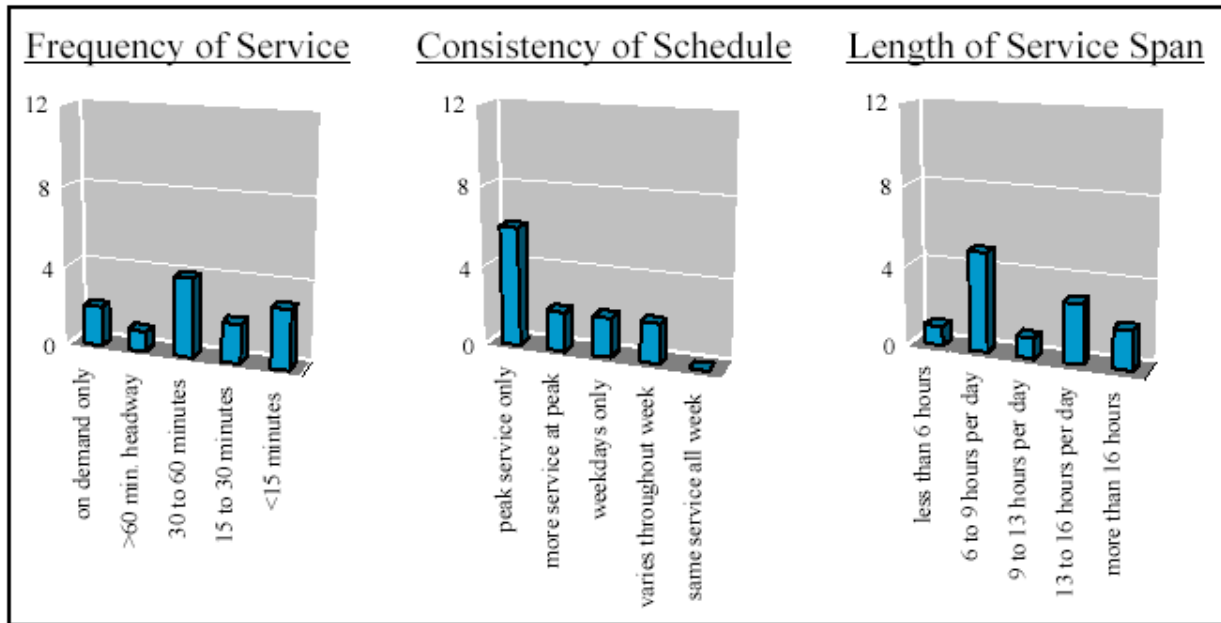
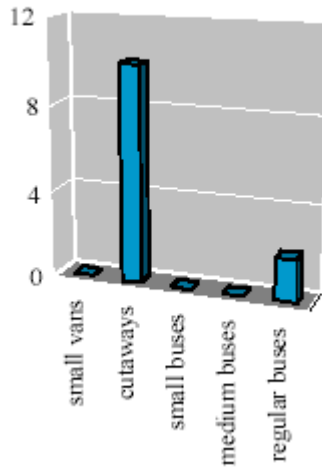


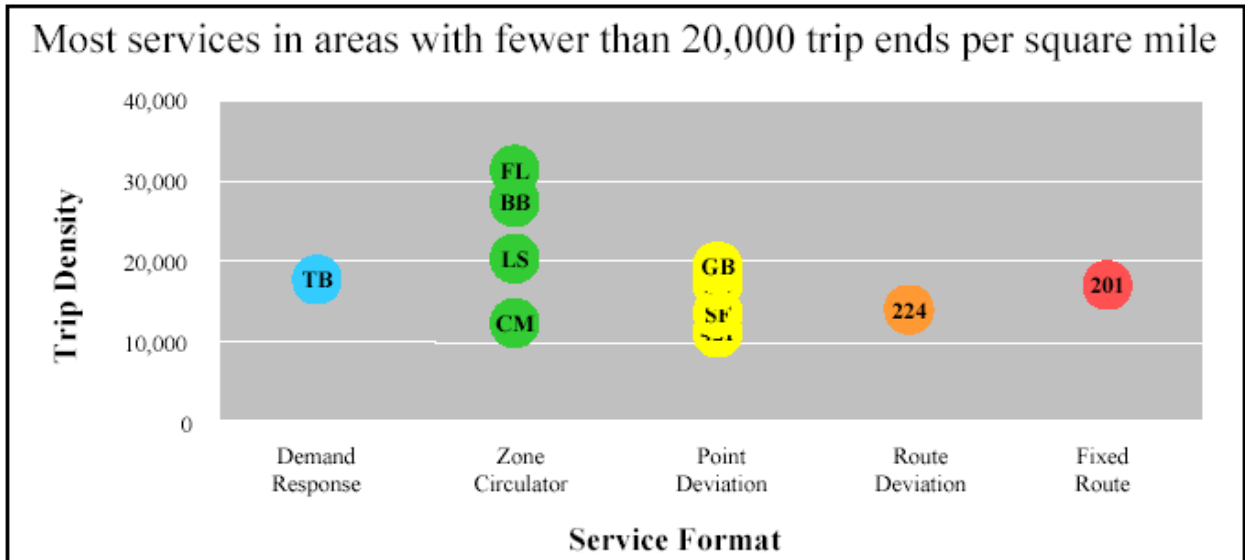
Figure 2-6: Demand Level

Capacity of Vehicles



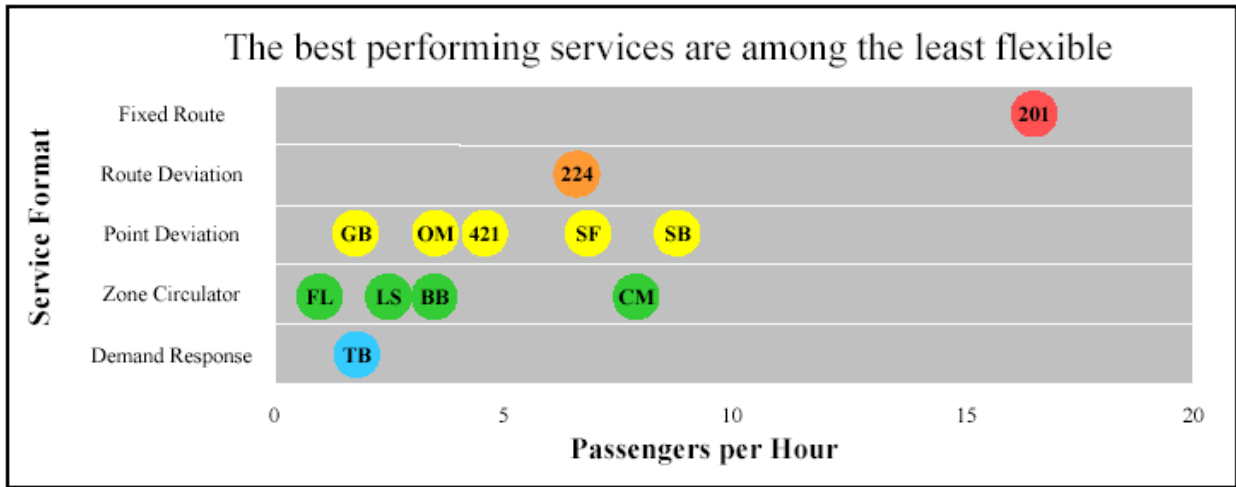
Some of the findings included:

Figure 2-7: Moderate Density



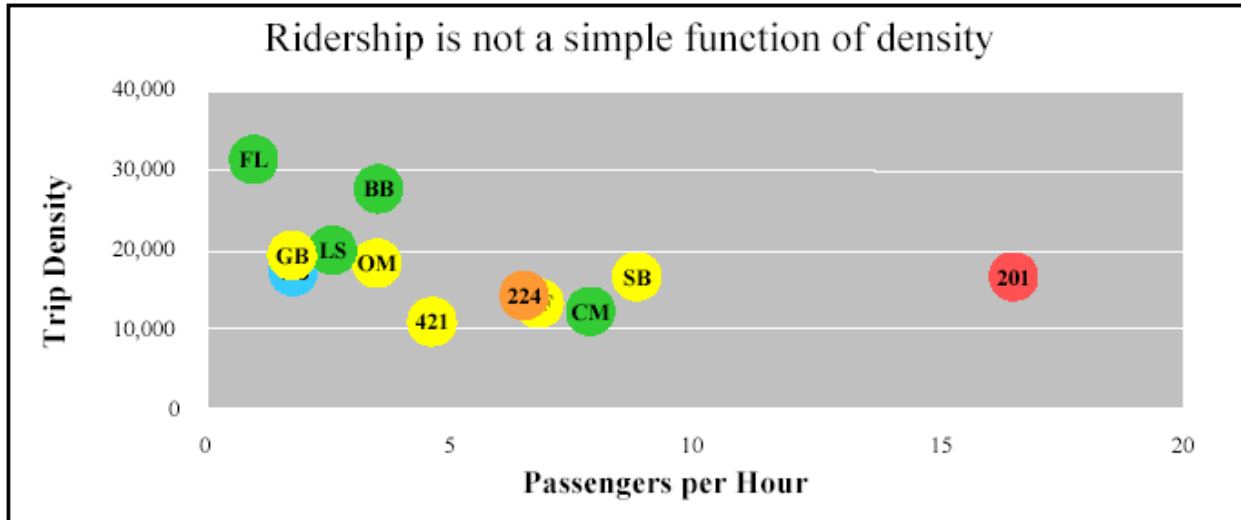
Trip ends per square mile appears to be a different metric to use in this type of analysis.

Figure 2-8: Fixedness and Productivity



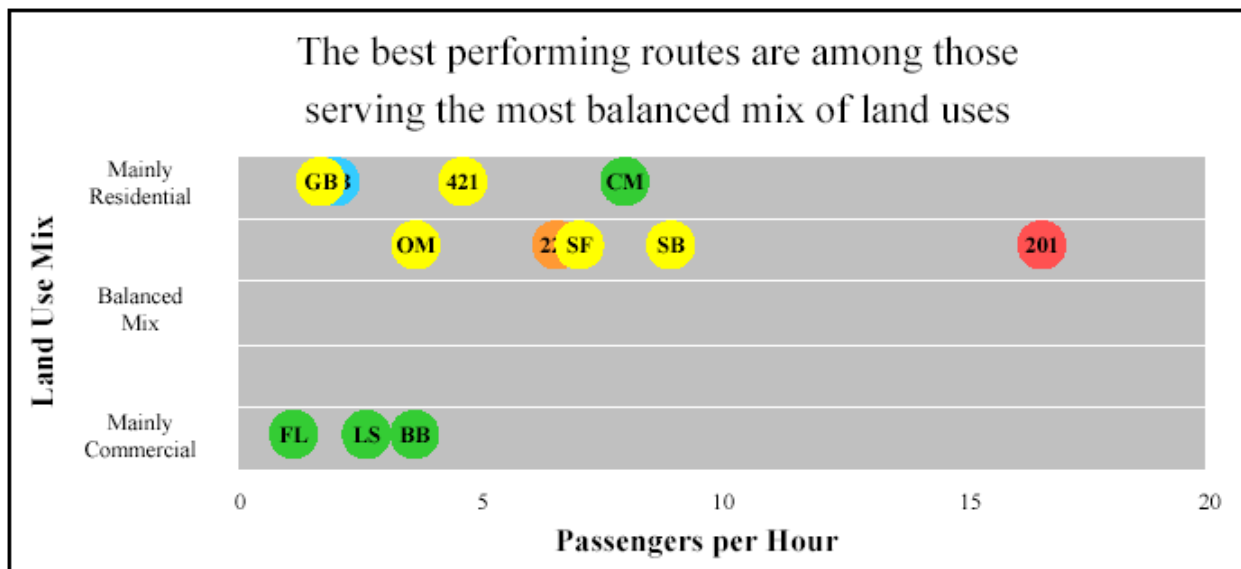
However, as will be discussed later, the local policy decisions appear often to accept this lower productivity as a trade-off for increased coverage.

Figure 2-9: Productivity and Density



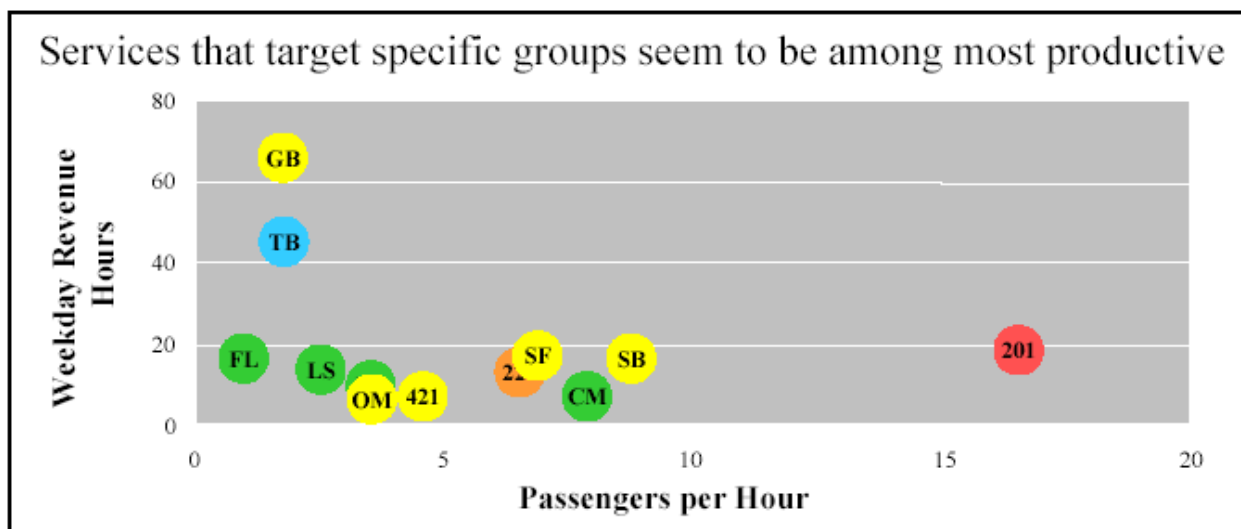
In this instance the best performing route was again the fixed route in Wilsonville. Also note that density in this analysis is “trip density” in contrast to the more usual population density analysis.

Figure 2-10: Productivity and Land-Use Mix



Logically having origins and destinations in one service area should result in improved productivity, although there are exceptions to this rule based on feeders to the regional network or concentrations of local residential area trips, such as by seniors or students.

Figure 2-11: Service Level and Productivity



Overview of Results

As indicated previously, in depth land-use data were able to be collected for four of the case study areas. In those instances the level of detail was significant, but the varied types of service delivery made aggregated comparisons extremely general, as indicated by the results described above.

The reason that only four of the case studies were included the detailed land-use data was the lack of readily available data in a consistent format that could be similarly applied in the case studies. In general, it appeared that land-use data are becoming more readily available in many areas, but the lead agency for maintaining the data and the types of data maintained can vary from one locale to another. Further, although some transit operators are very familiar with these data, there are others that do not use the land-use information, especially in the specific ways developed in the research plan. As a result, there is no one path that can be prescribed as the technique to be employed in general to access similar land-use data across the country. In addition, our experience in trying to depict the detailed data as shown in the Service Area Characteristics Diversity pie charts was that a significant amount of time and therefore research budget were consumed in this effort. However, we would suggest that the general methodology employing the “Four Ds” as described in the research can provide comparative information at the local level that will assist in understanding the comparative potential of various land-use factors to better support suburban transit options. Further, that the peaks, ridges, points and plains terminology and analysis does accurately describe the best service delivery alternatives for a given disaggregated land-use area.

It should also be noted that the majority of the effort being expended by transit agencies, as reflected by the types of services included in the case studies, involve trying to serve lower density areas with multiple land uses (residential, schools, some commercial and health care). The range of solutions, varying from fixed route to route deviation, do have some interesting land-use correlations as described above:

- Most are operating in areas of less than 20,000 trip ends per square mile. This would appear to be a relatively new metric and perhaps a new threshold for transit agencies to consider in planning activities.
- Trip density in a given area was not a consistent factor in attracting more riders per hour.
- Land use with mixed development appeared to perform better than land use of one type, i.e. residential or commercial.

Clearly in many instances land use dictated the types of services provided, such as the job access routes in suburban Detroit serving the industrial areas, thus circulators with direct connections to the work sites were the best fit. However, it was interesting to note that in Minneapolis the difference between the route and point deviation was the higher number of attractors that needed to be served, thus the stricter scheduling of route deviation, versus the flexibility of broader service area coverage with fewer attractors in the point deviation example. However, the productivity of the former was significantly higher than the latter.

As will be discussed further below, these examples demonstrated several key findings that still appear to significantly influence suburban transit programs. First, there is a wide range of perspectives regarding the role of suburban services, with evidence that coverage is more important than productivity. Second, that recognizing the benefits of some of the coverage oriented programs has resulted in better working relationships with transit agencies and

communities, including passage of funding resources legislation. Conversely, in other areas locales have opted out of the transit district to make their own policy decisions and even provide funding for those services. Obviously, the ability to fund these services that have much lower productivity than many fixed-route systems is also critical to maintaining sustainability.

PERFORMANCE MEASUREMENT

Next more typical transit performance measurement analysis was performed with demographic, service delivery and pedestrian network factors evaluated for 20 case study routes using geographic information systems (GIS) software. Demographic data were obtained for the year 2000 from the Census Transportation Planning Package (CTPP). Street network files were obtained from the local metropolitan planning organizations (MPOs), except for Minneapolis, where Census TIGER files were used. Files showing fixed transit routes were obtained from the MPOs, when available, and were created in GIS when not available, based on route maps from the local transit agencies. The boundaries of deviated-route service areas were created in GIS, based on route maps from the local transit agencies. Route productivity data (passengers per revenue hour) were compiled from transit agency information gathered during the project case studies.

The routes were characterized in two ways: (1) by the trip type served (the home end of a trip versus the work end of a trip) and (2) by the type of service (local fixed-route, flexible route, and commuter). The following table shows the routes that were evaluated and their characteristics:

Table 2-3: Description of Case Study Routes

Route	Agency	Type	Trip End
Margate A	BCT	Fixed Route	Home
Margate B	BCT	Fixed Route	Home
Margate C	BCT	Fixed Route	Home
Margate D	BCT	Fixed Route	Home
Cedar Mill Shuttle	TriMet	Dial-a-Ride	Home
155 Sunnyside	TriMet	Fixed Route	Home
156 Mather Rd	TriMet	Fixed Route	Home
157 Happy Valley	TriMet	Fixed Route	Home
204 Wilsonville Rd	SMART (Wilsonville)	Fixed Route	Home
903 Federal Way	King County Metro	Deviated Route	Home
914 Kent	King County Metro	Deviated Route	Home
927 Issaquah-Sammamish	King County Metro	Deviated Route	Home
421 Burnsville-Savage	MVTA	Deviated Route	Home
152 Milwaukie	TriMet	Fixed Route	Work
41 Hawthorn Farm	TriMet	Fixed Route	Work
50 Cornell Oaks	TriMet	Fixed Route	Work
201 Barbur	SMART (Wilsonville)	Commuter	Work
1X Salem	SMART (Wilsonville)	Commuter	Work
291 Redmond	King County Metro	Deviated Route	Work
224 Shoreview-Roseville	MVTA	Fixed Route	Work

Service Area Definition

Each route's service area was defined as follows:

- **Fixed Route**—all areas within ¼ mile air distance of any branch of the route.
- **Dial-a-Ride**—the dial-a-ride service area.
- **Deviated Route**—the combination of the route deviation area and all other areas within ¼ mile of the fixed-route portion of the route.
- **Commuter**—the areas within ¼ mile of the local service portion of the route, where customers would mainly be boarding in the morning. The destination ends of the routes (in both cases, transit centers) were not included.

Demographic Factors

The smallest geographic unit available—either Census block group or Census traffic analysis zone (TAZ)—was used in the evaluation. A weighted averaging process, based on the percentage of a census block or TAZ falling within a route's service area, was used to calculate the following demographic variables, typically used in estimating the viability of transit service in a given area:

- **Population density**—the number of persons per square mile within the service area.
- **Job density**—the number of employees per square mile within the service area.
- **Percent of population 0-17 years old**
- **Percent of population 65 or more years old**
- **Percent of households with no vehicles available**
- **Percent of employees with no vehicles available at home**
- **Average median income**—the median income was known for each census block or TAZ; a weighted average of these median incomes was determined for the service area as a whole.

Service Delivery Factors

The following service delivery variables were evaluated:

- **Adult peak fare**—the case study agencies used a variety of fare systems, including the use of peak- and off-peak fares and zone-based fares. The lowest (e.g., one-zone) adult fare during peak periods was used.
- **Service area**—calculated in square miles, using GIS software.
- **Weekday TLOS Indicator**—The Florida Transit Level of Service (TLOS) Indicator¹ measures a combination of *service frequency* and *span*. In this application, it measures the percentage of a weekday that locations within the service area have access to transit. It was calculated for fixed-route and deviated-route services as (# of weekday round trips) * (10-minute window of opportunity to access transit per trip) / (1,440 minutes per day). For the lone dial-a-ride service, it was calculated as (service span in minutes) / (1,440 minutes per day).

¹ Ryus, Paul, Jon Ausman, Daniel Teaf, Marc Cooper, and Mark Knoblauch, "Development of Florida's Transit Level of Service Indicator," *Transportation Research Record 1731*, Transportation Research Board, National Research Council, Washington, DC (2000).

Pedestrian Network Factors

The following factors relating to street network connectivity were evaluated:

- **Network Connectivity Factor**—the number of links (i.e., street segments between intersections) within the service area, divided by the number of nodes (i.e., intersections). The index value ranges from about 1.7 for a well-connected grid pattern to approximately 1.2 for a cul-de-sac pattern.²
- **Average Minimum Circularity Ratio**—the circularity ratio compares the area of a polygon to that of a circle with an identical perimeter and is calculated as $(4 * \pi * \text{polygon area}) / (\text{perimeter}^2)$. The ratio ranges from 1 for a circle to 0.785 for a square to near 0 for long, thin polygons typical of blocks formed by freeways, railroads, canals, and other similar barriers to pedestrian travel. The circularity ratio was calculated for each block, the minimum circularity ratio was determined for all blocks falling within a given ½-mile grid square, and the average of the minimum circularity ratios was calculated based on all grid squares intersecting a route's service area.
- **Average Block Size Factor**—Florida defines 50 polygons (blocks) per square mile as the minimum needed to establish a multimodal transportation district.³ The block size factor was calculated as the ratio of a block's area (in square miles) to one-fiftieth of a square mile. An average value of 1.0 or less suggests a relatively dense, walkable street network. The average block size factor was calculated based on all blocks intersecting a route's service area.

PERFORMANCE FACTOR RELATIONSHIPS TO PRODUCTIVITY

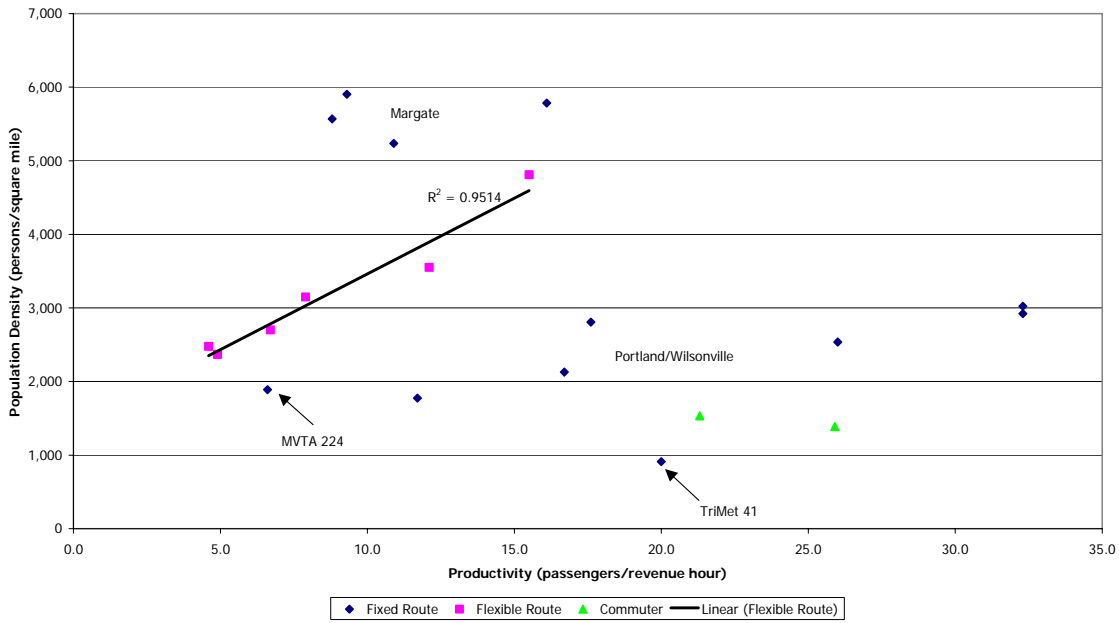
This section highlights the most promising relationships between the evaluated factors and route productivity.

The six flexible-route services showed a strong correlation between population density and productivity. In the above example, there was more limited correlation to trip density. Among the local fixed-route services, the Broward County, Margate routes are in a cluster by themselves and will be further discussed below. The remaining local fixed-route services showed a fairly weak correlation between population density and productivity.

² Ewing, Reid, *Best Development Practices*, APA Planners Press, Chicago, IL (1996).

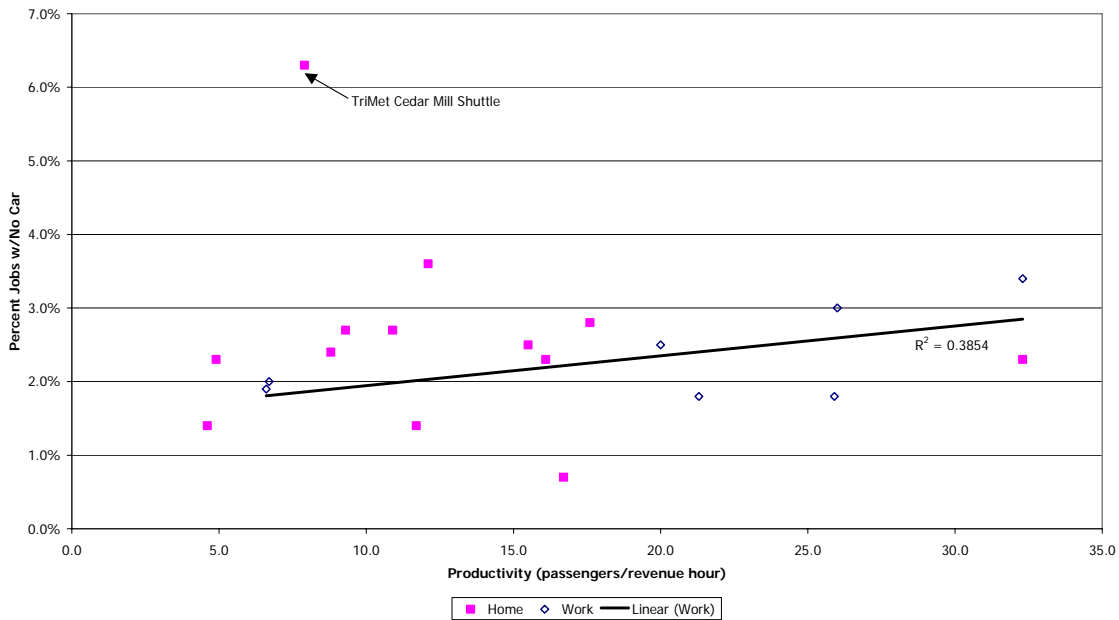
³ Florida Department of Transportation, Systems Planning Office, *Multimodal Transportation Districts and Areawide Quality of Service Handbook*, Tallahassee, FL (November 2003).

Figure 2-12: Population Density versus Productivity



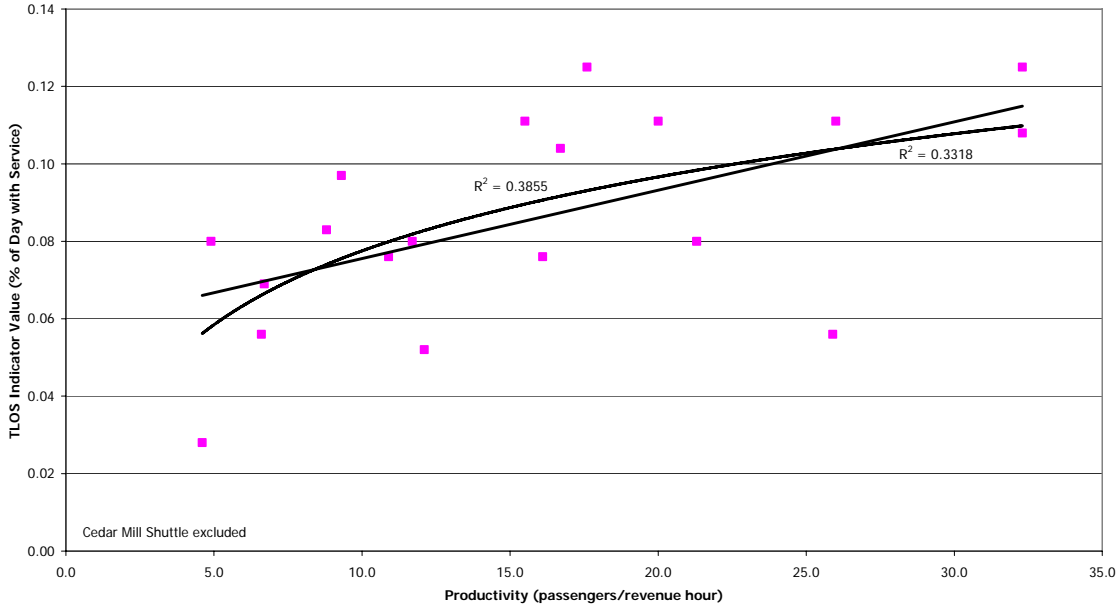
There was some correlation between the productivity of the employer-oriented services and the percentage of employees that had no vehicle at home:

Figure 2-13: Zero-Car Households versus Productivity



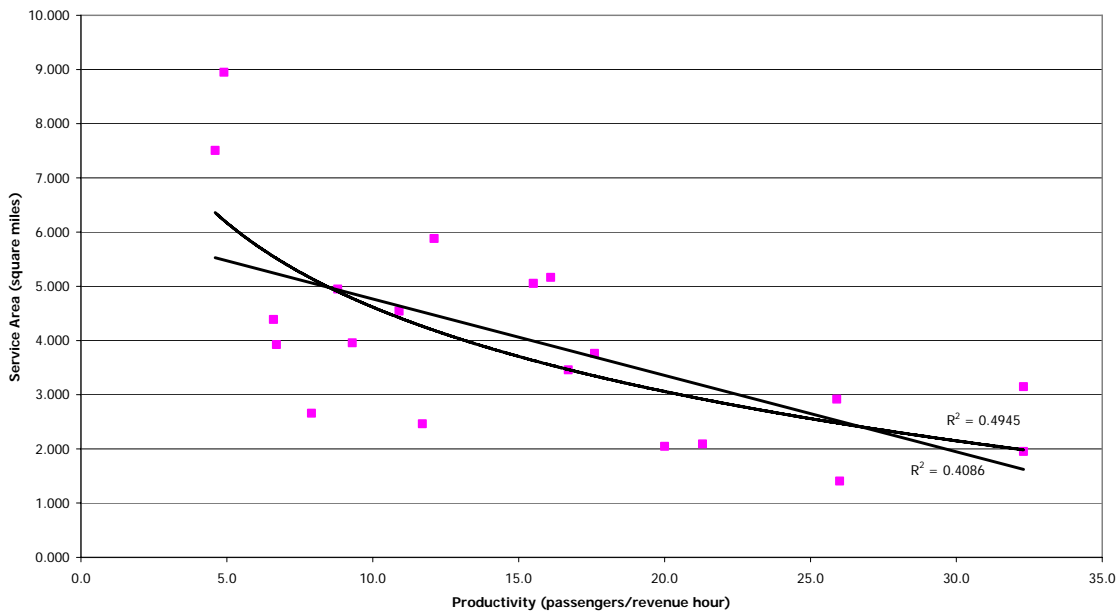
There was some correlation between productivity and the amount of service provided, as measured by the Florida TLOS Indicator, which includes both the span and frequency of service:

Figure 2-14: TLOS Indicator versus Productivity



There was relatively good correlation between productivity and the service area size with the logical result that the larger the service area, the less productive the service:

Figure 2-15: Service Area versus Productivity



Factors that showed no apparent correlation included fare, percent of population under 18, and all three of the walkability factors. It should be noted that all of these comparisons are based on single-variable regressions; multiple linear regression and other more advanced statistical techniques might reveal other trends in the data. However, given the variety of services studied and the differences between geographic areas and land uses, the potential for productivity trends for aggregated service data appear to be limited.

The demand-responsive services, when looked at as a group, tended to show better correlation for several factors that showed some correlation for all services combined. Two possible explanations for this are: (1) the demand-responsive services tended to serve larger areas than the fixed-route and commuter services, and (2) none of the demand-responsive services overlapped with each other.

Overview of Results

This performance measurement analysis also disclosed some other factors that would influence the results. Such as, when a ¼-mile service area around a bus route is assumed as the service area, it normally only covers a portion of individual block groups or TAZs in suburban areas, as block groups and TAZs tend to cover relatively large areas outside of central business districts. As a result, there can be significant variations in population density and other factors within a block group: multi-family residential might be located along the arterial street served by transit, with single-family residential located farther away from the street. In addition, larger TAZs in more suburban area would tend also to potentially skew the display of land-use data. For example, if one portion of a TAZ contained a relatively dense development, yet there were no other developments in the TAZ the overall area would appear to have a low population density.

These variations cannot be captured from the information available from the Census and would require more detailed land-use information, which is often available from MPOs. However, experience would suggest that transit agencies typically use TAZ data, thus another lack of consistent connection between land use and transit data. Demand-responsive services, in contrast, have a higher likelihood of serving entire census blocks and TAZs, and thus variations in density within individual census blocks/TAZs are blended out and comparisons between services in different cities tend to be more equal. The results from Broward County, which aggregated results to the city level, showed better correlations than the route-by-route results presented here and therefore suggest that evaluating larger areas may be more appropriate when trying to decide what type(s) of suburban services are appropriate.

Many of the fixed-route services that were studied (Margate, Portland, and Wilsonville) had service areas that significantly overlapped with other fixed-route services. Because the overlapping services covered areas with relatively similar population densities, any differences in productivity would be the result of other factors. In contrast, all of the demand-responsive services that were studied served unique areas that were not part of the service areas of other studied routes.

Thus, the variety of services that were included in this analysis from various parts of the country did not provide many significant findings with the possible general information:

- Use of population, not trip, density did prove to have a good correlation, especially for demand-responsive services.

- The size of TAZs in suburban areas may impact results from this type of performance analysis based on the potential impacts on the available data for the variables used in the analysis.

CORRELATION MATRIX

The final performance indicator used to assess the findings was the correlation matrix from the Broward County including Margate and surrounding areas as discussed below:

The Correlation between Passengers per Revenue Hour and Transit Utilization Factors

The hypothesized relationships between passengers per revenue hour and such measures as population density, income, the elderly segment of the population, the student-age segment of the population, the number of owner-occupied units, the number of renter-occupied units and car ownership were tested at the route level with data derived from the census blocks which permitted Pearson correlations to be conducted to measure the magnitude and sign of these relationships.

Pearson's correlation reflects the degree of linear relationship between two variables. It ranges from +1 to -1. A correlation of +1 means that there is a perfect positive linear relationship between variables. It is a positive relationship because high scores on the X-axis are associated with high scores on the Y-axis. A correlation of -1 means that there is a perfect negative linear relationship between variables. It is a negative relationship because high scores on the X-axis are associated with low scores on the Y-axis. A correlation of 0 means there is no linear relationship between the two variables⁴.

The correlation between passengers per revenue hour and income shows clearly that as the level of income declines the passengers per revenue hour rises and this noticeable inverse relationship confirms standard transit utilization theory. The elderly and student age segment are both positively correlated to passengers per revenue hour which also confirms transit utilization, though in this sample set, the relationship is rather minimal to non-significant. However, it is mildly interesting to note that the correlation between student population and transit ridership is stronger than the correlation between elderly and transit utilization.

Population density is highly positively correlated to passengers per revenue hour in the routes analyzed, so standard transit utilization theory holds firmly in this local circulator setting as well. Owner-occupied housing units had a mild negative correlation to passengers per revenue hour, showing that as the number of owners rose along the routes examined, it is expected that ridership per hour would decline. The number of renter occupied units was slightly positively correlated with passengers per revenue hour though the magnitude of this relationship is too small to be considered a strong factor. The segment of owner occupied units with no car was strongly correlated to passengers per revenue hour. This finding is again consistent with standard transit utilization theory.

The segment of owner-occupied units with one car is also positively correlated with passengers per revenue hour. This might be due to the fact that the owner occupied households with only one car have more people in the household with mobility needs that are not being met with a single car. The segment of renter occupied units with no car is positively correlated with passenger per revenue hour, once again consistent with the notion that the absence of personal transportation, especially in the case of persons renting units, implies transit utilization for many

⁴ Hyperstat Online Contents, "Pearson's Correlation," <http://davidmlane.com/hyperstat/A62891.html>

trip purposes. The segment of renter occupied units with one car is slightly negatively correlated with passengers per revenue hour, so as renters get personal vehicles, ridership on the shuttle system would decline. This finding might reflect that renter occupied units have fewer people and less travel demand. The chart and correlation matrix below show the results from the statistical analysis.

Table 2-4: Broward County Correlation Matrix

Pass. Rev. Hr./Income	-0.57648
Pass. Rev. Hr./Elderly Segment	0.061163
Pass. Rev. Hr./Student Segment	0.090209
Pass. Rev. Hr./Population Density	0.83333
Pass. Rev. Hr./Owner-Occupied	-0.39667
Pass. Rev. Hr./Renter-Occupied	0.036481
Pass. Rev. Hr./Owner-Occupied No Car	0.694742
Pass. Rev. Hr./Owner-Occupied 1 Car	0.380401
Pass. Rev. Hr./Renter-Occupied No Car	0.520486
Pass. Rev. Hr./Renter-Occupied 1 Car	-0.12368

Demographics

It might seem obvious to many that certain demographic characteristics contribute to better transit ridership, but with such limited experience in the provision of local circulators in primarily suburban settings, it was of benefit to confirm if normal indicators of transit potential apply to local circulators as they do to regular fixed-route transit service in a more regional setting. As noted above, there is a *very* strong (0.833) positive relationship between transit use and population density for the local circulators that were studied. In short, the higher the density, the higher the transit ridership per hour was for the local circulators.

Not too far behind in terms of relationships was the high positive correlation between lack of car ownership and transit use. Perhaps a little surprising was that the relationship was even stronger for owner-occupied dwellings (0.69) without cars versus renter-occupied dwellings (0.52) without cars and transit ridership per hour. It is hypothesized that rental apartments are usually smaller than owner-occupied homes, and there might be more total need for mobility in an owner-occupied dwelling due to more people living in the owner-occupied home. As expected, there was also a strong negative correlation (-0.58) between income and transit ridership per hour. In other words, the higher the income, the lower transit ridership per hour was in the local circulator systems.

Thus it was logical that transit ridership per hour was most successful in the City of Lauderdale. While the average passengers per hour for all five routes in Lauderdale were 22.0, two of the routes came close to carrying 30 passengers per hour. In Lauderdale, the population per square mile is 8,179, easily the highest among the eight city circulator systems reviewed. The median household income is \$32,070, which is among the lowest of all eight city systems reviewed.

Lack of car ownership (9.9% of the owner-occupied dwellings and 12.1% of the renter-occupied dwellings) was above average, but not extraordinarily so. It is interesting to note that the City of Dania service area has virtually the same median household income as Lauderdale's service area, a similar percentage of renter households without cars, and a better headway (40

minutes versus 45) than most of the Lauderhill routes. However, Dania's population density is only 3,272 persons per square mile, and realizes a local transit circulator ridership per mile that is slightly less than one-third that of Lauderhill. In fact, the listing of cities in order of passengers per mile follows quite closely to the listing of the cities by their population densities, regardless of other demographic characteristics.

Overview of Results

The first two evaluation techniques had a broader universe of case studies while the third focused on data only from Broward County, which resulted in a more uniform set of findings. As indicated above, within the parameters of local circulator funding which has been established by the local transit agency the correlations are similar to those typically found within transit analysis, such as:

- Higher population density results in higher transit usage
- The combination of higher population density and lower income also increases transit use
- To a lesser degree, lack of auto ownership, especially by residents, increases potential transit use
- In this instance, youth were more likely to use transit than the elderly

Thus, with the exception of the last finding, the results are more consistent with typical transit analysis. This indicates that measuring similar services within a given geographic area would likely lead to more specific findings.

SUMMARY AND CONCLUSIONS

There were limited results of value from the use of various tools to analyze the data from the detailed case studies to determine significant trends that could be reported from an aggregated data perspective. However, there were consistent results recorded when data were collected in a specific local area. In addition, there appeared to be a number of data collection and display consistency issues resulting from availability and scale differences.

CHAPTER 3: INTERPRETATION, APPRAISAL AND APPLICATIONS

The general goals of this research were to build on prior work that had been done in this area; to add in a more specific nexus between suburban land use and suburban transit; and to produce guidelines for evaluating, selecting and implementing suburban transit services. The research has included a thorough analysis of the state of suburban transit including:

- A detailed literature search of both land-use and transit documents and practices.
- The selection of almost thirty preliminary case studies and the compilation of data from all those systems.
- An extensive analysis of services and environments in eight detailed case studies located in across the country providing a variety of services.
- The cross sectional review of the results of those case studies using land use and performance measurement techniques.

The research team, which included a variety of skills and expertise in land-use planning, academic research, transit capacity and quality of service analysis, understanding of suburban settings and characteristics as well as extensive operational experience from both the public sector and private sector consulting perspectives, collaborated on a work program to stretch the paradigm, especially in the areas of land use and transit linkage to provide meaningful information to the transit industry.

In retrospect the land-use linkage goals proved to be too ambitious, with more time and energy expended in the pursuit of data collection and then the processing of these data into consistent and comparable formats. As a result, the extensive data expressed in the Detroit, Minneapolis, Albany and Portland case studies were not collected and processed for the other locations. However, it should be noted that when the services for the areas with detailed land-use data were analyzed, there were limited findings regarding consistent results.

Similarly a more traditional review of typical transit performance measurement factors did not produce any consistent findings that would suggest generalizations that could be applied to these services that were operating in various areas around the country. Interestingly, the most specific set of conclusions resulted from a Pearson correlation analysis of the local circulators in Broward County. In this analysis, the comparison of locales with similar characteristics appeared to be more valuable from the standpoint of reinforcing some typical transit norms, such as more transit use in higher density, lower income areas.

Thus, just as other data collected at the national level are sometimes criticized as comparing apples and oranges depending on the consistency and accuracy of reporting (for example, National Transit Data for paratransit), the suburban transit data regarding the services implemented and the comparative successes are influenced greatly by local factors.

With regard to the services themselves, they are very similar to the types of services that were previously evaluated, grouped into the following categories:

- Commuter
- Route deviation
- Demand response
- Circulators
- Shuttles

- Vanpools

The typical trip purposes that are served included longer distance commute, connections to the regional transit network and intra-community connections. As part of the data collection and analysis performed, there appear to be several factors that significantly influence the operation and availability of suburban transit services, including:

- Local policy and planning decisions regarding standards and performance measurement have the greatest impact on whether services are sustained.
- In many instances these decisions are influenced by the availability of local funding or the ability to obtain local funding through the provision of these services.
- A large percentage of the suburban services provided in the preliminary and detailed case study sites were developed to offer service connections in areas with relatively lower demand for transit and included solutions ranging from fixed-route to demand-responsive services.
- Many of these services, especially route deviation and demand-responsive, are focused on providing area coverage, but often provide connection to the regional bus system.
- The increase in population and development in new or growing suburban areas has also resulted in an increase in commuter services in corridors that access those suburban areas, especially commuter bus services.

As a result, the typical suburban system today includes local, regional and commuter services.

With regard to the potential for future research, it would appear that one of the difficulties associated with this research project has been developing a sufficient amount of data on service types and communities to expand that data to be of value to other communities. In essence, by attempting to include a greater variety of services the comparisons between services and communities was negatively affected, thus the lack of consistent findings for the aggregated data.

Since it appears that the most common suburban transit issue is serving areas with lower demand, there may be value to isolating research regarding these types of services. This research could also include service solutions for people with disabilities, including ADA complementary paratransit alternatives, as well as the growing area of human service transportation coordination that has resulted from the Federal United We Ride program.

CHAPTER 4: CONCLUSIONS AND SUGGESTED RESEARCH

The past twenty years of suburban transit service have expanded the universe of land-use environments in which transit can be applied and be successful. There are now many more land-use environments that support transit in its many forms and formats. There are also many more tools available to the transit operators and agencies to use as part of their planning process to establish transit in their expanding environments. These tools include the use of GIS which can assist in defining and refining the geographic, population and market areas to be served. While there are no substantial patterns which emerged to define with certainty which types of transit will work in specific geographic typologies, we believe the research furthered the knowledge base which transit professionals can use in understanding the range of transit applications, and understanding more clearly expectations for performance. As suburban transit appears to be extremely dependent on local conditions and expectations, this research can be of assistance to the transit community as the art and science of suburban transit moves past its infancy. The following trends, we believe capture the findings and features for suburban transportation:

- Local policy and planning decisions regarding standards and performance measurement have the greatest impact on whether services are sustained.
- In many instances these decisions are influenced by the availability of local funding or the ability to obtain local funding through the provision of these services.
- A large percentage of the suburban services provided in the preliminary and detailed case study sites were developed to offer service connections in areas with relatively lower demand for transit and included solutions ranging from fixed-route to demand-responsive services.
- Many of these services, especially route deviation and demand-responsive, are focused on providing area coverage, but often provide connection to the regional bus system.
- The increase in population and development in new or growing suburban areas has also resulted in an increase in commuter services in corridors that access those suburban areas, especially commuter bus services.
- As a result, the typical suburban system today includes local, regional and commuter services.

OPERATING ENVIRONMENTS

The universe of suburban environments is limitless and spans the ranges and needs to be served as a result. The diversity includes markets and needs to be served, as much as the physical environment. Successful suburban service has creatively adapted transit practice to complement local landscapes. Clearly, these findings lend support to the continued integration of land-use planning and transit service planning as a means to continually strengthen transit's ability to be present in ever expanding suburban environments. Understanding the operating environment is increasingly important for transit professionals. GIS tools can be used substantially in this regard to display both physical and market attributes of the suburban environments, such that the types of services implemented can complement both the market and the regions. The four D's of Design, Density, Diversity and Deterrents to Driving can be readily adapted to local environments and conditions.

MEASUREMENTS/EVALUATION PROCESS

Measurement and evaluation processes need to be reflective of local priorities and conditions. What is deemed successful is a local issue, but ensuring that expectations for performance are understood would appear to provide the transit professionals with tools to educate local policy boards and communities. Denver RTD presents a clearly defined evaluation and performance measuring process for its services. This provides its policy board with an informed knowledge base, and establishes standards which can be shared with the community, which remains key to local transit investment, which is tax driven. This study clearly points to more comprehensive service monitoring and evaluation programs as a means to forward the practice. Because of budget and time constraints, evaluation is often an afterthought. To properly assess and control the provision of service, both from a customer and a cost investment perspective, it is essential for the transit community to understand and clarify its service performance expectations, and to educate its policy boards and communities as to these expectations, if investments are to continue to the level that will be required.

INNOVATIONS

There have been many innovations in the area of suburban transit. These range from financial partnerships to the use of technology in the implementation of service. These trends and innovations will and should continue as they expand the opportunities available to the transit community.

Real time information is a service both to customers and to operators. Direct communication between operators and customers has enhanced transit's ability to serve its markets more effectively and ultimately make transit more competitive and convenient..

Financial partnerships now include private investment in capital resources and operating costs. Municipal investments are also a growing phenomenon, with local communities either partnering with transit agencies to provide enhanced coverage to non-transit traditional neighborhoods, or opting on their own to supply resources for public transit access. It would also appear that many of these services are developed with the goal of expanding suburban transit service coverage, which is sometimes counter to the goal of fixed-route services which have traditionally focused on maximizing productivity. Some of these services incorporate the responsibility to deliver ADA complementary paratransit services by blending in those ADA-eligible clients into the suburban service solutions, thus eliminating the need for the separate ADA service.

FUTURE RESEARCH

The research clearly delineated the current limitations available in the nexus of research between land use and suburban transit forms in a national format. The best use of this application is completed at the local level, with an emphasis on strengthening the relationship between land-use planning and transit planning. At the local level, however, these tools can be a valuable asset in the furtherance of suburban transit planning and its ultimate success in the transit family of services.

Additional research may prove beneficial which could focus on suburban non-fixed-route alternatives. In many communities, primarily suburban, non-fixed-route alternatives are an increasingly prevalent means by which to expand service coverage. These services may also have the potential to further the federal priority of human service transportation coordination with public transit programs. Further research could also uncover some significant groundwork

toward examining alternatives for ADA paratransit service in this regard, as costs continue to outpace demand in both urban and suburban locales for the funding resources available to finance transit.

BIBLIOGRAPHY

- Arndt, Jeffrey. Private/Public Partnerships to Serve Suburban Markets. Proceedings of the APTA Bus Operations and Technology Conference. Reno, NV: American Public Transportation Association, 1995.
- Boylan, Michael. "The Best Practices in Vanpooling." TDM Review Winter 1999: Vol. VII Number 1. Association of Commuter Transportation. Winter 1999.
- Campoli, Julie and Alex S. MacLean. *Visualizing Density*. Lincoln Institute of Land Policy, 2002.
- Carey, Graham N. Applicability of Bus Rapid Transit to Corridors with Intermediate Levels of Transit Demand." Journal of Public Transportation 5.2 (2002): 97-114.
- Cervero, Robert. "Making Transit Work in the Suburbs." Transportation Research Record 1451 (1994): 3-11.
- Cervero, Robert and John Beutler. Adaptive Transit: Enhancing Suburban Transit Services. Monograph 99-01. Berkeley, CA: University of California at Berkeley, Institute of Urban and Regional Development, 1999.
- Cervero, Robert C. and Mark Dunzo. An Assessment of Suburban-Targeted Transit Service Strategies in the United States. UCTC Working Paper 178. Berkeley: University of California Transportation Center, UC Berkeley, 1993.
- Cervero, R. and R. Ewing. "Travel and the Built Environment." *Transportation Research Record*, Vol. 1780, pp. 87-114.
- Cronin, J. Joseph, Roscoe Higyhtower, and Michael K. Brady. "Niche Marketing Strategies: The role of Special-Purpose Transportation Efforts in Attracting and Retaining Transit Users." Journal of Public Transportation 3.3 (2000): 63-86.
- Dutton, John A. *New American Urbanism*. Abbeville Publishing Group, New York. 2000.
- Ewing, R. "Pedestrian and Transit Friendly Design: A Primer for Smart Growth." American Planning Association. 1999.
- Farwell, Randall G. "Evaluation of OmniLink Demand-Driven Transit Operations: Flex-Route Services." Transportation Quarterly 52.1 Winter (1998): 31-43.
- Farwell, Randall G. and Eric Marx. "Planning, Implementation, and Evaluation of OmniRide Demand-Driven Transit Operations: Feeder and Flex-Route Services." Transportation Research Record 1557 (1996): 1-14.
- Hess, P. and A.V. Moudon. "Site Design and Pedestrian Travel." *Transportation Research Record*, Vol. 1674, pp. 9-19.
- Hess, P., A.V. Moudon and M. Logsdon. "Measuring Land Use Patterns for Transportation Research." *Transportation Research Record*, Vol. 1780, pp. 17-24.
- Hooper, Katherine. Innovative Suburb-to-Suburb Transit Practices. Synthesis of Transit Practice 14. Washington, D.C.: National Academy Press, 1995.

-
- Kimley-Horn & Associates. Local Municipal Transit Circulator Policy Study for Miami-Dade County. Orlando, FL: Miami-Dade County Metropolitan Planning Organization, 2002.
- Kittelson & Associates, Inc., KFH Group, Inc., Parsons Brinckerhoff Quade & Douglas, Inc., and Katherine Hunter-Zaworski. Transit Capacity and Quality of Service Manual, 2nd Edition. TCRP Report 100. Washington, D.C.: National Academy Press, 2003.
- Landis, B., V. Vattikuti, R. Ottenberg, D. McLeod and M. Guttenberg. "Modeling the Roadside Walking Environment." *Transportation Research Record*, Vol. 1773, pp. 82-88.
- Levinson, Herbert, Samuel Zimmerman, Jennifer Clinger, Scott Rutherford, Rodney L. Smith, John Cracknell, and Richard Soberman. Bus Rapid Transit, Volume 1: Case Studies in Bus Rapid Transit. Transit Cooperative Research Program Report 90. Washington, D.C.: National Academy Press, 2003.
- Maat, K. and J.J. Harts. "Implications of Urban Development for Travel Demand in the Netherlands." *Transportation Research Record*, Vol. 1780, pp. 9-16.
- Minerva, Victor, David Sampson, and Herbert Levinson. "Employer Shuttles – Concepts and Studies." *Transportation Research Record* 1557 (1996): 32-39.
- Moudon, A.V. and P. Hess. "Effects of Site Design on Pedestrian Travel in Mixed Use, Medium Density Environments." *Transportation Research Record*, Vol. 1578, pp. 48-55.
- Murray, Gail, David Koffman, Cliff Chambers and Peter Webb. Strategies to Assist Local Transportation Agencies in Becoming Mobility Managers. Transit Cooperative Research Program Report 21. Washington, D.C.: National Academy Press, 1997.
- Nelessen, Anton and Linda Howe. Flexible, Friendly Neighborhood Transit: A Solution for the Suburban Transportation Dilemma. Working Paper 86. Piscataway, NJ: Center for Urban Policy Research, 1995.
- Rosenbloom, Dr. Sandra. Transit Markets of the Future: The Challenge of Change. Transit Cooperative Research Program Report 28. Washington, D.C.: National Academy Press, 1998.
- Round, Alfred and Robert Cervero. Future Ride: Adapting New Technologies to Paratransit in the United States. UCTC Working Paper 306. Berkeley: University of California Transportation Center, UC Berkeley, 1996.
- Southern California Association of Governments. *Employment Density Study: Summary Report*. The Natleson Company, Inc., 2001.
- Srinivasan, S. "Quantifying Spatial Characteristics." *Urban Studies*, Vol. 39, No. 11, pp. 200H-2028.
- Thompson, Gregory, L. "Achieving Suburban Transit Potential." *Transportation Research Record* Report 1571. Washington, D.C.: National Academy Press, 1997.
- Urbitran Associates, Inc., Multisystems, SG Associates, and Robert Cervero. Guidelines for Enhancing Suburban Mobility using Public Transportation. Transit Cooperative Research Program Report 55. Washington, D.C.: National Academy Press, 1999.
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APPENDIX A: LAND USE

This section defines suburban features in terms of three major themes (density, diversity, and design, plus adds a fourth, deterrents to driving) and sets the stage for a discussion of transit services that could successfully operate in environments with varying characteristics within each theme. In the context of transit service, contemporary suburbia is defined by the features that inhibit the provision of productive service. For example, previous research has identified a significant difference in productivity between bus routes in urban areas and those in suburban areas. Suburban routes frequently attract fewer than one-half as many boardings per hour as urban routes.

Traditional urban transit services are characterized by fixed-route alignments and frequent all-day service. Such services are effective in areas where a sufficient number of travel markets combine, allowing one vehicle to serve the overlapping travel needs of a number of passengers and attracting sufficient ridership to justify frequent all-day service.

In places where the traditional urban transit model has been applied without the presence of overlapping travel markets, most routes are far less productive or cost effective. Those qualities that contribute to high travel demand, and which suburban areas often lack, include:

- **Development Intensity:** The more trip ends located within walking distance of a bus stop, the more potential passengers transit can draw,
- **Mix of Activities:** The greater the variety of trip purposes that occur in the area served, the more likely that consistent, all-day ridership levels will materialize, and
- **Pedestrian Accessibility:** The more comfortable an environment is for pedestrians, the more likely it is that potential passengers will choose to walk to a bus stop and use transit.

These qualities correspond to the three main dimensions used to characterize land use, known as the “three D’s”: Density, Diversity and Design. Impediments to automobile use, such as parking costs and traffic congestion, constitute another feature that can increase the effectiveness of transit by making it more competitive with the private automobile. We will consider this a fourth “D” – Deterrents to driving.

Each of these qualities, or features, has a continuum between the characteristics of the urban center and the rural countryside. For the purposes of this project, contemporary suburbia begins at the threshold that would not exhibit the qualities that support traditional urban transit service. Likewise, the threshold at which a place loses rural qualities establishes a lower bound for suburbia.

While there has been a considerable amount of research on quantifying development patterns, creating an objective definition of contemporary suburbia in relation to these dimensions remains difficult due to variability from place to place. The following discussion summarizes the literature on this topic and presents some general thresholds at which communities transition from pedestrian-oriented and transit-friendly to automobile-oriented and transit challenged.

DENSITY

Density is a widely used characteristic in transit planning because it is easy to compute from readily available data and it provides a broad indicator of how supportive of transit an area may be. Depending on the size of the land unit described by the source data, density can provide meaningful insight for planning at the regional, corridor, neighborhood, or station scales. Three commonly used densities are:

- **Residential density** is frequently expressed in dwelling units per acre (gross or net). Gross residential density, typically used for regions or large parts of urban areas, expresses the number of households in an area of land that includes public uses, such as streets and open space. Net residential density is typically used for smaller areas such as neighborhoods or blocks. It is the number of households per acre of residential land, exclusive of streets and other common areas.
- **Employment density** is frequently expressed as jobs per gross or net acre. Employment densities vary by the type of land use, with offices generally providing higher densities than retail, hotel, or industrial uses.
- **Floor-area ratio (FAR)** is a measure of development intensity and building bulk that is computed by taking the ratio of the total building floor area and the area of the parcel on which the building sits. A two-story building that occupies one-half of its site has a FAR of 1.0. A five-story building that occupies its entire site has a FAR of 5.0.

Regardless of which type of density is used it is important to remember that density is a proxy for what transportation professionals hope to capture – the number of trips that are induced by the area’s activities.

DIVERSITY

Many suburban areas include all of the same land-use types that urban areas include. However, decades of suburban zoning restrictions have created areas composed of larger patches of single uses than are typically seen in urban areas. The scale at which the mix of land uses occurs has an important effect on transit supportiveness. In urban areas, it is common to find residential, retail, educational, medical, and employment uses mixed in such a way that people can reach many of their daily destinations by walking a short distance. When there are so many reasons for people to walk, a high-quality pedestrian environment typically follows. This finely-grained mix of uses and pleasant walking environment encourages transit use, and accessing transit on foot, by placing many destinations within walking distance of bus stops.

Researchers have developed various measures of land-use diversity, but the most common indices used in transportation planning do not yet capture the complexity of the interaction between uses. Landscape ecologists have developed techniques that show promise for urban planning in the way they evaluate the interactions between habitat areas of an ecosystem. One measure is the contagion index, which measures the total length of the edge shared by (i.e., the amount of exposure between) different uses. This index is able to measure the scale at which land-use variations occur in an area and can reflect different rates of trip generation between

adjoining uses. However, given that these techniques have only recently been introduced to the transportation-land-use field it is premature to include them in our methodology.

For this study, an important criterion for rating land-use diversity is the distance one must travel to reach a reasonable balance of uses. Ewing defines a balanced mix of uses as having at least 20 percent residential development, at least 20 percent employment-related development, and at least 10 percent civic uses, such as parks, schools, and other public areas. Ideally, an area would achieve a balance between jobs and housing to maximize the amount of travel demand that can be satisfied within the neighborhood. The minimum radius of a circle that contains this balance between uses is a conceptual measure that can be used to distinguish suburban areas from urban and rural ones.

DESIGN

Site and building design are considerably different in areas that support traditional urban transit services than in areas where attracting riders is a greater challenge for transit. Suburban areas are characterized by sites with buildings set back farther from property lines than in urban areas. In many urban areas buildings are built to the street edge and up against each other. Large setbacks contribute to longer walking distances between bus stops and the destinations where passengers want to go.

A by-product of larger setbacks is the discontinuity of the street wall, the edge created by buildings along the street. A continuous street wall is desirable in a good walking environment because it provides spatial definition for the street and provides a constant stream of changing views that enhances a pedestrian's experience. Gaps for parking lots, vacant lots, open space, or buildings that are not oriented toward the street create greater gaps between activity and a less interesting, or even unpleasant, pedestrian environment.

DETERRENTS TO DRIVING

Urban areas frequently offer incentives to transit use in the form of disincentives to automobile use. Parking scarcity limits the availability of free parking, creates a market for paid parking, and thereby increases the cost of driving. These costs come in many forms: the cost of time spent searching for a space or walking from a distant location, or simply the parking fee. In addition, the concentration of activities generates traffic congestion which creates delays, reduces travel time reliability, and adds stress to the driving experience. Where these conditions exist, transit becomes an increasingly desirable alternative to the automobile for people who have a choice in how they travel.

DEFINITION OF CONTEMPORARY SUBURBIA

A place should exceed minimum thresholds for urban-ness on each of these dimensions – density, diversity, design, and deterrents to driving - to be appropriate for traditional urban transit services. Therefore, contemporary suburbia can be defined as places that do not meet urban standards for more than one of these dimensions.

Because land-use patterns range from urban centers to rural countryside on each of these dimensions, it is necessary to define contemporary suburbia in terms of an upper threshold (above which traditional urban transit services are appropriate) and a lower threshold (below which purely demand-responsive rural services are appropriate). Because of the considerable variation from place to place and the presence of local complexities, finite thresholds are impossible to define. However, the following discussion presents insights derived from the

literature and it is reasonable to expect that localities will be able to define thresholds that reflect their unique environment.

- **Residential Density:** Conditions in residential areas begin to discourage transit use when net densities fall below approximately 8 to 10 dwelling units per acre. Single-family detached houses on small lots, such as in the streetcar suburbs built before World War II, are commonly developed at this density. Neighborhood retail within walking distance of the majority of residents becomes infeasible below this density. The number of people within walking distance to transit stops also begins to diminish to the point that frequent service becomes infeasible. As the reasons for walking diminish, the provision of facilities for pedestrians, such as sidewalks, also begins to decline and many residential areas take the form of post-World War II subdivisions, with cul-de-sacs, parking-dominated site designs, and poorly connected street networks. Below $\frac{1}{2}$ dwelling unit per acre (2-acre lots), residential areas take on a more rural character with large open spaces between buildings.
- **Employment Density:** Below approximately 100 jobs per net acre, employment centers begin to exhibit features that discourage transit use, including large setbacks and surface parking.
- **Floor-Area Ratio:** Below a FAR of 0.8 to 1.0, the incidence of suburban design features, such as low-rise buildings surrounded by open space, increases. Below a FAR of 0.1, places have very low densities common to rural areas.
- **Scale of Land-Use Mix:** In typical urban areas, a reasonable mix of uses can be reached within a 0.5-mile radius of any point. In suburban areas, the need to travel a mile or more from one's house to a reasonable selection of retail, school, or employment opportunities contributes to the automobile dependence that undermines transit use. A range between 1 and 4 miles for this measure is typical in contemporary suburbia. Rural residents must travel even greater distances, generally 5 or more miles, to reach typical destinations.
- **Building Setbacks:** Most urban areas have setback lengths of less than 10 feet while suburban areas typically have setbacks greater than 20 feet. Many suburban retail strips have a setback of at least one row of parking (approximately 70 feet) between the street and the building. Rural setbacks are generally at least 50 feet from the highway.
- **Street wall Continuity:** Urban street walls typically have no more than 40 percent gaps. Suburban areas typically fall in the range of 50 percent to 90 percent street wall porosity. Rural street walls rarely have any spatial definition, with gaps between uses generally exceeding 95 percent.

When lower densities, larger setbacks, and large areas of free surface parking combine with high speed arterial streets and poor quality or non-existent sidewalks and crosswalks, suburban areas become much less walkable than urban areas. Since at least one end of a transit trip is usually made on foot, walkability is a key factor in the ability of transit services to attract riders.

This characterization of suburbia moves beyond a jurisdictional definition. Older neighborhoods within the boundaries of traditional cities are gaining suburban qualities, such as auto-oriented retail development and lower density housing, while some suburban areas become more "city-like." Wherever urban features exist, guidelines for designing urban transit services apply. However, if the combination of urban features are lacking, the guidelines from this

research, published separately as *TCRP Report 116* (available online at http://trb.org/news/blurb_detail.asp?id=6525), can be used to identify which suburban transit services are most appropriate to provide service.

TCRP Report 55 (available online at http://trb.org/news/blurb_detail.asp?id=2563) identified six types of suburban land-use environments based on their diversity of uses and how the intensity of their development (density) relates to that of the surrounding area. These environments included residential suburbs, balanced mixed-use suburbs, suburban campuses, edge cities, suburban corridors, and exurban corporate enclaves. Thinking back to the discussion of the activity surface, each topographical feature of the activity surface corresponds to one or more of these suburban environments:

- **Peaks** represent the major activity centers, such as downtowns, shopping centers, edge cities, and community business districts. In a polycentric city, peaks have various heights based on their relative share of the region's total residential, employment, commercial, medical, and recreational activity. Edge cities and downtowns of balanced mixed-use suburbs are examples of peaks. Peaks generally have urban characteristics – a diversity of uses, higher densities, and perhaps deterrents to driving.
- **Ridges** represent the major travel corridors in a region. These corridors frequently connect peaks and are often lined with higher density residential, employment, or commercial uses. Suburban corridors are examples of ridges. Ridges have more suburban qualities – less diversity and design conditions where there are large gaps in the street wall, although there may well be deterrents to driving in the form of traffic congestion.
- **Points** represent places in the region that are destinations for trips, but that do not necessarily fall on peaks or ridges. Suburban areas are characterized by a relatively high share of destinations that are not located within walking distance of other major activity centers or on major transportation corridors. Suburban campuses and exurban corporate enclaves are examples of points. Points are largely characteristic of suburbs, without the qualities of urban areas.
- **Plains** represent the large areas of relatively low density residential, office or industrial development that frequently serve as one end of a trip. Residential suburbs are examples of plains. Again, plains are largely a phenomena of suburbia and do not have high diversity, density, design, or deterrents to driving.

Although there are a number of ways in which to characterize suburbia, using the dimensions of diversity, density, design, and deterrents to driving can help communities place themselves in the spectrum of development patterns.

APPENDIX B: SUBURBAN TRANSIT SERVICES

Characteristics of those services and their most effective applications within suburban environments are also discussed. Because various groups may use different terms to refer to the same transit concepts, we will be clear in how we define the various modes and uses of service. The goal is to ensure that when a particular term is used readers will understand what is being discussed. It is important to note that the services outlined in this chapter are not unique to suburban operating environments. Services like express buses are common in urban environments and demand-responsive service is the dominant transit service model in rural areas. Nonetheless, as this project progresses, it will become clearer that the way in which a particular transit service is operated in the suburbs can distinguish it from service in an urban or rural environment.

Additional detail on any of these concepts is available through the source documents listed in the bibliography at the end of this report.

ESTABLISHED SUBURBAN TRANSIT SERVICES

American suburbs vary widely and there are equally diverse transit services operating within them. This section describes the array of transit services traditionally operated in the suburbs and provides some basic information on characteristics of the environments in which they operate. Eventually these services will be related back to the typology of suburban environments, helping individual agencies choose the best transit service given their operating environment.

Here transit services are characterized by the form they take, rather than the function they serve. Most forms of transit serve a variety of functions. In the case of a fixed route, it may serve as an express service or a neighborhood circulator depending on the area's demographic characteristics, travel behavior and the form of the transportation network. In most cases the choice of transit form will be dictated by service area characteristics, scheduling capabilities, and the desired level of service. This discussion contains a general description of each form of transit and includes more detailed information on the various functions.

Fixed Routes

Among the most commonly deployed transit service, fixed routes are those which follow a predetermined alignment and schedule. Fixed routes may operate more frequently than other service forms, providing service during peak hours or all day. They tend to operate most effectively in areas with higher densities and diversities of land use, particularly along higher density corridors or where there are multiple origins and destinations to anchor the route. Consequently, fixed routes often experience higher productivity and lower costs per passenger than demand-responsive services. Fixed routes function as trunks, expresses, limiteds, circulators, and shuttles.

Fixed routes are often a desirable solution because they are a well understood service. They are relatively easy to implement and are a more intuitive service model for residents than route deviation.

Trunk

Trunk route transit service is often the backbone of any suburban service, providing consistent service along well defined corridors throughout the service span. Passengers often access trunk services from collector services and routes or use them to travel within the route's corridor. In most cases, trunk routes run along major arterials.

Trunk routes may play a variety of roles – either improving mobility within a community, or connecting neighboring communities. In order to minimize travel times associated with the route alignment, trunk routes tend to provide very direct service between major origins and destinations. Therefore, in order to improve the accessibility of the service, circulator and feeder routes often connect to trunk routes. Travel times for all passengers are minimized through coordinated transfers between trunk routes and other transit services.

Express

Express service focuses on providing long-distance regional trips at speeds competitive with private automobiles. These characteristics make it ideal for commute service between suburbs, from suburbs to a central city, or even a reverse commute from a central city to an employment concentration in the suburbs. These routes typically run on major arterials and highways.

The primary benefit of express service is reduced travel times, which are made possible by limiting the number of stops made by the route. Generally express routes make a limited number of stops near their starting and ending point, with few in between. Express routes tend to be longer, because their primary origins and destinations are dispersed, making their travel time savings more pronounced. Trip times are further reduced by having passengers depart from a single location (such as a transit hub or park and ride lot), having arrived via feeder routes, shared rides, or single occupant vehicles. To further encourage choice riders to use express routes, passenger amenities and service quality emphasize comfort, reliability and safety.

Two common applications of express routes are for commute service and corridor enhancement.

As mentioned above, express routes can compete with single occupant vehicles through their service design and by offering a high quality service. In addition to having a limited number of stops and collecting passengers from a single location, expresses can improve operating speeds by taking advantage of high occupancy vehicle (HOV) lanes and other priority treatments for transit. Priority treatments are discussed in another section and include such things as queue jump lanes and automatic vehicle detection.

Generally speaking, express commuter service is provided only during peak periods when the majority of work trips are made. When service is only offered during peak periods, it is important to provide passengers with transportation alternatives during the mid-day. These alternatives might include a guaranteed ride home program in cases of emergency or shuttles which facilitate mid-day errand running. Even if the mid-day services are rarely used, they may increase passengers' willingness to commute on transit.

Commuter services may operate to major employment destinations or to intermodal transit stations where passengers may access a regional rail system. They may also function as a reverse commute service, taking central city residents to jobs in suburban locations.

When used as a corridor enhancement, express service supplements local bus service with additional capacity and higher operating speeds. This differentiates the service to better meet the travel needs of different passengers. This service model requires high density areas or

major activity centers to anchor either end of the service and generate demand for trips in both directions.

Limited Service

Limited service routes are similar to express routes in that they supplement existing local routes along congested corridors. Frequently limited routes follow the same alignment as local routes, but they only serve a fraction of the stops. Reducing the number of stops allows the bus to increase operating speeds and reduce travel times.

The most notable characteristics of limited routes are the reduced number of stops and high service frequency. Instead of providing stops every quarter of a mile, a limited might have stops every one mile or every three-quarters of a mile. Although their faster speeds are a benefit in and of themselves, limited routes are made that much more attractive when they have headways between ten and twenty minutes. Services geared toward commuters might only operate during peak periods, but limited routes often operate all day.

Bus rapid transit, or BRT, is a newer, more sophisticated application of limited routes. BRT pairs a limited route with innovative bus designs and technologies to provide higher quality service. Characteristics often associated with BRT include:

- Dedicated running ways
- Enhanced stations and stops
- Vehicles that are easy to board
- Off-vehicle fare collection
- ITS technology

Many of these characteristics are adopted to improve travel times, while others aim to attract riders through higher quality facilities and improved information and marketing. More details regarding the features of BRT will be provided later in the chapter.

Like express buses, another application of limited routes is for workers who have a reverse commute – from a central city to the suburbs.

Circulators

Circulators collect passengers along their route and deposit them at local trip generators (such as shopping malls or health clinics) or at timed-transfer points to connect with express, limited, or trunk routes. Such a service improves the accessibility and coverage of a transit system by providing service within limited areas of lower density neighborhoods and connecting them to trunk or regional transit service. Fixed-route circulators are probably the most common application of neighborhood bus service. Based on vehicle running times and demand, vehicles can be added or removed from a route to reach the desired service frequency. A number of the agencies with fixed-route circulators market them with names and color schemes that are different from their standard bus service.

Service characteristics of a fixed-route circulator can vary a great deal depending on the characteristics of the operating environment and the desired level of service. Shorter routes within limited areas minimize travel times and permit higher service frequencies. Routes are often non-linear and sometimes even circuitous, allowing them to increase the coverage provided by the route. While some systems use full-size buses for fixed-route service, others use small buses or even vans depending on demand, road infrastructure, and community desires. Operating

characteristics of fixed-route circulators may vary according to the trip purpose anticipated for most riders.

One variation on the basic fixed-route strategy is to develop a hub-and-spoke system, where multiple circulator routes connect to one (or more) transit hub(s) to facilitate transfers to other circulators, intra-city routes, or express routes. A hub-and-spoke system uses multiple routes to improve directness to the hub and outside of the neighborhood, which is appropriate if most trips will be made outside the community.

For special purpose trips, such as from a rail station to employment locations, circulators should provide very short, high frequency, low cost trips because the segment of the trip on the circulator is a single part of the passenger's trip. These service characteristics will make the circulator as appealing as possible to choice riders who could switch to alternative modes of transportation.

When circulators serve multipurpose trips, the service characteristics do not need to be quite as appealing – although it may help in attracting additional ridership. For multipurpose trips, fares can be similar to those charged for trunk service and the routes and headways may be longer because the passenger is less likely to be transferring between multiple routes.

Circulator routes serve lower density neighborhoods with fewer or less significant trip generators. The routes operate along local streets where it is important that the road network has a high degree of connectivity. Although circulators serve lower density neighborhoods than other fixed routes, fixed-route circulators are more effective than other service forms when densities are high enough to provide a reasonable ridership base.

Shuttles and Feeders

Shuttles and feeders are similar to circulators in their service characteristics and common operating environments. The primary difference is that shuttles focus on providing service to one or both ends of the route, as opposed to internal trips within the route. Shuttles often provide a connection between major activities points – which could be a transit station and work or home. Feeders have a general collection/distribution function throughout an area, such as the commute shed of a rail station. Services going to residential neighborhoods are primarily publicly funded and operated, while services to employment locations are more likely to be privately subsidized or operated. The primary goals behind shuttles and feeders are to get choice transit riders out of their cars and to improve the mobility of non-choice riders.

Shuttle and feeder routes are necessarily short, quick routes because they represent only part of a passenger's overall trip. Similarly, the fare should be fairly low to reduce total travel costs. Minimizing total travel times requires that shuttle schedules be coordinated with those of the regional transit network. Finally, shuttles must be very reliable to ensure passengers' ability to transfer and estimate arrival times.

Shuttles and feeders are used in a variety of applications where there is a concentrated pool of potential riders. Three common applications are:

- Running a shuttle between a transit hub and an employment center,
- Running a feeder between a residential neighborhood and a transit hub, and
- Operating a mid-day shuttle between employment sites and a retail center for errands and meals.

The operating environment for shuttles may vary a great deal according to the type of service provided. In most cases, shuttle services are anchored by a regional rail station or intermodal transit hub. At a minimum, shuttles require major employers and/or destinations that are near a transit hub or rail station, but not within walking distance. If the destination is in a location with limited or expensive parking, shuttle service tends to be more successful. Fixed-route shuttles should operate in environments where the population or employment densities are high enough such that the pool of potential riders within the route's catchment area can justify the service.

Deviated Fixed Routes

In deviated fixed-route service, vehicles have the flexibility to move within a given service area as long as they arrive on schedule at various time points. Often the time points are located at transit hubs where passengers can transfer to trunk or express service. Deviated fixed-routes frequently use smaller vehicles, whether they are small buses or large vans. It is also common for these routes to have their own identities, with unique logos and color schemes.

Deviated routes generally take one of three forms. The most flexible form of deviated fixed-route is essentially a demand-response service that has two time points, one on each end of a service area. A slightly more restricted service might have a vehicle running along a route between 4 or 5 time points, but deviating as necessary for passengers to board and alight. Another common variation is to have a vehicle follow a fixed route, but allow it to deviate up to a given distance (typically $\frac{1}{2}$ or $\frac{3}{4}$ mile) from the route to pick-up or drop-off passengers.

Flexible routing improves the convenience of transit by allowing stops to be closer to a passenger's origin and/or destination. Because deviated routes tend to operate in lower density environments travel times can be significantly reduced. Due to the possibility of deviations, flexible routing can be more difficult for passengers to understand and use.

The most common applications of deviated routes involve circulators and shuttles, which are discussed below. Regardless of the type of application of the deviated fixed-route service, the key attribute of this service is its inherent flexibility which is ideally suited to serving suburban markets. The default transportation mode for most suburban residents is the private automobile, but deviated fixed-route service provides a viable alternative by emulating the flexibility of private automobiles. Deviated fixed-route service provides transit agencies with the ability to get closer to trip origins and destinations, thereby significantly increasing the overall accessibility and coverage of the entire transit network. New technologies, such as automatic vehicle locator and smart cards, stand to greatly enhance this particular service model. These technologies are discussed in greater detail in a following section.

Circulators

One of the more common applications of deviated fixed-route service is the circulator service. As defined by TCRP Report 55, circulators provide direct, timely linkages within communities, with connections to the regional rail or bus networks made available at designated transfer locations. Circulator service is often initiated to augment or even replace a fixed-route service due to various challenges in the operating environment, including the street network, lower densities, steep terrain, or increased operating costs. This type of transit service operates along a designated route alignment deviating as necessary to expand the effective service area.

Circulators generally serve the purpose of either collection or distribution in a passenger's overall trip; therefore, the circulator serves as either the first or final leg in a passenger's journey.

Shuttles

Another popular application for deviated fixed-route service is the shuttle. As defined by TCRP Report 55, shuttle service supplements the existing transit network by providing tailored, high-quality connecting services between major activity centers, one of which is often a transit center. Similar to the deviated fixed-route circulator service, it is possible to increase the service area of shuttle service by allowing the route to deviate from its designated alignment to pick-up and drop-off passengers. Shuttle services tend to be oriented towards serving niche markets, such as transportation to special events or transportation from a rail station to an employment center.

Demand Responsive Services

Demand responsive service, also called "dial-a-ride," schedules vehicles to pick-up and drop-off passengers throughout a service area, providing high quality, curb-to-curb service for the general public and persons with disabilities. These services are particularly effective in areas with low-density development and/or widely dispersed trip generators that are hard to serve with a fixed-route or full-size coach. All of these trips require a call-in request. Advance notice requirements vary from days in advance to the actual time of the desired trip. Demand response services use smaller vehicles, whether they are small buses, large vans or taxis, which can navigate residential neighborhoods and narrow streets.

Due to smaller passenger loads vehicles can follow more direct routes between origins and destinations, reducing trip travel times. Technological advances, including improved dispatching capabilities and real-time information, should allow transit systems to significantly reduce advance reservation requirements.

Similar to the deviated fixed-route service described above, demand-response service is generally provided as either shuttle, feeder or circulator service. Demand response service is probably most commonly associated with social service transportation and is also utilized to meet the paratransit requirements of the Americans with Disabilities Act (ADA). In the private sector, airport shuttles are probably the most common application of demand-response service. In the overall network of suburban transit services, demand-response service plays a critical role in serving niche markets that are not well served by fixed-route service and appears to be positioned to increase its relative profile in coming years.

Subscription Services

Subscription service offers a tailored transit service to specific individuals when they have paid a subscription fee. Many subscription services originated as private enterprises and have transitioned to public operation, although they may also be the result of a public/private partnership. Subscription vehicles, whether they be coaches or smaller vehicles, collect passengers at predetermined times and locations. Trips are scheduled to best meet the needs of a particular trip's passengers in terms of the origin, destination and pickup and drop-off times. Subscription services tend to operate from residential environments that have low average densities but have concentrations of residents who have similar work locations. Subscription services often experience farebox recovery ratios much higher than other transit services because the demand for service is known in advance and because such a premium service demands higher fares.

For the purposes of this document, the discussion of subscription services is limited to commute service, as this is the market upon which most public and public/private partnerships focus. However, it is worth noting that other subscription services exist for markets such as childcare, sporting events, and travel to airports. The most common examples of public subscription services are commuter buses and vanpools. Although some ADA trips are called “subscription” trips, in reference to a standing reservation for a particular trip made by a specific passenger, they are not included in this discussion. Rather these trips are classified as being part of demand-responsive service.

Subscription Commute Buses

Subscription commute services often originate in lower density suburbs where residents work in proximity to one another, but at a relatively distant location. These workers may live in a new community where public transportation is not yet available or where demand is insufficient for intercity fixed-route transit service or they may simply be isolated from their jobs. A commuter bus offers subscribers the ability to relax or do work while they travel and in congested corridors, passengers often benefit from shorter travel times by taking advantage of HOV facilities.

Commuter buses, or commuter clubs as they are sometimes called, offer guaranteed seats and a schedule tailored to the needs of the passengers. Depending on how closely passengers work to one another, they may be delivered to a single location, a transit hub for distribution to disparate destinations, or dropped off at a limited number of points.

In order for such a system to work, subscribers’ trips origins and destinations must be proximate and they must have similar schedules.

Vanpools

Vanpools primary market consists of suburban commuting where residents live and work in locations throughout a region, but may be concentrated in a number of specific locations. Vanpools are often organized through a ride-matching service associated with an employer or a regional agency that promotes transportation demand management strategies. These services identify passengers who live and work in proximity to one another and have similar work schedules.

Vanpool costs can be controlled fairly well because:

- A vanpool must meet a minimum passenger requirement,
- One or more vanpool participants are trained to drive the vehicle, and
- Vehicles are leased or provided by the employer.

Vanpools offer the advantage of being more flexible than subscription bus service due to fewer passengers whose trips and schedules need to be accommodated. This can make the service faster and of higher quality, while still promising subscribers a guaranteed seat.

Areas with limited or expensive parking and HOV lanes offer incentives for the use of vanpools. Constrained parking deters individuals from driving while HOV lanes offer the benefit of reduced travel time.

INNOVATIVE SUBURBAN TRANSIT SERVICE

The following sections discuss two basic approaches to making traditional transit more innovative. One approach is to use technological and infrastructure improvements to give transit more of the qualities of automobiles. The second approach is to modify service design to the same end. The technologies and designs discussed here may or may not be new discoveries or cutting edge science, but when they are successfully applied to traditional transit services they can create innovative solutions that allow transit to adapt to any environment in which it operates, suburban or otherwise.

Technology and Infrastructure Improvements

Technology plays an extremely important role in allowing public transportation to mimic the quality and characteristics of automobiles. The application of various technologies to existing infrastructure, or even the way infrastructure is utilized have profound impacts on transit's performance. Real-time information, transit preferential treatment and vehicle modifications represent the array of ways in which changes to the way technology and infrastructure are used can improve transit service.

Real-Time Information

Real-time information on traffic conditions, transit vehicle location, and passenger origin and destination information allows transit to increase its operating speeds, scheduling and routing flexibility, and overall convenience for passengers.

Automatic Vehicle Locator (AVL)

AVL is a global positioning system (GPS) application that relays the real-time location of a vehicle to a central computer. This technology has a variety of applications to improve the quality of suburban transit. The following list describes some of the more common applications of this technology:

- **Arrival time of next bus(es):** can be communicated to passengers via electronic displays (at transit hubs or individual stops), the internet, or personal digital assistants (PDAs). This decreases the uncertainty associated with waiting for a bus and allows potential passengers to make an informed decision about whether or not transit will meet their needs for a particular trip and allows passengers to better manage their time.
- **Routing:** when a transit vehicle has flexibility in its alignment, AVL can be used to generate directions to a passenger's origin or destination. Directions can be generated automatically and communicated to the driver via an in-vehicle display or a call from central dispatch. Similarly, AVL can be used for dynamic routing to identify the preferred vehicle to pick-up and drop off a passenger.

Transit Preferential Treatment

In order for transit to compete with cars, advantages must be afforded to transit vehicles that allow them to operate faster than personal vehicles. This will either make transit a faster, preferable alternative or it will help offset the time penalties associated with serving multiple passengers. Transit preferential treatments include technologies and infrastructure modifications.

Automatic Vehicle Detection

A series of different technologies are available that can identify when a transit vehicle is approaching an intersection. Within certain parameters, signal timing can be modified to either lengthen a green cycle or shorten a red cycle to expedite a transit vehicle's passage through an intersection. Some of the more common vehicle detection technologies include video recognition, AVL, and automatic vehicle identification in which each vehicle is outfitted with a transponder that signals its presence to an intersection's receiver.

Queue Jump Lanes

At congested or high volume locations the presence of an additional lane for transit vehicles, called a queue jump lane, allows these vehicles to easily re-enter traffic and bypass what may be long lines of waiting cars. Queue jump lanes may be installed in conjunction with an additional signal phase which allows the transit vehicles to start prior to other vehicles traveling in the same direction. This technique is applied to intersections and freeway on-ramps.

Exclusive or Limited-Use Roadways

Being able to travel in free flowing lanes is another way that transit vehicles can increase their speed relative to those of cars. In some applications, entire lanes are designated for the sole use of transit vehicles; in others they share them with other high-occupancy vehicles. Examples include highway HOV lanes, bus-only lanes (separated or not), and contra-flow lanes where transit vehicles use one or more lanes on a one-way road to travel in the opposite direction. Exclusive use lanes generally offer the highest travel time savings, but in cases where right-of-way is limited or costs are prohibitive, shared-use lanes are beneficial. BRT and express routes regularly make use of exclusive and limited use roads to minimize their travel times.

Vehicle Modifications

Vehicle modifications can make transit more comfortable, improve operating speeds, and facilitate near door-to-door service.

Smaller Vehicles

The use of smaller transit vehicles, whether they be cutaways, 10-15 passenger vans, or sedans, permits service expansion to areas that might be inaccessible to full-size coaches or lack the density to support them. By their very nature, small vehicles carry fewer passengers who take less time to load and unload and make fewer stops. These factors allow the service to be more flexible and adaptive to passenger needs without creating burdensome travel times. Passengers are often more comfortable in smaller vehicles and feel safer because they are closer to the driver.

Vehicle Design

A variety of modifications to bus design are making them more proficient at quickly loading and unloading passengers. One industry trend has been towards low-floor coaches, which facilitate the expeditious boarding and alighting of mobility impaired passengers. Another design modification is to increase the number of doors from which passengers may alight, making the bus function more like a rail vehicle. Increasing the number of doors allows for rapid alighting towards the rear of the vehicle, while the front doors accommodate boarding passengers.

INNOVATIVE SERVICE DESIGN

Service design is another important area in which progress is being made towards providing more innovative, non-traditional transit service. A variety of approaches have been implemented throughout the country that have improved transit's ability to provide valuable transit services to suburban environments. They include the use of tangential and circumferential routing, seamless transferring, and improved fare collection. This section provides a brief overview of these service designs that allow transit to better adapt to the suburban environment.

Tangential and Circumferential Routing

Tangential and circumferential routing techniques serve the non-central business district, cross-town travel market that has become increasingly common in suburban service areas. Tangential routes serve the cross-town travel market by providing direct connections between park-and-ride lots or transit centers and suburban employment centers. Houston, TX has a number of tangential routes within its service area, many of which serve the Texas Medical Center which boasts the highest transit mode split in the region at 14%. Circumferential routes provide service along the periphery of a region, often adjacent to a beltway. These routes serve a similar purpose to the tangential routes, but are less common and tend to be more expensive to operate. Having a dedicated bus lane greatly improves the operational efficiency and ridership potential of circumferential routes.

Seamless Transferring

As travel patterns have become more dispersed in suburban areas, it becomes more challenging to complete a trip via transit without needing to transfer between routes or even between transit systems. As such, many transit systems have made service design improvements to allow for seamless transfer opportunities between routes. Providing a timed transfer reduces the wait time and total travel time for passengers, thereby improving the quality of service particularly for routes with fairly long headways. In addition to coordinating the schedules of different routes to provide timed transfer opportunities, transit systems have often restructured their route network to more of a grid like system where interconnecting routes operate on a pulse schedule to best serve transfer centers throughout the service area. Many suburban transit operators have moved away from the large, centralized transit centers in favor of multiple smaller transit hubs which are often best suited to serve the polycentric travel patterns that are prevalent in most suburban areas.

Fare Collection

Innovative fare collection techniques have also become more common among many transit systems in recent years. Universal fare media allow passengers to utilize multiple transit services that are operated by different transit systems without having to deal with complex transfer arrangements. Smart cards, which were discussed in the technology section above, also facilitate passengers' ability to transfer between partnering transit agencies. Overcoming various institutional barriers and getting different transit agencies to cooperate with one another is usually the biggest challenge in the implementation of a universal fare media program. Although not very common in the United States, off-vehicle fare collection can reduce transit travel times by eliminating the delays associated with passengers paying a fare while boarding the bus.

A fare-related design feature which can improve the convenience and speed of transit service is the incorporation of automated fare collection, including smart card readers, onto transit vehicles. Equipping buses to read electronic fare media expedites the boarding process as passengers do not have to search for exact change or feed money into slow or malfunctioning fare boxes. In addition to reducing delays with passenger boarding, smart cards provide a convenience to passengers by eliminating the need to carry the exact fare and by facilitating transfers among transit providers. When linked to AVL systems, smart cards can provide useful origin-destination information, particularly when passengers must also tag their card when exiting (doing so can offset their time-savings benefits, however).

TRANSIT SERVICES AND THE ACTIVITY SPACE

The activity surface provides the basis for relating the spatial distribution of travel demand and the optimal arrangement of transit centers, line-haul routes, and other transit services. All transit services can be organized around the topographical features on the activity surface, as shown below:

- **Peaks** are the largest destinations for travel by all modes and are generally served by the highest frequency, highest capacity transit services in a region. They are also generally the best locations for transit hubs because the concentration of routes serves travel demand from all directions and the concentration of trip ends minimizes the need to transfer.
- **Ridges** generally represent the best locations for traditional line-haul transit services, including rail and fixed-route bus services, since they have a relatively high number of trip ends within walking distance and the mix of uses provides a source of relatively high, all-day travel demand.
- **Points** are among the most difficult locations to effectively serve with fixed-route transit. Not only are points geographically dispersed, but their travel demand also tends to be concentrated at certain times of day. As a result, these places tend to be poorly served by transit. Frequently they receive little or no service at non-peak times, are served by dedicated trips or scheduled route deviations that can confuse customers, or require customers to walk a long distance to a mainline bus route. Defining strategies to effectively serve points is one of the major objectives of this research.
- **Plains** are also notoriously difficult to serve with fixed-route transit because of the low density, coarsely grained mix of land uses, and lack of well-connected pedestrian facilities frequently found in suburban residential areas. As with points, identifying strategies to effectively serve plains is one of the major objectives of this research.

TYOLOGY OF TRANSIT SERVICES

The activity surface concept also provides the basis for a typology of transit service types. This chapter explores how transit services can be characterized by their relationship to the peaks, ridges, points, and plains on the activity surface. Chapter 3 identified a number of strategies that are providing transit services in the modern polycentric city, including: fixed-route trunk routes, express routes, limited routes, circulators, shuttles, and feeders; deviated route circulators, shuttles, and feeders; demand-response dial-a-ride services, commuter buses, and vanpools. Each of these strategies can be thought of as a response to a set of topographical

features on the activity surface. Table B-1 illustrates the association between these topographical features and common transit services.

Table B-1: Relationships between Activity Surfaces' Topographical Features and Transit Service Formats

Topographical Feature	Service Format
Peak	Circulator
Ridge	Trunk, Limited
Plain	Circulator, Dial-A-Ride, Shared Taxi
Peak - Peak	Trunk, Express, Limited
Peak - Point	Shuttle
Peak - Plain	Express, Feeder
Point - Point	Shuttle
Point - Plain	Commuter Bus, Vanpool

Suburban service formats can be characterized by how they relax the rigidities of traditional urban transit services. Standard urban transit service, such as a bus route operating in a dense urban corridor, operates on a fixed route such that every run is similar, stops every few blocks, runs frequently, and consistently, enough throughout the day that schedules are not really needed, provides capacity for high passenger loads with large buses, and runs primarily on major arterial streets relying on pedestrian access from nearby neighborhoods. Because of the multiple, overlapping travel markets in dense urban corridors, a transit run frequently repeated is able to serve the needs of passengers making many different trips. This 'one route fits all' feature of urban transit creates an economy of scale that is often not achievable on suburban services.

Table B-2 shows how various suburban transit strategies compare to traditional fixed-route bus service. Service formats are compared across seven parameters, including fixedness of route, closeness of stops, frequency of service, consistency of schedule, length of service span, capacity of vehicles, and hierarchy of street. In addition to describing the physical and operational characteristics of different service formats, these parameters also have relationships to the quality of service perceived by transit passengers. These relationships are described by service measures in the "Transit Capacity and Quality of Service Manual (TCQSM), 2nd Edition" (*TCRP Report 100*) and include the following:

- **Fixedness of route** relates to service coverage and how easily potential customers can access service;
- **Closeness of stops** relates both to service coverage (closer stops minimize walking distances to and from transit service) and travel time (closer stops—or, for demand-responsive service, the need to make intermediate stops to serve other passengers— increase overall passenger travel times as vehicles must stop more often);

- **Frequency of service** reflects how often passengers may travel and is measured directly by the TCQSM's frequency measure for fixed-route service and by response time for demand-responsive service; the longer wait times associated with lower frequencies are also an element of fixed-route passengers' overall travel time;
- **Consistency of schedule** and **length of service span** illustrate when passengers may travel; these parameters are combined into the TCQSM's hours of service measure for fixed-route service and service span measure for demand-responsive-service;
- **Vehicle capacity** relates to passenger loading (e.g., the ability to get a seat) and, for demand-responsive service, trips not served, where a lack of space on a vehicle or an insufficient number of vehicles to meet demand results in trip denials; and
- **Hierarchy of street** relates to service coverage, as service on lower-order streets decreases walking distances at the home end of trips and often provides for a safer street-crossing environment (e.g., due to lower traffic volumes and narrower streets); however, service on lower-order streets may also result in longer in-vehicle travel times due to lower travel speeds, a more circuitous street network, and other factors.

Table B-2: Characteristics of Various Transit Service Formats

Service Format	Fixedness of Route	Closeness of Stops	Frequency of Service	Consistency of Schedule	Length of Service Span	Capacity of Vehicles	Hierarchy of Street
<i>ideal characteristics of traditional urban bus route</i>	<i>all runs are alike</i>	<i>stops all along the route</i>	<i>short waiting times</i>	<i>runs all day without gaps</i>	<i>runs morning to night</i>	<i>uses large buses</i>	<i>runs on major streets</i>
Traditional Urban Bus Route	high	high	high	high	high	high	high
Suburban Fixed Bus Route	varies	varies	varies	varies	varies	varies	varies
Fixed-Route Circulators	high	high	high	varies	varies	medium	low
Route-Deviation Circulators	medium	medium	high	varies	varies	medium	low
Demand-Response Circulators	low	low	varies	varies	varies	low	low
Special Purpose Shuttles	high	low	high	varies	varies	varies	varies
Fixed-Route Feeders	high	high	varies	varies	varies	varies	low
Route-Deviation Feeders	medium	medium	varies	varies	varies	varies	low
Demand-Response Feeders	low	low	varies	varies	varies	low	low
Subscription Bus Routes	high	low	high	low	low	varies	high
Vanpools	high	low	high	low	low	low	high

Notes:

Fixedness of Route: high denotes that all runs deliver passenger to same destination(s), low denotes significant variation in points served

Closeness of Stops: high denotes boarding or alighting ability all along the route, low denotes significant express or unserved segments

Frequency of Service: high denotes short headways or promised arrival times for dial-a-ride, low denotes long headways requiring a schedule

Consistency of Schedule: high denotes even headways throughout the day, low denotes significant gaps in service

Length of Service Span: high denotes service availability during off-peak hours, low denotes peak-only or other limited service period

Capacity of Vehicles: high denotes use of 40-foot or larger buses, low denotes use of smaller buses or vans

Hierarchy of Streets: high denotes significant use of major arterials, low denotes service on neighborhood streets

While much of the variation between service parameters that responds to specific local conditions is lost in the generalized comparison provided by Table 2-2, it is apparent how suburban services adapt to their environments by building in flexibility that is not always necessary or desirable in urban settings.

Within each general transit service format there is room for considerable variation based on the demand for service and characteristics of the service area. This research will produce guidelines that relate service area characteristics to appropriate service design parameters for suburban transit services. A main objective of this research is thus to determine which rigidities (e.g. route alignment, stop spacing, vehicle size) associated with traditional urban transit should be relaxed, and to what extent, given the attributes of a suburban service area. Table 2-3 presents an initial set of relationships that will guide the development of a methodology. As an example, the frequency of transit service depends largely on the density within the service area – with less service in lower density environments and more service in higher density environments.

Table B-3: Relationships between Service Area Characteristics and Service Parameters

Service Design Parameter	Service Area Characteristic		
	Density	Diversity	Design
Fixedness of Route	✓		✓
Closeness of Stops	✓		
Frequency of Service	✓		
Consistency of Schedule		✓	
Length of Service Span		✓	
Capacity of Vehicles	✓		
Hierarchy of Street	✓		✓

APPENDIX C: INITIAL CASE STUDIES

The research team used a number of techniques to select sites for the initial case studies, which included:

- Identifying appropriate sites from the comprehensive literature search.
- Reviewing transit agency websites using APTA and similar information sources.
- Transmitting an information request via a listserv, maintained by CUTR.
- Applying personal knowledge of transit properties.
- Balancing the size and geographical coverage of agencies, while ensuring that unique programs were also included.

At the inception of this task, we recognized that many transit agencies are regularly asked to respond to a wide range of information requests and we were intent on not overburdening potential responders. On the other hand, we needed enough information to provide an overview of issues, trends and an assessment of practices, in order to recommend specific sites for in depth case studies. These sites would also need to have sufficient land-use data to reintroduce the correlation between transit services and the land-use typology that was discussed in the first deliverable.

To minimize the time commitment from public agencies, while still gathering the information we needed, we developed a qualitative case study data collection form (see Attachment 1). The form was distributed to approximately thirty agencies that had been identified using the process described above. As discussed in our monthly and quarterly reports, the time it took to distribute these forms, and receive them back, exceeded our initial estimates - largely due to competing demands placed on the transit agency staff. However, as you will see in the following pages, we were successful in accumulating a wealth of information. In general, we were pleased with the level of interest from representatives of these agencies in the research and also some of their, in essence, lobbying efforts to ensure that their agency was recommended for more in depth analysis. These types of responses reflect the high level of interest and importance that agencies are placing on suburban services. As will be discussed in Section 2, there are many common issues and trends, but there are also diverging conclusions being made about them.

The following pages present information gathered on the twenty-eight transit agencies that were part of the initial case studies. The agency profiles are organized first by geographic region (West, Midwest, South, and East) and then by agency size (starting with the smallest agencies). Each agency is listed below:

West

- Livermore Amador Valley Transit Authority (LAVTA)
- South Metro Area Rapid Transit (SMART)
- Eastern Contra Costa County Transit Authority (Tri Delta Transit)
- Orange County Transportation Authority (OCTA)
- Pierce Transit
- Valley Metro

- Metropolitan Transit Development Board (MTDB)
- King County Metro (Metro)
- Denver Regional Transit District (Denver RTD)
- Tri-County Metropolitan Transportation District (TriMet)

Midwest

- Champaign – Urbana Mass Transit District (C-UMTD)
- Des Moines Metropolitan Transit Authority (DMMTA)
- Madison Metro
- Suburban Mobility Authority for Regional Transportation (SMART)
- Toledo Area Regional Transit Authority (TARTA)
- Kansas City Area Transportation Authority (KCATA)
- Metropolitan Council
- Pace, Suburban Bus Division of the Regional Transportation Authority (Pace)

South

- Broward County, Florida and municipalities within the County
- Fort Worth Transportation Authority
- Charlotte
- Dallas Area Rapid Transit (DART)

East

- Potomac and Rappahannock Transportation Commission (PRTC)
- Merrimack Valley Regional Transit Authority (MVRTA)
- Capital District Transportation Authority (CDTA)
- Transportation District Commission of Hampton Roads (HRT)
- Rhode Island Public Transportation Authority (RIPTA)
- New Jersey Transit (NJ TRANSIT)

LIVERMORE AMADOR VALLEY TRANSIT AUTHORITY (LAVTA)

Location: Livermore, CA

Contact Person: Cory Lavigne, Manager of Transit Development

Size of Agency: Small

Transit Modes: Bus, shuttle, ADA paratransit

Agency Description

The Livermore Amador Valley Transit Authority (LAVTA) provides public transportation services in the Tri-Valley area, which includes Dublin, Livermore, Pleasanton and unincorporated areas of eastern Alameda County. In recent years, LAVTA's ridership has averaged 2 million annual unlinked passenger trips. LAVTA service can be divided into two separate service areas: Dublin/Pleasanton and Livermore. These two sub-service areas are separated by approximately three square miles of lightly developed industrial and agricultural land and are connected by several LAVTA routes.

Description of Suburban Transit Services

DART is an on-demand service with two fixed time points (Dublin/Pleasanton BART station and Livermore Transit Center) and serves various zones within Dublin, Pleasanton and Livermore. DART service was initiated in May 1997 and replaced midday service on several of LAVTA's fixed routes. DART has since expanded to provide service to Livermore, as well as evening and weekend service. DART provides WHEELS passengers with a custom service that is responsive to their constantly changing mobility needs. Unless transferring to a scheduled DART pickup at the Dublin/Pleasanton BART station or Livermore Transit Center, passengers must call to make reservations at least two hours in advance of their desired pickup time. DART utilizes the same fare structure as fixed-route WHEELS service.

LAVTA provides two subscription bus routes to the Silicon Valley during the week. Information is listed below for each of these "Prime Time" routes:

- PrimeTime Intel Express – LAVTA provides service to Intel by training Intel employees to drive their buses. One bus departs from the Portola park-and-ride lot in Livermore at 5:30 AM and makes one stop at the Pleasanton Fairgrounds at 5:45 AM en route to the Intel facility on Mission College Blvd at 7:00 AM. The bus is parked at the Intel facility during the day and is driven back to the Tri-Valley area leaving Intel at 4:10 PM and arriving at the Pleasanton Fairgrounds at 5:12 PM and the Portola Park & Ride at 5:36 PM.
- PrimeTime Lockheed Martin – Similar to the Intel service, Lockheed Martin employees are trained to operate the LAVTA buses and are considered to be employees of LAVTA's contract operator, MV Transportation, while behind the wheel. There are two (2) separate buses which provide service to the Lockheed Martin facility, one of which leaves the Portola park-and-ride lot at 4:43 AM and the other which leaves at 5:23 AM. Both of these buses make stops at the Pleasanton Fairgrounds (4:59 AM and 5:39 AM) before

running express to the Lockheed facility (5:39 AM and 6:39 AM). On the return, the first bus leaves Lockheed at 3:45 PM stopping at the Pleasanton Fairgrounds at 4:45 PM and getting into the Portola Park and Ride at 5:10 PM. The second bus departs Lockheed at 4:45 PM stopping at the Pleasanton Fairgrounds at 5:55 PM arriving at the Portola Park & Ride at 6:15 PM.

LAVTA has also recently added PrimeTime service to Sun Microsystems in Newark, CA, however this service has not performed particularly well, carrying less than 3 passengers per day during June, 2003.

Passengers can purchase monthly passes for these commuter services (\$95 for Livermore passengers and \$85 for Pleasanton passengers) or can pay on a daily basis at a rate of \$7.00 per roundtrip.

Description of Operational Issues

Similar to its fixed-route service, LAVTA contracts the DART service out to a private operator, which is currently MV Transportation. As mentioned above, PrimeTime service is operated by trained employees of Intel and Lockheed Martin and the vehicles are parked on-site during the work day. While operating the bus, these drivers are considered employees of MV Transportation for insurance purposes. Furthermore, these individuals must be in compliance with all the requirements established for MV drivers, such as obtaining and maintaining their commercial driver's license.

DART service also periodically runs into operational issues due to the rather intensive man-power requirements associated with the service. In fact, there is a full-time person assigned to coordinating the DART service, which includes scheduling trips and dispatching responsibilities. Currently, Dublin/Pleasanton DART operates four vehicles on non-weekdays. The productivity on two of the vehicles is consistent with DART expectations. However, the two other vehicles operate below established DART standards.

Description of Funding Arrangements

LAVTA relies upon its regular funding sources to pay for DART and PrimeTime service. Passenger fares are much higher for the PrimeTime service as compared to regular fixed-route transit service, which contributes to a much higher farebox recovery rate for this service.

Description of Marketing Program

LAVTA has an extensive marketing program for promoting their transit services, which includes special events, promotional materials, advertising spots, and effective use of their website.

Description of Performance Measurement Program

LAVTA has recently added specific performance measures to their overall performance measurement system designed to evaluate DART and PrimeTime service. LAVTA set the farebox recovery ratio at 75% for PrimeTime subscription service and also established a performance standard of 20 passengers/hour. For DART service, LAVTA has a performance standard of 6 passengers/hour.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

In recent years, LAVTA's more innovative suburban transit services have not fared well. The Lockheed Martin PrimeTime route is the only subscription route that continues to perform strongly. The Sun Microsystems route was eliminated due to low ridership. The Intel route continues to operate, but farebox recovery rates have been dropping below the 75% standard and the route is at risk of being eliminated. DART service has also struggled, costing LAVTA \$24.28 per passenger in May 2003. Through an on-board survey effort, it was learned that the general lack of weekend service is considered to be a system deficiency for existing as well as potential riders. As a result of this information and the poor performance of DART service, Saturday DART service has been replaced with fixed-route service and Sunday DART service will also be eliminated by the end of 2004. It is expected that mid-day and evening DART service will remain, however.

The economic recession has hit LAVTA particularly hard and the system has responded to decreasing ridership by eliminating service. Up until 2001, LAVTA had experienced constant ridership growth and continued to provide additional services to its customers, such as DART and PrimeTime service. These services flourished during the strong economy but have not done so well of late.

Transferability to Other Systems

DART and PrimeTime service are both highly transferable to other transit systems. DART type service needs to be highly integrated with the fixed-route network in order to do well. Subscription service, such as LAVTA's PrimeTime service, works well in suburban communities in which there is a concentration of residents that work at a common, but distant location.

SOUTH METRO AREA RAPID TRANSIT (SMART)

Location: Wilsonville, OR

Contact Person: Steven Allen, Operations Manager

Size of Agency: Small

Transit Modes: Fixed-route bus, commuter bus, general public dial-a-ride

Agency Description

Under Oregon laws governing transit districts, cities with fewer than 10,000-15,000 residents, as well as unincorporated areas at least one square mile in size containing at least 200 voters, have the opportunity every five years to withdraw from a transit district if certain conditions are met. In 1988, Wilsonville (2000 population: 13,991), located approximately 18 miles south of downtown Portland and 25 miles north of Salem, was the first city in Oregon to use this law. Wilsonville successfully petitioned to withdraw from TriMet, the Portland-area service provider, and start its own transit service.

Wilsonville's central location between Portland and Salem makes it both a growing suburban residential community whose residents commute to jobs in the two regions, and a business center that attracts commuters from the same regions. Wilsonville's six largest private employers have between 400 and 1,350 employees on the payroll, and the city has fifteen private employers with more than 135 employees. Wilsonville is considered within the Portland urban growth boundary; however, there is currently a two-to-five mile wide buffer of land between Wilsonville and the rest of the Portland region that lies outside the regional urban growth boundary, making Wilsonville a 6.8-square-mile urbanized island on the fringe of the Portland area.

Ridership on the City of Wilsonville system, South Metro Area Rapid Transit, or SMART, has grown steadily from 7,100 in the first year of operation to over 243,000 in FY 2003. Service is funded primarily by a 0.3% tax assessed on business payrolls, which is one-half the tax rate that Wilsonville businesses had been paying to TriMet. No fares are charged. All routes use a combination of cutaways and 30, 35, and 40-foot buses.

Description of Suburban Transit Services

SMART currently operates two fixed-routes that operate exclusively in town: Route 204, which primarily serves residential areas and Route 203, which primarily serves employers on the west side of town. Route 201, the oldest of the fixed routes, is both a local route that serves employers on the east side of town and an express route that connects Wilsonville to TriMet service in Portland.

SMART also operates fixed-routes that primarily provide connections to other communities. SMART and Salem Area Transit jointly operate an express route (1X) on Interstate 5 between Wilsonville and Salem, the state capital, serving commuters in both directions. In 2003, SMART began operating Route 205, connecting Wilsonville to another outer Portland suburb, Canby (2000 population: 12,790) eight miles to the southeast. Connections can be made

in Canby to Canby's local circulators, TriMet and Canby service north to Oregon City, and east to another outer suburb, Molalla. Former SMART Route 202 operated to Meridian Park Hospital 6 miles north of Wilsonville, and continued to Oregon City, 13 miles northeast of Wilsonville, but was cancelled in December 2001 due to low ridership.

Dial-a-ride service is available to the general public within the city, although ADA customers have priority for service and passengers who are able to access the fixed-route system are requested to use the fixed routes. Dial-a-ride service has been provided since the system started in 1989 and currently averages 5 boardings per revenue hour, with rapidly growing ridership. Service is available between 5:30 a.m. and 7:15 p.m. weekdays throughout the city, and limited Saturday service is also provided. Rides can be scheduled up to two weeks in advance and a minimum 24-hour notice is recommended.

Description of Operational Issues

The ability to travel fare-free between Salem and the southern portion of Portland attracts some transients, who are willing to accept the long transfer connection. The first northbound bus from Salem to Wilsonville leaves at 5:05 a.m., which is before the morning start of service for Salem Keizer Transit. As a result, passengers on that first trip are unable to use transit for their entire trip, unless they happen to live near downtown Salem.

Description of Funding Arrangements

All services are funded solely by SMART. The majority of SMART's revenue (77% in 2003) comes from a 0.3 percent payroll tax levied on employers within the city. Virtually all of the remaining revenue comes from federal or state grants. The three Salem trips operated by Salem Keizer Transit, extra Route 201 service to Portland, and Route 205 service to Canby are funded by JARC grants.

Description of Marketing Program

SMART services are marketed through newspaper and cable television ads, employer transportation fairs, and the county fair. SMART has a web site (<http://www.ridesmart.com>) that provides schedule and route information. SMART also provides bus service to Portland Trail Blazer basketball games from Wilsonville, which makes transit service more visible to those who normally do not use it. A fare is charged for this special service, which is marketed in conjunction with two local restaurants where passengers are picked up at.

Description of Performance Measurement Program

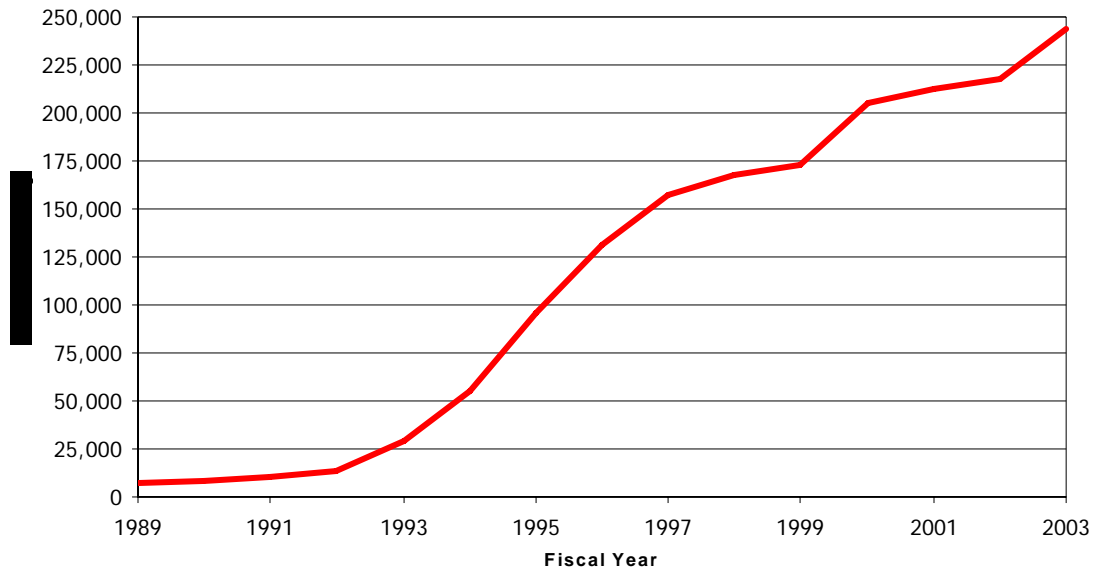
The main performance measures relate to cost-efficiency and cost-effectiveness, measured by statistics such as cost per passenger, cost per hour, and cost per mile. Overall ridership is also tracked. Routes are evaluated annually by SMART's Operations Manager. All routes are evaluated the same way. Data used for the measure from ridership counts and financial data, and are collected by bus operators, the dispatcher, and the Operations Manager. On-time performance is also reported annually as part of the City's budgeting process.

Customer satisfaction is measured through comments provided by the public, who may call, write a letter, or fill out a feedback card. SMART also conducts on-board checks of customer satisfaction.

Successes, Challenges and Lessons Learned with the Suburban Transit Service

Strong ridership growth began in 1993, coinciding with the startup of the first fixed route, Route 201, which serves three of Wilsonville's four largest employers, and provides connections to Portland.

Figure C-1: Wilsonville Annual Ridership 1989-2003



The agency's reliance on a payroll tax requires a balance between the amount of residential and employment development occurring within the city. If population grows at a faster rate than jobs, demand for service could outstrip available resources. Similarly, if employers were to lay off employees, the amount of resources available for transit service would drop. At the same time, having a lower payroll tax than most of the rest of the region is a selling point in getting businesses to locate in the city.

Transferability to Other Systems

Wilsonville enjoys a location between two significant commute destinations—Portland, the largest city in Oregon, and Salem, the state capital—as well as a sizable employment base of its own. This provides a market for both commute and reverse-commute services. Many suburbs elsewhere in the country may not have the balanced mix of employment and residential land uses that Wilsonville has, nor the same geographic advantages.

Because not all of the revenue generated in Wilsonville was returned in the form of service when the city was within the TriMet district, the City was able to reduce the payroll tax rate by one-half (popular with business) and still increase the amount of service provided within Wilsonville (popular with residents). In addition, the withdrawal of Wilsonville did not harm

TriMet financially, as the same state law permitting withdrawals also permits TriMet to increase its payroll tax rate to make up the lost revenue. As a result, TriMet ended up with the same revenue, but saved most of service hours it had been providing Wilsonville. Three other outer Portland suburbs have since followed Wilsonville's lead. However, it is unlikely that same combination of state laws and transit financing systems exists elsewhere.

Nevertheless, Wilsonville does provide a good example of the evolution of transit service in a growing suburb—starting with solely demand-response service, adding fixed-route service as demand and funding permitted, and progressing to the current mix of in-town fixed-route, commuter, inter-suburb, and demand-responsive service. Wilsonville also provides a good example of how a smaller transit agency in a region with several transit operators can integrate its services with others'.

EASTERN CONTRA COSTA COUNTY TRANSIT AUTHORITY (TRI DELTA TRANSIT)

Location: Eastern Contra Costa County, CA

Contact Person: Steve Ponte, Director of Service Planning

Size of Agency: Small

Transit Modes: Bus, express bus, ADA paratransit

Agency Description

The Eastern Contra Costa County Transit Authority, also known as Tri Delta Transit, operates fixed-route, commuter express, and paratransit service for Eastern Contra Costa County. Eastern Contra Costa County is one of the fastest growing suburban areas within the San Francisco Bay Area, and includes older industrial communities in the cities of Pittsburg, Antioch, and transitioning agricultural areas in the unincorporated county areas of Oakley, Byron and Brentwood.

Description of Suburban Transit Services

From these locations, the Delta Express provides express bus service to Lawrence Livermore National Laboratory (LLNL) and Sandia Labs, both of which are nationally recognized research labs employing approximately 25,000 persons, and to Hacienda Business Park, a sub-regional employment hub, employing over 12,000 persons and the Bay Area Rapid Transit District (BART), which provides regional employment access. The LLNL/Sandia Lab service began operating July 2001 and the Dublin BART/Hacienda Business service started August 2002. The LLNL/Sandia service operates four trips daily to the labs from the mushrooming communities of Antioch, Oakley, Brentwood, Byron via Mountain House Road. The express bus shaves an average of 20 to 30 minutes from the average commute time from these areas. The Delta Express to Hacienda Business Park connects to the Dublin BART system and Hacienda Business Park operates four trips daily along the same route as the LLNL bus, but adds one stop in Discovery Bay, another fast growing suburban community.

Description of Operational Issues

ECCTA contracts the Driver/Supervisor portion of the Delta Express service (currently operated by Laidlaw). Maintenance and Administration are provided by ECCTA staff. Except for the initial capital costs of purchasing the buses, the cost of this service has been minimal. ECCTA purchased 6 MCI "E" series coaches at a cost of approximately \$394,000 each which was considered a "steal" because ECCTA was one of the first transit agencies to purchase this style of buses. (The current cost is approximately \$600,000.) The coaches seat 52 passengers and are equipped with reclining seats, headphone jacks at all seats, TV, VCR, multi-player CD's, spill-proof commuter mugs, spiral staircases, and rear door wheel chair lift.

Delta Express service operates daily during peak commute times. Passenger drop-off and pick up locations are at designated park and ride lots, or central locations within each community. There are no major operational issues or constraints to provide this service.

Description of Funding Arrangements

The service is fully funded by fares and ECCTA through TDA funds. The current fares are \$110 for a monthly pass, and \$65 for a 20-ride punch pass.

Description of Marketing Program

Tri-Delta has done extensive marketing for the Delta Express Service. Marketing promotions cover all media, and includes the following:

- Local newspaper advertising
- Local magazine advertising
- Press releases sent to local newspapers
- Delta Express brochures distributed at community events
- Posters placed at Dublin/Pleasanton BART Station
- Article placed in Hacienda Network Newsletter that is distributed to all employees in the Hacienda Business Park
- Delta Express information placed on Hacienda Business Park website
- Participated in transportation fair at Hacienda Business Park
- Direct mailed postcard to all residents in Antioch, Oakley, Brentwood, Byron, and Discovery Bay with information on the Delta Express and a free ticket offer to try the service
- Partnered with Contra Costa Commute Alternative (CCCAN) to offer “Buy 1 Get 1 Free Monthly Pass” on the Delta Express
- Direct mailed information to all commute coordinators within the Hacienda Business Park
- Article placed in Bishop Ranch employee newsletter
- Partnered with Bishop Ranch and the Hacienda Business Park to promote Delta Express
- Bus Back posters advertising the Delta Express are on the buses
- Delta Express listed in LLNL employee newsletter
- Participated in transportation fair at LLNL
- Delta Express information distributed to new residents in Eastern Contra Costa County
- Distributed flyers at the Martinez Court House and Regional Medical Center
- Article placed in employee newsletter at the Regional Medical Center
- Delta Express information in Tri Delta Transit bus schedule
- Delta Express information on Tri Delta Transit website

Description of Performance Measurement Program

Tri-Delta collects monthly data on passenger per mile/hour and cost per hour/mile. The data is collected by the service contractor which is reviewed by the ECCTA Director of Finance. This performance measure is different than measurements for other service, because the Delta Express is a high-end service that is structured to provide incentives to attract passengers to transit rather than provide service to the more transit dependent. This service is limited to eight commute runs, but has strong ridership and a solid cost recovery ratio. In contrast, ECCTA's regular service is geared to the general commuter population and all day riders and is measured by passenger per mile/hour. Cost per hour and total ridership, whereas Delta express is measured by farebox return. If standards are not met on regular service, typically the route is changed or eliminated.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

This high-end service is difficult to measure with typical performance standards because this particular commuter market is different than the general commuter and fixed-route patrons. They expect a different level of service because the fare is much higher and the service is limited to eight daily runs. Ridership is growing more slowly than regular fixed-route service because it serves a limited area. However, combined, both services have a 98% fare-box recovery ratio, although the Dublin BART/Hacienda Business Park service operates at a lower ratio (50%).

Transferability to Other Systems

Tri-Delta Express provides fixed-route, commuter service targeted at a specific ridership markets with established regional employment destinations, which are cost effective. The target market is high-end professionals who are one of the most difficult market segments to shed their cars for transit, despite the significant amount of traffic congestion on the Route 4/Highway 580 corridor. Due to the luxury features of the buses, the commute has essentially become an extension of the workday for most commuters, which provides an additional travel time savings.

Operating Data

Table C-1: Tri Delta Express – Service Characteristics

Tri Delta Express – Eastern Contra Costa Business Authority			
Service Characteristics	Lawrence National and Sandia Labs	Livermore Hacienda Business Park	Total
Annual Passengers	18,000	3,700	21,700
Annual Miles	43,000	57,000	100,000
Annual Service Hours	1,500	1,600	103,100
Annual Service Costs	\$75,000	\$80,000	155,000
Span of Service	5:18 am / 6:18 am 3:55 am / 4:55 pm	5:03 am / 5:18 am 4:20 pm / 5:35 pm	N/A
Days of Operation	Monday thru Friday	Monday thru Friday	N/A
Type of Equipment	MCI "E" Series	MCI "E" Series	N/A
Schedule/Frequency	Four am and four pm trips	Four am and four pm trips	N/A
Transit Priority	Buses are Equipped ⁽¹⁾	Buses are Equipped ⁽¹⁾	N/A

⁽¹⁾ All buses are equipped with signal priority, however we are still working on getting all cities to allow the use of these devices.

ORANGE COUNTY TRANSPORTATION AUTHORITY (OCTA)

Location: Orange County, CA

Contact Person: Scott Holmes/Beth McCormick

Size of Agency: Medium

Transit Modes: Bus, commuter rail, ADA paratransit, light rail (planned)

Agency Description

Orange County Transportation Authority, “OCTA,” is the county’s primary transportation agency, responsible for all forms of transportation ranging from streets and roads projects to bus and paratransit service. OCTA is responsible for providing fixed-route bus service in its 797 sq. mi. service area, which consists of 34 cities, unincorporated areas, and a total of nearly 3 million residents. In 2003, the OCTA fixed-route bus network had more than 65 million passenger boardings.

Description of Suburban Transit Services

Although OCTA is planning to implement some more creative suburban transit services in the near future, their current services are not particularly innovative. OCTA’s fixed-route bus system is expanding rapidly to meet increasing passenger demand in Orange County, however, and OCTA does utilize smaller vehicles to provide fixed-route service in some parts of the county that have either steep terrain or lower demand.

Description of Operational Issues

Since OCTA is not currently providing any innovative suburban transit services, there are no operational issues to report.

Description of Funding Arrangements

In addition to regular state and federal funding sources, OCTA relies upon Measure M funding, which is one half cent sales tax that was approved by Orange County voters in November 1990 for countywide transportation improvements. In 2002, approximately 20% of the \$136 million Measure M revenues went towards transit projects.

Description of Marketing Program

OCTA uses traditional approaches to marketing transit services, including website development, special events, PSAs, etc.

Description of Performance Measurement Program

OCTA is currently revising their performance measurement program to be more extensive. The current program includes factors such as minimum service span, ACCESS standards, transfer wait time, loading standards, etc. OCTA does have different standards for its different types of bus service as follow:

- Core bus service: 30 pass/hr
- Local bus service: 20 pass/hr
- Small bus service: 10 pass/hr

Successes, Challenges and Lessons Learned with the Suburban Transit Services

OCTA is considering operating deviated fixed-route service but is optimistic about the probable success of this service model. Recent outreach in its service area suggests that each community would like to have its own OCTA sub-system of circulator type routes. OCTA has yet to act on these service requests.

PIERCE TRANSIT

Location: Pierce County, WA

Contact Person: Eric Phillips, Senior Planner

Size of Agency: Medium

Transit Modes: Bus, ADA paratransit, vanpool, and demand-response - hybrid

Description of Suburban Transit Services

In addition to traditional fixed-route services that often extend into the suburban service areas, Pierce Transit operates two non-traditional general public services (hybrid services) designed to serve the rural portions of the service area. *Bus PLUS* service is a route-deviated regularly scheduled service that allows off-route deviations for customers who make advance reservations. This service began in September 2003.

Loop service is a general public dial-a-ride type service that provides reservations-only service. Both services operate as a curb-to-curb type of general public service from established pick-up and drop-off locations. This service began in 2001.

Description of Operational Issues

Bus PLUS and Loop services can be operated internally or by contractors. Services are either demand-responsive route deviated or reservations only. Operating issues typically relate to the overall design of the service, locating passenger pick-up and drop-off locations and meeting connecting services that meet the travel needs of customers traveling into and out of the more rural portions of the service area.

Description of Funding Arrangements

Funding for hybrid services comes from local operating resources and special needs transportation grants. Special Needs Transportation funding is only available through special appropriation by the state legislature and receipt of funding is based on submittal of grant requests through a competitive process.

Description of Marketing Program

Service is marketed in local printed media, through community presentations, promotional brochures, direct mailings to area residents and through Pierce Transit's public timetable book and website.

Customer satisfaction is measured consistent with other transit services provided by Pierce Transit including service monitoring and adjustments during regularly planned service changes, handling direct customer complaints consistent with practices in place for fixed-route and paratransit services and through community outreach provided to garner additional input on how service can be improved or modified to best meet the needs of the communities served.

Specific service standards and performance measures are in place and adopted by the Board of Commissioners to monitor these services.

Description of Performance Measurement Program

Hybrid services are a combination of fixed-route and demand-responsive services that serve low-density suburban or rural areas which cannot be cost-effectively served by conventional fixed-route services alone. These are generally areas with a combined employment and residential density that is less than 1,800 persons per square mile. Recognizing that hybrid services generally have excessive operating costs per passenger carried, they are only initiated when the social benefit provided by these services outweighs their financial limitations.

Hybrid services possess far more flexibility than other fixed-route services. Generally, the specific operating characteristics of a particular hybrid service should be tailored to meet the needs of the neighborhoods it serves. Because they combine general public and paratransit services, hybrid routes do not need ADA complementary paratransit services.

Pierce Transit operates two forms of hybrid service:

- Zone routed services provide a vehicle to area residents at specified hours of the day. Customers must reserve a ride in advance. Zone routed services will transport customers from any part of the pickup zone to one or more drop-off points, where connections to other Pierce Transit services are provided.
- Deviated fixed-route services operate along a fixed route and schedule but will deviate off that fixed route to pick up passengers when they reserve a trip in advance.

Hours of operation, service frequency and bus stop locations provided on hybrid services vary, depending upon the specific needs of the area served. Generally, service levels are much less than what is offered on traditional fixed-route services.

New hybrid services should be determined to have the potential to transport five passengers per total vehicle hour of operation within three years of the startup of services. Hybrid services will be evaluated periodically on the basis of total passengers carried per vehicle hour and operating costs per passenger boarding. Each Hybrid service will be judged to be “S” (Satisfactory) or “U” (Unsatisfactory) based upon the results of this evaluation. Unsatisfactory routes will be considered for service level reductions or elimination, as appropriate.

Table C-2: Pierce Transit Hybrid Services

<u>Passengers per Vehicle Hour</u>		<u>Cost per Boarding Passenger</u>
New Routes (less than one year old):		
Satisfactory <\$11.30/pass		>3.0 pass/hr
Unsatisfactory >\$11.30/pass		<3.0 pass/hr
Routes one to two years old:		
Satisfactory	>4.0 pass/hr	<\$8.50/pass
Unsatisfactory	<4.0 pass/hr	>\$8.50/pass
Routes more than two years old:		
Satisfactory	>5.0 pass/hr	<\$6.80/pass
Unsatisfactory	<5.0 pass/hr	>\$6.80/pass
All costs in 2003 dollars. They should be indexed for inflation.		

Successes, Challenges and Lessons Learned with the Suburban Transit Services

In September of 2003 service on the Key Peninsula was converted from a “Loop” service to “Bus PLUS” service. Ridership went from 7 passengers per day to over 30 per day average. Bus PLUS service has resulted in lower reservation requests and more general use of the system for local trips as well. Customer response, given the service is only every two hours, weekdays only, has been excellent. Marketing for this type of rural services has been a challenge and opportunities to boost ridership are most likely to come from personal attention (neighborhood meetings, meetings with schools, senior centers, etc.).

Transferability to Other Systems

Designing a service that allows deviation based on time seems to allow flexibility for a service while allowing consistent hours of service to be known. Should more demand arise at a particular trip time than can be accommodated then, riders still have options to catch that trip or make a reservation on a later or earlier trip. Reducing call activity to a reservations center makes this option easy to integrate into an existing reservations center with minimal staffing and budget impacts. The system is flexible and allows operators to manage optimal operations at their discretion within set business parameters.

VALLEY METRO

Location: Phoenix

Contact Person: Teri Collins, Principal Transit Planner

Size of Agency: Medium – large

Transit Modes: Bus, light rail, shuttles

Agency Description

Valley Metro serves a population of 2.9 million with a peak-period fleet of 501 vehicles. Approximately 37 million annual unlinked trips are served with 1.25 million vehicle-hours and an annual operating budget of \$104 million.

Description of Suburban Transit Services

Valley Metro has 3 types of suburban services: express service, neighborhood circulators and RAPID. RAPID service makes fewer stops than the express as some express routes service as local routes in the suburbs. Plans are to move away from routes that provide both services. There is one flex route service in southwest Avondale.

Description of Operational Issues

Most of the fixed-route service is contracted out. Cities individually run and maintain their own Dial-A-Ride services.

Description of Funding Arrangements

The Valley Metro service area does not have a dedicated funding source. They usually get 2 percent of the half-cent sales tax. Some cities (Phoenix, Tempe and Glendale) have passed local dedicated taxes. These funds are only used for services that are strictly within their respective cities. There currently are no private partnerships with major employers, etc. These are avenues that are being explored.

Description of Marketing Program

On the whole, Valley Metro does very little marketing due to funding constraints. The City of Phoenix has marketed the RAPID service and neighborhood circulators—mostly because these are new services.

Description of Performance Measurement Program

Valley Metro does little to no performance based planning. Service evaluations are not routinely conducted because local politicians are not pleased with the resulting numbers. Ridership is monitored on a monthly basis, but is not used for service evaluation purposes. A

customer satisfaction survey is conducted on an annual basis. The results of this survey give the agency a better idea of where to center their focus.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

The root of a lot of the challenges faced by Valley Metro is the lack of a dedicated funding source. The agency is in the process of making service reductions in cities that do not have a local dedicated tax.

METROPOLITAN TRANSIT DEVELOPMENT BOARD (MTDB)

Location: San Diego, CA

Contact Person: Conan Cheung, Senior Transportation Planner

Size of Agency: Medium - large

Transit Modes: Bus, rail, trolley

Agency Description

The San Diego Metropolitan Transit Development Board (MTDB) provides regional Metropolitan Transit System (MTS) bus and rail services directly or by contract with public or private operators for southwestern San Diego County. MTDB's area of jurisdiction is approximately 570 square miles and has about 2 million residents. MTS consists of 15 express bus routes, 2 trolley routes, 74 local/urban bus routes, 6 demand-responsive services and 2 ADA complementary paratransit operators. These services have a peak fleet requirement of 173 vehicles and provide 547,000 revenue-hours of service. On average, MTS has an annual ridership level of 84.5 million unlinked trips and an annual operating budget of \$23 million.

Description of Suburban Transit Services

- Suburban: Intercommunity services, serves low to medium densities, inconsistent stop spacing
- Corridor Express: Operates on freeways/major arterials, usually compliments local service along corridor, less frequent stop spacing, more streamlined routing
- Commuter Express: Operates on freeways/major arterials during peak hours, limited stop, serving major employment centers
- Neighborhood: Provides neighborhood circulation, short routing

Description of Operational Issues

About one-third of MTDB's service is contracted out.

The agency's most utilized, and therefore most successful routes are those that target low-income, minority communities. Commuter Express services are also popular (mostly choice riders) because they utilize managed lanes on otherwise very congested facilities, such as the I-15.

Due to budget cut backs, most dial-a-ride services are being cut. There are currently some flex routes, however, they will also eventually be cut as a result of budget constraints.

Description of Funding Arrangements

Some routes use JARC funding. The air district funds some routes that provide service between the Coaster (commuter rail) and business parks.

Description of Marketing Program

Suburban transit services are not marketed any differently than other services. Some special market services will be especially advertised, but these are not necessarily suburban services.

Description of Performance Measurement Program

MTDB is in the process of making amendments to their performance measurement program. As it stands now, however, MTDB uses a service evaluation program that is equally based on quantitative and qualitative criteria. The quantitative criteria include three productivity measures: passengers per revenue mile, passengers per revenue hour and subsidy per passenger.

The qualitative criteria can be summed into 3 aspects: transit supportive land uses (population & employment densities, activity centers, pedestrian orientation), regional transportation priorities (support of MTDB's transit plan, support of major capital investments such as a transit center, serves a congested corridor) and quality of service (operator priority, schedule adherence and reduces overcrowding).

Land-use data is collected by SANDAG.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

As smart growth has become trendier, there are pockets of new residential development that are based on neotraditional design (e.g., Otay Ranch). In MTDB's experience, while these areas are more transit friendly, the residents living in these areas are typically more affluent and not as likely to use transit. In areas where concentrations of transit captive customers reside, site design is not as conducive to transit use; however, ridership levels in these areas are much higher.

Transferability to Other Systems

MTDB's service planning and evaluation methodology are relatively sophisticated as they are able to utilize regional data from SANDAG. Not all agencies are likely to have the same data resources, though MTDB would serve as a good example to other agencies of what they could do given the right resources.

Suburban bus services in the San Diego do not demonstrate the same level of innovation as found in other notable case studies.

KING COUNTY METRO (METRO)

Location: Seattle, WA

Contact Person: Mike Beck, Transit Contractor Administrator, 206-684-1753

Size of Agency: Large

Transit Modes: Bus, rail, shuttle

Description of Suburban Transit Services

In the suburban communities in King County, Metro provides the DART transit program which is a combination of fixed-route and route-deviation service. The service has been in operation since the early 80's and provides transit service to the general public in areas with low population densities and multiple destination points. The service is established on fixed routes for increased productivity, but each route has an element of route-deviation to improve rider convenience.

Description of Operational Issues

Requests made for deviations off the fixed route are made within a previously designated zone and are limited to the time available to provide such service while still maintaining the fixed-route schedule. The DART service is provided by a contractor who is responsible for operating the routes and providing the staff, vehicles, facilities and equipment necessary for the service. The contractor manages the day-to-day operation of the service, including a call center for scheduling and dispatching trip reservations. Metro establishes a multi-year contract with the service provider, who is paid once a month based on the contract's hourly rate.

Description of Funding Arrangements

Funding for this service comes from the County's annual operating budget for transit service.

Description of Marketing Program

There is no marketing program for DART service.

Description of Performance Measurement Program

Performance is primarily measured by productivity and on-time operations. Data is collected and provided by the contractor as a requirement under the service contract. In addition, Metro has staff that monitors the service performance in the field. The data and performance information is provided to the DART program manager. The findings are used to evaluate schedules, driver performance, routing revisions and other service factors.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

The DART program has proven to be an effective transportation tool for providing convenient, cost-effective service for suburban communities. The service operates primarily as fixed-route service using transit vans, but has the flexibility to deviate off the specific routing within a limited service area. This concept of combining fixed-route service with route-deviation flexibility has increased productivity while providing more convenient service for suburban areas.

The challenge continues to be managing the schedules and routes for service that has both a fixed-route element and the ability to deviate off route. The fixed-route service must have time available to make deviations but still maintain the fixed schedule. Establishing the service areas for deviations must be large enough to make the service convenient, but not so large that the deviations result in poor schedule adherence.

For this type of service, it is important to have performance standards clearly identified in the contract. In addition, the staff has found that financial penalties and incentives are effective tools in managing the service quality provided by the contractor. Also, it is important that customer communication pieces (timetables, website, etc.) provide clear information about the nature of this service and how it can be used, since it differs from regular transit.

Transferability to Other Systems

It is assumed the DART service program used by King County Metro could be incorporated by other transit agencies, particularly in areas that have communities with low population densities and multiple destination point. This type of service is generally more productive than strict dial-a-ride, but can provide more customized service with the flexibility of route deviation.

DENVER REGIONAL TRANSIT DISTRICT (DENVER RTD)

Location: Denver, CO

Contact Person: Jeff Becker, Senior Manager of Service Development

Size of Agency: Large

Transit Modes: Light rail, fixed-route bus service, express routes, and ADA paratransit service

Agency Description

Denver RTD provides transit service to 38 municipalities in 6 counties. Its service area is 2,406 square miles and has a population of 2.5 million. RTD operates 175 fixed routes and had nearly 79 million annual passenger trips in 2003.

Description of Suburban Transit Services

RTD operates a number of suburban transit services throughout its service area. One of the more interesting services is RTD's Call-n-Ride (cnR) service, which is general purpose demand-response service operating in geographically defined communities. The cnR service is shared-ride public transportation service that requires passengers to call the service provider to arrange for their pick-up. Instead of calling a central dispatch office to make their reservation, passengers call the driver directly on his/her cell phone. The driver then schedules the trip and provides the passenger with an estimated pick-up time. Smaller vehicles are used to provide this service. RTD has been operating the cnR service since 2000 and the service generally transports between 3 and 5 passengers per hour at a \$9 to \$14 subsidy per passenger.

Description of Operational Issues

All cnR service is contracted out to a private operator. By decentralizing the responsibilities for vehicle routing and scheduling to the drivers, the cnR program reduces the cost of control room personnel and facilities compared to traditional demand-responsive service delivery (e.g., access-a-Ride), but also burdens the driver with these responsibilities. The totally manual solution now in place for drivers is time consuming, error prone, distracting, and requires significant back-office data entry and analysis. RTD is considering a transition to mobile computer technology that will simplify driver's order taking, scheduling, and data recording responsibilities, as well as automating the most of the back-office data compilation requirements. Making this task easier, safer and efficient has the potential to make drivers more productive and improve quality of service for the customer. In addition, RTD would have the basis to incrementally modernize service delivery. This application and its data communication component is also intended to function as a building block for future cnR technology innovations, for example, internet reservations, e-mail, driver maps/directions (positioning), caller ID data capture, and automated scheduling assistance.

Description of Funding Arrangements

All suburban transit services, including cnR service, are funded through RTD's regular set of revenue sources, including farebox revenues and local, state and federal funds.

Description of Marketing Program

RTD uses their traditional advertising channels to market and promote the cnR service, including direct advertising, special events, promotional materials, and the RTD website. RTD also believes in strong customer service and conducted a ridership survey in late 2000 to gauge customer satisfaction with the cnR service. When asked to rate their overall satisfaction with cnR service, customers rated the service between good and very good, or 4.6 on a scale from 1 to 5. Availability of cnR when wanted, on-time performance and driver courtesy were the three factors that had the greatest influence in respondents overall satisfaction.

Description of Performance Measurement Program

Data is regularly collected by RTD to evaluate the cnR services. RTD staff calculates productivities for each of the cnR service areas and evaluate their performance to one another and to established performance standards for the cnR service. As necessary, staff recommends corrective action to address poorly performing cnR service.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

RTD's cnR local circulation and feeder service provides many-to-many and many-to-one service to its customers through an innovative approach to service delivery. The cnR service provides complementary service to many of the other more traditional transit services operated by RTD, which likely results in an overall increase in ridership for the transit system. As mentioned above, there have been some operational issues with the cnR service that RTD is taking measures to address through the use of mobile computing technology, but the service has generally been considered a success. In fact, due to the success of cnR services, RTD has replaced poorly performing fixed-route service with cnR service, which has resulted in a higher performing service that serves the community better.

Transferability to Other Systems

The cnR service should be highly transferable to many communities with similar a similar service area and network of transit services to RTD.

TRI-COUNTY METROPOLITAN TRANSPORTATION DISTRICT (TRIMET)

Location: Portland, OR

Contact Person: Kerry Ayres-Palanuk, Service Planner

Size of Agency: Large

Transit Modes: Bus, light rail, ADA paratransit, general public dial-a-ride

Agency Description

TriMet is the transit service provider for the majority of the Oregon portion of the Portland metropolitan area, serving a 575-square-mile area that includes the city of Portland and many of its suburbs. As described in more detail in the Wilsonville, Oregon case study, Oregon law permits Portland's smaller, outer suburbs to withdraw from the TriMet district; four cities in 15 years have chosen to withdraw and start their own transit services and thus are no longer (or only minimally) served by TriMet.

Description of Suburban Transit Services

Three types of suburban transit services are addressed in this case study:

- Cedar Mill Shuttle, a general demand-response service feeding a light rail station;
- Suburban circulator routes in Clackamas County; and
- Shuttle routes in Washington County distributing trips from light rail to major employers.

Cedar Mill Shuttle

The Cedar Mill Shuttle started in 1999 as a weekday many-to-few general demand-responsive service in the Cedar Mill area, a primarily low-density, somewhat hilly residential area located about 8 miles west of downtown Portland by road. The service area covers 2.6 square miles.

When service started in 1999, it was contracted to a local taxi company. TriMet's union agreement allows contractors to provide service for pilot projects for 18 or 36 months, after which time the service must be brought in-house or eliminated. It served the Sunset Transit Center light rail station, as well as several other designated destinations within the area (e.g., supermarkets and a library). When TriMet brought the service in-house in 2002, the service hours were reduced to peak hours only as a cost-saving measure, based on an analysis that showed that most trips were commute trips to and from the light rail station. Although, in theory, one could use the shuttle to access other destinations within the service area, the service is currently promoted as a many-to-one light rail feeder.

A 12-passenger accessible van is used for the shuttle. One-day advance notice is preferred, with reservations being handled in-house by a TriMet Trainer. Same-day service can be provided subject to availability (the driver is called directly for same-day requests and for last-minute changes or cancellations). Subscription service is offered. Regular TriMet fares are charged (currently \$1.30–\$1.60, depending on overall trip length, with free transfers). The pick-

up window is +/- 10 minutes of the scheduled time, and the driver will wait one minute after arriving. The shuttle currently operates weekdays, 6–9 a.m. and 3–7 p.m.

Clackamas County Circulators

The northwestern portion of Clackamas County is urbanized and is part of the Portland metropolitan area. It includes the cities of Oregon City and Milwaukie, smaller outlying communities such as Happy Valley, and an extensive amount of unincorporated urban residential land.

In the late 1980s, demand-response service was started in the Milwaukie area, later converted to deviated-route service due to low ridership, and eventually, after the passage of the ADA, converted to fixed-route service. This route is now Route 152, *Milwaukie*, which runs between a transit center in downtown Milwaukie and the Clackamas Town Center regional mall and transit center, serving retail developments and residential areas along the way.

In 1992, the County Board of Commissioners requested that TriMet extend service to the area along Sunnyside Road, which ran through a hilly, rapidly urbanizing portion of the county. More of TriMet's customers requested that service be provided to the Sunnyside area than any other portion of the region. Further, a 1,900-home "neo-traditional" development, Sunnyside Village, was proposed toward the east end of the corridor.

In May 1993, the Sunnyside Shuttle began service within the Sunnyside area, connecting to the Clackamas Town Center. Service was originally demand-responsive, because it could be contracted out and therefore was less expensive than fixed-route service would have been. TriMet's ADA contractor was used to provide the service and handle reservations. The same minibuses used for ADA service were used for the shuttle routes. Following discussions with the union, the service was brought in-house in December 1994, a conversion that "was neither anticipated nor planned." Costs increased from \$27/hour as a contracted operation to \$50/hour with union operators. A union dispatcher was also required to handle reservations.

Route 154, *West Linn*, was started in 1994. It connects a hilly, residential area to the Oregon City Transit Center.

In 1995, TriMet's service district was expanded to include Sunnyside Village and the city of Happy Valley, and service was extended to those areas. In 1998, in an effort to reduce the cost per ride, eliminate the need for the dispatcher dedicated to these routes, reduce peak bus requirements, and increase local awareness of bus service and local ridership potential, the demand-responsive service was proposed to be converted to fixed-route service. TriMet took input from current riders, the general public, and agency staff, and combined it with demand-responsive trip patterns, population data, and land-use data to develop four fixed routes. The new routes were implemented in March 1999 and were operated using 27-foot buses.

Routes 155, *Sunnyside*, and 156, *Mather Road*, form a loop between Clackamas Town Center and Sunnyside Village—an eastbound Route 155 becomes a westbound Route 156 bus on the return trip, and vice versa. Route 157, *Happy Valley*, travels between Clackamas Town Center and Happy Valley, duplicating Route 155 for the portion of its route along Sunnyside Road. Buses are scheduled to spread out the 155 and 157 buses, resulting in alternating 20- and 40-minute headways on the shared portion of the routes, rather than having two buses arriving

together every 60 minutes. Route 158, *Stevens*, served an area closer to the Clackamas Town Center than the other three routes, but was discontinued in December 2002 due to low ridership.

The Sunnyside routes currently operate hourly with service on weekdays and Saturdays; Routes 155 and 156 also provide Sunday service. The Milwaukee and West Linn routes operate hourly on weekdays only; the Milwaukee route provides 30-minute peak service. Regular TriMet fares are charged.

Westside Light Rail Feeders/Distributors

When TriMet's light rail line was extended west to Washington County in 1998, much of the western end of the line between Beaverton and Hillsboro ran through relatively undeveloped land adjacent to the former railroad right-of-way that was used for the line. This land is planned for—and, in some areas, has already developed as—transit-supportive residential uses, whose residents can walk to light rail to travel to jobs in downtown Portland. At the same time, several large employers, such as Intel and Nike, plus a number of office parks, are located in Washington County. Their employees who live elsewhere in the region potentially could use transit to commute in the opposite direction to work. These job sites are located beyond walking distance from the light rail line. Therefore, there was a need to provide a bus connection between the stations and the job sites for light rail to serve those trips. Finally, bus service in residential areas on the west side generally was realigned to feed the light rail stations.

Four routes (41, *Hawthorn Farm*, 42, *Orenco*, 49, *Quatama*, and 50, *Cornell Oaks*) were developed to distribute trips from light rail stations to job sites; all were discontinued between 2002 and 2004. Two other routes (46, *North Hillsboro* and 47, *Baseline/Evergreen*) toward the east end of the light rail line serve a mix of poorly connected, medium-density residential areas and office parks and have been somewhat more successful. Service is or was provided by standard 30- and 40-foot buses. Regular TriMet fares are charged.

Description of Operational Issues

TriMet's union agreement requires that all service be provided in-house, except for the first 18 or 36 months of pilot projects. Other than the van purchased for the Cedar Mill Shuttle when TriMet took over the service, all other routes use buses that are part of the regular fleet. When the Sunnyside fixed-routes were being designed, residents of local streets being proposed as turnarounds strongly objected. As a result, routes were redesigned to travel only on the major traffic streets in the area. On the west side, at least one major employer (Intel) operated its own private shuttle system that connected four of its campuses and two light rail stations. The Intel service was more attractive to Intel's employees not because of cost (employees' transit costs were provided as a benefit, so there was no cost to employees to use either Intel's shuttle or the TriMet service), but convenience. The Intel shuttle ran more frequently and stopped at the building entrance, while the TriMet service stayed on the street, requiring a several-minute walk across a parking lot to get to the building entrance.

Description of Funding Arrangements

All services are funded solely by TriMet. The majority of TriMet's operating revenue (54% in 2003) comes from a 0.6218 percent payroll tax levied on employers within the district.

Description of Marketing Program

Marketing efforts (brochures) were made when the Cedar Mill Shuttle started and when TriMet took over operations, but not much has been done since. TriMet staff meet with the Cedar Mill Community Planning Organization annually to review the service and get feedback.

TriMet's marketing department sponsored a public meeting during the service design phase of implementing the Sunnyside fixed-route services. A marketing brochure was also mailed to all households and businesses in the community. No general marketing efforts are currently underway for the Clackamas services.

TriMet's employer coordinators worked with west side employers to promote the shuttles to employees who might benefit from them, and a special branding was designed for them ("The Local") and a few similar services elsewhere in the region.

Special efforts are made to redesign and/or promote a service when it is determined to be low-performing. For the West Linn circulator, for example, TriMet solicited public input and met with City of West Linn staff in an effort to find ways to make the route more attractive. As a six-month trial, the route was shortened and the frequency doubled to half-hourly; however this experiment does not appear to have improved ridership. If the route is eventually eliminated, TriMet plans to use the service hours to improve service on a trunk line serving West Linn.

Customer satisfaction is measured the same way for the suburban services as for other TriMet services. TriMet tracks compliments and complaints on a continual basis, and conducts an Attitude and Awareness Survey once a year.

Description of Performance Measurement Program

The main performance measure used is boarding rides per vehicle hour, with TriMet's threshold for a low-performing route being 15 boarding riders per vehicle hour. The Cedar Mill Shuttle does not have a defined performance threshold; qualitatively, TriMet's performance expectations are lower for it than for fixed-route service.

Except for the Cedar Mill Shuttle, boarding rides are collected using automatic passenger counters, which are installed on most of TriMet's fleet. The data are evaluated quarterly by the service planning department and are used to adjust service as needed. Passenger boarding data for the Cedar Mill Shuttle are collected by the van operator and are reviewed by the shuttle project manager.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

The Clackamas County suburban circulators have been modestly successful, with growing ridership, with the exception of the West Linn route. The Sunnyside routes draw their best ridership from the multi-family residential along Sunnyside Road itself, and less so from the

single-family residential areas away from the Sunnyside Road; in that respect, the Happy Valley portion of Route 157 “struggles,” even though the route as a whole meets TriMet’s performance criteria.

The lesson from the west side light rail distributors was that service that has a single destination (e.g., one major employer) is very difficult to serve effectively. The economic downturn that started in 2001 hurt ridership on those routes, as companies in the area laid off employees and reduced the potential customer base for those routes. The private shuttle service offered by Intel competed with one of the routes for customers and offered better headways, as well as service to the building door. Most of the high-tech manufacturing plants on the west side are set well back from the street and are surrounded by large parking lots, making them difficult to serve: if service remains on the street, customers must walk a considerable distance to their destination; if service is allowed to enter the site, travel time increases. The two routes studied that serve both residential (albeit low-density residential) and office parks, with connections to light rail, are not meeting TriMet’s performance standard, but are showing gradual increases in ridership.

As a 14-hour-per-day service, the Cedar Mill Shuttle averaged about 135 boardings per day. In its new peak-period-only configuration, the shuttle averages 50-55 boardings per day. Clearly, there was a midday market for the service; however, the cost differential between the contracted operation and the unionized in-house operation required the reduction in service.

Transferability to Other Systems

The west side feeder and Cedar Mill Shuttle experience would be most applicable to agencies operating rail or rapid bus service, where connections are required between stations and trip origins or destinations. The Clackamas County circulator experience is applicable to developing suburban areas, particularly those with topographical constraints.

CHAMPAIGN – URBANA MASS TRANSIT DISTRICT (C-UMTD)

Location: Champaign - Urbana, IL

Contact Person: Mike Stubbe

Size of Agency: Medium

Transit Modes: Fixed-route bus service, shuttle service, ADA paratransit

Agency Description

C-U MTD has operated local bus service in Champaign and Urbana since 1970. Beginning in 1989, C-UMTD also began operating bus service on the University of Illinois campus. In FY 2001, C-UMTD's ridership figures were over 10 million.

Description of Suburban Transit Services

Demand Responsive (dial-a-ride) service operates within an area with fixed boundaries. The service operates from a pulse (transfer) point every 30 minutes, where connections to fixed-route services can be made. Customers within the area can schedule a ride during the service's operating hours by calling a published number and speaking directly with the driver of the vehicle. The customer provides the driver with a street location for pick-up, their destination, and whether or not they need to transfer to a fixed-route service. The driver will provide the customer with an estimated time of arrival. Trip making consists of passengers traveling between points within the service area and passengers utilizing the service to complete trip making between fixed-route services at the pulse points. The Demand response service operates in low density areas of a community (total population of 125,000) where ridership does not warrant fixed-route service or the area and street network is conducive to implementing fixed-route service. The demand-response service utilizes smaller vehicles, such as 10-13 passenger vans. The service typically operates during off-peak service periods (i.e. Evenings and Weekends).

C-UMTD operates three Direct routes, which are demand-responsive services where passengers can either board at one designated location or call C-UMTD to be picked up. Two of these (Southeast and Southwest Direct) operate during the weekday evenings and on weekends in substitution for fixed routes that operate during the weekday daytime period. The other (Northeast Direct) runs during the weekday peak period.

The Northeast Direct serves an area in northeastern Urbana that is a mix of light industries, a mobile home park, and other low-density residential areas. Service is provided during the weekday peak periods from 6:55 a.m. to 9:06 a.m., and from 4:06 p.m. to 6:06 p.m. The Southeast Direct service operates in Urbana during weekday evenings and on weekends in substitution for weekday daytime fixed-route service. It runs on weekdays from 7:44 p.m. to 11:25 p.m., on Saturdays from 7:00 a.m. to 11:25 p.m., and on Sundays from 9:14 a.m. to 5:25 p.m. There are several shopping centers in this zone. The rest of the service area is a mix of single-family homes and apartment complexes. The Southwest Direct service is based at a shopping center in Champaign. It runs from 7:48 p.m. to 11:25 p.m. on weekday evenings, 7:00 a.m. to 11:25 p.m. on Saturdays, and 9:18 a.m. to 5:40 p.m. on Sundays. The District has been utilizing this service concept for seven years. In FY 2003, the Direct services transported a total of 25,839 passengers at a cost of \$221,973.

Description of Operational Issues

C-UMTD operates service internally at same hourly rate as other services. No significant constraints exist for operating this service. Bus drivers serve as the dispatcher for the Direct service, which can create challenges for the drivers at times. Due to the designated pickup location for the Direct service, there are instances in which passenger's travel times are extended in order to serve this location as scheduled.

Description of Funding Arrangements

C-UMTD does not have any special partnerships for funding the Direct services. Similar to all transit services, the Direct services are funded through farebox revenues, local property tax revenues and state funding.

Description of Marketing Program

Other than the regular channels that C-UMTD uses to market all its transit services, there are no special marketing approaches taken to market the Direct services.

Description of Performance Measurement Program

Every four months the District completes a performance evaluation of each service type. Passengers per hour is the key performance indicator for C-UMTD. C-UMTD's Direct routes are expected to transport a minimum of 2.5 passengers per hour. C-UMTD's Operations Department reviews the system's performance and provides staff reports to the C-UMTD Board. Individual Direct services that fall below this level are evaluated to determine if any measures could be taken to increase ridership. If it is determined that there are none, then the possibility of reducing the level of service or total elimination is explored. Individual Direct services that exceed 7.5 passengers per revenue hour, which is 50 percent greater than the peer average, become candidates for improved service. This can include adding vehicles to improve frequency, expanding the coverage area, or conversion to fixed-route service. C-UMTD occasionally performs customer service surveys to gauge overall customer satisfaction.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

Direct service has had better success when it substitutes for fixed-route service in lower demand times, such as evenings and weekends. Ridership is lower on the Northeast Direct, which serves a lower density area that does not have any fixed routes. Basing the service at a location that is both a destination and a major transfer point is an important feature in the design of C-UMTD Direct services, particularly when timed transfers are scheduled. Trip purpose is also an important factor that influences the success of these C-UMTD routes. Direct service is convenient for local shopping trips that stay within a neighborhood. Many of these trips are taken during the evenings and on weekends, which are when the routes perform the best. A disadvantage of having one of these demand-response routes based at an outlying location, which tend to be served by fewer routes, is that some passengers may have to transfer twice to complete

their trip, which increases travel time and reduces systemwide ridership. Because of the demand-response feature of the C-UMTD Direct services, passenger productivity can be expected to be lower than fixed-route service.

Based on the experience of C-UMTD and other similar services, the Direct service is not expected to exceed an average of ten passengers per vehicle hour. Of the three Direct services, the Northeast Direct is the only one performing below the recommended standard. Another lesson learned for the analysis of the Direct services was that it relied primarily on two types of trips for ridership – riders accessing a major shopping destination and those transferring to fixed routes. The fact that the transfer location and shopping generator were one and the same in the case of the Southeast and Southwest directs were largely what made those services successful.

Transferability to Other Systems

It is expected that these services are fully transferable to other areas with similar land-use characteristics. This service model appears to do best in areas in which the demand-response service supplements regular daytime fixed-route service during off-peak periods such as evening and weekends. This is the case with the Southwest and Southeast Direct services, but not with the less productive Northeast Direct service. Having demand-response services complement fixed routes provides an existing base of fixed-route bus riders who may be willing to use a demand-response service in some instances. Building a ridership base for general public demand-response services from scratch would be considerably more challenging, however.

DES MOINES METROPOLITAN TRANSIT AUTHORITY (DMMTA)

Location: Des Moines, IA

Contact Person: Donna Grange, Paratransit Director; Sherry Cooper, DMMTA analyst;
Becky Wymore, MPO contact

Size of Agency: Medium

Transit Modes: Fixed-route bus, express bus, demand-response, and paratransit

Agency Description

DMMTA serves a population of 371,000 with a peak-period fleet of 175 vehicles. Approximately 4.2 million annual unlinked trips are served with 230,000 vehicle-hours and an annual operating budget of \$12 million.

Description of Suburban Transit Services

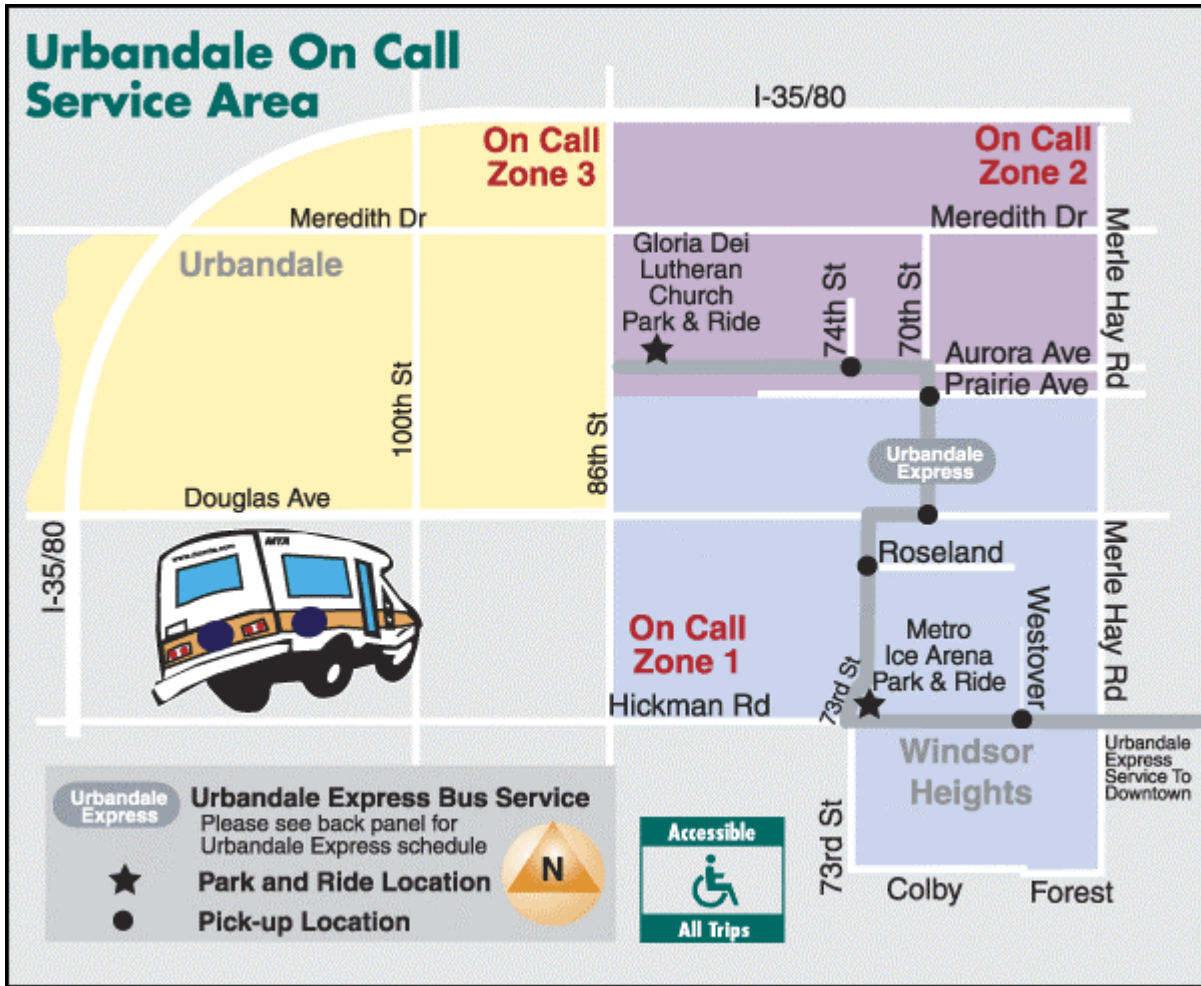
DMMTA has operated demand-responsive night services in the southern and eastern parts of its service area for more than 5 years. Two years ago, the agency expanded the concept to include a weekday peak-period feeder service in suburban Urbandale and a midday service in suburban Johnston.

Description of Operational Issues

The night service operates with one vehicle providing service between 6:30 p.m. and 11:00 p.m. on weeknights from the downtown transit hub to two zones in southern and eastern Des Moines. The service is available only to customers requiring drop-offs more than 4 blocks from a bus route. The vehicle returns to the transit center every 60 minutes to make timed transfers with fixed routes. Reservations are accepted by a supervisor before 6:00 p.m. and transmitted to the driver on a written manifest. Calls after 6:00 p.m. are relayed by radio on a first-come, first served basis. The service was started before cellular telephones were widely available and the operating procedure has not been updated.

The Urbandale On-Call service replaces three express routes with one modified express route and three zones services that provide feeder and distributor functions. Anyone can ride. The service operates on weekdays between 5:45 a.m. and 8:45 a.m. and between 3:45 p.m. and 6:30 p.m. Some reverse commute demand is accommodated. A central call center handles advanced reservations, which represent 95% of demand. The driver has a cellular telephone and accepts spontaneous requests en-route. When demand is high, DMMTA negotiates slight adjustments in pick-up time or locations with customers. The service area is shown in the figure below.

Figure C-2: Urbandale On Call Service Area



The Johnston On-Call service shares a vehicle with the Urbandale service and operates on Tuesdays between 9:00 a.m. and 3:00 p.m. While anyone can ride, a major function of the service is to serve shopping trips for seniors. Recreational, medical, and after-school employment trips are also served.

DMMTA operates all of the services with paratransit drivers who volunteer for the duty and enjoy the challenge. When demand is high, adjustments to pick-up times or locations are negotiated with customers. The \$2.00 fares are greater than those of the regular fixed-route services.

Description of Funding Arrangements

The night services are funded with JARC grants and are intended for employees who end work after the afternoon peak period. The Urbandale feeder service is funded with a CMAQ grant. The city of Johnston funds the midday circulator.

Description of Marketing Program

DMMTA has relied on word of mouth since shortly after the initiation of the Urbandale and Johnston On-Call services. Initially, the services were promoted with flyers on vehicles at park-and-ride lots, flyers at apartment complexes, bulletin boards at grocery stores and community centers. The night services have not received much marketing.

Description of Performance Measurement Program

DMMTA tracks the NTD statistics for each service, but has established no rigid standards. The night services average 2.5 passengers per hour. The Urbandale service averages between 4.2 and 8.2 passengers per hour, depending on zone. The Johnston service averages approximately 2.9 passengers per hour. The Urbandale service has also diverted some people from paratransit, resulting in significant cost savings. DMMTA has received no negative feedback from customers.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

DMMTA has learned about optimum zone sizes and demand levels. Zone sizes range from approximately 2 to 4 square miles. DMMTA is comfortable accommodating at least 4 passengers per hour per zone, which is slightly greater than its paratransit productivity of 3.5 passengers per hour.

Transferability to Other Systems

DMMTA provides limited experience operating flexible services and could provide several good data points to compare with other systems.

DMMTA has provided historical data on operating experience with Urbandale On-Call service and the express routes it replaced. This data is summarized in the tables and figure on the following page.

Table C-3: Urbandale On-Call Operating Statistics

Urbandale On-Call

Before - After Comparison:

Average Ridership on 3 Express Routes before On-Call	3,292
Average Ridership on 1 Express Route after On-Call	3,527
Average Ridership on 3 Flex Feeders	1,873

Operating Performance by Zone	Zone 1	Zone 2	Zone 3	All
Approximate Zone Size (sq. mi.)	4.2	2.0	3.9	10.1
Average Monthly Revenue Hours	103	111	98	311
Average Monthly Revenue Miles	1,176	842	1,234	3,251
Average Monthly Passengers	841	464	568	1,873
Average Monthly Passengers per Sq. Mi.	200	237	146	186
Average Monthly Revenue Hours per Sq. Mi.	25	57	25	31
Average Monthly Revenue Miles per Sq. Mi.	280	429	317	323
Average Passengers per Hour	8.2	4.2	5.8	6.0
Average Passengers per Mile	0.7	0.6	0.5	0.6
Average Miles per Hour	11.4	7.6	12.6	10.4

Figure C-3: Urbandale On-Call Ridership

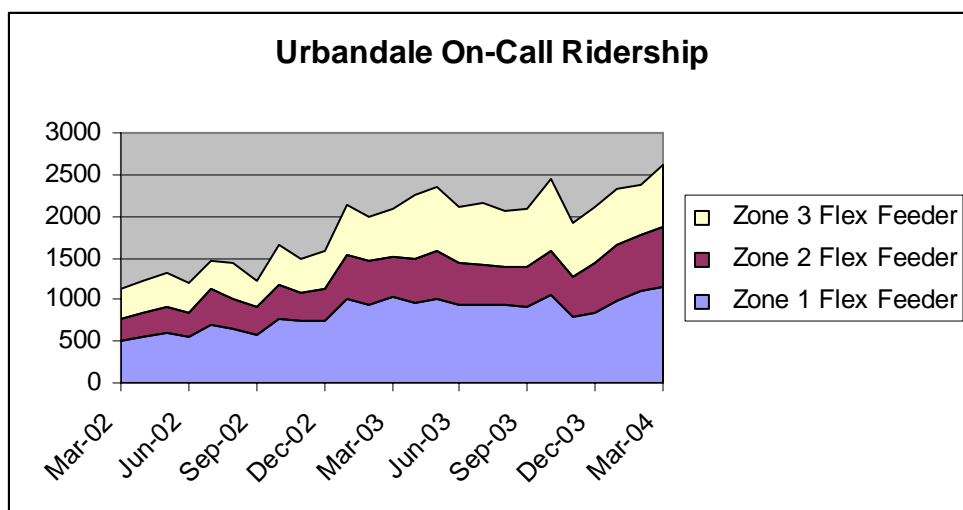


Table C-4: Johnson On-Call Operating Performance**Johnson On-Call**Operating Performance

Average Monthly Revenue Hours	46
Average Monthly Revenue Miles	548
Average Monthly Passengers	134
Average Passengers per Hour	2.9
Average Passengers per Mile	0.2
Average Miles per Hour	11.8

MADISON METRO

Location: Madison, WI

Contact Person: Julie Maryott-Walsh, Marketing Manager

Size of Agency: Medium

Transit Modes: Fixed-route bus, express bus, and paratransit

Agency Description

Madison Metro serves a population of 219,000 with a peak-period fleet of 240 vehicles. Approximately 35 million annual unlinked trips are served with 468,000 vehicle-hours and an annual operating budget of \$36 million.

Description of Suburban Transit Services

Madison Metro reorganized its system in 1998 to serve four transit hubs through its downtown isthmus. These transit hubs serve as transfer points between routes going through the center of the city and local community circulators. The transit hubs are generally located on the periphery of Madison before reaching areas where newer automobile-oriented development predominates. None of the community circulator routes currently exhibit any flexibility or targeting to specific trip purpose or destination markets.

Madison Metro operates one reverse-commute limited-stop route to an employer that relocated from downtown Madison to the suburbs. This service is the subject of the following discussion.

Description of Operational Issues

The reverse commute express has been in operation since April 2002. The service operates on weekdays with one trip in the morning and one trip in the afternoon. The service provides limited-stop point-to-point service from near the former downtown location of Alliant Energy to the American Center office park. The business park accommodates 48 employers with more than 4,000 employees, including Alliant Energy, American Family, and University of Wisconsin Health / Herzog College. Madison Metro also provides taxi vouchers to participating employers as a “guaranteed ride home” program.

Description of Funding Arrangements

When the service was initiated, the developer of the office park contributed \$25,000 and to cover the first four months of operating costs. In exchange it received a number of special passes to distribute to subscribers at employers in The American Center Owner’s Association. After interlining the route with its regular fixed-route system, Madison Metro assumed the costs of the route. Many employees take advantage of a commuter benefit program.

Description of Marketing Program

Madison Metro worked through American Center employers to distribute flyers and emails to employees. Subscribers were provided with free passes for four months, personalized trip itineraries, and a guaranteed ride home. The agency followed up with surveys of commuting frequency and travel patterns.

Transferability to Other Systems

This single service may not be sufficient to warrant a full case study in Madison.

SUBURBAN MOBILITY AUTHORITY FOR REGIONAL TRANSPORTATION (SMART)

Location: Southeast Michigan, including Wayne, Macomb and Oakland counties

Contact Person:

Size of Agency: Medium

Transit Modes: Bus, ADA paratransit

Agency Description

SMART is a suburban bus agency that operates fixed-route and advanced reservation demand-response service in three southeast Michigan counties: Wayne, Oakland, and Macomb. SMART operates sixty-two routes, serving suburb to suburb trips and service operating between the suburbs and Detroit. SMART's fixed-route ridership was 8.4 million last year. In 1967, SEMTA (now SMART) began fixed-route service including some routes that it had acquired from private operators. Some of those early routes have continued to this day. Demand response service started in 1975 and ADA paratransit service began in 1994.

Description of Suburban Transit Services

SMART operates several types of demand-response services including advance reservation, flex route, ADA Paratransit, and Job Express service. Job Express service is provided in specified job express zones, offering same day demand-response trips between the fixed-route bus stop and the passenger's destination or pick up location within the zone. Flex route service began in 1995.

SMART indirectly provides service through its Community Partnership Program (CPP). The CPP is a unique vehicle procurement program designed to help local communities acquire vehicles by using federal funds and revenue generated by county transportation millages (local tax). The CPP gives communities control of transit service that meets their specific needs. Fifty-five community partners provide service through this program. The CPP began in 1996, expanding upon a purchase of service program involving four local service providers.

Description of Operational Issues

All fixed-route service is operated internally. Demand response service is operated internally and by communities participating in the Community Partnership Program. Some night and weekend ADA trips are assigned to designated private operators. Regarding capital requirements, SMART has purchased 136 paratransit vehicles over and above its normal requirement to support the services operated by the CPP providers. In addition to the benefit of flexibility, this program is a cost efficient way to provide local service, as it would cost SMART significantly more to provide these services internally.

Description of Funding Arrangements

These services are funded through federal, state and local millage (property tax). The use of millage tax revenue requires a number of partnerships including participation from county commissions, special purpose transit authorities, and 75 local communities.

Description of Marketing Program

Radio, TV, newspapers, local community outreach programs, public forums (e.g., transportation fairs), targeted outreach to local businesses, SMART web site (www.smartbus.org). Customer satisfaction is measured through periodic customer surveys and by tracking comments/complaints received.

Description of Performance Measurement Program

SMART collects data daily for its performance measurement program, which consists of basic operational items such as passengers, hours, miles, accidents, complaints received, etc. SMART management reviews the data and the services are primarily evaluated based upon their productivities, ridership, and number of complaints received.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

Need to closely monitor that the service is meeting the needs of the communities served; particularly as it relates to SMART's target market of entry level employees, older adults, and persons with disabilities.

TOLEDO AREA REGIONAL TRANSIT AUTHORITY (TARTA)

Location: Toledo, OH

Contact Person: Jim Gee, Director of Planning

Size of Agency: Medium

Transit Modes: Fixed-route bus, express bus, demand-response, and ADA paratransit.

Agency Description

TARTA serves a population of 429,000 with a peak-period fleet of 188 vehicles. Approximately 3.6 million annual unlinked trips are served with 328,000 vehicle-hours and an annual operating budget of \$22 million.

Description of Suburban Transit Services

TARTA operates Call-a-Ride services in three suburbs to serve intra-community trips and to provide connections to the regional fixed-route system. The first service was initiated in Perrysburg in 2002. Maumee was added a year later. Sylvania began service in March 2004.

TARTA also operates the Alexis Industrial Express, a reverse-commute service between the downtown Toledo transit center and an employer that relocated to the suburbs. A second reverse-commute express operates to the Arrowhead business park, a large industrial area, but this service is not targeted at any specific employer.

Description of Operational Issues

Call-a-Ride services are provided using a single 19-passenger cutaway bus in each community. All reservations and route planning is performed by drivers who volunteer for this challenging and customer relations-intensive duty. Services operate from 6:00 a.m. to 9:00 p.m. on a 60- to 80-minute headway in a route-deviation format along a designated loop route with timepoints. Approximately 50% of the running time is allocated to deviations. Passengers can call the driver just before the bus reaches them, but deviations are provided on a first-come, first-served basis. No subscriptions are offered. The 50¢ fare is less than for regular TARTA service.

The service is popular with senior citizens and students after school. Seniors are generally comfortable with the reservation procedure and their travel times overlap very little with the students. The majority of riders travel within the community without any transfer to other regional bus services.

Description of Funding Arrangements

Call-a-Ride services are funded from the same 2.5 mil property tax and fare revenue as the rest of the TARTA system. The suburbs like the service because they perceive that they are getting better return on their contribution to the regional transit system, even though service hours have not necessarily increased.

Description of Marketing Program

TARTA has promoted the Call-a-Ride service in each community through community newspapers, presentations at city council, speakers' bureau services, posters, and yard signs. A similar approach is used each year as TARTA adds a new service area.

Description of Performance Measurement Program

Call-a-Ride services average from 20 to 80 passengers per day in each community or approximately 3 passengers per vehicle-hour (TARTA paratransit averages 2.4 passengers per hour). No customers are diverted from paratransit. TARTA follows up after one year of service with a customer satisfaction survey, which have been positive. TARTA monitors route alignment and response time more than riders per hour. Given that similar coverage could not be achieved with a fixed-route service and its performance would likely be low in these suburban settings, TARTA is generally satisfied if the service outperforms paratransit.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

TARTA initially marketed the service as a large taxi. This created expectations of a private ride and the agency has had to work to make the concept of shared rides acceptable to some passengers.

On the Arrowhead Industrial Express service, which attracts fewer than 5 passengers per trip, TARTA has realized the importance of working directly with employer sponsors in designing and funding reverse commute services. The service does not closely match shift change times and operates in a large area without a focus on any single employer.

Transferability to Other Systems

TARTA demonstrates how a flexible service can be implemented with very little capital investment, with very little technology, and at less cost than fixed-route service covering an equivalent area.

As a result of a recent regional transit study by TMACOG, the Toledo MPO, there is good availability of data on service area characteristics.

KANSAS CITY AREA TRANSPORTATION AUTHORITY (KCATA)

Location: Kansas City

Contact Person: Julie Hostak, Planner

Size of Agency: Medium - large

Transit Modes: Bus, shuttle

Agency Description

KCATA is an interstate agency of Missouri and Kansas City, having jurisdiction over seven counties with a service area population of 756,000. KCATA's Metro division operates 70 bus routes, which carries approximately 50,000 passengers a day or 14.7 million unlinked trips per year. These services are provided using a peak fleet of 329 vehicles offering 650,000 annual revenue hours of service. The Metro has an annual operating budget of \$40.5 million.

Description of Suburban Transit Services

KCATA provides three classes of service: Freeway Flyers, Rapid Riders and Local Links.

Under the Local Links classification, KCATA provides fixed, flexible and demand-responsive service. For each flex-route service, customers are provided an area in which customers may request personal service. They must give KCATA 24 hours notice or set up a standing order for service. Flex-route service is provided with 12 passenger vans. Full-size buses cannot maneuver through the local routes.

Description of Operational Issues

KCATA operates all of its own service.

Description of Funding Arrangements

KCATA receives 3/8 cent for every dollar made in sales tax. Route #229 receives JARC funding. There are no other known dedicated funding sources.

Description of Marketing Program

Special marketing is done only for brand new or newly improved services. Also, there are special marketing programs for services that cater to the elderly. Customer satisfaction is measured through an annual survey.

Description of Performance Measurement Program

Route performance is usually based on passengers per mile, however, these statistics usually don't look impressive due to the greater lengths traveled in suburban areas. Currently,

there is no consistent set of criteria used to evaluate performance. Performance measures are in the process of being developed.

KCATA values community buy-in and typically plans its services based on needs identified by the community. The community identifies the region's major activity centers. Little to no planning is done based on zoning, land-use or census data, although this is a direction in which the agency plans to move.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

When KCATA was just beginning to provide Flex Route service, they started by providing fixed routes that could deviate up to three blocks from the route. The lesson that they learned was that you should not have a combination of fixed and flex—that a route should be one or the other. Customers were getting confused and passed up by buses that deviated from the fixed route. Additionally, customers were frustrated when they needed the service to go just beyond the 3 blocks allowed to the operator.

Transferability to Other Systems

In the absence of service area data, many operations could benefit from KCATA's experience with leveraging community involvement to “gather data” about community transportation needs. Most of KCATA's outreach efforts have been targeted at meeting the needs of the elderly and peoples with disabilities.

METROPOLITAN COUNCIL

Location: Twin Cities, MN

Contact Person: David Christianson

Size of Agency: Large

Transit Modes: Light rail, bus, circulators, general public dial-a-ride

Agency Description

The Metropolitan Council's area of jurisdiction includes all or portions of nearly 190 cities and townships in the Twin Cities region. This region has approximately 2.6 million residents and Metro Transit serves an area populated by approximately 1.9 million people. The MetCouncil operates Metro Transit and provides oversight to local semi-autonomous transit services. Metro Transit operates 70 local, 51 express and 16 contract service routes, serving over 230,000 riders per weekday or 70 million annual trips. This service is provided with a peak fleet of 841 vehicles providing 2 million annual vehicle-hours of revenue service and an annual operating budget of \$193 million.

Description of Suburban Transit Services

Suburban transit services are provided by three means: Metro Transit, private operators and semi-autonomous private operators (called opt-out services). Metro Transit provides approximately 35 percent of suburban service. 65 percent is provided by private operators. The most innovative services are generally provided by the opt-out services since these operations are based mostly on community input.

The community based operations have been in existence for 12 to 15 years and were initiated by local agencies that opted out of the regional dedicated transit tax and decided to run their own local transit services. There are a variety of services available, varying by municipality. Some of the services include dial-a-ride, circulators and vanpools. Vanpools were recently taken over by the MetCouncil as a regional program—subsidized through CMAQ and regional TDM program funds.

Description of Operational Issues

Opt-out services are privately operated, but are subsidized and receive some oversight from the MetCouncil. The MetCouncil helps to evaluate opt-out service performance, but cannot give these operations any directives.

Description of Funding Arrangements

Sixty percent of community based operations (opt-out services) are subsidized by MetCouncil as required by state law. The municipalities cover the rest of the cost. Since transit subsidies must flow through MetCouncil, the Council maintains some oversight, providing

evaluation and guidance. MetCouncil, however, cannot make any directives on how opt-out services should operate.

Description of Marketing Program

Typically, there are no special marketing efforts made for any services other than new services.

A customer satisfaction survey is done annually for transit riders and biennially for non-riders. It is done region-wide and covers all operators and providers of regular route service in the 7-county area. The information is used to direct marketing campaigns to improve public perception and increase ridership, as well as restructuring internal training, supervisory, and management efforts to address any evident shortcomings or negative trends.

Description of Performance Measurement Program

The MetCouncil divided its planning region into 8 sectors. Each sector is evaluated on a rotating basis through a redesign process, a process that takes about 3 years from start to implementation. The redesign process involves starting from a clean slate and examining a sector's land use and demographics to restructure the transit operations within that sector. The data supporting the redesign process includes census data, land-use data (e.g., major activity points), transit amenities (e.g., sidewalks, park and ride facilities). Most of the data used in the redesign process is a result of an original data collection process. This data is not collected on a routine basis by the MetCouncil outside of the redesign process. Each sector undergoes the redesign process on average once every 10 years. The redesign has a direct impact of how service is provided through Metro Transit. At times opt-out services voluntarily follow redesign efforts.

Performance measures used by the MetCouncil include: subsidy/ride, riders/hour, adherence to transit policy, adherence to transit redesign, coverage in area and political realities.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

Opt-out operations are all doing relatively well. Larger operations have not had as much success with dial-a-ride services as the small and medium operations. Larger operations are finding dial-a-ride to be too costly to operate. A premium dial-a-ride service (idea borrowed from Winnipeg) is being operated in two areas (Stillwater?), where customers are guaranteed same day service, giving at least 2 hours notice. The ridership on these services has gone up from the original fixed-route service that it replaced. Circulator routes are pretty healthy and very well-received. However, ridership levels are still low.

From Metro Transit's point of view, flex-route services that deviate from a fixed route are not performing very well. These services will probably be discontinued. Another experiment with flex-route service, called Dog Bone routes, was an attempt to combine express service from the suburbs (the end where the service would go door-to-door) to the downtown area (the end where there were only a few stops). The collection zone on the suburban end of the operation

was proven to be too costly, especially since full-size buses were used. This service will likely be restored to being strictly express.

Transferability to Other Systems

Other agencies could probably learn a lot from MetCouncil's redesign process. Though it may be too costly for many agencies to conduct such an evaluation, agencies can still benefit from learning what a more thorough transit design effort would entail and begin to incrementally implement these processes.

The funding structure in the Twin Cities is what allows for local communities to take ownership of local transit design by means of opt-out services. This may not be a political reality for many other metropolitan areas.

PACE, SUBURBAN BUS DIVISION OF THE REGIONAL TRANSPORTATION AUTHORITY (PACE)

Location: Chicago, IL (suburban)

Contact Person: Lorraine Snorden, Strategic Services

Size of Agency: Large

Transit Modes: Fixed-route bus, employer shuttle, subscription commuter bus, vanpool, paratransit

Agency Description

Pace is one of the largest transit operators operating primarily in a suburban area in the United States. Pace serves a population of 4.5 million with a peak-period fleet of 1,380 vehicles. Approximately 35 million annual unlinked trips are served with 2.2 million vehicle-hours and an annual operating budget of \$131 million.

Description of Suburban Transit Services

Although Pace operates more than 200 traditional fixed-route bus services, we concentrated on several services introduced over the last decade that are targeted to specific groups and markets:

- 12 Shuttle Bug routes and 4 reverse commute bus routes that provide connections between Metra commuter rail stations and employment campuses.
- Several subscription bus routes using over-the-road coaches to provide long-distance connections between neighborhood park-and-rides and major suburban employers.
- Vanpool services, especially several recent variations on the traditional arrangement, including Metra feeder vanpools in which the vehicle overnights at a commuter rail station to serve the last mile between the train station and the workplace, municipal vanpools operated by a community as a circulator, and non-emergency medical vanpools operated by medical providers to serve some trips otherwise taken on paratransit.

Description of Operational Issues

Pace operates the majority of its fixed routes. Exceptions include some Metra feeder routes. Pace operates its Shuttle Bug services. Subscription services are contracted to private intercity coach operators. For vanpool services, Pace provides the capital equipment.

Description of Funding Arrangements

Pace receives a share of the regional sales tax under the stipulation that it achieve a minimum recovery ratio, currently at 40 percent. Shuttle Bug services are funded 50% by

employer contributions to a transportation management association (TMA) and 50% by Pace and Metra JARC grants. Vanpools and subscription services are nearly fully funded by employer subsidies or employee fares. Fare revenue makes up the majority of remaining funding.

Description of Marketing Program

For Shuttle Bug services, most of the promotion is provided by the TMA through participating employers. Pace provides assistance in the development of marketing materials. Pace targets promotions for its other services on an area-wide basis, rather than targeting specific services.

Description of Performance Measurement Program

Pace collects farebox and AVL data constantly. Automatic passenger counters are coming online. Because of its high farebox recovery ratio requirements (currently 40%), Pace has a long tradition of conducting a quarterly service review to identify the worst-performing routes. Metrics include average daily ridership, passengers per revenue-hour, subsidy per rider, and recovery ratio. Pace's vanpool shuttles are expected to achieve a recovery ratio of 153% in 2004, compared to a non-ADA vanpool program average of 102%.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

Pace has found that the traditional fixed route is not effective in much of its service area. The agency is in the process of revamping its service planning process to broaden the spectrum of service formats that it uses to respond to the wide variety of market conditions in its service area. Pace is exploring restructured fixed routes that provide faster suburb-to-suburb connections between radial rail lines. Pace is exploring various mixes of fixed-route community circulators, off-peak deviated route services, and general public dial-a-ride services to supplement its streamlined arterial- and expressway-based inter-suburban fixed-route network.

Transferability to Other Systems

Pace's experience with employment-oriented suburban services, especially the Shuttle Bugs and the newer Metra feeder vanpools could provide models for elsewhere in terms of public-private partnerships in planning, operations, promotion, and funding.

Pace has regional land-use data, employer location data, limited on-off count data, and other information that could support analysis of relationships between land use and service performance in specific areas.

BROWARD COUNTY, FLORIDA AND MUNICIPALITIES WITHIN THE COUNTY

Location: Broward County, FL

Contact Person: Robert Fossa, Senior Planner (954-357-8336) and multiple municipal representatives

Size of Agency: Medium (250 vehicles)

Transit Modes: Buses on major arterials, and minibuses in local transit circulator services

Agency Description

Broward County Transit is a division of the county government in the Ft. Lauderdale area (southeast Florida) and has the Board of County Commissioners as its policy board. The agency carries approximately 27,000,000 passengers per year, or 90,000 passengers a day. The County focuses on providing fixed-route, line haul service on the major corridors throughout this county of 1.7 million people that is mostly suburban in nature, with various degrees of density. In addition, there are about 17 local municipalities within the county that have entered inter-local agreements with the county to provide local transit circulator services. These services are also fixed-route, fixed-schedule services, and are provided through standard minibuses provided by the county.

Description of Suburban Transit Services

As noted above, a number of cities within Broward County now provide local transit circulator services with standard minibuses. The areas served by these circulators vary considerably in terms of density, though most focus on residential areas and commercial areas. These services tend to be provided from approximately 8 am to 6 pm (again this varies from city to city). The vast majority provide service only between Monday and Friday. Service is provided in a fixed-route, fixed-schedule basis, and varies in frequency from once every 30 minutes to once every 90 minutes. The circulators are intended to provide a basic level of service for those who have no vehicles or prefer not to drive for local trips. The routes within the cities are all required to connect with the regional service provided by Broward County Transit.

Description of Operational Issues

In most cases, the local municipal transit circulator services are provided on a contracted basis. A couple of cities provide service with their own drivers. The unusual thing is that the ATU local union representing employees at Broward County Transit never objected to the fact that federal grant money received by BCT was used to purchase the minibuses being used by the local municipalities through the inter-local agreement with the County. A cottage industry of sorts has sprung up to provide these contracted services within the cities. Hourly rates to provide service vary from \$29 to \$35, significantly lower than Broward County Transit's costs of approximately \$60 an hour. The possible explanation for the union's silence was that they were not willing to open the door to two-tier wages that would have been required for BCT to provide

such service within the cities. It appears the cities are pleased with the performance of the private contractors.

Description of Funding Arrangements

The primary reason these local transit circulator services have flourished is that the County passed an additional one-cent local option gas tax about three years ago, and dedicated a substantial portion of the proceeds to local municipalities to provide local circulator services. The county provides \$20 an hour toward the cost of these services, and it also provides the vehicles required. If the city would like to receive it, the county also provides technical advice in terms of routing and scheduling, and provides training to operators prior to them starting service. Hence, it costs the cities approximately \$10 an hour from their own treasuries to pay for and provide these local circulators.

Description of Marketing Program

There are too many local systems in place to have found out just how the services are marketed and promoted. However, one of the principles behind the county establishing the inter-local agreements was the awareness that local cities know their own citizen's needs and desires better than the county ever could. There is more energy at the local level to see these services succeed since they are identified with the city rather than the county. It is fairly easy for the local officials to promote awareness of the transit service through utility bills, notices in government buildings, mentioning it at city hall meetings, direct mail notices, visiting civic association meetings, working with local businesses and shopping malls, etc. These are all very direct, targeted promotion efforts, versus shotgun advertising campaigns. City officials also talk with the drivers and the managers of the contracted service to get feedback on how the service is working. In almost all cities, the local circulator service is provided fare free. In three cities, a fare of \$.25 is charged.

Description of Performance Measurement Program

Each municipality is required to keep accurate records of ridership on a daily basis by route. Ridership is recorded manually by drivers and handed in to either city officials or the contract manager. Then monthly reports are provided to the County. The County requires that municipal circulators carry at least five people an hour in order for county funding to continue. The performance varies by route and by city, and ranges from five passengers an hour to 30 passengers per hour.

Successes, Challenges, and Lessons Learned with the Suburban Transit Services

Broward County Transit regards these services as being highly successful. At first, the local circulators allowed the County to remove its large buses from certain low density, low ridership neighborhoods. This in turn allowed the county to straighten out its routes for more direct, faster service and better frequency on cross-county routes. Now the local circulators are being implemented in areas where no transit service exists, and is helping to feed more

passengers to the regional system. The challenge is always how to design a route that is the most efficient and effective possible in terms of carrying the most passengers possible with the limited resources at hand. One lesson learned is that charging even low fares makes a huge difference in ridership. One local circulator service saw its ridership double when it changed its fare from \$0.50 to free. Another lesson learned is that high school students are a big problem for these local circulators. When the majority of passengers are elderly in particular communities, there are real conflicts when the circulator goes by local schools, resulting in loud, energetic kids to be in the bus at the same time as there are senior citizens.

Transferability to Other Systems

While not unique, it still might be tough for other transit systems to deal with potential union objections to establishing the kind of inter-local agreements that exist in Broward County. It would be possible as long as no existing union operators have their current conditions lessened in any way. However, the model of local circulators feeding a regional system is still sound, and there are various ways of accomplishing this through either two-tier wage scales, private contracting where no existing employees are losing their jobs, or through some other form of partnership.

FORT WORTH TRANSPORTATION AUTHORITY

Location: Fort Worth, TX

Contact Person: Carla Forman, Assistant Vice President

Size of Agency: Medium (175 vehicles)

Transit Modes: Bus and paratransit

Agency Description

Fort Worth Transportation Authority, “The T,” is a medium sized transit authority that operates bus and paratransit services, with all services provided by McDonald Transit Associates, Inc. The agency has almost 600 employees and serves the city of Ft. Worth and those surrounding areas that elect to be part of the taxing district of the transit authority.

Description of Suburban Transit Services

The T provided flexible transit services in some of the spread out suburban areas just outside of Ft. Worth from 1998 to 2003. The service offered was point deviation in areas that were a mix of low density residential, commercial, and industrial land uses. While the start point and the end point, and the scheduled time associated with each of these points was known, the routes were otherwise completely flexible and traveled along roads based on requests for pick ups or drop offs by passengers either on the bus or would-be passengers who were calling the bus operator on his/her cell phone. Passengers could also flag down a bus coming toward them, even if there was no bus stop sign. It was referred to as “Rider Request” service. These point deviation routes connected with other T routes, at some shopping centers, and at one train station, allowing passengers to connect with the broader system. In one route’s case, the rider request service replaced former fixed-route service, while in two other routes’ cases, it was new service placed where the agency thought fixed route was not feasible. These routes were provided Monday through Saturday.

Description of Operational Issues

The point deviation services that were provided in the Fort Worth area were provided with minibuses that operated with frequencies of once an hour, generally from 6 am to 7 pm Monday through Saturday. Operators carried cell phones and made their deviations based on calls they received, balancing requests for deviations against their awareness of other passengers’ requests for drop offs and pick ups. Cost for the service was \$1.25 per trip. Some of the passengers liked the service because they were picked up and dropped off right where they wanted to be, which was particularly helpful during any bad weather. However, other passengers disliked it because they did not like having to plan their trips a day in advance. Others disliked the service because they thought it was unreliable. The bus operators were apprehensive at first, and most regular operators adopted over time, though they found it difficult to provide. The extra board operators never adopted well. They were not interested in learning how to provide demand-responsive service.

The challenge seemed to be how to develop the appropriately designed zone for point deviation. If the zone is too large, then it becomes hard to meet your schedule. If it is too small, then you don't have enough market to draw from. If the philosophy is to provide mobility regardless of cost, it doesn't matter, but if the philosophy is to be efficient, they didn't accomplish that in Fort Worth with Rider Request. They ultimately eliminated all of these flex services and now provide only fixed-route services.

Description of Funding Arrangements

The T is funded with sales tax revenue from those cities that elect to be part of the authority's taxing powers. The other revenue collected by the T is through the farebox.

Description of Marketing Program

The marketing of the flex service was done on a targeted basis, with door-to-door flyers handed out. These flyers provided information on the service and discount coupons to use the service. The service represented a very small percentage of the agency's overall responsibility, so there was limited effort. One noteworthy technique was distribution of a postcard with a magnet attached that could be placed on a refrigerator, with the message "Every house is a bus stop".

Description of Performance Measurement Program

The T kept daily records of ridership, and use service standards to judge performance of bus routes. The ridership was not very good on any of the routes, ranging from .25 passengers per mile to .5 passengers per mile, or from 2.3 passengers per hour to 6.8 passengers per hour, averaging less than four passengers per hour and approximately .3 passengers per mile. The subsidy per passenger ranged from \$10.44 to \$25.73, averaging \$17.16. By comparison, the fixed-route service in Ft. Worth averaged 17 passengers per hour, 1.5 passengers per mile, and cost approximately \$4 per passenger.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

In two routes, fixed-route service was not feasible, so rider request service was a good alternative to try. It was very well received by students who lived within two miles of their school and were not eligible for school bus transportation. Parents liked having their children picked up at home, dropped off at school, and brought back home for \$15 a month. For many passengers who had been used to fixed-route service, they never got used to having to call in advance for service, and consequently they were not pleased with the rider request alternative. For those who are used to reading a schedule, they know when they have to be at a bus stop to be picked up. However, with flexible rider response service, operators have a 30-minute window in which to pick a passenger up. Those passengers who were used to fixed-route service would often panic after 20 minutes and just didn't feel like the service was reliable.

Driver training, booking trips correctly, drivers' ability to find the pick up locations, educating the passengers on how to use the service (especially in predominately Hispanic areas

where English was limited), expense of having enough staff to book and schedule the trips, and having enough vehicles to meet the demand all presented significant challenges. One agency representative believed that rider request service was particularly hard for those who spoke only Spanish, given the limited bilingual skills at the agency. Another issue was that the T hoped to attract paratransit passengers to the flexible rider request service. However, paratransit is door-to-door while flex service is curb to curb, and it did not attract many people from paratransit.

Transferability to Other Systems

The experience is probably very transferable to other agencies.

CHARLOTTE AREA TRANSIT SYSTEM (CATS)

Location: Charlotte, North Carolina

Contact Person: Brad Miller, Director of Operations; Larry Kopf, Director of Planning

Size of Agency: Medium sized transit agency with 325 vehicles

Transit Modes: Bus and paratransit, planning for light rail and bus rapid transit (BRT)

Agency Description

CATS is actually a department of the City of Charlotte, but has a separate board that provides guidance and policy to the agency. The Charlotte area has gained considerable positive notoriety for its attention to coordinating land use and transportation corridor investments. CATS is well on its way to getting approval for major investments in a number of corridors, which will feature either light rail or Bus Rapid Transit. Charlotte is a rapidly growing area that passed a general half-cent sales tax in 1998 for transportation improvements. Prior to that time, virtually all transit services were provided in the city of Charlotte. Now, all residents of Mecklenberg County pay the half-cent tax, and that has meant that CATS has needed to address how to provide some type of transit service in the suburban areas outside of the city limits. Virtually all of the bus service is provided through a contract with McDonald Transit Associates.

Description of Suburban Transit Services

CATS has provided non-traditional services in four different settings within lower density suburban areas. These services were put in place after the passage of the half-cent general sales tax, and after a consultant prepared a county-wide 10-year transit services study that identified a number of new service areas. Two of the services were established but discontinued when they were carrying less than three passengers per hour.

One of those services (South Park) was a neighborhood circulator that focused on a service area comprised of office buildings surrounding a major shopping center, with some apartment residential. The service was provided in a fixed-route, bi-directional loop operating on 30 minute frequencies and operated seven days a week from 9 am to 9 pm. The second service that was tried but later discontinued was a route deviation service to the township of Matthews, south of Charlotte. This was an area that had had no local transit service prior to the route deviation experiment. Matthews is a relatively low density area (2-3 units per acre) without a well defined downtown. Two routes providing route-deviated service every 30 minutes were established, operating Monday through Saturday from 7 am to 8:30 pm.

Two other suburban services stemming from the transit services study succeeded and are still in operation. Route deviation services were put in place in the north Mecklenberg towns of Davidson, Huntersville, and Cornelius. Four routes, providing 60-minute service, pulse at the regional library and operate seven days a week, from approximately 7 am to 7 pm. These routes average almost 10 passengers per hour. The last of the four suburban services is a demand-response shuttle service that connects with regional CATS routes near two interstate highways, and feeds passengers from the regional service to businesses within the industrial park region around the interstate highways. Six cutaway minibuses provide service in the area, with three

providing service throughout the day from 6 am to 6:30 pm, while the other three provide service only during the peak morning and afternoon hours.

Description of Operational Issues

The South Park circulator was intended to serve the second largest concentration of office buildings in Mecklenberg County, in a manner similar to a very successful downtown circulator in downtown Charlotte that carries over 60 passengers per hour. The hope was that employees in the area would use the circulator to go to the shopping center and restaurants in the area, and that residents in the surrounding area would also use the circulator to access the mall. There was also the thought that the circulators would be used by people going from one shopping mall to other malls in the service area connected by the shuttle. The service was offered for free to passengers. The circulator also connected with CATS routes in the region. This service never generated significant ridership. There was an enormous amount of free parking for the office complexes and the shopping centers that made using a car very convenient and inexpensive. There were a number of office buildings that offered cafeteria-type eating services in the buildings, making it less necessary for anyone to leave their buildings to get meals. The surrounding residential areas were relatively higher end apartments that tended to have few transit dependent people living in them. Some shopping mall employees used the circulator as it connected with CATS regional routes, and a few transit dependent people also used it. However, ridership never exceeded over four passengers per hour.

The Matthews route deviation transit service also failed to generate meaningful ridership. The area served was mostly single family development with densities of two to three households per acre. There was no defined downtown center. There were also no sidewalks or safe, convenient ways for people to access bus service. The majority of people who used the service on an ongoing basis were teenagers going to movies, the YMCA, or to shopping areas. There was also a senior citizen center that generated occasional use depending on where activities with lunch services were being held. The transit service started out as two buses on one route providing service every 30 minutes, but was changed to two routes with 60-minute service each. It was a difficult area to serve even with route deviation techniques because of the lack of centralized activities. Almost 70 percent of all trips were deviation requests. Passenger fares were \$.25

The route deviation services provided in the north Mecklenberg towns was considerably more successful. Densities were approximately the same among the single family areas as in Matthews, but there are also a number of areas with townhouses and apartments, and there is a substantial trailer park as well. In addition, there is a large immigrant population in the area that tends to be more reliant on public transit. Davidson University is located in this service area, generating both student and employee ridership. The number of requests for actual deviation among all passengers is only 25 percent, versus the 70 percent experience in Matthews. Pedestrian access is an issue of concern in the north Mecklenberg towns as it was in Matthews, with few sidewalks. The passenger fare for this transit service is \$.25. Four minibuses are used to serve the north towns, and they meet in a time-transferred fashion at a central location near the regional library.

The last service to be noted is the demand-response shuttle service to and from the Arrow Wood Industrial Park. The area served by the six shuttle vehicles is totally non-residential.

While service is in place from 6 am to 6:30 pm, all six vehicles are only in service for about two hours in the morning and two hours in the afternoon. In the middle of the day, only three vehicles remain in service. While the service is demand-responsive in nature, it is almost entirely subscription service that is being provided at present. The shuttle services meet on a scheduled basis with CATS express and regular route service at a “hub” outside of the industrial park.

Description of Funding Arrangements

The shuttle services for the Arrow Wood industrial park were initiated with state grant funds as part of an economic development program supported by businesses in the industrial park. Otherwise, all other services in the suburban areas were funded through the new revenues made available through the half-cent general sales tax. The fact that the tax was passed was the impetus for providing service in areas that had not received service before. In the South Park area, the businesses located within the circulator service area provided \$25,000 to help market the service.

Description of Marketing Program

The majority of the marketing was done through direct mail to households and businesses versus other forms of media advertising. There were meetings held in the various towns prior to the service being designed and established, and each town had the opportunity to promote the services. It should also be noted that the minibuses used in the north Mecklenberg towns were “psychedelic” in color and helped to make the service that much more visible.

Description of Performance Measurement Program

CATS is very serious about monitoring and measuring the performance of all of its transit service, and decisions on the provision or termination of service are made in accordance with these standards. CATS uses an index that measures all of their services through two different perspectives. First, each route’s performance is measured against all other routes of the same type by reviewing the ridership per hour and the subsidy per passenger. The average performance for all similar routes is rated “1”. Then every route is judged against all routes in the entire system (regardless of whether it is a local shuttle, express route, cross town, etc.) again using ridership per hour and subsidy per passenger as the measures, with the average for all services recorded as a “1”. If a route falls below a measurement of .5, it is eligible for termination. As noted earlier, two of the route services fell below this rating, and in spite of attempts to strengthen their performance, they could not improve enough to be justified for continued operation. The Board of Directors of CATS is very supportive of using these measures. The first priority for virtually every member of the board is to put premium services into place, and they would rather fund premium services that will be used rather than suburban services that are very weak.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

One of the lessons learned at CATS was that it is a challenge to get quality citizen input, particularly from senior citizens. It has been their experience that more accurate predictions of use among seniors are gained from social service representatives familiar with the seniors travel patterns than from the seniors themselves. Another lesson learned is that having highly visible buses is a plus when promoting new suburban transit services.

A challenge that they must now deal with is how to provide better pedestrian access to new suburban services. The routes generally follow major arterials, many of which do not have sidewalks. An injury experienced by a bus passenger trying to cross the street to a shopping center has brought the issue to light.

Finally, CATS has benefited from having a strict performance measurement system in place. They have found that they were given “good press” for putting in new services in these suburban areas, but they were also given good press when removing service due to low ridership. As mentioned above, the CATS policy board appreciates the standards as well, and lives by them even though there might be questions of equity that could be raised by areas that contribute to the half-cent tax yet have service removed.

Transferability to Other Systems

The experiences are highly transferable.

DALLAS AREA RAPID TRANSIT (DART)

Location: East Plano, North Central Plano, East Rowlett, Farmers Branch, Lakewood, North Dallas, TX

Contact Person: Tim Newby, Service Planning Manager
Katherine Eagen, Planner

Size of Agency: Large (over 800 fixed-route buses, 170 paratransit vehicles)

Transit Modes: Fixed-route, on-call neighborhood shuttle service, ADA paratransit, light rail, vanpool/carpool, HOV network

Agency Description

DART is a regional transit authority that serves Dallas and 12 surrounding cities with more than 130 bus routes, light rail transit, HOV lanes, on-call shuttle service and ADA paratransit service. The agency is governed by a 15-member board of appointed officials from member city councils.

Description of Suburban Transit Services

DART On Call provides limited curb-to-curb service in six neighborhood zones, roughly 4 to 5 square miles, within the DART service area. The system is a feeder shuttle serving six communities: East Plan, North Central Plan, East Rowlett Farmers Branch, Lakewood and North Dallas. Shuttles make daily stops at DART Light Rail stations or Park n Ride lots, Monday through Friday. During the midday hours, passengers may call the driver or central office to schedule a trip within a neighborhood service area. Pick ups and drop-offs are at designated stops within a service area. (See examples of service are maps attached). Typical stops include local neighborhood medical facilities, shopping centers, municipal centers, and social services.

Service hours are Monday through Friday, 5 am to 8 pm. During morning rush hours (5:00 am to 8:30 am) and afternoon rush hours (3:30 p.m. to 6:30 p.m.), DART On-Call provides neighborhood residents with service to and from the designated Light Rail station or Park and Ride station for each particular service area. During midday (8:30 to 3:30 pm), DART On-Call circulates throughout each neighborhood with stops at specified locations within each zone.

Fares are \$2.25 per trip. Exact change or one of several DART passes is required; drivers do not make change. To make as reservation for curb-to-curb service, rider must call at least one hour prior to travel time. Reservations are not required for service from a designation rail station or park and ride lot. Customers call the driver directly, who are equipped with cell phones to make a reservation. Reservations can be made up to one week in advance. Same-day service is available by calling at least one hour in advance.

Description of Operational Issues

Our first zone began operation in 1999, our second in 2000, and our third in 2001, and three more zones began service in October 2003. A seventh zone is scheduled for implementation in May 2004.

Service is provided by three private contractors who serve different portions of the service area. Of the six zones, one operator covers four zones, with the remaining two, covering one zone each.

Description of Funding Arrangements

DART receives sales tax revenues (1%) from each member city, and that funds all operations.

Description of Marketing Program

Prior to implementing a new zone, we hold an open house for prospective passengers; this teaches them how to use the service, and attendees of these open houses can use the service the week before the service is initiated. We also wrap all our vans with the DART On Call logo. We are currently working on a new marketing plan for one of our zones.

Description of Performance Measurement Program

The DART Board has adopted a service standard which is a subsidy of \$4.30 per passenger, and 6.0 passengers per trip. The On Call standard subsidy per passenger is the same as for transit feeder routes, and the passenger per trip standard is comparable. Fixed route also tracks passengers per mile, which we don't use for On Call.

Contractors collect data using the passenger manifest, and this information is reviewed monthly by the Project Manager for DART On Call. There is no formal mechanism to measure customer satisfaction. Typically, satisfaction is anecdotal, through complaints or commendations received by DART and the contractors.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

The main lesson is that On Call might look like fixed route to planners, as far as service span and performance, but we're the only department that sees On Call as a "fixed route." We've spent a lot of time explaining the service and how to use it to stakeholders inside AND out.

Transferability to Other Systems

DART On Call is similar to other zone-based demand-response services that will be further reviewed.

POTOMAC AND RAPPAHANNOCK TRANSPORTATION COMMISSION (PRTC)

Location: Prince Williams County, VA

Contact Person: Eric Marx, Director of Planning

Size of Agency: Small

Transit Modes: Point deviation bus, commuter bus, ride-sharing

Description of Suburban Transit Services

PRTC provides OmniLink local bus service on 2 routes in the western part of suburban Prince Williams County, including Manassas, and 3 routes in the eastern part of the county, including Woodbridge, Dale City, and Dumfries. The services operate as linear or loop routes with deviations on demand to designated points within $\frac{3}{4}$ miles on each side of the route. OmniLink was the focus of this review.

PRTC also provides OmniRide commuter bus services provide express service to downtown Washington, DC and OmniMatch ridesharing services.

Description of Operational Issues

OmniLink is noteworthy due to its use of ITS technologies to automate scheduling of requests for deviations, dispatch, and vehicle navigation. The service began in 1995 as a new start and operated with manually dispatched deviations to avoid the need for complementary paratransit service. In 1998, automated scheduling and dispatch software was added and reduced the advance notice requirement from 24 hours to 2 hours. In 2003, mobile data terminals were added to automate control center to vehicle communication and allowed vehicle itineraries to be changed on the go.

Description of Funding Arrangements

Awaiting further discussion with PRTC.

Description of Marketing Program

PRTC conducts a bi-annual customer survey. Approximately $\frac{3}{4}$ of riders like the deviation feature, even though it is used on only approximately 12 percent of trips.

Description of Performance Measurement Program

PRTC tracks daily ridership, passengers per revenue-hour, cost per passenger, percent of passengers requesting deviations, and turndown rate.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

PRTC initially marketed the deviation feature very strongly and encountered challenges meeting the demand for these time-consuming trip segments (between 25 and 33 percent of a route's run time is allocated for deviations). Since then the deviation rate has fallen despite increasing service levels, such as shorter advance request times. As part of a recent fare increase, PRTC recently added a premium fare (not assessed to elderly and disabled) to discourage the practice further.

PRTC also provides a pioneering example of the costs, benefits, and challenges associated with technology implementation.

Transferability to Other Systems

PRTC was one of the first route deviation services, thus there is extensive data and history regarding modifications, etc. to consider.

MERRIMACK VALLEY REGIONAL TRANSIT AUTHORITY (MVRTA)

Location: Haverhill, MA

Contact Person: Joe Costanzo, Administrator

Size of Agency: Small - medium

Transit Modes: Bus and ADA paratransit service

Agency Description

MVRTA serves the northeast corner of Massachusetts, providing a mix of city, suburban, interurban, and rural scheduled bus service. Bordered on the north and east by the state of New Hampshire and the Atlantic Ocean, the MVRTA's service area includes Andover, Amesbury, Haverhill, Lawrence, Merrimac, Methuen, Newburyport and North Andover. The Authority also provides service to the Lowell Transit Center for connections with the Lowell Regional Transit Authority. While the MVRTA generally provides a mix of services to their member municipalities, many of which are characterized as suburban, the subject of this report will be two programs, the Ring and Ride program and the limited stop Express service to Boston, MA.

Description of Suburban Transit Services

Ring and Ride is a curb-to-curb demand-response transportation service for the residents of the town the service is provided in. The service is provided in wheelchair lift-equipped vans Monday through Friday 5am-7pm and 9am-6pm on Saturdays. Reservations need to be made at least 1 day in advance Monday through Friday 8:00am-4:30pm. It should be noted that the Ring and Ride service does not perform any better than MVRTA'S typical demand-response service, carrying an average of 2.3 passenger trips per revenue hour. Consequently, the average cost per trip is similar to other DR services operated by MVRTA.

The Commuter Express service consists of two A.M. and two P.M. trips between Methuen and Boston. The service serves park and ride lot locations in Methuen as well as in Lawrence, and Andover, and provides express service from the last pickup location to five locations in downtown Boston, including Haymarket Square, Government Center, the Park Street MBTA station, Park Square, and Copley Square.

Description of Operational Issues

Ring and Ride Salisbury started on November 1, 2001. Ring and Ride Georgetown started on February 4, 2002. The service used to be provided by private contractors. A sub corp. of the MVRTA's operating company called Special Transportation Services has provided the service since July 1, 2002. There are no special capital requirements to operate the Ring and Ride service.

The commuter express service had previously been operated by a private operator but was taken over by the MVRTA in January of 2003. Over the road coaches are used to provide this service.

Description of Funding Arrangements

The Ring and Ride service is funded by the MVRTA, the Commonwealth of Massachusetts and the local town the service is provided in, which is typical of transit services provided in MA.

The commuter express service maintains an 85% farebox recovery, with a fare of \$5.00 each way, and commuter fares available in 10 ride pass increments. The pass has magnetic strip capability to expedite boarding. Additionally, passengers have access to commuter check programs through their employers.

Description of Marketing Program

The Ring and Ride service is marketed through the operating company's Director of Marketing. Brochures describing the service are placed in the town hall as well as the senior centers in each town that the service is provided. The Director of Paratransit Operations and the Director of Marketing also organize presentations explaining the services at local senior centers and job fairs, job development workshops, etc. Information is also available on MVRTA's website. Customer satisfaction is measured by on-time performance, formal complaints filed, and missed or denied trips. Between July 2003 and March 2004, there were four formal complaints filed with MVRTA's Office of Special Services. The Commuter Express service is marketed on the MVRTA website as well as through local advertisements.

Description of Performance Measurement Program

On-time performance for the Ring and Ride service is recorded for every trip and MVRTA monthly reports track on-time performance by route. The Director of Paratransit Operations regularly analyzes the data to ensure that the system is meeting its goals. The entire management team also reviews MVRTA monthly reports. Trip logs are also maintained to track missed or denied trips. Between July 2003 and March 2004, MVRTA Special Services have had 302 no shows, 56 late cancels, and 37 other passenger disruptions.

Since MVRTA has taken over the commuter express service, ridership has increased from 55% capacity to 68% capacity. Other performance measures include: Cost per Hour, Mile and Passenger, and Passengers per Hour, Mile and Farebox Recovery.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

Success is measured by the level of customer satisfaction. Service can be provided without using a fixed route to meet the needs of potential passengers within communities not needing a fixed route. The Ring and Ride service has been a great addition to the other demand-response service operated. It can fill down time and be worked into other shared ride services. Analysis needs to be done to determine the need for this type of service. Seniors and the disabled community use most of the service in Georgetown, while many different riders use the service in Salisbury. Most of the trips are standing orders and the trips are the same from week to week. The service is mostly used to go from dialysis and/or jobs.

Transferability to Other Systems

The experience gained by MVRTA is applicable to any other transit system in the country.

CAPITAL DISTRICT TRANSPORTATION AUTHORITY (CDTA)

Location: Albany, New York

Contact Person: Jack Reilly, Deputy Director and Director of Planning and Development and Kristina Younger, Service Analyst, and Carm Basile, Marketing Director

Size of Agency: Medium

Transit Modes: Route-deviation

Agency Description

CDTA is an all-bus system with 250 vehicles, providing service in a three county area including the cities of Albany, Schenectady, and Troy in upstate New York along the Hudson River. The area being served has a population of approximately 750,000. It is in the northeast and does not experience the explosive growth seen in southern and western parts of the country, but the area is still economically viable, with the state capital in Albany and a number of universities in the service area. Growth continues in the suburban areas in particular, and CDTA is one of the first agencies in the country to institute flexible services with minibuses as a way to serve this new growth in some of its suburban areas.

Description of Suburban Transit Services

CDTA stated to provide its “shuttle” services (Shuttle Bug, Shuttle Bee, and the Shuttle Fly) six years ago. These services are provided with 24-foot minibuses and operate on a route-deviation basis. The areas served by these routes are primarily non-residential suburbs. The routes vary from three to six miles in length. They are primarily commercial and industrial in nature, with some residential areas interspersed, as well as some institutional land uses. This would include office parks, industrial parks, colleges, and elderly housing complexes, as well as some scattered standard suburban residential growth. The services are provided seven days a week on the busiest route, six days a week on the next busiest, and five days a week on the lowest ridership route.

Description of Operational Issues

The shuttle services are route deviation services that generally operate from 6 am to 9 pm, with headways that vary from every 15 minutes during the morning and afternoon peak to once an hour in the middle of the day. The routes deviate up to a quarter of a mile based on calls from passengers who call the dispatcher, who in turn calls the minibus operator. The dispatcher makes the decision as to whether the deviation can be accommodated. The schedulers and planners built in up to 15 minutes of deviations in each direction for these routes. Minibuses are used because it allows vehicles to get in and out of tighter spaces than large buses could, and the deviations require the vehicles to make tighter turns. Requests for deviations can be made on a subscription type basis, or people can call five minutes in advance and hope to be picked up.

One of the shuttle routes is provided through private contract, while CDTA personnel provide the other services. One of the operational issues is that some of the routes are now full

and cannot accept any more requests for deviations. In essence, the success of the service has become the challenge for the future. They are looking to cluster their deviations and essentially “subscriptionize” the route as much as possible to make the route more manageable. The frequent requests for deviations are not easy to administer.

Description of Funding Arrangements

Much of the original funding for these services came from Job Access Reverse Commute (JARC) sources, with the remainder provided from the budget of the CDTA. However, they do get a limited amount of funding from two other sources. One source is a local city that contributes up to \$50,000 toward the cost of the service. Another source is fairly rare, whereby developers who want to build in the service area can pay a one-time mitigation fee. In essence, this is an impact fee, and can be used by CDTA for either capital or operating expenses. The amount available in any given year is not likely to exceed \$50,000. The Shuttle services are regarded as connectors, and fares are only \$.25.

Description of Marketing Program

As can be seen by the name, CDTA deliberately gave distinctive names to these new services (Shuttle Fly, Bug, and Bee). The primary reason was to emphasize that these services were new, different, and special. This also allowed people in the service area to think in terms that this new service was “theirs”, not just another route on CDTA. The agency used special letterhead and envelopes with the insects on them. All of the effort was specifically targeted to the service area. There was almost no mass media used in the campaign. There was a lot of direct mail, with follow up phone calls and face-to-face meetings with major employers and institutions in the service area. There were lunches and breakfasts dedicated to providing specific information on the services.

Description of Performance Measurement Program

Fares are collected in electronic fare boxes and daily ridership reporting is available. CDTA does not necessarily have separate standards for this service versus the rest of the service it provides throughout the capital district. The different routes carry between seven and 12 passengers per hour in total, though during peak hours some of the minibuses are running full.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

The CDTA regard these shuttle services as successful, with one of the routes carrying almost 700 passengers a day, another carrying approximately 350 passengers per day, and the most recent carrying about 175 passengers per day. The challenge as noted earlier is that some of the runs on at least one of the routes are totally full, and there is no additional funding to put extra buses on the route. The agency has gone through a number of operational issues such as contemplating making the routes with right turns only to save time, to short-tripping some runs, to developing some form of hybrid route deviation that is primarily fixed route with just some strategic deviations. They can't put bigger buses out there to increase capacity if they wish to continue all the types of deviations they are doing.

Another challenger is that the private contractor's service is the subject of an unacceptable number of complaints for reliability and bus condition. CDTA has been providing these sorts of flexible services for six years and they have considerable experience to offer to this project.

Transferability to Other Systems

All the lessons learned through this case study are completely transferable to other transit agencies.

TRANSPORTATION DISTRICT COMMISSION OF HAMPTON ROADS (HRT)

Location: Hampton Roads, VA

Contact Person: Clayton Ashby, Chief Planning Officer

Size of Agency: Medium

Transit Modes: Bus, ferry, vanpool, ADA paratransit services

Agency Description

Hampton Roads Transit (HRT) provides bus and ferry service to a number of communities around the Chesapeake Bay, including Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk and Virginia Beach. HRT service area is 369 square miles and the service area population is 1.2 million.

Description of Suburban Transit Services

Two routes have been identified for demonstrating Deviated-Route Service. Both routes provide regular fixed-route service; however, should someone need service within the specified distance, they are to contact HRT to make arrangements for pick-up and return trips. Route 116 was the first route to offer deviated service approximately 3 years ago. Route 57 has been providing service for about 1 year.

Description of Operational Issues

HRT operates the deviated route service internally and has not experienced any operational constraints or issues. There are no significant capital requirements for this service.

Description of Funding Arrangements

Service is funded through federal CMAQ program with the respective cities providing the local match.

Description of Marketing Program

Service is marketed through the distribution of schedules and rack cards. HRT measures customer service by tracking comments and complaints received by its customers.

Description of Performance Measurement Program

HRT does have a performance measurement program, which consists of collecting basic operational data such as ridership, revenue, hours, miles, productivity, etc. The data is reviewed monthly by the Service Planning Manager who gathers the information and prepares a staff report. This report is also reviewed by HRT's Chief Planning Officer and other staff.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

Productivity measures are utilized to determine whether a particular service is successful. HRT believes the Deviated-Route service to be successful based upon its performance. Foreseeable challenge may be if more riders utilize the deviated route, it may affect the actual fixed-route schedule. Service is also monitored for on time and safety performance. One lesson learned from this service is that it can take months to educate the public on route deviation and to get them to try the service.

Transferability to Other Systems

These services can be used by other systems to expand their coverage area and to less dense locations not generally served by transit, especially in rural areas, or areas with sprawling development patterns.

RHODE ISLAND PUBLIC TRANSPORTATION AUTHORITY (RIPTA)

Location: Providence, RI

Contact Person: Mark Therrien, AGM/Director Transit System Development; Tim McCormack, Service Planner

Size of Agency: Medium (220 buses and 125 vans)

Transit Modes: Bus, ADA paratransit, and trolleys

Agency Description

RIPTA is a statewide authority, providing bus and paratransit service with 675 employees.

Description of Suburban Transit Services

RIPTA has established “Flex Service” in six different zones throughout the state. Some of the zones have regular fixed-route transit within a half mile, while others are located a long distance from regular fixed-route service. All Flex Service connects with a RIPTA fixed route, but not all the zones have time points associated with their service. In what they regard as “rural zones”, there are time points that show service being at certain locations once every two hours. However, in the zones they refer to as “outlying minor urban areas”, there are no time points. These outlying minor urban areas are generally near other fixed-route service and RIPTA does not want to encourage people who could use the fixed-route service to switch to Flex service. Hence, they require people in those zones to reserve 48 hours in advance to use Flex service.

The Flex services were established primarily to assist those who needed mobility to get to work or get to vital human services. Zones were established based on the number of unemployed and the elderly and disabled people that were located in certain areas without transit service. Job Access Reverse Commute funds were used to fund these services initially. RIPTA regards these Flex services as serving both lifeline purposes and as feeders to the statewide transit system.

Description of Operational Issues

The Flex services generally operate five days a week, from 6 am to 6:30 pm, making them usable to those who work, as well as to the elderly, disabled, and others. They do not operate the services based on frequency, since it is almost entirely demand-response in nature. People are required to call 48 hours in advance for this curb-to-curb service. Almost 80% of the passengers are subscription riders. The vehicles used are 26-foot, 18- passenger vehicles with wheelchair lifts. All of the services are provided with RIPTA personnel who are bargaining unit employees working under a two-tier wage system. There were no real problems noted with the operations of the service to this point. Passengers call a dispatcher for service, who in turn calls the bus operator to convey the need to pick up a passenger. The major issue for the agency is how to most efficiently design a service zone that can be responsive to demand at the lowest cost.

Description of Funding Arrangements

As noted earlier, federal funds from the JARC program provided the primary source of funds for these services. As those funds phase out, RIPTA uses its other funding to pay for these services. In one zone, the state's Health and Human Services pay for a portion of some of the trips.

Description of Marketing Program

Targeted marketing is used in all cases. Examples include sending agency representatives to senior high-rise developments or to meal sites where they set up tables and distribute information about the Flex services. RIPTA claims that door-to-door flyers were not that effective. The agency makes use of press releases that tend to get printed in all local newspapers. They use no radio or television ads. They have found that targeting daycare services and welfare to work services provides the most effective way of reaching those they most want to help. RIPTA also painted the vehicles they use for the service a very distinct color, and put the phone number of the service on the outside of the vehicle in very large numbers to help people become aware of the availability of the service as the vehicles travel through their zones.

Description of Performance Measurement Program

RIPTA keeps track of all passenger activity on a daily basis. They report performance to their board. Performance varies based on the different zones, with the rural zones performing at lower levels. In the worst such zone, vehicles carry slightly more than one passenger per hour, while in the outlying minor urban zones, vehicles carry approximately 5 passengers per hour. In the more productive zones, it costs approximately \$10 per passenger trip, while in the worst performing rural zone, costs might be higher than \$40 per passenger trip. Even though Flex service is very expensive on a per passenger cost basis, there is no movement to eliminate such service. The availability of this service "quiets" virtually any otherwise heartbreaking story of isolation caused by non-mobility.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

RIPTA planners regard the Flex services as successful. In one zone, they claim they are carrying twice as many passengers as they used to carry with fixed-route service at about half the cost. In other zones where productivity is low, they believe it is still the best they can do under the circumstances, and provides needed mobility. The biggest challenge for the service planners is how to design a Flex zone for maximum productivity and efficiency. It is a function of size, population, and demand. There have been times when socioeconomic information would indicate likely demand, yet ridership never really developed. They have noted that a zone cannot be too large, or it will simply be too much for a single vehicle to cover effectively. This could cause people to feel that their trip is taking too long due to multiple pickups and drop-offs. However, the zone must be large enough to generate a population capable of providing a market.

The service planner for the agency noted that if he had to do it over, he would have started service in some of the rural areas with service only one or two days a week. They could

have bunched the shopping trips with such a schedule, and then gained public input on how much more service was needed and expand service accordingly.

Transferability to Other Systems

The experience gained by RIPTA is applicable to any other transit system in the country.

NEW JERSEY TRANSIT (NJ TRANSIT)

Location: Newark, NJ

Contact Person: Sally Stocker

Size of Agency: Large

Transit Modes: Bus, commuter rail, light rail, ADA paratransit

Agency Description

Created by the Public Transportation Act of 1979, NJ TRANSIT was established to "acquire, operate and contract for transportation service in the public interest."

In 1980, NJ TRANSIT purchased Transport of New Jersey, the State's largest private bus company at that time. Between 1981-85, the services of several other bus companies were incorporated into NJ TRANSIT Bus Operations, Inc. On January 1, 1983, a second subsidiary, NJ TRANSIT Rail Operations, Inc. was launched to assume operations of commuter rail in the State after Congress ordered Consolidated Rail Corporation (Conrail) to cease its passenger operations. A third subsidiary, NJ TRANSIT Mercer, Inc., was established in 1984 when the agency assumed operation of bus service in the Trenton/Mercer County area. In 1992, following a full reorganization, all three subsidiaries were unified and operations were significantly streamlined.

As stakeholders in NJ TRANSIT, State residents are represented by a seven member Board of Directors, appointed by the Governor. Four members are from the general public and three are State officials. The agency is structured to encourage broad public participation in the formation of transit policy for the State. NJ TRANSIT's board meets monthly at NJ TRANSIT headquarters in Newark. The Governor can override board actions by vetoing the board meeting's minutes.

NJ TRANSIT Corporation's Board selects an Executive Director to administer the entire agency. The Executive Director serves as President of all three subsidiaries (NJ TRANSIT Bus Operations, NJ TRANSIT Rail Operations, Inc. and NJ TRANSIT Mercer, Inc.). In addition, NJ TRANSIT employs a Chief Operating Officer to coordinate operations.

Two transit advisory committees provide the agency with additional input from the public. The North Jersey Transit Advisory Committee and the South Jersey Transit Advisory Committee are each comprised of fourteen unsalaried members. Members of the North Jersey Transit Advisory Committee serve four-year terms. Members of the South Jersey Transit Advisory Committee serve three-year terms.

Description of Suburban Transit Services

NJ TRANSIT has been experimenting with the provision of transit service oriented towards increasing suburban employment and commuting patterns with widely varying results over the past ten years. NJ TRANSIT has experimented with deviations to existing NJ TRANSIT routes, initiation of reverse-commute transit services, park/ride oriented services, suburban

employment services, flexibly routed subscription services, and various connecting services to rail stations and other transit hubs.

Description of Operational Issues

The WHEELS services are contracted out to a private operator. The only significant purchase at the time was the purchase of smaller cutaway vehicles for some of the circulator routes. The cost of these suburban transit services was similar to existing NJ TRANSIT service.

Description of Funding Arrangements

These experimental transit services were supported through the use of federal Congestion Mitigation and Air Quality (CMAQ) funds for the first three years of operation. At the end of the third year of operation, “successful” services became part of NJ TRANSIT’s network of services and are funded through the regular channels, while routes that were not meeting their performance standards were eliminated.

Description of Marketing Program

During the initial implementation phase, NJ TRANSIT worked extensively with local TMAs to market the suburban transit services. Promotional events were held initially and free fares were offered to passengers.

Description of Performance Measurement Program

In 1993, NJ TRANSIT launched 40 new experimental transit routes, which were named WHEELS services. A performance measurement program was established for these services, with farebox recovery as the primary performance indicator. Second year farebox recovery goals for these services were 20% for new services and 25% for service extensions or enhancements. After two years in operation, fifty percent of the WHEELS services were meeting their goals and the remaining services had either already been discontinued or were scheduled for discontinuation. Ten years after these routes were inaugurated, approximately twenty five percent of the routes were still in operation.

Successes, Challenges and Lessons Learned with the Suburban Transit Services

Several lessons learned have emerged from NJ TRANSIT’s foray into the realm of experimental transit services. First of all, there was considerable enthusiasm and marketing for these routes when they were first implemented and the ridership increased rather significantly on many routes. Over time, enthusiasm and marketing waned, as did the route’s ridership. NJ TRANSIT learned that marketing must be sustained for the long haul in order to ensure continued success for their WHEELS transit services. Routes that provided a direct connection to other transit services were also more likely to succeed than new routes in primarily auto-oriented parts of the state that do not provide a connection to the existing transit network. Lastly, routes operating in areas with higher employment and population density were much more likely to

succeed, as would be expected. While many of these issues were painful lessons at the time, NJ TRANSIT has learned from these experiences and has significantly improved their ability to plan non-traditional suburban oriented transit routes throughout the state.

Transferability to Other Systems

The WHEELS minibuses are probably some of the most transferable of NJ TRANSIT's suburban services. NJ TRANSIT still operates 15 of these routes and average ridership in FY 2003 was 7.36 passengers/hour, which is a respectable performance for a small vehicle, circulator type service.

APPENDIX D: CASE STUDY METHODOLOGY

The methodology for this study was based on four fundamental efforts, described below:

- **Background research and preliminary analysis** focused on reviewing previous studies in the area of suburban transit service, defining “contemporary suburbia”, describing the characteristics of transit services, and exploring the relationships between land use and activity patterns, and how they relate to various types of transit service.
- **Preliminary case studies** generated a wealth of information on a wide range of agencies, identified common issues and trends faced by these agencies, and elucidated how agencies make decisions about what service to implement and how its performance will be measured. This effort also helped identify which agencies operate a variety of service types, which were willing to participate more heavily in the study, and what land-use and operating data they have available.
- **Detailed case studies** offered the opportunity to follow-up with a limited number of agencies to better understand their operating environment, transit services, and political and funding situation, among others. Nine sites were selected and visited by a team member to collect various data, explore the service area, and meet with agency representatives. Qualitative information is being synthesized for each site while the land-use data is being used to generate an activity surface for the region and specific land-use statistics for the service areas of selected services. This information, along with service operating statistics and ridership data, will be used to evaluate the relationship between development or activity patterns and transit service. This work is in progress at the time of this writing.
- **Guidelines** are the final component of the work. This step will synthesize our findings from the detailed case studies and develop guidelines for operators and policy makers that can be used to inform their choice of transit service.

In each region, several specific suburban services, such as individual express routes, circulators, flex routes, or dial-a-ride services were selected for more detailed analysis of land-use patterns, service characteristics, and operating performance. The analysis of these sites includes development of a regional activity surface that locates each local service within the context of regional trip making.

The surface is used to determine how strong a correlation exists between the topographic features contained in a service area and the service format that is most appropriate. For example, peaks on the surface represent the largest destinations for travel by all modes and are generally served by the highest frequency, highest capacity transit services in a region. They are also frequently the best locations for transit hubs because the concentration of routes serves travel demand from all directions and the concentration of trip ends minimizes the need to transfer. Peaks are frequently served by fixed-route circulator services that provide “last mile” connections to nearby densely developed areas.

In contrast, plains are notoriously difficult to serve with fixed-route transit because of the low density, coarsely grained mix of land uses, and lack of well-connected pedestrian facilities frequently found in suburban residential areas. These areas are frequently served by flexible routes or demand-responsive feeder services that connect to regional transit at a peak.

Several land-use measures were also developed for each local service area, depending on data availability, including:

- Service area size
- Population density
- Household density
- Employment density
- Jobs - housing balance
- Industry mix (relative share of employment by industry)
- Land-use mix (relative share of residential, commercial, industrial, and other land uses)
- Sidewalk coverage (measure of completeness of pedestrian network)
- Street connectivity (measure of grid or cul-de-sac development patterns)
- Urban places (whether there is a significant place with walkable urban characteristics of small setbacks and street-fronting “Main Street-style” buildings)
- Parking cost (whether there is a significant place in the service area where charges for off-street parking are in effect)
- Transit priority features (whether there is are any significant traffic signal priority systems, queue jumper lanes, or bus lanes in the service area)
- Service format (e.g. express, fixed-route, flex-route, dial-a-ride)
- Service supply (e.g. revenue-hours per day)
- Performance (e.g. riders per hour)

These statistics provide the basis for the development of guidelines that identify conditions under which specific service formats and service levels have been most effective.

In each region, several specific suburban services, such as individual express routes, circulators, flex routes, or dial-a-ride services were selected for more detailed analysis of land-use patterns, service characteristics, and operating performance. The analysis of these sites includes development of a regional activity surface that locates each local service within the context of regional trip making.

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- Service format (e.g. express, fixed-route, flex-route, dial-a-ride)
- Service supply (e.g. revenue-hours per day)
- Performance (e.g. riders per hour)

These statistics provide the basis for the development of guidelines that identify conditions under which specific service formats and service levels have been most effective.

APPENDIX E: DATA COLLECTION FORMAT TRANSIT CHARACTERISTICS

Table E-1: Transit Characteristics

Service Characteristics	Route						
% of households or jobs within service area							
Response time (DAR)							
Number of vehicles in peak service							
Intermodal hubs?							
Technology - Signal preemption - Next bus - -							
Vehicle Characteristics							
Vehicle type							
Capacity (seats/wheelchair positions)							
Technology - Annunciators - AVL - Smart Cards - -							
Route Characteristics							
Headway - Peak - Off peak							
Average speed							
Trips per - Weekday - Saturday - Sunday							
Route length (mi/hr)							
Service span - Weekdays - Saturday - Sunday							

Transit Performance (FY 2004)

Table E-2: Transit Performance (FY 2004)

Performance	Route						
Annual passengers							
Revenue hours							
Revenue miles							
Vehicle hours							
Vehicle miles							
Cost/passenger							
Cost/hour							
Cost/mile							
Subsidy/passenger							
Farebox recovery ratio							
On-time performance (define)							
Trip denials							
Missed trips							
% of pax requesting deviations							

Funding Sources

Table E-3: Funding Sources

Source	% of Total Revenue	Longevity	Renewability

Transit Policy

- A. Board role and involvement
- B. Decision-making process
- C. Guidelines
- D. Performance Measurement System (describe)
- E. Organizational model (e.g. opt-out program)
- F. Other unique characteristics

Land Use & Travel Patterns

City and/or Community:

- A. Key Attractions

(Large employers, schools, shopping centers, medical centers, museums, arenas, hotels)

Table E-4: Key Attractions

Name	Location	Magnitude

B. Land Use by Parcel:

Source –

Data available?

- Residential (dwelling units by parcel or block)
- Commercial (square footage of leasable space)

Yes	No
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

C. Travel Behavior

- Origin-Destination Travel Patterns
- Trip Purposes
- Trip Frequency

Demographics

A. Data Available?

Filename/Source

- Household income
- Car ownership
- Age composition
- Unemployment rate
- Non-English speaking populations
- Average household size
-
-
-
-

Yes	No	Scale
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	

B. Customer survey and outreach

Demographics

Attitudes and preferences toward personal travel

Potential Transit Advantages

A. Street Network Characteristics

Table E-5: Street Network Characteristics

	Service/Route/Route Segment						
Street width							
Number of lanes							
Speed limit							
Signal spacing							
ADT							
V/C or LOS							
Connectivity							
Distance between bus stops							

B. Aerial Photos of Service Area

Available: Yes / No

Source/Filename:

Table E-6: Aerial Photos of Service Area

Sidewalk network characteristics	Service/Route/Route Segment						
Completeness							
Separation from street							
Width							

C. Transit Priority Features

Table E-7: Transit Priority Features

	Service/Route/Route Segment						
Traffic signal priority							
Queue jump lanes							
Exclusive lanes							

D. Parking Cost or Scarcity

(Average cost of parking, metered parking, structures, etc.)

APPENDIX F: QUANTITATIVE FACTORS DECISION MATRIX

Table F-1: Quantitative Factors Decision Matrix

Property	City	State	Type of Service	No Standards	Min # pax/hr during Probation	Min # pax/hr after Probation	Probationary Period (months)	Different Level of Service on Nights or Weekends	Maximum subsidy/pax (\$)	Minimum Ridership % on route of System Average	Farebox Recovery Ratio (%)	Replacement service for underperforming fixed route	Funding Availability of partner (for service to start)	Service in Areas with Minimum of 1,800 persons/mile ²	Households/Acre
Eastern Contra Costa County Transit System	Antioch	CA			9	12	12				20		✓		
Regional Transportation District	Denver	CO	Call-and-Ride		3		12					✓			
South Metro Area Rapid Transit	Wilsonville	OR		✓											
Metropolitan Transit Development Board	San Diego	CA	Access Routes		12		24		6.50						
Pierce Transit	Tacoma	WA	New routes		3		12		11.30				✓	✓	
			Routes 13 – 24 months		4		12		8.50				✓	✓	
			Route 25 months +		5				6.80				✓	✓	
Champaign-Urbana Mass Transit District	Champaign-Urbana	IL	Dial-A-Ride		3										
Kansas City Area Transportation Authority	Kansas City	MO	Demand Response	✓											
Suburban Mobility Authority for Regional Transportation	Detroit	MI	Flex Routes	✓											

Property	City	State	Type of Service	No Standards	Min # pax/hr during Probation	Min # pax/hr after Probation	Probationary Period (months)	Different Level of Service on Nights or Weekends	Maximum subsidy/pax (\$)	Minimum Ridership % on route of System Average	Farebox Recovery Ratio (%)	Replacement service for underperforming fixed route	Funding Availability of partner (for service to start)	Service in Areas with Minimum of 1,800 persons/mile ²	Households/Acre
Des Moines Metropolitan Transit Authority	Des Moines	IO	Dial-A-Ride (evenings only)		5			✓				✓			
Toledo Area Regional Transit Authority	Toledo	OH	Dial-A-Ride		3										
Metro Transit	Minneapolis	MN	Suburban		5				4.50						3 - 5
			Dial-A-Ride		2				4.50						<3
Potomac Rappahannock Transportation Commission	Manassas	VA	Route Deviation (evenings)		4										
Capital District Transit Authority	Albany	NY	Flex Routes	✓									✓		
Pace Transit	Chicago	IL					12		5.00	50	20		✓		
Tri-Met	Portland	OR	Circulator		15		24 – 36								
Dallas Area Rapid Transit	Dallas	TX	Curb-to-Curb	✓	6				4.30			✓			
Rhode Island Public Transportation Authority	Rhode Island	RI		✓											
Broward County	Ft. Lauderdale	FL	Circulator		5										
Ft. Worth Transportation Authority	Ft. Worth	TX		✓						> paratransit services					
New Jersey Transit	Newark	NJ					24				20				

APPENDIX G: QUALITATIVE FACTORS DECISION MATRIX

Table G-1: Qualitative Factors Decision Matrix

Property	City	State	Type of Service	Substitute Service for Unproductive Fixed Routes	Reviews Land-Use Development Plans/Proposals	Geography & Topography considered	Ensuring Communitywide Mobility Opportunities	Community Feedback Determined Need	Developing Community Support for Transit	Employment Opportunity/Unemployment/Population Motivated	Avoids ADA Requirement/Expenses	Lifeline Service	Proximity to Rail Station	Funding Availability of Partner (for service to start)	Feeder Service to Regular or Premium Transit Network	Environmentally Motivated	Desire to Streamline Regional Network	Desire for Internal Community Trips	Protest against Large Buses in Neighborhood	Visible Use of Taxpayers \$	
Eastern Contra Costa County Transit System	Antioch	CA			✓																
Regional Transportation District	Denver	CO	Call-and-Ride						✓										✓	✓	
South Metro Area Rapid Transit	Wilsonville	OR																			
Metropolitan Transit Development Board	San Diego	CA	Access Routes																		
Pierce Transit	Tacoma	WA	New routes			✓															
			Routes 13 – 24 months			✓															
			Route 25 months +			✓															
Champaign-Urbana Mass Transit District	Champaign-Urbana	IL	Dial-A-Ride			✓	✓														
Kansas City Area Transportation Authority	Kansas City	MO	Demand Response	✓						✓											
Suburban Mobility Authority for Regional Transportation	Detroit	MI	Flex Routes						✓	✓											
Des Moines Metropolitan Transit Authority	Des Moines	IO	Dial-A-Ride (evenings only)	✓							✓	✓									
Toledo Area Regional Transit Authority	Toledo	OH	Dial-A-Ride				✓		✓												

Property	City	State	Type of Service	Substitute Service for Unproductive Fixed Routes	Reviews Land-Use Development Plans/Proposals	Geography & Topography considered	Ensuring Communitywide Mobility Opportunities	Community Feedback Determined Need	Developing Community Support for Transit	Employment Opportunity/Unemployment/Population Motivated	Avoids ADA Requirement/Expenses	Lifeline Service	Proximity to Rail Station	Funding Availability of Partner (for service to start)	Feeder Service to Regular or Premium Transit Network	Environmentally Motivated	Desire to Streamline Regional Network	Desire for Internal Community Trips	Protest against Large Buses in Neighborhood	Visible Use of Taxpayers \$
Metro Transit	Minneapolis	MN	Suburban				✓				✓	✓								
			Dial-A-Ride					✓				✓	✓							
Potomac Rappahannock Transportation Commission	Manassas	VA	Route Deviation (evenings)								✓									
Capital District Transit Authority	Albany	NY	Flex Routes					✓		✓										
Pace Transit	Chicago	IL								✓				✓						
Tri-Met	Portland	OR	Circulator		✓										✓			✓		
Dallas Area Rapid Transit	Dallas	TX	Curb-to-Curb						✓				✓		✓				✓	✓
Rhode Island Public Transportation Authority	Rhode Island	RI					✓			✓		✓								
Broward County	Ft. Lauderdale	FL	Circulator												✓		✓	✓		
Ft. Worth Transportation Authority	Ft. Worth	TX		✓																
New Jersey Transit	Newark	NJ								✓		✓			✓	✓				

APPENDIX H: DETAILED CASE STUDIES

As indicated previously, the following sites were selected:

- Suburban Mobility Authority for Regional Transportation (Detroit, Michigan)
- Metropolitan Council and Minnesota Valley (Minneapolis / St. Paul, Minnesota)
- Tri-Met (Portland, Oregon)
- South Metro Area Rapid Transit (Wilsonville, Oregon)
- King County Metro (Seattle, Washington)
- Capital District Transportation Authority (Albany, New York)
- Broward County Transit (Broward County, Florida)
- Regional Transit District (Denver, Colorado)

1. DETROIT, MICHIGAN

Suburban Mobility Authority for Regional Transportation

SMART operates in three counties in the greater Detroit area – Wayne, Oakland and Macomb Counties – and is notable among major metropolitan transit agencies in that its service area does not include the central city. The service area includes all or portions of 86 communities with a total population of approximately 3.3 million. SMART operates 62 fixed routes with peak vehicle requirements of 230 buses, serving suburb-to-suburb trips and trips between suburbs and Detroit. Total ridership on the fixed routes is 8.4 million annual unlinked trips.

In response to the suburban nature of its service area, the agency has also introduced several types of demand-responsive services, including advance reservation, flex route, ADA paratransit, and Job Express, a connector service that accommodates same-day requests for pick-ups and drop-offs between a fixed-route bus stop and employment locations in specified zones. SMART also indirectly provides service in 55 communities through a Community Partnership Program, which is a vehicle procurement program designed to help local communities acquire vehicles using federal funds and local property tax revenues. Local communities provide advance reservation services using 136 vehicles purchased through this program. Total ridership on demand-response services is more than 1 million rides per year, with approximately 60 percent on services operated by community partners.

SMART relies on a property tax for much of its public funding. A dedicated transit millage was passed by communities in the three counties in 1995 and is reauthorized by referenda every four years. This need for periodic voter approval has encouraged SMART to become very responsive to community mobility needs. The Community Partnership Program is one element of this community orientation. SMART sets aside a portion of each community's property tax contribution to fund local services. While some communities use their discretionary funds to enhance local services operated by SMART, many have found it more cost-effective to procure vehicles and operate their own services.

The agency's seven-member board includes two representatives from each of the three counties it serves and one representative from adjacent Monroe County. The system operates out of three main garages, one in each county. The Board has given management significant latitude to experiment with new services.

SMART identifies entry-level employees, especially those who live in Detroit and work in suburban employment centers, as one of its key markets. The agency has implemented a marketing program with the tagline "Get a Job, Get a Ride" aimed at service industry workers whose job opportunities are increasingly located in suburban areas. The program provides a free bus pass to full-time employees during their first month of employment at participating employers.

This case study focuses on a group of services in the Troy area of Oakland County that represent how suburban transit services can evolve over time. SMART has provided dial-a-ride service within the city limits of Troy since 1975. A major suburban employment corridor has also developed along Big Beaver Road in the southern part of Troy over the last few decades. To relieve the dial-a-ride service from repetitive daily travel patterns associated with major employers, the original dial-a-ride service has been supplemented by two demand-responsive services that focus on specific submarkets within the service area. The Big Beaver Job Express provides a connection between a transit center at one end of the Big Beaver corridor and major

employers in the area. The Oakland Mall Job Shuttle provides a connection between another transit center and employers at the opposite end of the Big Beaver Road corridor.

This case study also includes a second Job Express service in a much less densely developed area. The Lakeside Job Express operates as a connection between a transit center and entry level jobs at a cluster of big-box retailers in an automobile-dominated area where pedestrian access is very difficult.

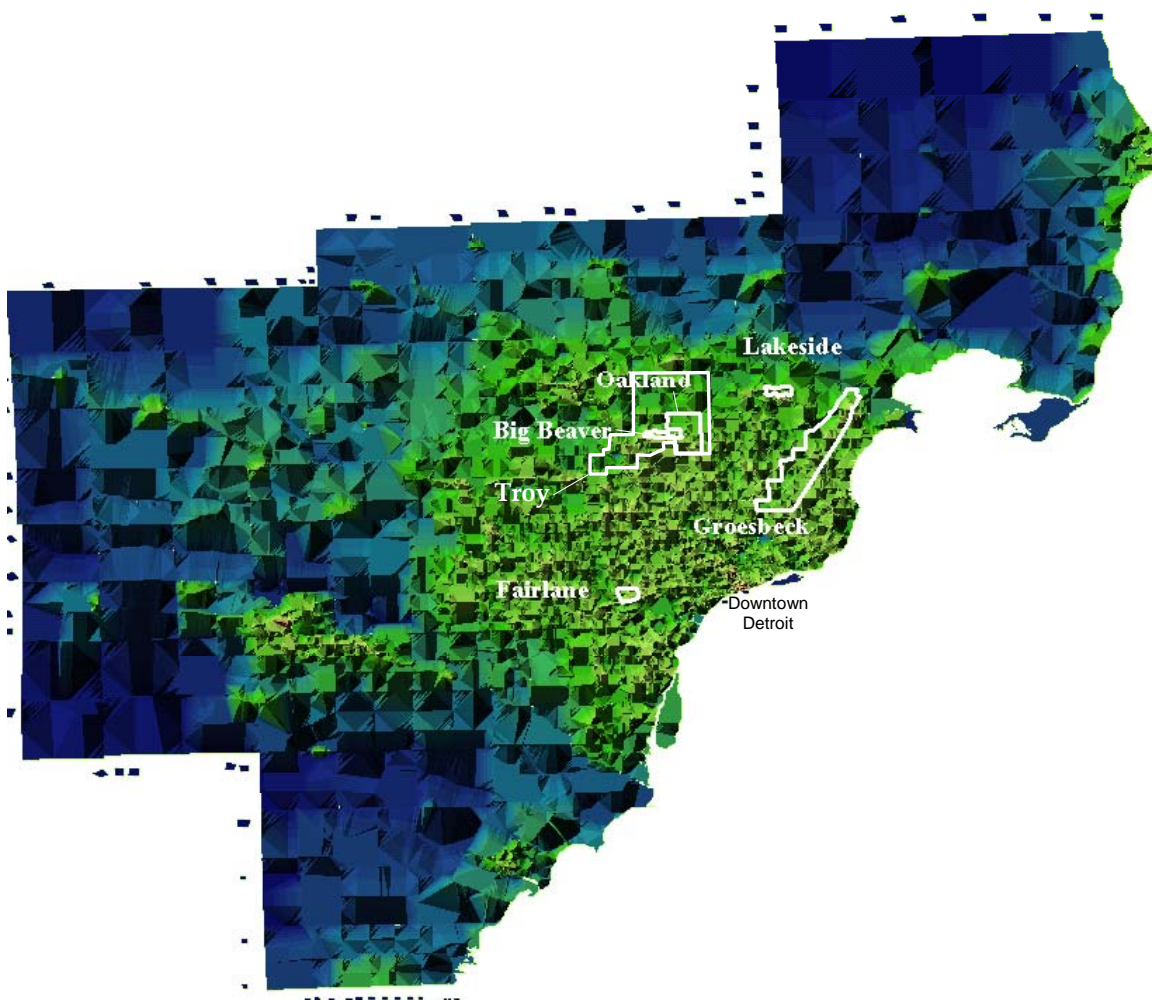
Two other demand-responsive services operated by SMART elsewhere in the Detroit metropolitan area are presented for comparison and contrast, but at a lower level of quantitative detail than the Troy area services and the Lakeside Job Express. These services include the Groesbeck flex route and a third Job Express service centered at Fairlane Town Center, a regional shopping center surrounded by major employers, including the Ford Motor Company headquarters.

Regional Travel Patterns

Figure H-1 shows the distribution of activity throughout the Detroit metropolitan area. Activity is measured by trip ends (origins or destinations) per square mile, as represented in the Southeast Michigan Council of Governments (SEMCOG) regional travel demand model. Blue areas have the least activity density, generally representing rural areas on the edge of the metropolitan area. Red areas represent areas with the highest density of activity. Compared to other metropolitan areas with stronger downtowns, Detroit has a much larger share of activity in moderately dense urban neighborhoods and suburban business districts, which are represented as green areas.

The Troy area, which includes the Troy – Birmingham Dial-a-Ride, Big Beaver Job Express, and Oakland Mall Job Shuttle service areas, is characterized by a ridge of activity in its southern portion. The Groesbeck flex route operates along a local ridge of activity. The Fairlane and Lakeside Job Express services operate around local peaks of activity.

Figure H-1: Detroit Metropolitan Area Activity Surface



Source: Southeast Michigan Council of Governments regional travel demand model, 2005.

Troy Area Services

The Troy area is served by an established general public demand-response service, the last survivor of a number of community dial-a-ride services introduced in the 1970s. The service provides connections between all points in the Troy city limits on request between 6:00 a.m. and 6:00 p.m. weekdays. Customers call a SMART toll-free hotline to request pick ups. SMART processes the requests in the order received, usually within one hour after the call is placed. Advanced reservations are also accepted. In late 2003, the Troy dial-a-ride was merged with a similar community transit service in nearby Birmingham and Beverly Hills to reduce operating costs.

The combined service operates using five accessible 12-15 passenger cutaway vans, as shown in Figure H-2. SMART charges a base community transit fare of \$2.00 for the service, plus \$0.25 for a transfer to fixed-route service. Discounts are available for seniors, people with disabilities, Medicare patients, and children under 6 years of age.

Figure H-2: SMART Community Transit Vehicle



SMART introduced a Job Express, an employment-oriented “last mile” service, in each of its three counties in 1995 following the initial property tax referendum. Each of the Job Express services operates as a point deviation service from a single hub where connections to fixed routes are available. Service areas were limited to approximately 2 square miles to keep round trips from the hub to approximately 10 minutes. Because of the short trips, services generally operate without schedules – they just return to the hub as frequently as possible. Timed transfers with fixed-route services are not an explicit objective, but the service frequency is intended to keep wait times as short as possible. Drivers are typically drawn from the agency’s paratransit roster.

The Big Beaver Job Express serves one of the five largest employment centers in the region, an area that rivals downtown Detroit in employment concentration. The Big Beaver Job Express was implemented as an overlay service in the Troy dial-a-ride area, where it relieved the city-wide service of a number of peak-period commuter trips concentrated along Big Beaver Road. The service operates using one van from 6:00 a.m. to 10:00 a.m. and from 2:30 p.m. to 6:00 p.m. on weekdays. All trips begin and end at the Somerset Collection, an upscale regional shopping center where management has welcomed the access provided by the convergence of six fixed routes, especially for mall workers.

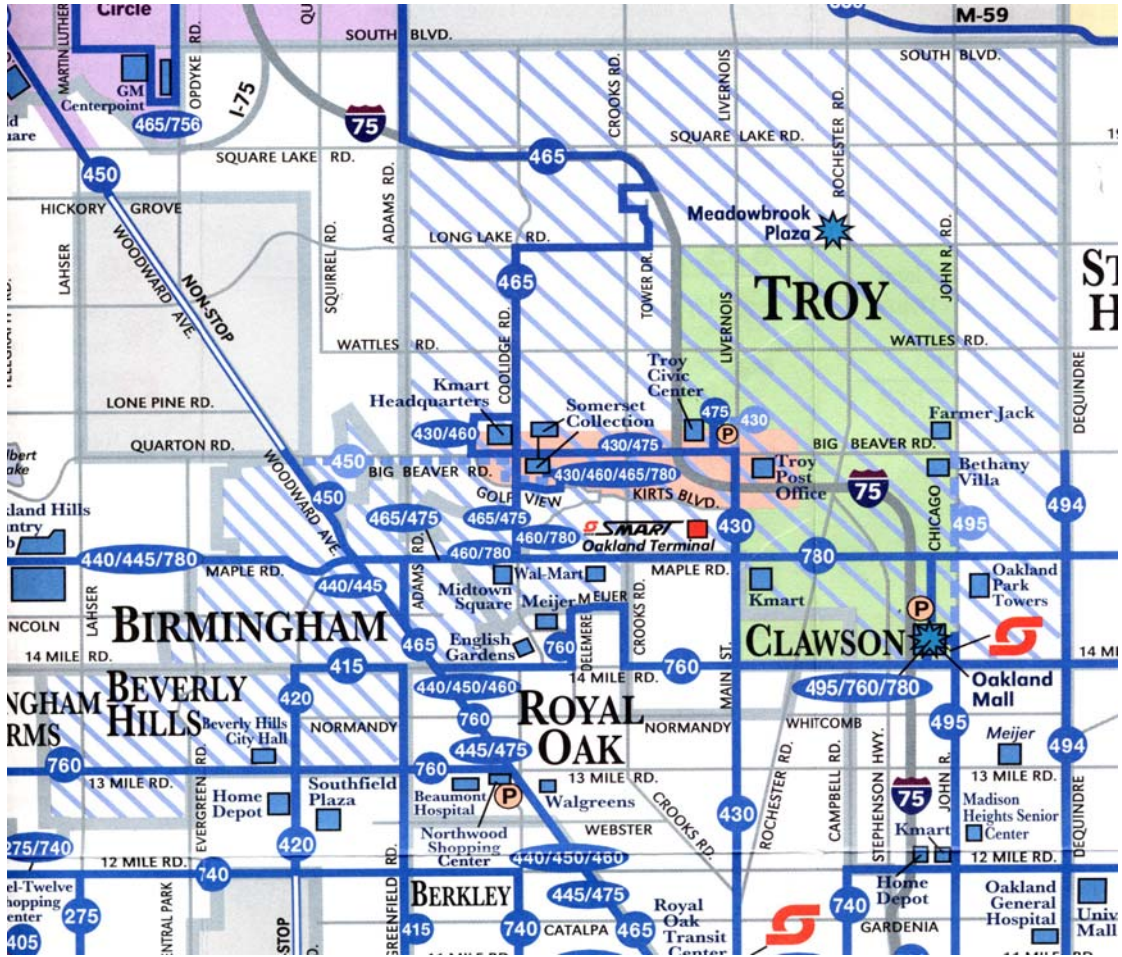
Trip itineraries are designed by the driver on the fly based on drop off requests made by passengers on boarding, telephone trip requests relayed by the dispatcher, and return trip requests made by passengers earlier in the day. Base fares for all Job Express services are \$0.25 each way, which is equivalent to the cost of a fixed-route transfer.

The Oakland Mall Job Shuttle is similar to the Big Beaver Job Express in its peak-period employment orientation, but it operates as a point deviation route between two timepoints – the Oakland Mall transit center on the south and the Meadowbrook Plaza shopping center on the north. The route taken between the two points varies based on pick up and drop off requests. Four 4H-minute round trips each weekday morning and three trips each weekday afternoon are scheduled. The service operates using one van. As with the other services, pick up requests can be arranged with the driver or made by telephone to SMART’s toll-free number. The agency charges a two-level fare depending on boarding location. Passengers boarding at either timepoint pay the \$1.50 line-haul fare. Passengers boarding anywhere else pay the \$2.00 community transit fare. Transfers to fixed routes cost \$0.25.

Service/Route Characteristics

The service area of the three Troy area services is shown in Figure H-3. The Troy-Birmingham Dial-a-Ride service area is hatched in blue. The Big Beaver Job Express is shown in salmon. The Oakland Mall Job Shuttle is shown in green.

Figure H-3: Troy Service Area



Source: SMART

Table H-1 summarizes the operating characteristics of the Troy area services.

Table H-1: Operating Characteristics of Troy Area Services

Operating Characteristic	Troy-Birmingham Dial-a-Ride	Big Beaver Job Express	Oakland Mall Job Shuttle
Service format	Demand response	Point deviation (1 point)	Point deviation (2 timepoints)
Headway (in minutes)			
Peak	n/a	approx. 10	45
Off peak	n/a	—	—
Average speed (miles per hour)	approx. 20	approx. 20	approx. 20
Number of trips per			
Weekday	n/a	up to approx. 120 per demand	9
Saturday	0	0	0
Sunday	0	0	0
Service span			
Weekday	6:00 a.m. – 6:00 p.m.	6:00 – 10:00 a.m. 2:30 – 6:00 p.m.	7:00 – 10:00 a.m. 2:30 – 5:10 p.m.
Saturday	—	—	—
Sunday	—	—	—
Vehicles used in service	5	1	1
Vehicle type	12-15 passenger cutaway van, ADA accessible	12-15 passenger cutaway van, ADA accessible	12-15 passenger cutaway van, ADA accessible
Technology in use	AVL, CAD	AVL, CAD	AVL, CAD

Source: SMART

Table H-2 summarizes the operating performance of the Troy area services. The services carry from 1.8 to 3.5 passengers per revenue hour, with the flex-route services having about twice the productivity of the dial-a-ride service. This performance level is at the low end of the suburban services included in the case studies.

Table H-2: Operating Performance of Troy Area Services

Performance Measure	Troy-Birmingham Dial-a-Ride	Big Beaver Job Express	Oakland Mall Job Shuttle
Annual passengers	20,828	6,604	5,334
Revenue hours	11,593	1,905	1,524
Passengers per hour	1.8	3.5	3.5
Cost per passenger	\$39.71	\$20.62	\$20.42
Cost per hour	\$71.47	\$71.47	\$71.47

Source: SMART

Note: Operating costs are based on a composite of SMART community services.

Service Area Characteristics

For the Troy-Birmingham Dial-a-Ride, the service area is defined as the city limits inside which pick ups and drop offs are available. Service areas for the point deviation services are as defined by SMART in Figure H-3. The table includes indicators that correspond to the four D’s – density, diversity, design as well as deterrents to driving. The Troy area has moderate population density corresponding to approximately two dwelling units per acre on average, relatively high employment density, a surplus of jobs over residents, a broad industry mix, and predominantly single-family residential land use.

The Big Beaver Road corridor has an especially intensive concentration of retail and office activities, as reflected by its high employment density and high share of commercial land uses. This area is shown in Figure H-4, as viewed from an elevated walkway at the Somerset Collection shopping center and transit hub.

Figure H-4: Big Beaver Corridor

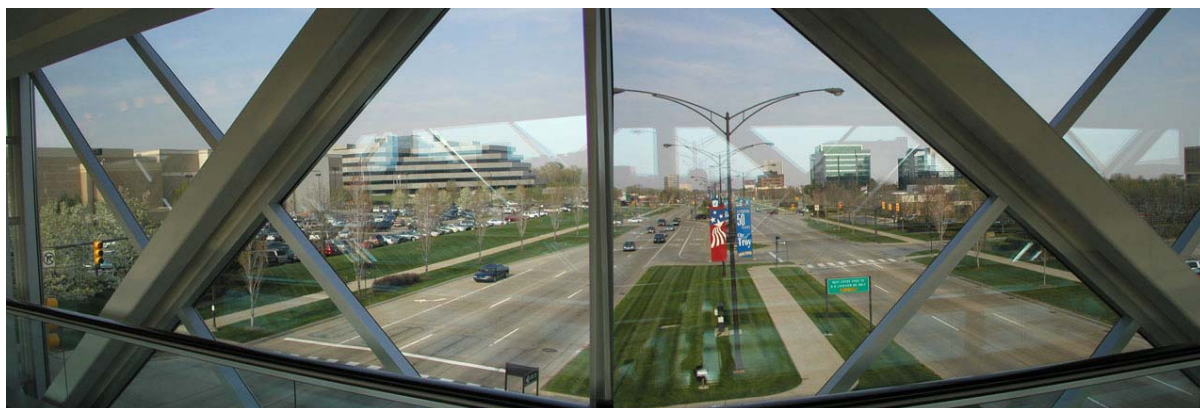
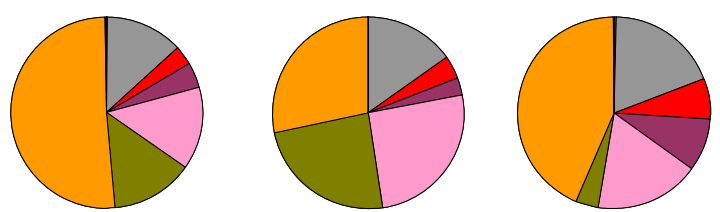
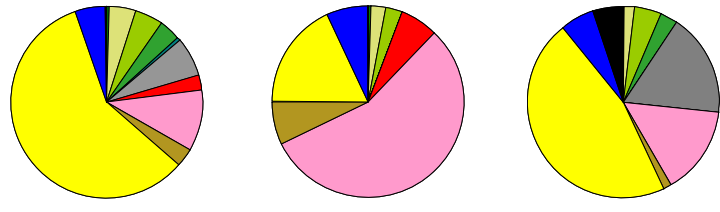


Table H-3 summarizes the land-use and demographic information for the Troy area services.

Table H-3: Service Area Characteristics of the Troy Area Services

Characteristic		Troy-Birmingham Dial-a-Ride	Big Beaver Job Express	Oakland Mall Job Shuttle
Population				
Service area size (sq. miles)				
		43.1	1.9	9.6
Service area population				
		112,684	4,573	22,310
Population density (per sq. mile)				
		2,617	2,392	2,322
Service area households				
		44,031	1,955	8,653
Household density (per sq. mile)				
		1,023	1,022	900
Employment				
Service area employment				
		163,537	17,647	46,053
Employment density (jobs per sq. mile)				
		3,799	9,230	4,792
Jobs/housing balance				
		1.5	3.9	2.06
Employment by sector				
<ul style="list-style-type: none"> ■ Agriculture ■ Manufacturing ■ Transportation ■ Wholesale Trade ■ Retail Trade ■ Finance, Insur., Real Est. ■ Service ■ Public Service ■ Other 				
				
Land use				
<ul style="list-style-type: none"> ■ Agriculture ■ Open Space ■ Grassland / Shrub ■ Woodland / Wetland ■ Water ■ Industrial ■ Transportation ■ Commercial ■ MF Residential ■ SF Residential ■ Institutional ■ Under Development ■ Undeveloped 				
				
Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)				
		4	4	4
Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)				
		2	2	2
Urban place in service area				
		yes	no	no
DETERRENENTS TO DRIVING	Off-street parking costs	no	no	no
	Transit priority features	no	no	no

Source: SEMCOG for socioeconomic data, SMART for interviews

Lakeside Job Express

The Lakeside Job Express serves a suburban retail shopping area with a very poor pedestrian environment. Big box retailers surrounded by large parking lots line a 2-mile stretch of M-59, a major divided arterial highway with limited access and few sidewalks or opportunities for pedestrians to cross. SMART operates four fixed routes to a transit hub at Lakeside Center, a regional mall that spawned the retail concentration in this growing area of Macomb County. The Job Express service was introduced to address the difficult walk from the transit center to the many shopping opportunities and entry-level jobs in the area. Most of the ridership works in the area.

The service started as a freeform loop that made pick ups and drop offs while returning to the transit center as frequently as possible. To better accommodate timed transfers, the service now operates between pulses of fixed-route arrivals. The service is provided using one dedicated van between 8:15 a.m. and 6:00 p.m. weekdays. The \$0.25 fare is similar to other Job Express services.

Service/Route Characteristics

Figure H-5 shows the service area of the Lakeside Job Express.

Figure H-5: Lakeside Job Express Map



Source: SMART

Table H-4 summarizes the operating characteristics of the Lakeside Job Express.

Table H-4: Operating Characteristics of Lakeside Job Express

Operating Characteristic	Lakeside Job Express
Headway (in minutes)	
Peak	approx. 10
Off peak	approx. 10
Average speed (miles per hour)	approx. 20
Number of trips per	
Weekday	up to 100 per demand
Saturday	0
Sunday	0
Service span	
Weekday	8:15 a.m. – 6:00 p.m.
Saturday	—
Sunday	—
Vehicles used in service	1
Vehicle type	12-15 passenger cutaway van, ADA accessible
Technology in use	AVL, CAD

Source: SMART

Table H-5 summarizes the operating performance of the Lakeside Job Express. The service carries approximately 2.5 passengers per revenue hour. This is only somewhat less than the productivity of the Big Beaver Job Express, which serves an area with nearly three times the employment density.

Table H-5: Operating Performance of Lakeside Job Express

Performance Measure	Lakeside Job Express
Annual passengers	8,636
Revenue hours	3,429
Passengers per hour	2.5
Cost per passenger	\$28.59
Cost per hour	\$71.47

Source: SMART

Note: Operating costs are based on a composite of SMART community services.

Service Area Characteristics

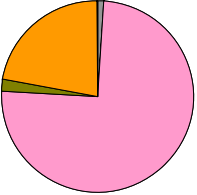
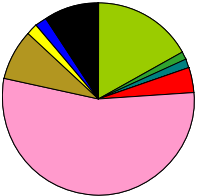
Figure H-6 shows the automobile-oriented environment around the Lakeside Center.

Figure H-6: Lakeside Center Area



Table H-6 summarizes the land-use and demographic information for the Lakeside Job Express. The service area is defined by SMART, as shown in Figure 5. The Lakeside Center area has moderate population and employment density with approximately the same number of jobs as residents. The area is dominated by commercial activity, as evidenced by its high proportion (3 of 4) of jobs in the retail sector and high proportion (more than half) of land area in commercial uses.

Table H-6: Service Area Characteristics for Lakeside Job Express

	Characteristic	Lakeside Job Express	
DENSITY	Population		
	Service area size (sq. miles)	1.6	
	Service area population	5,492	
	Population density (per sq. mile)	3,426	
	Service area households	2,264	
	Household density (per sq. mile)	1,412	
	Employment		
	Service area employment	5,466	
	Employment density (jobs per sq. mile)	3,410	
	Jobs/housing balance	1.0	
DIVERSITY	Employment by sector		
	<ul style="list-style-type: none"> ■ Agriculture ■ Manufacturing ■ Transportation ■ Wholesale Trade ■ Retail Trade ■ Finance, Insur., Real Est. ■ Service ■ Public Service ■ Other 		
	Land use		
	<ul style="list-style-type: none"> ■ Agriculture ■ Open Space ■ Grassland / Shrub ■ Woodland / Wetland ■ Water ■ Industrial ■ Transportation ■ Commercial ■ MF Residential ■ SF Residential ■ Institutional ■ Under Development □ Undeveloped 		
	DESIGN	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)	1
		Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)	1
		Urban place in service area	no
	DETERRENTS TO DRIVING	Off-street parking costs	no
		Transit priority features	no

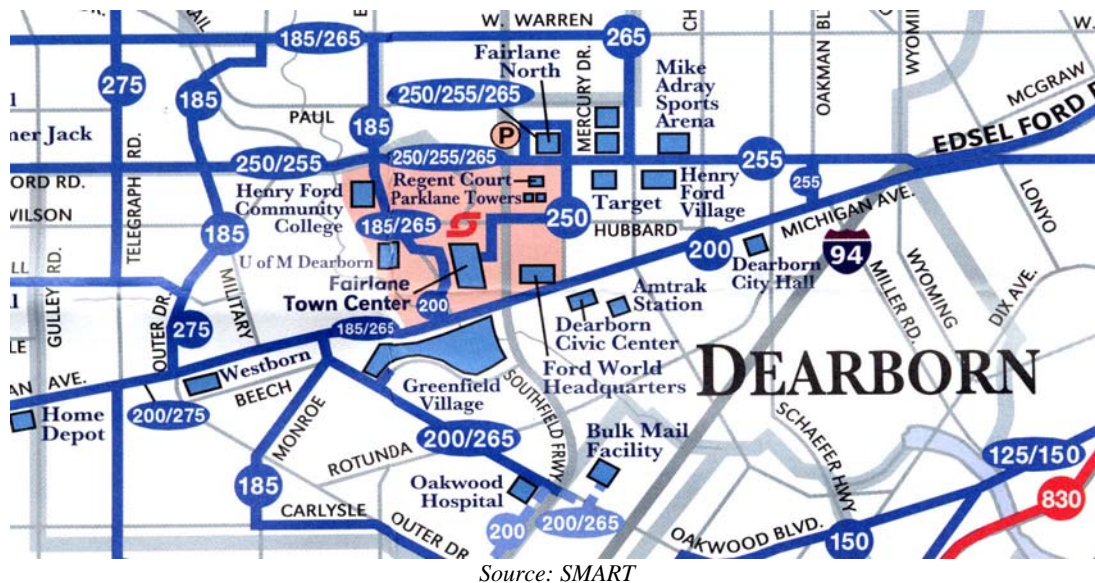
Source: SEMCOG for socioeconomic data, SMART for interviews

This section provides information on two other demand-responsive suburban transit services for comparison with the services described above.

Fairlane Job Express

The Fairlane Job Express serves a major regional employment center that includes the Ford Motor Company world headquarters. As with the other Job Express services, it operates from a transit center at a regional shopping center, the Fairlane Town Center. Connections to four fixed-route bus services are available at this transit center, as shown in Figure H-7. The flex-route service area includes a number of mid-rise office buildings and hotels along a ring road surrounding the mall. Each trip returns to the transit center as quickly as possible after serving a pick up or drop off request relayed by SMART dispatchers. The service began with two vehicles in 1995, but has been scaled back to a single vehicle due to low demand. The service operates during morning and afternoon weekday peak periods only and shares the \$0.25 fare structure with other Job Express services.

Figure H-7: Fairlane Job Express Map



Groesbeck Flex Route

The Groesbeck flex-route was introduced as a more flexible alternative to fixed-route service along approximately 12 miles of the Groesbeck Highway corridor, an area of moderately dense residential, commercial, and industrial development north of Detroit. As shown in Figure H-8, the service operates between a transit center at Eight Mile Road, where connections can be made with a fixed-route to or from Detroit, and Mount Clemens, a small historic downtown with regional medical centers and a seat of county government. Each run serves two intermediate timepoints located at regional shopping centers and any point within approximately 1 mile of Groesbeck Highway. To address union concerns, SMART agreed to supplement the flexible service with a part-time fixed route (Route 225 Groesbeck Helper) on runs on which the ridership typically exceeds 10 passengers per hour or 18 passengers per trip. The Groesbeck Helper currently operates on two outbound trips on weekday mornings.

Figure H-8: Groesbeck Route Map



Source: SMART

Table H-7 summarizes the operating characteristics of the Fairlane Job Express and the Groesbeck Flex Route.

Table H-7: Operating Characteristics of Other Regional Services

Operating Characteristic	Fairlane Job Express	Groesbeck Flex Route
Headway (in minutes)		
Peak	approx. 10	20 – 30
Off peak	—	90 – 120
Average speed (miles per hour)	approx. 20	approx. 20
Number of trips per		
Weekday	up to approx. 55 per demand	32
Saturday	0	0
Sunday	0	0
Service span		
Weekday	7:00 a.m. – 10:15 a.m., 2:00 p.m. – 7:00 p.m.	5:20 a.m. – 7:00 p.m.
Saturday	—	—
Sunday	—	—
Vehicles used in service	1	5
Vehicle type	12-15 passenger cutaway van, ADA accessible	12-15 passenger cutaway van, ADA accessible
Technology in use	AVL, CAD	AVL, CAD

Source: SMART

Table H-8 summarizes the operating performance of the Groesbeck flex route and the Fairlane Job Express. At less than two passengers per revenue hour, these services are among the least productive community transit services that SMART operates.

Table H-8: Operating Performance of Other Regional Services

Performance Measure	Fairlane Job Express	Groesbeck Flex Route
Annual passengers	4,064	29,464
Revenue hours	4,191	16,929
Passengers per hour	1.0	1.7
Cost per passenger	\$71.47	\$42.04
Cost per hour	\$71.47	\$71.47

Source: SMART

Note: Operating costs are based on a composite of SMART community services.

Service Area Characteristics

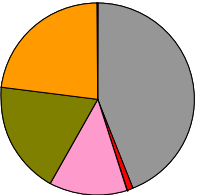
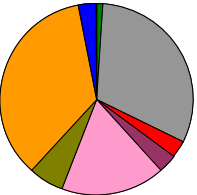
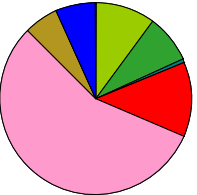
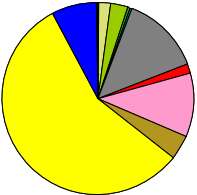
Figure H-9 shows the moderately dense setting of mid-rise office buildings around the Fairlane Town Center. The large expanse of parking is the mall parking lot.

Figure H-9: Fairlane Town Center Area



Table H-9 summarizes the land-use and demographic information for the Fairlane Job Express and the Groesbeck Flex Route. The Fairlane Job Express serves one of the most intensive concentrations of employment in the Detroit area, with the greatest employment density of the Detroit service areas evaluated and a predominance of commercial uses. The Groesbeck Flex Route serves a less dense, but more balanced area with a variety of residential, commercial, and industrial uses.

Table H-9: Service Area Characteristics for Fairlane Job Express and Groesbeck Flex Route

	Characteristic	Fairlane Job Express	Groesbeck Flex Route	
DENSITY	Population			
	Service area size (sq. miles)	1.9	29.8	
	Service area population	1,614	103,697	
	Population density (per sq. mile)	863	3,474	
	Service area households	773	51,263	
	Household density (per sq. mile)	414	1,718	
	Employment			
	Service area employment	26,899	82,901	
	Employment density (jobs per sq. mile)	14,157	2,778	
	Jobs/housing balance	16.7	0.8	
DIVERSITY	Employment by sector			
	<ul style="list-style-type: none"> ■ Agriculture ■ Manufacturing ■ Transportation ■ Wholesale Trade ■ Retail Trade ■ Finance, Insur., Real Est. ■ Service ■ Public Service ■ Other 			
	Land use			
	<ul style="list-style-type: none"> ■ Agriculture ■ Open Space ■ Grassland / Shrub ■ Woodland / Wetland ■ Water ■ Industrial ■ Transportation ■ Commercial ■ MF Residential ■ SF Residential ■ Institutional ■ Under Development ■ Undeveloped 			
	DESIGN	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)	3	3
		Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)	1	2
		Urban place in service area	no	yes
	DETERRENENTS TO DRIVING	Off-street parking costs	no	no
		Transit priority features	no	no

Source: SEMCOG for socioeconomic data, SMART for interviews

Summary and Conclusions

SMART provides a variety of suburban services, including those that focus on job access, but the primary goal of the Community Partnerships Program is to foster excellent relations within those communities, which in turn provide the impetus for retaining the funding base. Regarding the land-use aspects, as will be discussed later, there are some linkages to typical density relationships, but it appears that some of the better performing services are those with multiple types of destinations.

2. MINNEAPOLIS/SAINT PAUL, MINNESOTA

Metropolitan Council – Metro Transit Minnesota Valley Transit Authority

The Metropolitan Council's area of jurisdiction includes all or portions of nearly 190 cities and townships in the Twin Cities region. This region has approximately 2.6 million residents. Suburban transit services are provided by three means: Metro Transit, private operators and semi-autonomous private operators, called opt-out services. The MetCouncil operates Metro Transit and provides oversight to opt-out services (services operated in jurisdictions that have opted out of the regional tax, as described below). Metro Transit serves an area populated by approximately 1.9 million people and provides approximately 35 percent of suburban service. Thus, the majority of suburban service is provided by private operators. Metro Transit operates 70 local, 51 express and 16 contract service routes, serving over 230,000 riders per weekday or 70 million annual trips. This service is provided with a peak fleet of 841 vehicles, providing 2 million annual vehicle-hours of revenue service with an annual operating budget of \$193 million.

The most innovative services are generally provided by the opt-out services, since these operations are designed in and by the communities they serve. The community-based operations have been in existence for 12 to 15 years and were initiated by local agencies that opted out of the regional dedicated transit tax and decided to run their own local transit services. There are a variety of services available, varying by municipality. Some of the services include dial-a-rides, flexible routes, and circulators. Sixty percent of opt-out services are subsidized by MetCouncil, as required by state law. The municipalities cover the remainder of the cost. Since transit subsidies must flow through MetCouncil, the agency maintains some oversight, providing evaluation and guidance. MetCouncil, however, cannot make any directives on how opt-out services should operate. Performance measures used by MetCouncil include: subsidy per ride, riders per hour, service area coverage, and political realities.

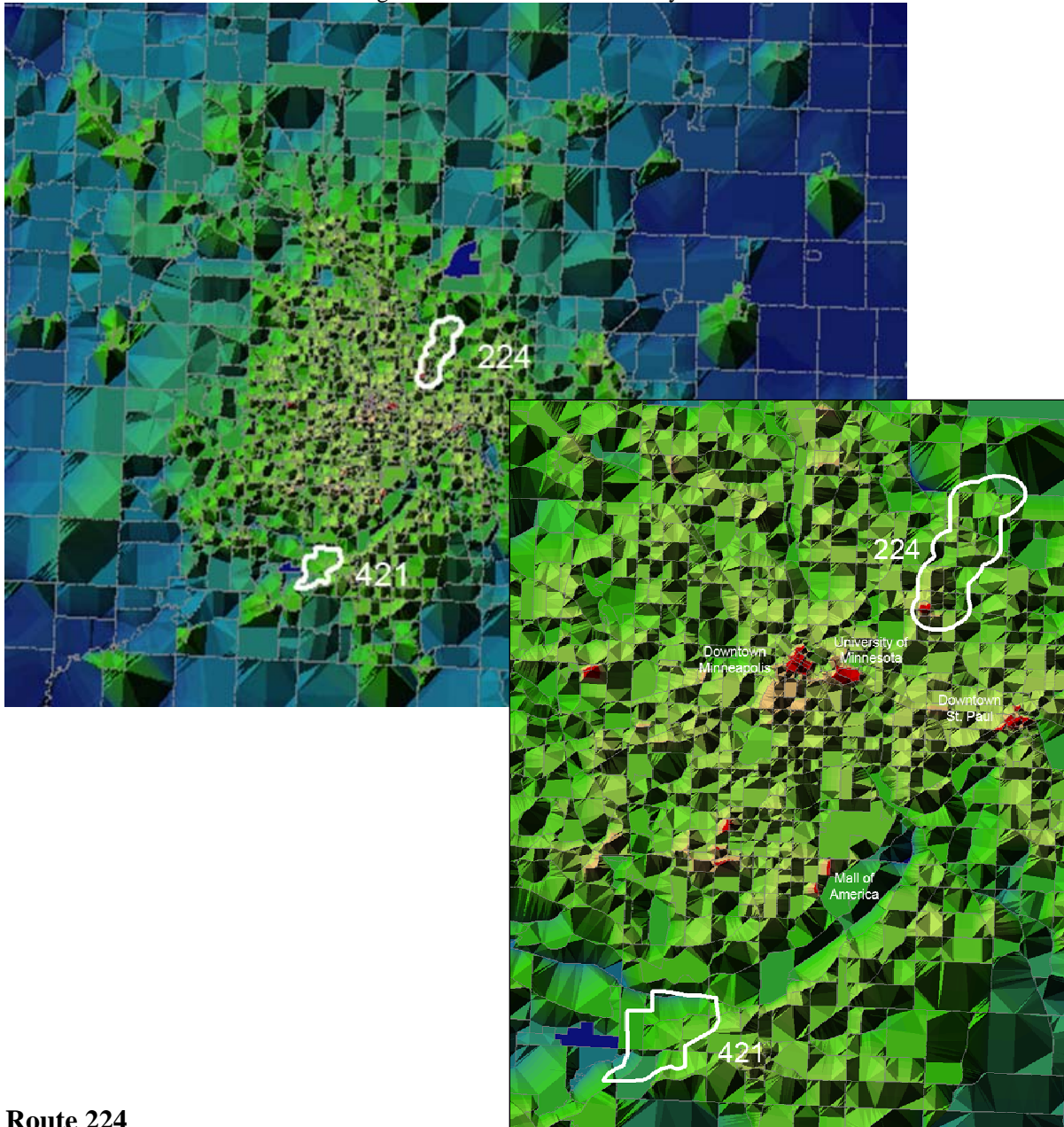
Two services that were evaluated in the Twin Cities region include Route 224, operated by Metro Transit, and Route 421 Savage/Burnsville, which is an opt-out service operated by the Minnesota Valley Transit Authority. While both services are flex-routes, they represent different approaches to flexing. Route 224 is mainly a fixed-route service with point deviations that provide 5 pre-defined opportunities to deviate from the fixed route. Each deviation is allocated a certain amount of time for the deviation to be made and returns to the main route where it departed. Route 421 is a route deviation service that allows deviations between 5 scheduled timepoints on advanced request.

Regional Travel Patterns

Figure H-10 shows the distribution of activity throughout the Twin Cities region. Activity is measured by trip ends (origins or destinations) per square mile, as represented in the

MetCouncil regional travel demand model. Blue areas have the least activity density, generally representing rural areas on the edge of the metropolitan area. Red areas, including the peaks of downtown Minneapolis and downtown St. Paul, represent areas with the highest density of activity. Route 224 operates from a local peak at the Rosedale transit center along a ridge of activity to the north. Route 421 operates in a plain representing relatively low density suburban development.

Figure H-10: Twin Cities Activity Surface



Route 224

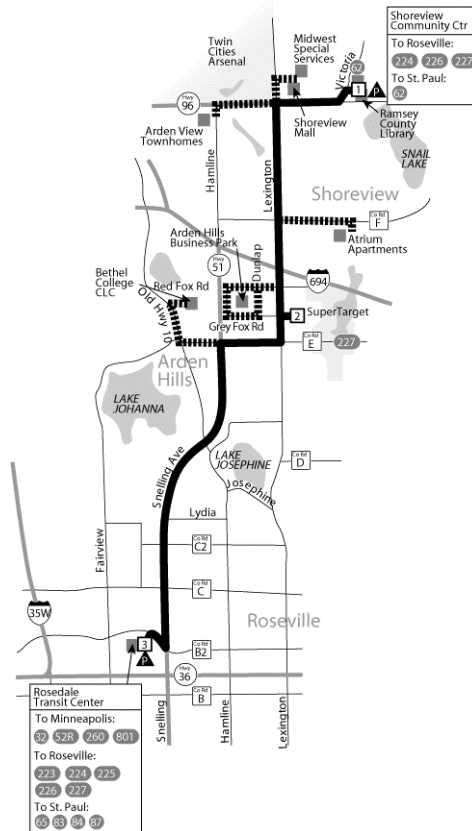
Route 224 is a mid-day flex-route service operated by Metro Transit that provides connections between a transit center, several multi-family residential communities, a community center, a job training center for people with disabilities, a medical clinic and a small private college. From the fixed portion of the route, upon request, the bus deviates onto pre-defined flex portions of the route. The deviations were added to the original fixed-route service as a cost effective means of providing transit to newly developed areas that would otherwise be left unserved by transit.

Service Characteristics

Figure H-11 shows the area served by Route 224, with point deviations indicated by broken lines. Each deviation is allocated a set amount of time for the bus to return to the fixed

portion of the route. Depending on the deviation, the allocated amount of time ranges from 2 to 7 minutes. Given the development activity within the service area and the route's service hours, in all likelihood, this route largely caters to non-commuters that need to access mid-day services at the medical clinic and the community center.

Figure H-11: Route 224 Map



Source: www.metrotransit.org

Table H-10 shows the service characteristics of Route 224, including frequency, service span and fleet requirements.

Table H-10: Operating Characteristics of Route 224

Operating Characteristic	Route 224
Headway (in minutes)	
Peak	No Peak Service
Off peak	60 minutes
Number of trips per	
Weekday	8
Saturday	0
Sunday	0
Service span	
Weekday	8:20AM – 4:10 PM
Saturday	N/A
Sunday	N/A
Vehicles used in service	2
Vehicle type	Regular full-sized bus

Source: www.metrotransit.org

Table H-11 shows the operating performance of Route 224, including annual ridership, passengers per hour, and operating cost. As a route-deviation route, Route 224 is both the least flexible flex route in the sample in terms of number of potential deviation points and also the most productive at 6.6 passengers per revenue hour.

Table H-11: Operating Performance of Route 224

Performance Measure	Route 224
Annual passengers	11,599
Revenue hours	1,770
Passengers per hour	6.6
Cost per passenger	\$6.48
Cost per hour	\$42.45

Source: MetCouncil Route Profiles

Service Area Characteristics

Table H-12 summarizes land-use and demographic information for the service area of Route 224. The service area is defined as the area within $\frac{3}{4}$ mile of the route, including all deviations. Indicators that correspond to the four D's – density, diversity, design as well as deterrents to driving – are presented. The service area has moderate population density corresponding to dwellings on $\frac{1}{2}$ to 1 acre lots on average, a mix of land uses dominated by residential uses, and a surplus of jobs compared to residents, suggesting that the area is a net importer of workers from elsewhere in the region. Development pattern of this service area is typical of many suburban areas with relatively poor sidewalk coverage and medium to low street network connectivity. Nearly half of the fixed-route portion of the route runs along a facility that does not have any sidewalk. Also, many streets that feed into the route path do not have

sidewalks. There are also no parking costs or transit priority measures in place that enhance transit’s competitiveness with the private automobile.

Table H-12: Service Area Characteristics of Route 224

	Characteristic	Route 224		
DENSITY	Population			
		Service area size (sq. miles)	11.0	
		Service area population	22,289	
		Population density (per sq. mile)	2,023	
		Service area households	8,673	
		Household density (per sq. mile)	787	
		Employment		
		Service area employment	33,817	
		Employment density (jobs per sq. mile)	3,070	
		Jobs/housing balance	1.5	
DIVERSITY	Employment by sector			
		<ul style="list-style-type: none"> ■ Agriculture ■ Construction ■ Manufacturing ■ Transportation ■ Wholesale Trade ■ Retail Trade ■ Information ■ Finance, Insur., and Real Est. ■ Professional Services ■ Education ■ Arts ■ Government ■ Other 		
		Land use		
		<ul style="list-style-type: none"> ■ Agriculture ■ Open Space ■ Water ■ Industrial ■ Transportation ■ Commercial ■ Mixed-Use ■ MF Residential ■ SF Residential ■ Institutional ■ Undeveloped 		
	DESIGN	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)		1
		Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)		2
		Urban place in service area		no
		DETERRENTS TO DRIVING	Off-street parking costs	no
	Transit priority features		no	

Source: Metropolitan Council for socioeconomic data, MetCouncil Transit interviews

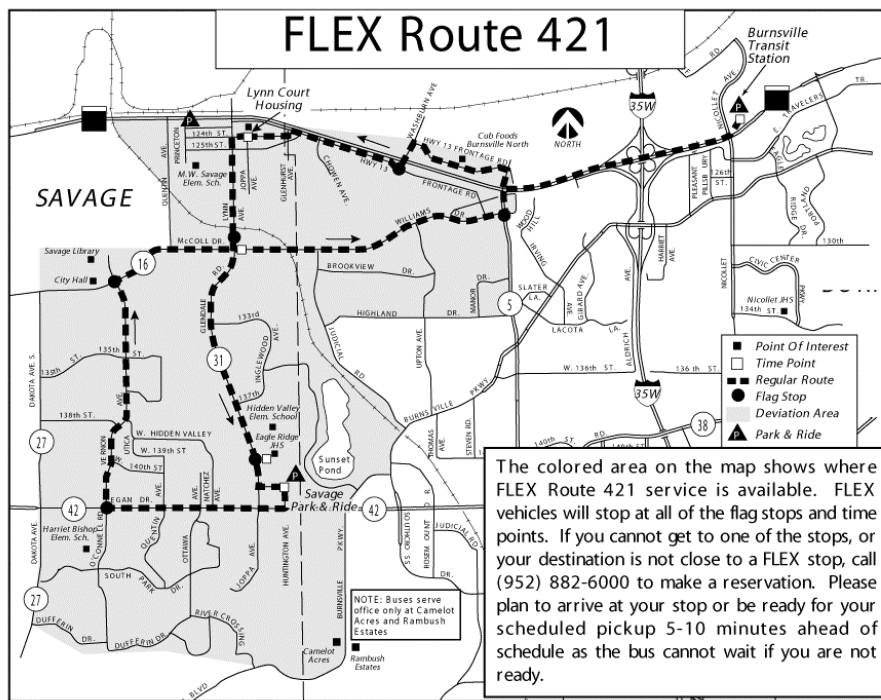
Flex Route 421

Route 421, which is operated by the Minnesota Valley Transit Authority as part of the opt-out program, is a mid-day flex-route service that deviates off of the route upon advanced request. The route follows a general loop and serves five fixed timepoints on every run. While a few schools are located in the service area, Route 421 also provides connections to the Savage Park & Ride and the Burnsville Transit Station. This service was put in place to ensure the availability of transit in these areas. The dispersion of development in this area could not support a fixed-route service, but residents expressed the desire for the reliable mobility that comes with a fixed-route service. The resulting flex route was a means of both appeasing the desires of the community and overcoming the operational challenges of serving a low-density area. Though the service is available to all riders, the main markets served by this route are low-income residents and the elderly.

Service Characteristics

Figure H-12 shows the area served by Route 421, with the general path of travel indicated by the broken line and arrows, the route-deviation service area indicated by shading, and timepoints marked.

Figure H-12: Route 421 Map



Source: <http://www.mvta.com>

Table H-13 shows the service characteristics of Route 421, including frequency, service span and fleet requirements.

Table H-13: Operating Characteristics of Route 421

Operating Characteristic	Route 421
Headway (in minutes)	
Peak	N/A
Off peak	60-180 minutes
Number of trips per	
Weekday	4
Saturday	0
Sunday	0
Service span	
Weekday	9:25 AM – 3:51PM
Saturday	N/A
Sunday	N/A
Vehicles used in service	1
Vehicle type	Cut-away, 12-15 passenger, ADA accessible

Source: <http://www.mvta.com>

Table H-14 shows the operating performance of Route 421, including annual ridership, passengers per hour, and operating cost. In terms of productivity, Route 421 performs better than sampled point-deviation routes in Detroit and worse than point-deviation routes in Albany.

Table H-14: Operating Performance of Route 421

Performance Measure	Route 421
Annual passengers	4,352
Revenue hours	953
Passengers per hour	4.6
Cost per passenger	\$18.73
Cost per hour	\$85.54

Source: MetCouncil Route Profiles

Service Area Characteristics

Table H-15 summarizes land-use and demographic information for the service area of Route 421. The service area is defined as the area within $\frac{3}{4}$ mile of the route, including all deviations. Indicators that correspond to the four D's – density, diversity, design as well as deterrents to driving – are presented. The service area has moderate population density corresponding to dwellings on $\frac{1}{2}$ to 1 acre lots on average, predominantly single-family residential land use, and a surplus of residents compared to jobs, suggesting that the area is essentially a bedroom community for people working elsewhere in the region. Development patterns are typical of many suburban areas with relatively poor sidewalk coverage (many streets do not have sidewalks) and low to medium street connectivity. Lacking a gridded street network, the many cul-de-sacs and dead-ends in this service area increase the walking distance to arterials

and may inhibit efficient transit operations. There are also no parking costs or transit priority measures in place that enhance transit’s competitiveness with the private automobile.

Table H-15: Service Area Characteristics of Route 421

	Characteristic	Route 421
DENSITY	Population	
	Service area size (sq. miles)	7.3
	Service area population	18,944
	Population density (per sq. mile)	2,582
	Service area households	6,218
	Household density (per sq. mile)	848
	Employment	
Service area employment	3,745	
Employment density (jobs per sq. mile)	510	
Jobs/housing balance	0.2	
DIVERSITY	Employment by sector	
	<ul style="list-style-type: none"> ■ Agriculture ■ Construction ■ Manufacturing ■ Transportation ■ Wholesale Trade ■ Retail Trade ■ Information ■ Finance, Insur., and Real Est. ■ Professional Services ■ Education ■ Arts ■ Government ■ Other 	
	Land use	
	<ul style="list-style-type: none"> ■ Agriculture ■ Open Space ■ Water ■ Industrial ■ Transportation ■ Commercial ■ Mixed-Use ■ MF Residential ■ SF Residential ■ Institutional ■ Undeveloped 	
	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)	1
	Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)	2
	Urban place in service area	no
	DETERRENTS TO DRIVING	
	Off-street parking costs	no
	Transit priority features	no

Source: Metropolitan Council for socioeconomic data, MetCouncil Transit interviews

Summary and Conclusions

This case study provides different perspectives on services as well as governance. From a service perspective, the route-deviation service has fairly strict limits on distance deviated as well as restricting deviations to known activity centers. The flex-route service on the other hand has more ability to cover a larger geographic area, but does so by trading off strict schedule adherence. Governance wise, the ability to opt out of the regional transit district appears to offer more potential for community control of services, within the general governance structure of the Met Council.

3. PORTLAND, OREGON

Tri-Met

TriMet is the transit service provider for the majority of the Oregon portion of the Portland metropolitan area, serving a 57H-square-mile area that includes the city of Portland and many of its suburbs, with a combined population of approximately 1.25 million residents. In 2002, the agency operated 568 buses, 58 light rail cars, and 173 demand-responsive vehicles in maximum service.

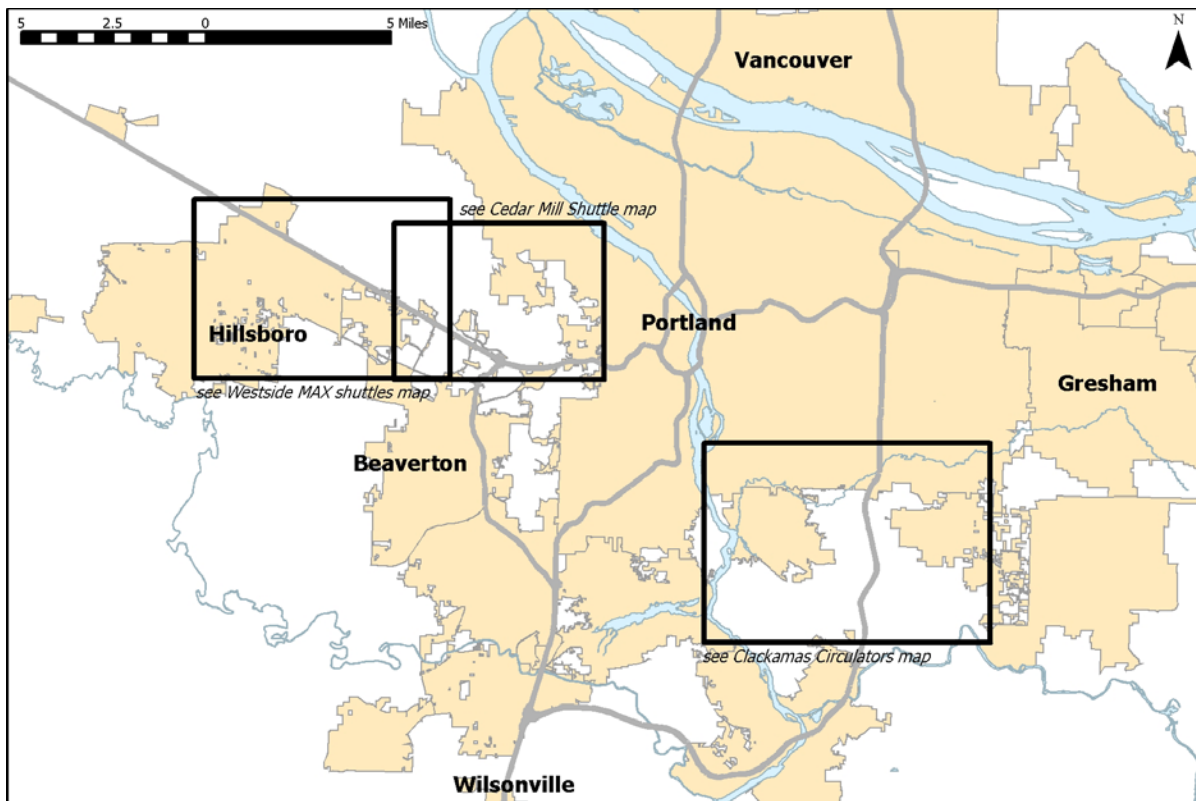
TriMet is governed by a seven-member Board of Directors, appointed by the Governor of Oregon. Board members represent, and must live in, certain geographical districts. The term of office is four years, but a Board member serves at the pleasure of the Governor. The Board sets agency policy, enacts legislation (taxing and ordinances relating to policy ordinances), and reviews certain contracts.⁵ The agency is organized as a Mass Transit District in the state of Oregon, giving it the ability to issue bonds and assess a payroll tax on employers and self-employed individuals. The majority of TriMet's operating revenue (52% in 2004) comes from the payroll tax; the tax is in the process of being raised gradually from 0.6218 to 0.7 percent over a 10-year period.

TriMet's main performance measure is boarding rides per vehicle hour, with the threshold for a low-performing route being 15 boarding riders per vehicle hour. TriMet tracks compliments and complaints on a continual basis and conducts an Attitude and Awareness Survey once a year.

This case study looks at three different types of suburban services that are or have been offered by TriMet:

- Four fixed-route circulators serving mainly urban unincorporated Clackamas County, southeast of Portland;
- The demand-responsive Cedar Mill Shuttle, connecting a low-density residential area in the hills west of downtown Portland to a light rail station; and
- Two fixed routes that distributed passengers from the westside light rail line to major employers, and which have since been discontinued.

⁵ TriMet, <http://www.trimet.org/inside/board.htm>, accessed March 16, 2005.

Figure H-13: Portland Vicinity Map

Source: Metro Regional Land Information System

Regional Travel Patterns

Figure H-14 shows the distribution of activity throughout the Portland metropolitan region. Activity is measured by trip ends (origins or destinations) per square mile, as represented in the Portland Metro regional travel demand model. Blue areas have the least activity density, generally representing rural or mountainous areas on the edge of the metropolitan area. Red areas, including the peaks of downtown Portland and a secondary peak at suburban Gresham, represent areas with the highest density of activity.

The figure also shows the service areas of two suburban transit services evaluated in more detail. The Cedar Mill Shuttle operates between a plain of mainly residential development to a ridge along the sunset Highway (U.S. Highway 26). Route 201 Barbur operates along a ridge of activity along Interstate 5 from Wilsonville to downtown Portland.

Figure H-14: Portland Activity Surface

Source: Portland Metro regional travel demand model.

Clackamas Circulators

The northwestern portion of Clackamas County is urbanized and is part of the Portland metropolitan area. It includes a number of small- to medium-sized incorporated cities ranging in population from 600 to 25,000, as well as an extensive amount of unincorporated urban residential land.

In the late 1980s, demand-response service was started in the Milwaukee area, later converted to deviated-route service due to low ridership, and eventually, after the passage of the ADA, converted to fixed-route service. This route is now Route 152, *Milwaukee*, which runs between the Milwaukee Transit Center and the Clackamas Town Center regional mall and transit center, serving a number of industrial employers along the way.

In 1992, the Clackamas County Board of Commissioners requested that TriMet extend service to the area along Sunnyside Road, which ran through a hilly, rapidly urbanizing portion of the county. More of TriMet's customers requested that service be provided to the Sunnyside area than to any other portion of the region. Furthermore, a 1,900-home "neo-traditional" development, Sunnyside Village, was being proposed toward the east end of the corridor. In May 1993, the Sunnyside Shuttle began service within the Sunnyside area, connecting to the Clackamas Town Center. Service was originally demand-responsive, because it could be contracted out and therefore was less expensive to operate than fixed-route service would have

been. TriMet's ADA contractor was used to provide the service and handle reservations. The same minibuses used for ADA service were used for the shuttle routes. Following discussions with the union, the service was brought in-house in December 1994, a conversion that "was neither anticipated nor planned," according to TriMet staff. Operating costs increased from \$27/hour as a contracted service to \$50/hour with in-house union operators. A union dispatcher was also required to handle reservations.

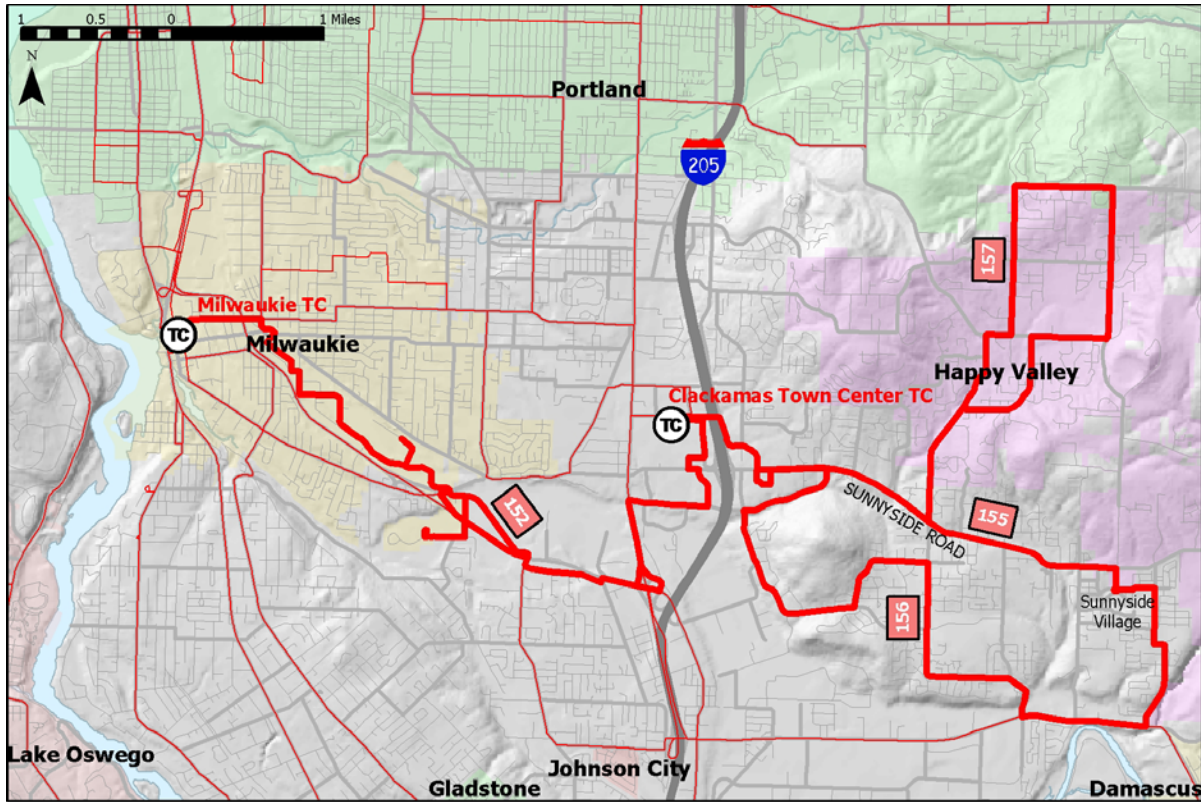
In 1995, TriMet's service district was expanded to include Sunnyside Village and the city of Happy Valley, and service was extended to those areas. In 1998, to reduce the cost per ride, the demand-responsive service was proposed to be converted to fixed-route service. TriMet took input from current riders, the general public, and agency staff, and combined it with demand-responsive trip patterns, population data, and land-use data to develop four fixed routes. When the routes were being designed, residents of local streets being proposed as turnarounds strongly objected. As a result, routes were redesigned to travel only on the major traffic streets in the area. The new routes were implemented in March 1999 and were operated using 27-foot buses.

Routes 155, *Sunnyside*, and 156, *Mather Road*, form a loop between Clackamas Town Center and Sunnyside Village—an eastbound Route 155 becomes a westbound Route 156 bus on the return trip, and vice versa. Route 157, *Happy Valley*, travels between Clackamas Town Center and Happy Valley, duplicating Route 155 for the portion of its route along Sunnyside Road. Buses are scheduled to spread out the 155 and 157 buses, resulting in alternating 20- and 40-minute headways on the shared portion of the routes, rather than having two buses arriving together every 60 minutes. Route 158, *Stevens*, served an area closer to Clackamas Town Center on the east side of I-205, but was discontinued in December 2002 due to low ridership. The routes serve an area that is primarily single-family residential, but which also has some multi-family residential and grocery-anchored shopping centers along Sunnyside Road. Regular TriMet fares are charged.

TriMet's marketing department sponsored a public meeting during the service design phase of implementing the Sunnyside fixed-route services. A marketing brochure was also mailed to all households and businesses in the community. No general marketing efforts are currently underway for the Clackamas services.

Service/Route Characteristics

Figure H-15: Clackamas Circulators Map



Source: Metro Regional Land Information System

Table H-16: Operating Characteristics of Clackamas Circulators

Operating Characteristic	Route 152	Route 155	Route 156	Route 157
Headway (in minutes)				
Peak	30	60	60	60
Off peak	60	60	60	60
Average speed (miles per hour)	17.0	18.0	20.7	19.6
Number of trips per				
Weekday	31	36	36	30
Saturday	0	30	30	26
Sunday	0	26	26	0
Service span				
Weekday	11	17.5	17.5	14
Saturday	0	14.5	14.5	12
Sunday	0	12	12	0
Vehicles used in service	2	2 buses alternate between these 3 routes		
Technology in use	AVL, APC	AVL, APC	AVL, APC	AVL, APC

Source: TriMet

Table H-17: Operating Performance of Clackamas Circulators

Performance Measure	Route 152	Route 155	Route 156	Route 157
Weekday passengers	420	200	220	130
Revenue hours	13	6.2	12.5	7.8
Revenue miles	185	140	268	172
Cost per passenger	\$2.80	\$2.80	\$5.14	\$5.43
Cost per hour	\$90.48	\$90.48	\$90.48	\$90.48
Cost per mile	\$7.21	\$7.21	\$7.21	\$7.21
Farebox recovery ratio	20%	20%	11%	10%

Source: TriMet, costs per hour & mile are 2002 systemwide averages from the National Transit Database (NTD), average fare is derived from the NTD

Cedar Mill Shuttle

The Cedar Mill Shuttle started in 1999, soon after the opening of westside light rail. The shuttle started as a weekday many-to-few general demand-responsive service. Cedar Mill is a primarily low-density, somewhat hilly residential area located about 8 road miles west of downtown Portland. The shuttle's service area covers 2.6 square miles.

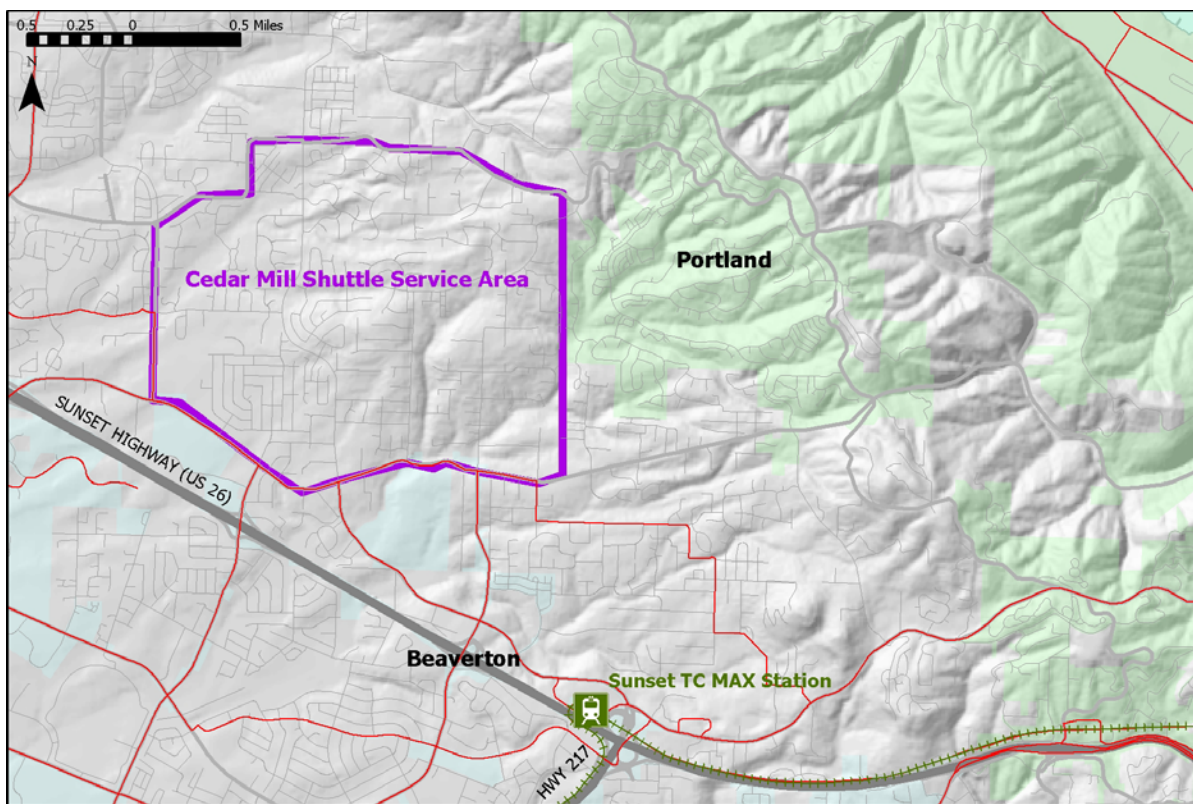
When service first started, it was contracted to a local taxi company. TriMet's union agreement allows contractors to provide service for pilot projects for 18 or 36 months, after which time the service must be brought in-house or eliminated. The shuttle served the Sunset Transit Center light rail station, as well as several other designated destinations within the area (e.g., supermarkets and a library). When TriMet brought the service in-house in 2002, the service hours were reduced from 14 hours per day to peak hours only as a cost-saving measure, based on an analysis that showed that most shuttle trips were commute trips to and from the light rail station. Although, in theory, one can still use the shuttle to access other destinations within the service area during the times service is provided, the service is currently promoted as a many-to-one light rail feeder.

A 12-passenger accessible van is used for the shuttle. One-day advance notice is preferred, with reservations being handled in-house by a TriMet Trainer. Same-day service can be provided subject to availability (the driver is called directly for same-day requests and for last-minute changes or cancellations). Subscription service is offered. Regular TriMet fares are charged. The pick-up window is ± 10 minutes of the scheduled time, and the driver will wait one minute after arriving. The shuttle currently operates weekdays, 6–9 a.m. and 3–7 p.m.

Marketing efforts (brochures) were made when the Cedar Mill Shuttle started and when TriMet took over operations, but not much has been done since. TriMet staff meets with the Cedar Mill Community Planning Organization annually to review the service and get feedback. Unlike all other TriMet bus services, the Cedar Mill Shuttle does not have a defined performance threshold; qualitatively, TriMet's performance expectations are lower for it than for fixed-route service.

Service/Route Characteristics

Figure H-16: Cedar Mill Shuttle Service Area Map



Source: Metro Regional Land Information System

Table H-18: Operating Characteristics of Cedar Mill Shuttle

Operating Characteristic	Cedar Mill Shuttle
Headway (in minutes)	
Peak	NA
Off peak	NA
Average speed (miles per hour)	No data
Number of trips per	
Weekday	NA
Saturday	NA
Sunday	NA
Service span	
Weekday	7
Saturday	0
Sunday	0
Vehicles used in service	1
Technology in use	None

Source: TriMet

Table H-19: Operating Performance of Cedar Mill Shuttle

Performance Measure	Cedar Mill Shuttle
Weekday passengers	55
Revenue hours	7
Revenue miles	No data
Cost per passenger	\$11.52
Cost per hour	\$90.48
Cost per mile	\$7.21
Farebox recovery ratio	5%
Trip denials (annual)	4
Missed trips (annual)	7

Source: TriMet, costs per hour & mile are 2002 system wide averages from the National Transit Database (NTD), average fare is derived from the NTD

Service Area Characteristics

Table H-20 summarizes the land-use and demographic information for the service area of the Cedar Mill Shuttle, as depicted in Figure H-16. Indicators that correspond to the four D's – density, diversity, design as well as deterrents to driving – are presented. The service area has moderate population density corresponding to dwellings on ½ to 1 acre lots on average, predominantly single-family residential land use, and a surplus of residents compared to jobs, suggesting that the area is essentially a bedroom community for people working elsewhere in the region. The quality of the pedestrian environment is better than many of the service areas evaluated, with sidewalks generally on at least one side of every street. However, much of the service area includes cul-de-sacs and dead-ends, which increase the walking distance to arterials and may inhibit efficient transit operations. There are also no parking costs or transit priority measures in place that enhance transit's competitiveness with the private automobile.

Table H-20: Service Area Characteristics for Cedar Mill Shuttle

	Characteristic	Cedar Mill Shuttle		
DENSITY	Population			
		Service area size (sq. miles)	4.9	
		Service area population	13,722	
		Population density (per sq. mile)	2,828	
		Service area households	5,051	
		Household density (per sq. mile)	1,041	
		Employment		
		Service area employment	2,994	
		Employment density (jobs per sq. mile)	617	
		Jobs/housing balance	0.2	
DIVERSITY	Employment by sector			
		<ul style="list-style-type: none"> ■ Agriculture ■ Manufacturing ■ Transportation ■ Wholesale Trade ■ Retail Trade ■ Finance, Insur., Real Est. ■ Service ■ Public Service ■ Other 		
		Land use		
		<ul style="list-style-type: none"> ■ Agriculture ■ Open Space / Water ■ Industrial ■ Transportation / Comm. ■ Commercial / Office ■ MF Residential ■ SF Residential ■ Institutional □ Vacant / Under Devel. ■ Other 		
	DESIGN	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)		3
		Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)		2
		Urban place in service area		no
		DETERRENENTS TO DRIVING	Off-street parking costs	no
	Transit priority features		no	

Source: Portland Metro

Westside Light Rail Feeders

When TriMet's light rail line was extended west to Washington County in 1998, much of the western end of the line between Beaverton and Hillsboro ran through relatively undeveloped land. This land is planned for—and, in some areas, has already developed as—transit-supportive residential uses, whose residents can walk to light rail to travel to jobs in downtown Portland. At the same time, several large employers, including Intel and Nike, plus a number of large office parks, are located in Washington County. Their employees potentially could use light rail to commute in the opposite direction to work. As the larger job sites are located beyond walking distance from the light rail line, there was a need to provide bus connections between the light rail stations and the job sites for transit to be a travel option.

Four peak-period feeder routes (41, *Hawthorn Farm*, 42, *Orenco*, 49, *Quatama*, and 50, *Cornell Oaks*) were developed to distribute trips from light rail stations to job sites. TriMet's employer coordinators worked with westside employers to promote the shuttles to employees who might benefit from them, and a special branding was designed for them ("The Local") and a few similar services elsewhere in the region. Ridership was generally in the range of 8-11 boarding rides per hour, well below TriMet's standard of 15, and tended not to increase over time. An economic downturn in 2001 caused many companies in the area to lay off employees. All four routes were discontinued between 2002 and 2004. Regular TriMet fares were charged on the routes, which included a free transfer to and from light rail.

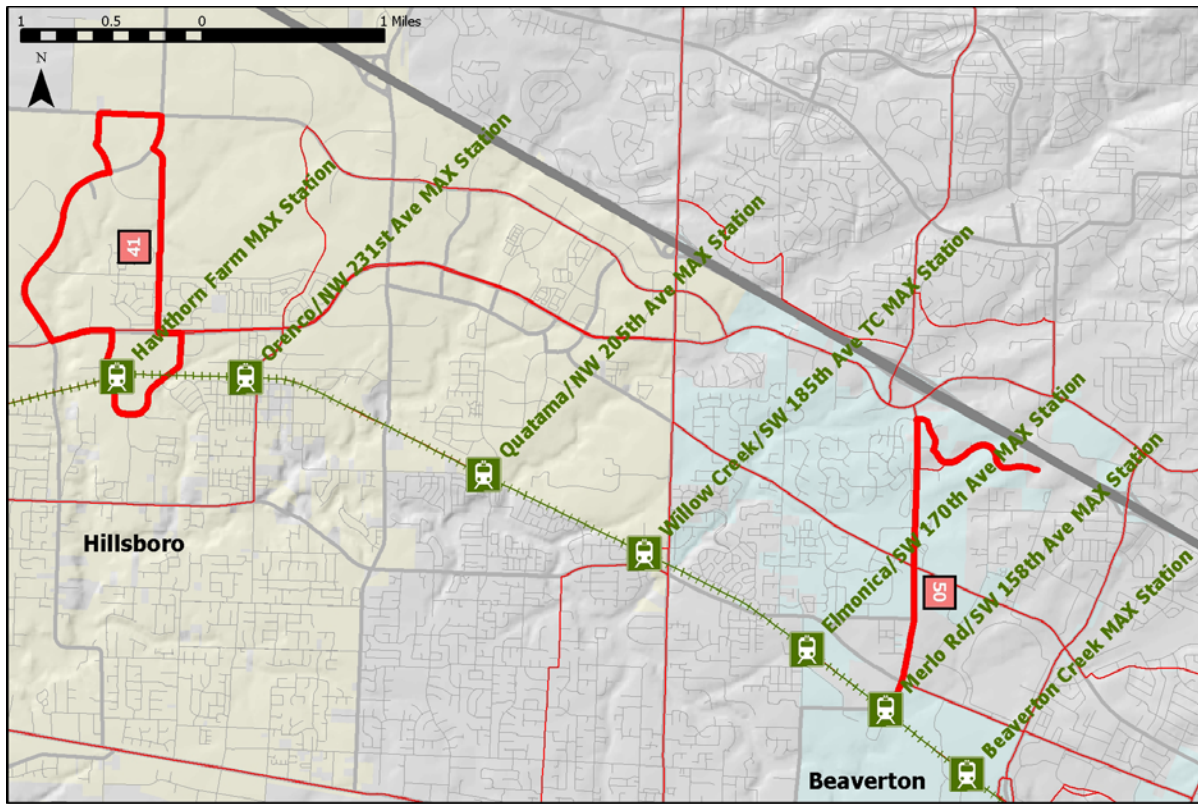
Two other all-day fixed routes (46, *North Hillsboro* and 47, *Baseline/Evergreen*) toward the west end of the light rail line serve a mix of poorly connected, medium-density residential areas and office parks, and have been somewhat more successful than the employer-focused feeder routes. These routes have shown an upward trend in ridership over time, and had 13 and 14 boarding rides per hour respectively in 2003, just below TriMet's standard.

At least one major employer (Intel) operated its own private shuttle system that competed with the TriMet feeder service. Intel's shuttle system connected four of its campuses and a few satellite offices with two light rail stations. The Intel service was more attractive to Intel's employees not because of cost (employees' transit costs were provided as a benefit, so there was no cost to employees to use either Intel's shuttle or the TriMet bus), but convenience. The Intel shuttle ran more frequently and stopped at the building entrance, while the TriMet bus stayed on the street, requiring a several-minute walk across a parking lot at the larger campuses to get to a building entrance.

This case study focuses on two of these routes: Route 41, which was discontinued entirely, and Route 50, which was absorbed into another fixed route that was already serving the general area. Route 41 connected the Hawthorn Farm light rail station with the Dawson Creek Corporate Park (1.3 million square feet of office and manufacturing space). Route 50 connected the Merlo Road/SW 158th Avenue station with the Woodside Corporate Park (474,000 square feet of office space) and the Cornell Oaks Corporate Center (684,000 square feet of office and light manufacturing space).

Service/Route Characteristics

Figure H-17: Routes 41 and 50 Map



Source: Metro Regional Land Information System

Table H-21: Operating Characteristics of Routes 41 and 50

Operating Characteristic	Route 41	Route 50
Headway (in minutes)		
Peak	30	30
Off peak	No service	No service
Average speed (miles per hour)	24.0	14.2
Number of trips per		
Weekday	32	32
Saturday	0	0
Sunday	0	0
Service span		
Weekday	5.5	6.5
Saturday	0	0
Sunday	0	0
Vehicles used in service	1	1
Technology in use	AVL, APC	AVL, APC

Source: TriMet

Table H-22: Operating Performance of Routes 41 and 50

Performance Measure	Route 41	Route 50
Weekday passengers	60	130
Revenue hours	3	5
Revenue miles	75	77
Cost per passenger	\$3.98	\$3.06
Cost per hour	\$79.64	\$79.64
Cost per mile	\$6.42	\$6.42
Farebox recovery ratio	14%	18%

Source: TriMet, costs per hour & mile are 2000 systemwide averages from the National Transit Database (NTD), average fare is derived from the NTD

Summary and Conclusions

There are a number of differences in the development and evaluation of the suburban services in this case study. It appears that there are stricter rules and standards in this evaluation, which resulted in modification or elimination of some of the services. One of the lessons learned appeared to be that feeder service to the light rail was often difficult to sustain based on ridership. Also, the ability to offer lower cost alternatives was ultimately limited by the prevailing labor agreement.

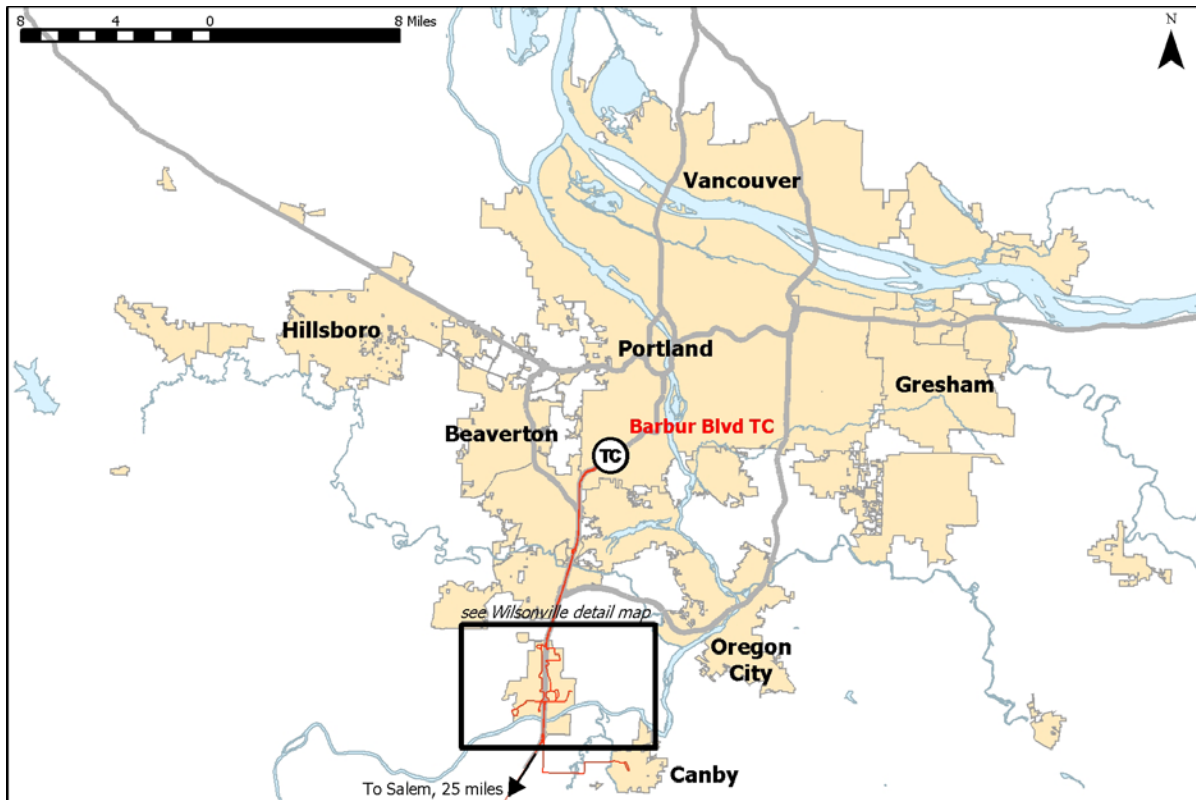
4. WILSONVILLE, OREGON

South Metro Area Rapid Transit

Under Oregon laws governing transit districts, cities with fewer than 10,000-15,000 residents, as well as certain unincorporated areas, have the opportunity every five years to withdraw from a transit district if certain conditions are met. In 1988, Wilsonville was the first city in Oregon to use this law. Wilsonville successfully petitioned to withdraw from TriMet, the Portland-area service provider, and start its own transit service. Ridership on the City of Wilsonville system, South Metro Area Rapid Transit, or SMART, has grown steadily from 7,100 in the first year of operation to over 243,000 in FY 2003.

Wilsonville had a population of 13,991 in 2000. The city's central location between Portland (18 miles to the north) and the state capital, Salem (25 miles to the south), makes it both a growing suburban residential community whose residents commute to jobs in the two regions, and a business center that attracts commuters from the same regions (see Figure H-18). Wilsonville's six largest private employers have between 400 and 1,350 employees on the payroll, and the city has fifteen private employers with more than 135 employees. Wilsonville is considered part of the Portland metropolitan area; however, a buffer of rural land 2-5 miles wide lies between Wilsonville and the rest of the metropolitan area, making the city a 6.8-square-mile urbanized island on the fringe of the Portland region.

Figure H-18: Wilsonville Vicinity Map



Source: Metro Regional Land Information System

SMART is a department of the City of Wilsonville, making the Wilsonville City Council the agency's governing body. SMART has the ability to assess a payroll tax on employers and self-employed individuals. The majority of SMART's revenue (66% in 2004) comes from a 0.3% payroll tax; this tax rate is one-half what Wilsonville businesses had been paying prior to the city's withdrawal from TriMet. No fares are charged.

The agency's main performance measures relate to cost-efficiency and cost-effectiveness, measured by cost per passenger, cost per hour, and cost per mile. Overall ridership is also tracked. Routes are evaluated annually by SMART's Operations Manager, based on ridership counts and financial data that are collected by bus operators, the dispatcher, and the Operations Manager. On-time performance is also reported annually as part of the City's budgeting process. Customer satisfaction is measured through comments provided by the public, who may call, write a letter, or fill out a feedback card. SMART also conducts on-board checks of customer satisfaction.

This case study looks at three of SMART's services:

- Route 204, *Wilsonville Road*, a local fixed-route bus which connects residential areas to the city's commercial center;
- Route 201, *Barbur*, which provides local fixed-route service to employment areas in Wilsonville, and express service on the I-5 freeway north to TriMet's Barbur Transit Center, where connections to downtown Portland can be made; and
- Route 1X, *Salem*, a jointly operated service of SMART and Salem-Keizer Transit, serving commute trips between Wilsonville and Salem.

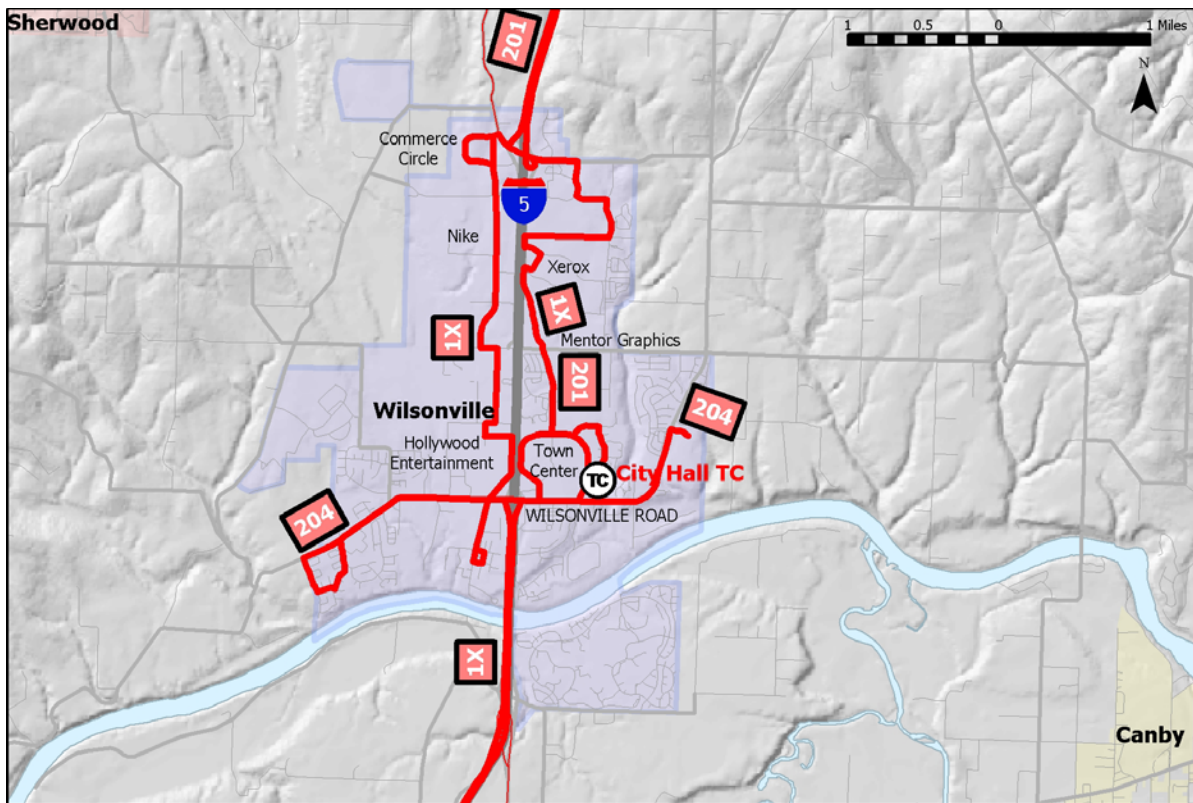
Route 204, Wilsonville Road

Route 204, *Wilsonville Road*, provides weekday and Saturday service that focuses on connecting residential areas to schools (two elementary, one middle, and one high) and to the city’s commercial center. Connections to other SMART routes can be made at City Hall. Service is provided at 30-minute headways during peak hours and at 60-minute headways at other times. Service is provided 5:45 a.m. to 7:15 p.m. weekdays, and 8:30 a.m. to 5:30 p.m. on Saturdays (including a one-hour gap in service at lunchtime). The route started in 1996, and currently averages about 16 boardings per revenue hour, with growing ridership.

All SMART services are marketed through newspaper and cable television ads, employer transportation fairs, and the county fair. SMART has a web site (<http://www.ridesmart.com>) that provides schedule and route information. SMART also provides bus service to Portland Trail Blazer basketball games from Wilsonville, which makes transit service more visible to those who normally do not use it. A fare is charged for this special service, which is marketed in conjunction with two local restaurants where passengers are picked up at.

Service/Route Characteristics

Figure H-19: Wilsonville Map



Source: Metro Regional Land Information System, SMART

Table H-23: Operating Characteristics of Route 204

Operating Characteristic	Value
Headway (in minutes)	
Peak	30
Off peak	60
Average speed (miles per hour)	13.5
Number of trips per	
Weekday	23
Saturday	9
Sunday	0
Service span	
Weekday	13.5
Saturday	8
Sunday	0
Vehicles used in maximum service	2
Technology in use	None

Source: SMART

Table H-24: Operating Performance of Route 204

Performance Measure	Value
Annual passengers	86,400
Weekday revenue hours	18
Weekday revenue miles	263
Cost per passenger	\$5.43
Cost per hour	\$88.67
Cost per mile	\$4.34
Farebox recovery ratio	0% (fareless)

Source: SMART, costs per hour & mile are 2003 systemwide averages

Route 201, Barbur

Route 201, *Barbur*, is the oldest of SMART's fixed routes, having started in 1993. Starting at the City Hall Transit Center, the route provides local service to employers on the east side of I-5. Three of Wilsonville's four largest private employers, with a combined workforce of over 2,800 employees, are served by this route. The route also serves the Commerce Circle office park area on the west side of I-5. From Commerce Circle, the route becomes an express route on I-5 that serves commute trips into and out of the Portland region. The route stops at the Tualatin Park-and-Ride seven miles north of downtown Wilsonville, where connections can be made to four TriMet routes, including the non-stop portion of Route 96 into downtown Portland (which does not operate between 9:00 a.m. and 1:30 p.m.). The route continues an additional five miles north to the Barbur Transit Center in southwest Portland, where connections can be made to TriMet service to the Marquam Hill hospital complex and to downtown Portland.

Although non-stop service on TriMet to downtown Portland is available from Tualatin much of the time, some travelers to Portland choose to ride to the Barbur Transit Center anyway, likely because the TriMet fare is lower from that location. The route operates every 30 minutes during peak periods and every 60 minutes otherwise. Service is provided between 5:30 a.m. and 8:30 p.m. The route averages 14 boardings per revenue hour and has growing ridership. About

60% of the ridership consists of people commuting from Wilsonville to Portland and 40% consists of people commuting from Portland to Wilsonville. Some of the Route 201 service is supported by Jobs Access/Reverse Commute (JARC) grants.

Service/Route Characteristics

Table H-25: Operating Characteristics of Route 201

Operating Characteristic	Route 201
Headway (in minutes)	
Peak	30
Off peak	60
Average speed (miles per hour)	21.5
Number of trips per	
Weekday	23
Saturday	0
Sunday	0
Service span	
Weekday	15
Saturday	0
Sunday	0
Vehicles used in maximum service	3
Technology in use	None

Source: SMART

Table H-26: Operating Performance of Route 201

Performance Measure	Route 201
Annual passengers	83,800
Weekday revenue hours	20
Weekday revenue miles	609
Cost per passenger	\$6.22
Cost per hour	\$88.67
Cost per mile	\$4.34
Farebox recovery ratio	0% (fareless)

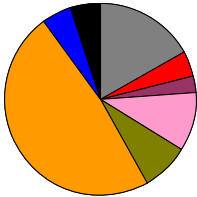
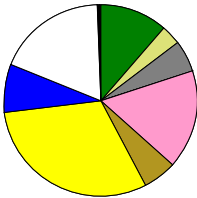
Source: SMART, costs per hour & mile are 2003 system wide averages

Service Area Characteristics

Table H-27 summarizes land-use and demographic information for the service area of Route 201. The service area is defined as the area within $\frac{3}{4}$ mile of bus stops along the route, plus a five-mile radius park-and-ride catchment area at each park-and-ride stop. This results in the largest service area of any of the suburban transit services evaluated and includes much of Portland. Indicators that correspond to the four D's – density, diversity, design as well as deterrents to driving – are presented. The service area has moderate population density corresponding to dwellings on $\frac{1}{2}$ to 1 acre lots on average, a broad mix of land uses (although the Wilsonville area at the end of the route has a higher proportion of single-family residential land use), and a balance of jobs and residents (although the Wilsonville area by itself has a surplus of residents compared to jobs, suggesting that the area is essentially a bedroom community for

people working elsewhere in the region). Development patterns are typical of many suburban areas with fair sidewalk coverage (some streets do not have sidewalks) and medium street connectivity. Downtown Portland provides a transit-friendly urban place as a destination, with walkable streets and parking costs that provide a deterrent to driving. However, there are no transit priority measures in place that enhance transit's competitiveness with the private automobile.

Table H-27: Service Area Characteristics of Route 201

	Characteristic	Route 201	
DENSITY	Population		
	Service area size (sq. miles)	121.8 ¹	
	Service area population	350,606	
	Population density (per sq. mile)	2,878	
	Service area households	145,179	
	Household density (per sq. mile)	1,192	
	Employment		
	Service area employment	360,161	
	Employment density (jobs per sq. mile)	2,956	
	Jobs/housing balance	1.0	
DIVERSITY	Employment by sector		
	<ul style="list-style-type: none"> ■ Agriculture ■ Manufacturing ■ Transportation ■ Wholesale Trade ■ Retail Trade ■ Finance, Insur., Real Est. ■ Service ■ Public Service ■ Other 		
	Land use		
	<ul style="list-style-type: none"> ■ Agriculture ■ Open Space / Water ■ Industrial ■ Transportation / Comm. ■ Commercial / Office ■ MF Residential ■ SF Residential ■ Institutional □ Vacant / Under Devel. ■ Other 		
	DESIGN	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)	2
		Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)	3
		Urban place in service area	yes
	DETERRENENTS TO DRIVING	Off-street parking costs	yes
		Transit priority features	no

Source: Portland Metro

Note 1: This large service area results from the assumption that the park-and-ride catchment area is a five-mile radius.

Route 1X, Salem

Route 1X, *Salem*, serves commute trips in both directions between Wilsonville and Salem. Southbound trips originate at Wilsonville City Hall and travel non-stop on I-5 to the state Capital complex in Salem, continuing to the Salem Transit Center, where connections can be made to other points in the Salem area using Salem-Keizer Transit buses. The northbound return trip proceeds directly up I-5 to Wilsonville and circulates through the employment areas on both sides of the freeway before ending at Wilsonville City Hall.

Four morning and four afternoon trips are operated in both directions. Ridership is very balanced—about as many people use the service to commute from Salem to Wilsonville as commute from Wilsonville to Salem. Three of the eight trips are operated by Salem-Keizer Transit, but are paid for by SMART through a JARC grant. The route averages 15 boardings per revenue hour and has growing ridership. Transfers between Route 1X and Route 201 continuing to Portland are deliberately designed to be inconvenient, to discourage travel by non-Wilsonville residents and employees who would benefit from the free service, but not help support the cost.

Service/Route Characteristics

Table H-28: Operating Characteristics of Route 1X

Operating Characteristic	Value
Headway (in minutes)	
Peak	4 am & 4 pm round trips
Off peak	No service
Average speed (miles per hour)	31.6
Number of trips per	
Weekday	8
Saturday	0
Sunday	0
Service span	
Weekday	9.5
Saturday	0
Sunday	0
Vehicles used in maximum service	3
Technology in use	None

Source: SMART

Table H-29: Operating Performance of Route 1X

Performance Measure	Value
Annual passengers	38,100
Weekday revenue hours	9
Weekday revenue miles	322
Cost per passenger	\$6.00
Cost per hour	\$88.67
Cost per mile	\$4.34
Farebox recovery ratio	0% (fareless)

Source: SMART, costs per hour & mile are 2003 system wide averages

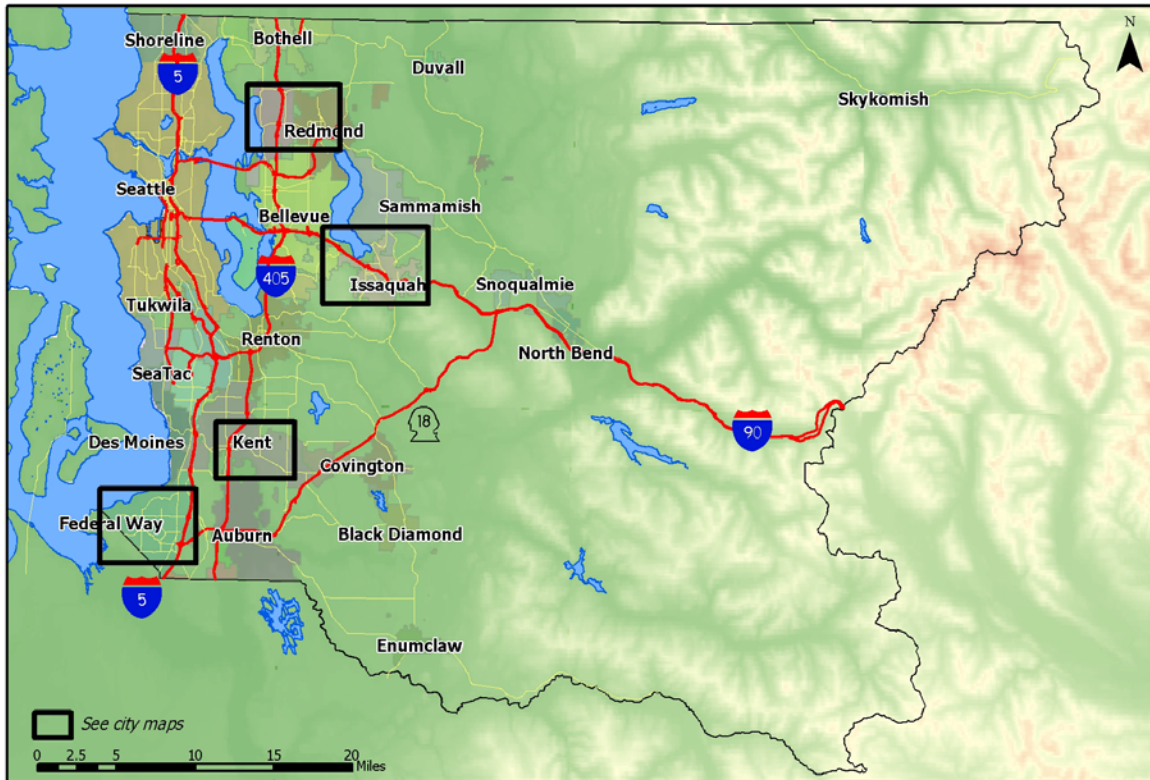
Summary and Conclusions

This case study include two local and one commuter services and also looks at another example of opting out of the regional transit district. In that regard, this local decision included the use of local funding to offer free fare to residents. The fixed-route circulator reinforces the general efficiency of fixed-route over route-deviation or demand-response alternatives, if there are sufficient ridership demands (in this instance reinforced by three strong employment destinations connecting through residential areas and the center of town).

5. SEATTLE, WASHINGTON

King County Metro

King County Metro is the public transit provider for Seattle and suburban King County, Washington, serving a 2,134-square-mile area with more than 1.7 million inhabitants. Metro provides both local bus service and freeway-based express service, and manages the nation's largest vanpooling program. (Bus routes operated by the regional transit provider, Sound Transit, are generally freeway-based express services connecting park-and-ride lots to regional employment centers. In comparison, Metro's freeway routes typically include a local service component in the suburbs, although the routes may also serve park-and-ride lots.) Figure H-20 depicts King County.

Figure H-20: King County Map

King County Metro is a service of the King County government, housed within the Metro Transit Division of the King County Department of Transportation, with the elected King County Executive serving as the ultimate administrative officer. Plan, policy, and budget recommendations are reviewed by the Regional Transit Committee, which includes representatives of the King County Council (6 members), the Seattle City Council (2 members) and suburban cities (8 members); these decisions are ultimately made by the King County Council. The majority of revenue (61% in 2003) comes from a 0.8% sales tax.

This case study focuses on four of Metro's DART (Dial-a-Ride Transit) routes, which provide deviated-route service in suburban areas, and on the vanpool program. The DART routes are contracted out, and the contract specifies performance standards for the following: on-time performance, average ride time, productivity (riders per hour), average trip scheduling time, and accuracy of the estimated rider pickup time. Data are collected monthly by the contractor and reviewed by Metro's DART Project Manager and Operations Supervisor. On-board surveys are also used.

DART Routes

Service/Route Characteristics

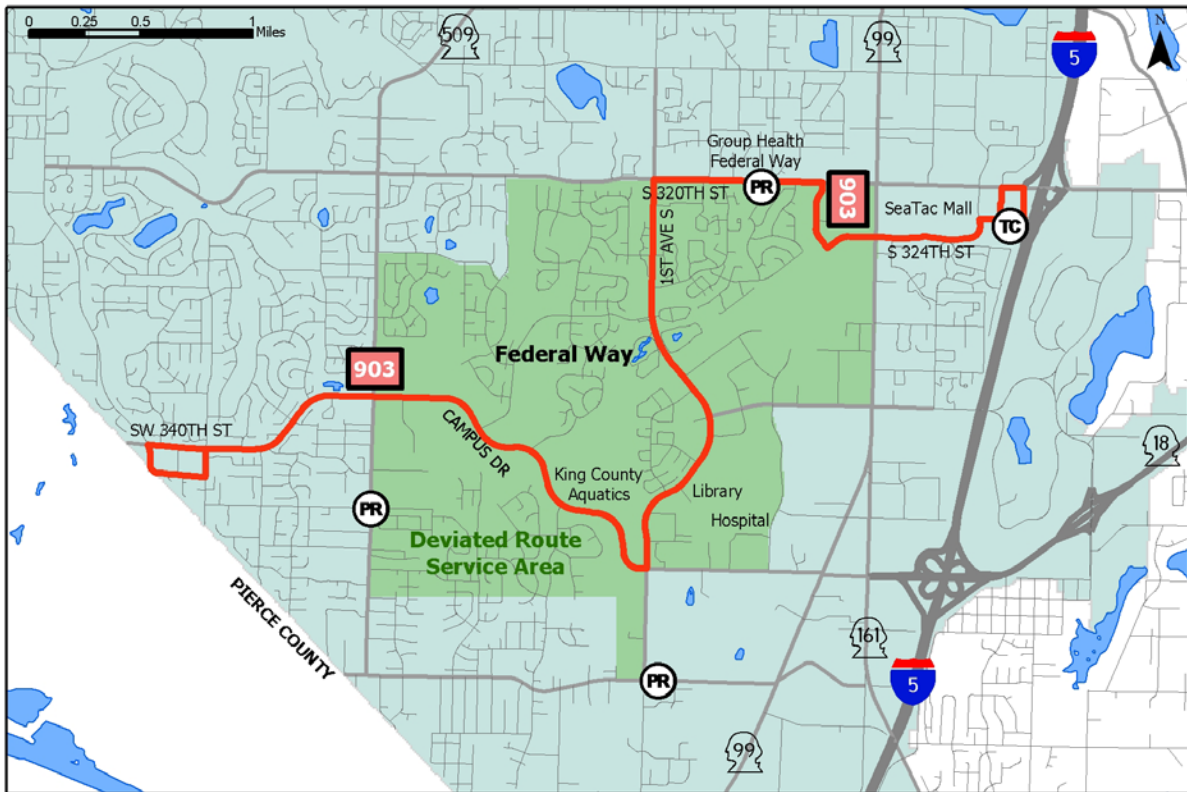
King County Metro operates 12 DART routes in communities south and east of Lake Washington. The service has been in operation since the early 1980s and provides transit service to the general public in areas with low population densities and multiple destination points. With few exceptions, the DART routes all include a fixed route and stops, but also have a designated

service area in which the vehicle can deviate off-route to pick up and drop off passengers. Route deviations are not offered during the entire service day on some routes. The fixed-route component increases route productivity, while the route-deviation component improves customer convenience.

Service is currently provided by a contractor to King County Metro. The routes are operated by 18-passenger, lift-equipped vans. Requests for route deviations must be made at least 2 hours in advance, either by calling the contractor's toll-free number, or online through the contractor's web site. Requests can be made up to 30 days in advance. Route-deviation reservations are made on a first-come, first-served basis, and are limited to what can be accommodated within the fixed-route schedule. Service is not necessarily door-to-door, as the vans cannot operate in cul-de-sacs and on narrow streets; passengers may need to walk a block or more to and from their pick-up and drop-off point.

A one-zone fare is charged; with no premium fare charged for a route deviation (exceptions are Kent Shopper Shuttle routes 914 and 916, which are free). Passengers may transfer to King County Metro bus routes, as well as to other regional transit providers, under same transfer rules that apply to regular bus service.

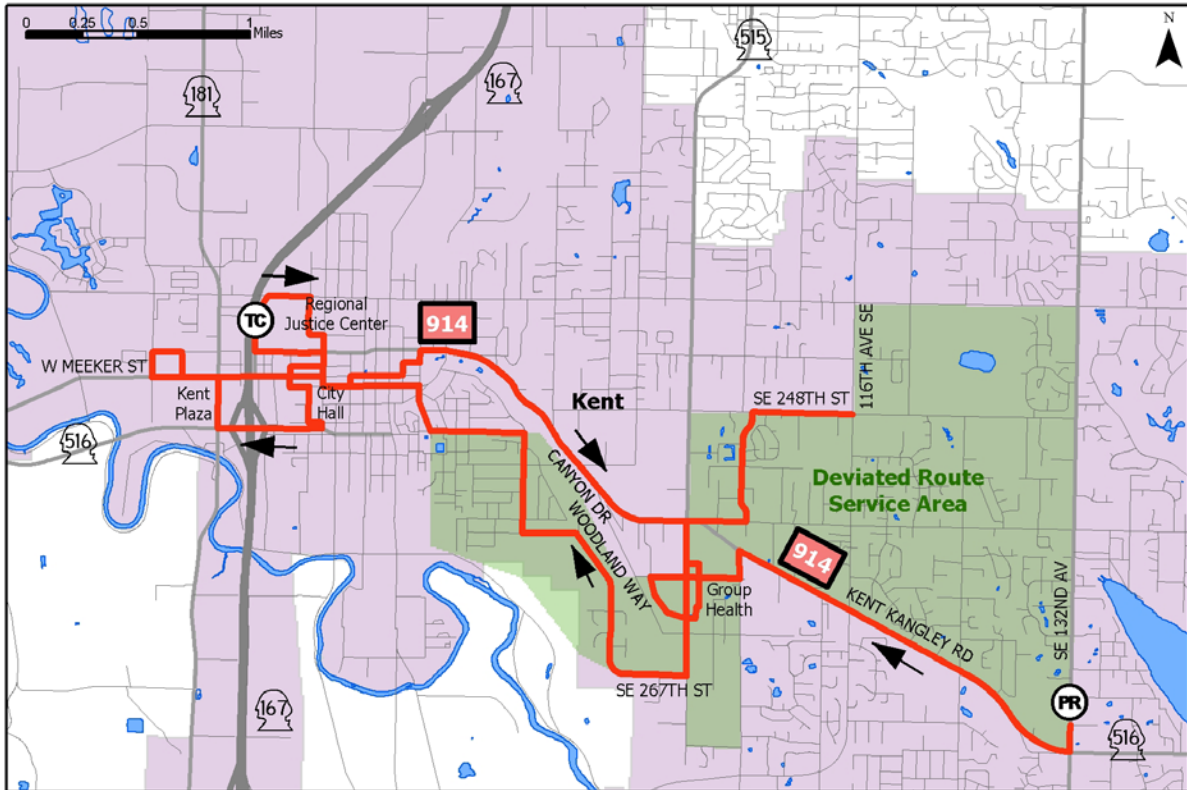
Federal Way is Washington's sixth-largest city (2000 population: 83,000) and is located 25 miles south of Seattle and 9 miles northeast of Tacoma. Primarily residential and incorporated only in 1990, the city is also home to a regional mall and other retail development close to Interstate 5. *Route 903* serves the southern half of the city, which is at the southern edge of King County Metro's service area. (Another DART route, *Route 901*, serves the northern portion of the city, and vehicles alternate between Routes 901 and 903.) Most of route passes through residential neighborhoods and also serves three park-and-ride lots (two by route deviation only). Destinations along the route include a health clinic, a library, and the regional mall. The route-deviation area also covers a hospital. The route ends at the Federal Way Transit Center, where passengers may transfer to Sound Transit express bus service to major employment centers in the region, King County Metro local bus service, as well as Pierce Transit local bus service south to Tacoma. Figure H-21 shows the route's service area.

Figure H-21: Route 903 Map (Federal Way)

Sources: King County GIS, King County Metro

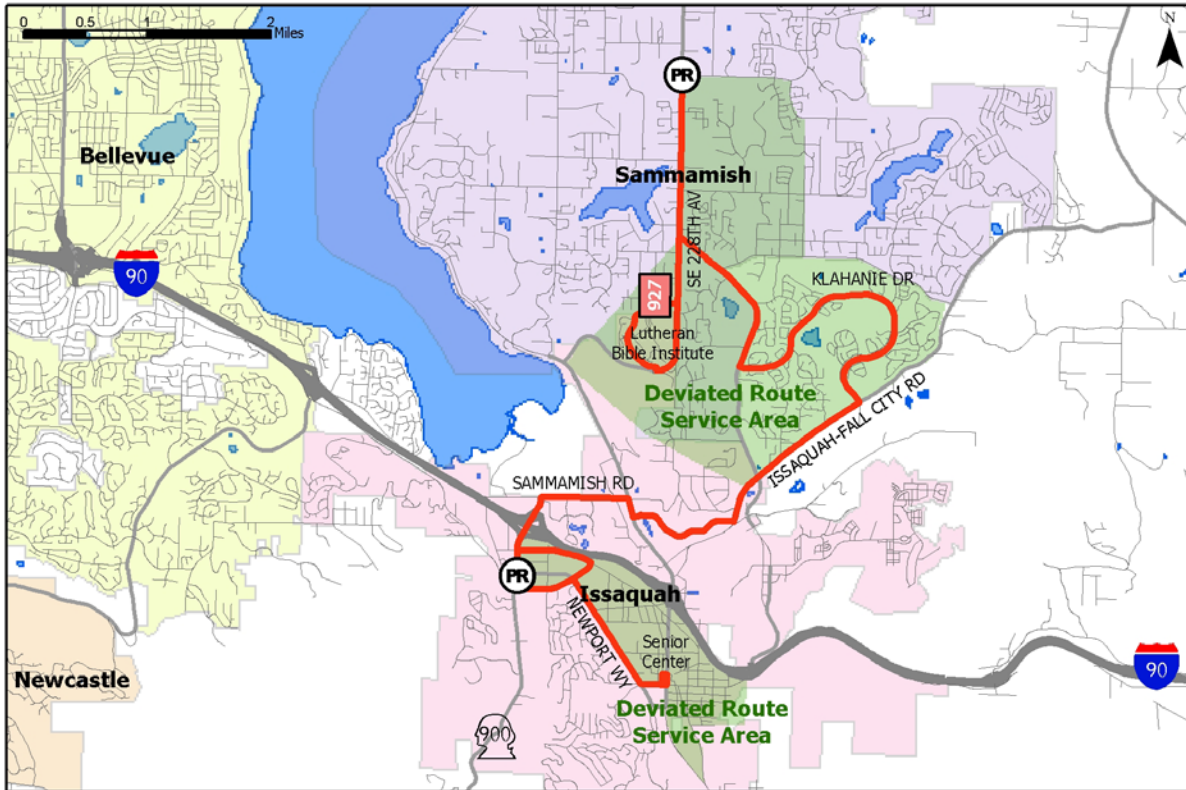
Kent, Washington, located 18 miles southeast of Seattle, is a suburban residential community, government center, and warehouse and distribution hub, with a growing amount of office and manufacturing uses. *Route 914* connects residential southeastern Kent (2000 population: 79,500) to the city center. (A second DART route, *Route 916* serves northeastern Kent, and vehicles alternate between Routes 914 and 916). The two routes together are marketed as the Kent Shopper Shuttles and have no fare. Vans alternate between the two routes, and extra fixed-route service is offered between 11:54 a.m. and 1:24 p.m. between the Regional Justice Center and downtown Kent. Other destinations along the route include the Kent Transit Center, several grocery stores and discount retail stores, several apartment complexes for seniors, a health clinic, and a park-and-ride lot. Connections can be made at the Kent Transit Center to Sound Transit commuter rail service to downtown Seattle, Sound Transit express bus service to the east side of Lake Washington, and King County Metro local bus service. Figure H-22 shows the route's service area. On outbound trips, fixed-route service ends at SE 248th Street and 116th Avenue SE, and resumes at the Lake Meridian Park-and-Ride at the start of the inbound trip.

Figure H-22: Route 914 Map (Kent)



Sources: King County GIS, King County Metro

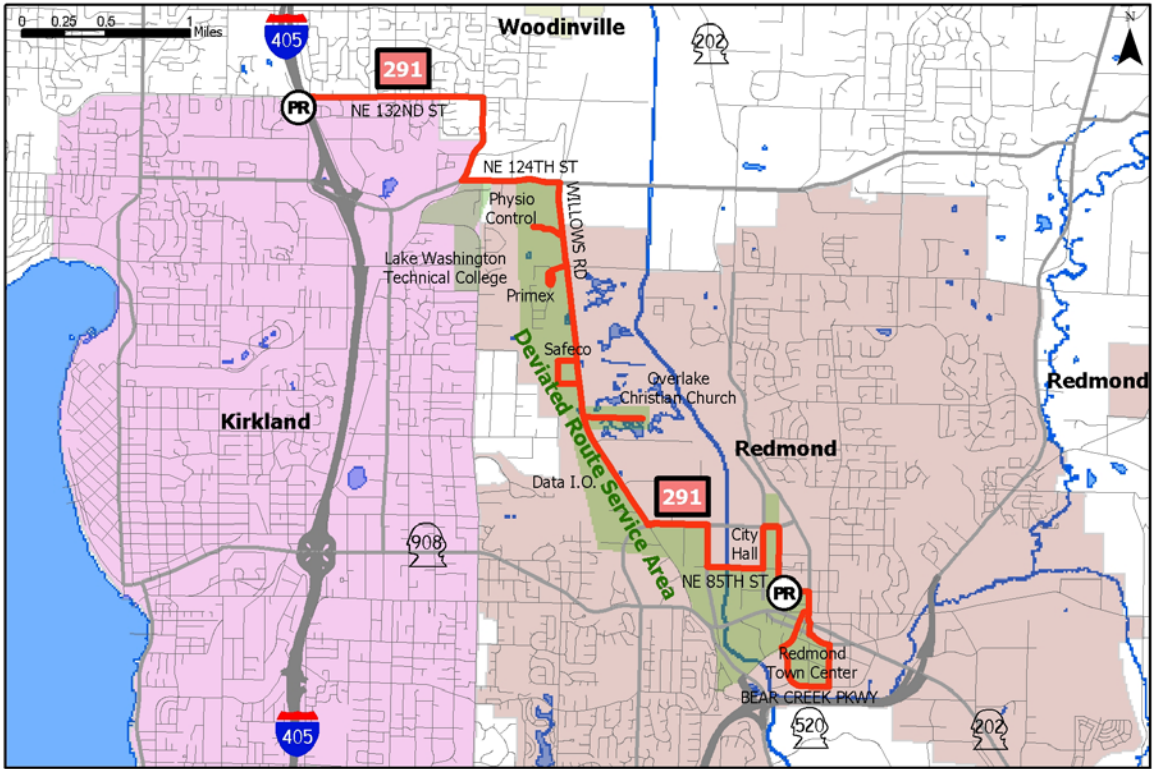
Route 927 serves the eastern Seattle suburb of Issaquah (2000 population: 11,000) and the southern portion of the community of Sammamish, which incorporated in 1999 (2000 population: 34,000). Issaquah is the retail center for this portion of the Seattle region, given its proximity to Interstate 90, and has a growing number of office parks. Sammamish is primarily residential and is located on a plateau above Lake Sammamish. Route 927 serves newly developed residential areas of Issaquah and Sammamish on the plateau, along with a park-and-ride lot and the Lutheran Bible Institute, and connects them to the Issaquah city center and a park-and-ride lot in the valley. The route has two branches on the plateau—one to the park-and-ride and one to the Lutheran Bible Institute. The route also serves the older core of Issaquah south of I-90. Connections can be made at the park-and-ride lot to Sound Transit express bus to various regional destinations and to King County Metro local bus service. Figure H-23 shows the route's service area.

Figure H-23: Route 927 Map (Issaquah)

Sources: King County GIS, King County Metro

Route 291 serves the northeastern Seattle suburb of Redmond (2000 population: 45,000). In addition to being Microsoft's corporate headquarters, Redmond provides office space for a number of other companies and has a large downtown retail district. *Route 291* provides connections from other bus routes at two park-and-ride lots: the Kingsgate Park-and-Ride along I-405 in the neighboring city of Kirkland, and the Redmond Park-and-Ride in downtown Redmond, both of which are served by both regional and local bus routes. The route-deviation portion of the route encompasses downtown Redmond, a narrow strip of land in a valley between bluffs and the Sammamish River, and the Lake Washington Technical College. A number of office developments are located in the river valley, and the fixed-route service enters three of the office parks, as well as a large church. Figure H-24 shows the route's service area.

Figure H-24: Route 291 Map (Redmond)



Sources: King County GIS, King County Metro

Table H-30: Operating Characteristics of Selected DART Routes

Operating Characteristic	Route 291	Route 903	Route 914	Route 927
Headway (in minutes)				
Peak	30	30	--	60
Off peak	--	30-60	60	60
Average speed (miles per hour)	15.3	11.0	10.9	18.4
Number of trips per				
Weekday	20	32	15	23
Saturday	0	22	0	17
Sunday	0	17	0	0
Service span				
Weekday	5.5	17 (dev. rte. 10)	7.5	12 (dev. rte. 10)
Saturday	0	12	0	8.75
Sunday	0	8.25	0	0
Vehicles used in service	3	4	4	2
Technology in use	none	none	none	none

Source: King County Metro

Table H-31: Annual Operating Performance of Selected DART Routes

Performance Measure	Route 291	Routes 901/903	Routes 914/916	Route 927
Annual weekday passengers	23,232	242,521	78,353	32,187
Revenue hours	3,454	15,637	6,497	6,546
Revenue miles	37,188	223,068	68,870	85,871
Cost per passenger*	\$7.34	\$3.18	\$4.09	\$10.04
Cost per hour*	\$49.35	\$49.35	\$49.35	\$49.35
Cost per mile*	\$4.58	\$3.46	\$4.66	\$3.76
Farebox recovery ratio	11%	25%	0% (no fare)	8%

Source: King County Metro (2004 data), average fare is derived from the NTD for 2002

*Cost data reflect the contract hourly rate and do not include fuel costs. Management and administration of the entire DART program (12 routes) requires 1.25 FTE, which is not included in the cost.

Note that performance data for Route 903 include data for Route 901, and that data for Route 914 include data for Route 916—vehicles alternate between these pairs of routes.

Vanpools

Service/Route Characteristics

King County Metro administers the largest publicly owned and operated vanpool program in the nation, serving commuters who live and/or work in King County. The program provides vans, staff support, maintenance, fuel, and insurance to groups of 5 to 15 people who commute together. Fleet maintenance is contracted out, but the remainder of program is operated internally. The fleet consists of 8, 12, and 1G-passenger vans.

Many vanpools serve traditional vanpool destinations, such as major employers (e.g., Microsoft, Boeing), large employment centers (e.g., downtown Seattle), and post-secondary schools (e.g., the University of Washington). However, in 2001, King County Metro expanded the program by introducing a short-distance (less than 20 miles round trip) program to address the connectivity needs of commuters riding buses, ferries, and trains.

By County ordinance, the vanpool program is required to establish fares for vanpool service at a level that is reasonably estimated to recover 100% of the program's operating and capital costs, and at least 25% of the program's administrative costs. Drivers do not have to pay a fare, but have other responsibilities in addition to driving, as described later. Vanpool participants share the monthly cost of their van; this cost varies depending on the van size and the daily round-trip mileage required for the vanpool. The more seats that are filled in the vanpool, the lower the per-person cost. For example, in 2005 the monthly van cost for a 50-mile round trip was \$570, \$640, and \$670 for 8, 12, and 1G-passenger vans, respectively. The equivalent daily passenger fare for this example vanpool ranges from \$2.28 for a full 1H-passenger van to \$5.43 for an 8-passenger van with two unused seats. (As shown below)

Figure H-25: Vanpool Fare Schedule

VanPool Program Fare Schedule Effective January 1, 2005

5 - Day Work Week Schedule - Monthly Rates



Fare Round Trip Miles	8 Passenger Vans					11 and 12 Passenger Vans					15 Passenger Vans				
	Monthly Fixed Rate	Number of Paying Participants:				Monthly Fixed Rate	Number of Paying Participants:				Monthly Fixed Rate	Number of Paying Participants:			
		5	6	7	8		9	10	11	12		12	13	14	15
20	\$300	\$60.00	\$50.00	\$42.86	\$37.50	\$370	\$41.11	\$37.00	\$33.64	\$30.83	\$400	\$33.33	\$30.77	\$28.57	\$26.67
25	\$345	\$69.00	\$57.50	\$49.29	\$43.13	\$415	\$46.11	\$41.50	\$37.73	\$34.58	\$445	\$37.08	\$34.23	\$31.79	\$29.67
30	\$390	\$78.00	\$65.00	\$55.71	\$48.75	\$460	\$51.11	\$46.00	\$41.82	\$38.33	\$490	\$40.83	\$37.69	\$35.00	\$32.67
35	\$435	\$87.00	\$72.50	\$62.14	\$54.38	\$505	\$56.11	\$50.50	\$45.91	\$42.08	\$535	\$44.58	\$41.15	\$38.21	\$35.67
40	\$480	\$96.00	\$80.00	\$68.57	\$60.00	\$550	\$61.11	\$55.00	\$50.00	\$45.83	\$580	\$48.33	\$44.62	\$41.43	\$38.67
45	\$525	\$105.00	\$87.50	\$75.00	\$65.63	\$595	\$66.11	\$59.50	\$54.09	\$49.58	\$625	\$52.08	\$48.08	\$44.64	\$41.67
50	\$570	\$114.00	\$95.00	\$81.43	\$71.25	\$640	\$71.11	\$64.00	\$58.18	\$53.33	\$670	\$55.83	\$51.54	\$47.86	\$44.67
55	\$615	\$123.00	\$102.50	\$87.86	\$76.88	\$685	\$76.11	\$68.50	\$62.27	\$57.08	\$715	\$59.58	\$55.00	\$51.07	\$47.67
60	\$660	\$132.00	\$110.00	\$94.29	\$82.50	\$730	\$81.11	\$73.00	\$66.36	\$60.83	\$760	\$63.33	\$58.46	\$54.29	\$50.67
65	\$705	\$141.00	\$117.50	\$100.71	\$88.13	\$775	\$86.11	\$77.50	\$70.45	\$64.58	\$805	\$67.08	\$61.92	\$57.50	\$53.67
70	\$750	\$150.00	\$125.00	\$107.14	\$93.75	\$820	\$91.11	\$82.00	\$74.55	\$68.33	\$850	\$70.83	\$65.38	\$60.71	\$56.67
75	\$795	\$159.00	\$132.50	\$113.57	\$99.38	\$865	\$96.11	\$86.50	\$78.64	\$72.08	\$895	\$74.58	\$68.85	\$63.93	\$59.67
80	\$840	\$168.00	\$140.00	\$120.00	\$105.00	\$910	\$101.11	\$91.00	\$82.73	\$75.83	\$940	\$78.33	\$72.31	\$67.14	\$62.67
85	\$885	\$177.00	\$147.50	\$126.43	\$110.63	\$955	\$106.11	\$95.50	\$86.82	\$79.58	\$985	\$82.08	\$75.77	\$70.36	\$65.67
90	\$930	\$186.00	\$155.00	\$132.86	\$116.25	\$1,000	\$111.11	\$100.00	\$90.91	\$83.33	\$1,030	\$85.83	\$79.23	\$73.57	\$68.67
95	\$975	\$195.00	\$162.50	\$139.29	\$121.88	\$1,045	\$116.11	\$104.50	\$95.00	\$87.08	\$1,075	\$89.58	\$82.69	\$76.79	\$71.67
100	\$1,020	\$204.00	\$170.00	\$145.71	\$127.50	\$1,090	\$121.11	\$109.00	\$99.09	\$90.83	\$1,120	\$93.33	\$86.15	\$80.00	\$74.67
105	\$1,065	\$213.00	\$177.50	\$152.14	\$133.13	\$1,135	\$126.11	\$113.50	\$103.18	\$94.58	\$1,165	\$97.08	\$89.62	\$83.21	\$77.67
110	\$1,110	\$222.00	\$185.00	\$158.57	\$138.75	\$1,180	\$131.11	\$118.00	\$107.27	\$98.33	\$1,210	\$100.83	\$93.08	\$86.43	\$80.67
115	\$1,155	\$231.00	\$192.50	\$165.00	\$144.38	\$1,225	\$136.11	\$122.50	\$111.36	\$102.08	\$1,255	\$104.58	\$96.54	\$89.64	\$83.67
120	\$1,200	\$240.00	\$200.00	\$171.43	\$150.00	\$1,270	\$141.11	\$127.00	\$115.45	\$105.83	\$1,300	\$108.33	\$100.00	\$92.86	\$86.67
125	\$1,245	\$249.00	\$207.50	\$177.86	\$155.63	\$1,315	\$146.11	\$131.50	\$119.55	\$109.58	\$1,345	\$112.08	\$103.46	\$96.07	\$89.67
130	\$1,290	\$258.00	\$215.00	\$184.29	\$161.25	\$1,360	\$151.11	\$136.00	\$123.64	\$113.33	\$1,390	\$115.83	\$106.92	\$99.29	\$92.67
135	\$1,335	\$267.00	\$222.50	\$190.71	\$166.88	\$1,405	\$156.11	\$140.50	\$127.73	\$117.08	\$1,435	\$119.58	\$110.38	\$102.50	\$95.67
140	\$1,380	\$276.00	\$230.00	\$197.14	\$172.50	\$1,450	\$161.11	\$145.00	\$131.82	\$120.83	\$1,480	\$123.33	\$113.85	\$105.71	\$98.67
145	\$1,425	\$285.00	\$237.50	\$203.57	\$178.13	\$1,495	\$166.11	\$149.50	\$135.91	\$124.58	\$1,525	\$127.08	\$117.31	\$108.93	\$101.67
150	\$1,470	\$294.00	\$245.00	\$210.00	\$183.75	\$1,540	\$171.11	\$154.00	\$140.00	\$128.33	\$1,570	\$130.83	\$120.77	\$112.14	\$104.67

PERSONAL USE RATE IS 38¢ PER MILE

PRORATED DAILY RATES ON REVERSE SIDE

Vanpool marketing is conducted primarily through employer Commute Trip Reduction programs. However, marketing aimed at vanpool participants points out the financial benefit to existing participants by adding more riders to the vanpool. All participants fill out an application form. Primary and backup drivers and bookkeepers have additional application requirements. In particular, drivers must have a clean (or nearly clean) driving record, no drug or alcohol charges within the last 10 years, good health, and a stable employment history. (see information below)

Figure H-26: Vanpool Driver and Bookkeeper Selection Criteria

Leaders of the Pack
Vanpool Driver and Bookkeeper Selection Criteria

Vanpool Solutions from King County Metro

Bookkeeper	Primary/Backup Driver	Applicable for primary and backup drivers
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1. Age. At least 21 years of age is preferred.
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	2. Employment. Employed by present employer for two years, or other indication of stable employment.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	3. License and Experience. Must have a current and unrestricted Washington State driver's license and have driven for at least five years. (Restrictions for glasses or contact lenses are acceptable. Others must be reviewed in light of Question 6 below.)
<input type="checkbox"/>	<input checked="" type="checkbox"/>	4. Insurance History. Cancellation or non-renewal within the past five years will be closely analyzed. If the action is related to the applicant's driving behavior, this will result in not being accepted.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	5. Suspension or Revocation of License. Anyone reporting a suspension or revocation of driver's license within the past five years will not be accepted. Also unacceptable is any applicant reporting a suspension or revocation of license within the past 10 years for Reckless Driving, Hit and Run, Leaving the Scene of an Accident, Driving While Under the Influence of Alcohol and/or Drugs, Driving While Impaired, Felony, or concurrent Violations of Lane Changing.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	6. Medical Conditions. The highest health standards are required for van drivers. Any condition that would impair a driver's ability to operate the van may result in not being accepted. (Poor eyesight that is correctable by lenses is acceptable.) If necessary, Metro may require a physical examination to make a determination.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	7. Accidents. A preferred driver will be accident-free for at least three years. However, an otherwise superior driver may have not more than one non-preventable accident within three years.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	8. Violations. A preferred driver will have no violations for the past three years (except parking citations). This will be confirmed by checking state records.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	9. Alcohol and Drugs. An applicant who reports any alcohol- or drug-related charge within the past 10 years will not be accepted.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	10. Certificate of Financial Responsibility (CFR). An applicant who has had to file a CFR due to his or her personal driving record will not be accepted.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	11. Other Autos. The preferred driver will have at least one other auto.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	12. Personal Use of Van. Routine carrying of a group of unrelated persons (e.g., Cub Scout or Little League groups) is not allowed. An applicant who expects to commit the van to such routine non-commuting use will not be accepted.
<input type="checkbox"/>	<input checked="" type="checkbox"/>	13. Off-Street Parking. Drivers are expected to provide off-street parking at a private residence at the home end.
<input checked="" type="checkbox"/>	<input type="checkbox"/>	14. A Good Credit History. Vanpool bookkeeper applicants must consent to a credit check. The credit report will be used to determine acceptability for handling bookkeeping responsibilities. All prospective bookkeepers must complete the Metro Vanpool Orientation course before assuming bookkeeping duties.
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	15. Vanpool Orientation. All drivers and bookkeepers must complete the Metro Vanpool Orientation course before taking possession of a Metro van.

King County METRO

Drivers are responsible for coordinating van maintenance and servicing, keeping daily and monthly records, and coordinating the van's operating rules (e.g., regarding smoking, waiting times, and radio use). Drivers also serve as a contact point for prospective new riders. Drivers are allowed 40 miles of personal use of the van per month, and pay 38 cents per mile beyond that. At least one backup driver is required for each vanpool.

King County vanpoolers typically travel twice the distance of the typical fixed-route bus rider. In many areas of the county, vanpools are the only direct link from a rider's place of origin and place of employment. Vanpools are able to travel to work locations where fixed-route transit would be too costly to operate, and can serve long-distance commutes where fixed-route transit is available, but is uncompetitive with the auto over that distance from a travel time standpoint. HOV lanes are provided on most Seattle-area freeways, as well as on a few arterial streets, giving vanpools a significant time advantage over single-occupant vehicles, given the level of traffic congestion in the Seattle area.

Summary and Conclusions

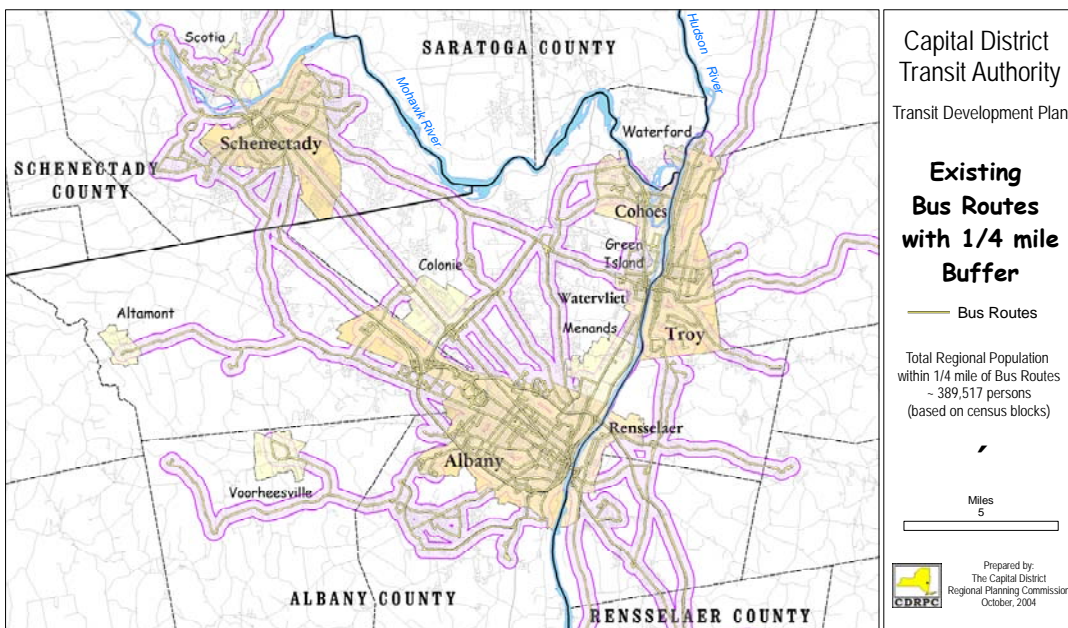
The vanpool program information indicates another path to providing suburban mobility options. As indicated, the vanpool users typically travel twice as far as bus patrons, so, in this instance vanpools are an effective alternative for longer distance trips. The route-deviation services have all operated for a comparatively long period of time and indicate that these services can sustain in the right environments, that deviation rules can be developed over time and that augmentations, such as noon time shuttles can enhance the total system.

6. ALBANY, NEW YORK

Capital District Transportation Authority

The Capital District Transportation Authority (CDTA) operates a bus fleet of 250 vehicles to serve a 4-county service area that encompasses some 2300 square miles in upstate New York. Over 750,000 people live in the service area. The vast majority of CDTA's 44 regular routes are centralized in a 150 square mile urbanized area. Close to 35,000 customer boardings take place each weekday on regular route buses. CDTA provides a range of service, including local, limited stop-express, park & ride and suburban shuttle service. In addition to regular route service, CDTA provides rural bus service to a number of communities in the service area.

Figure H-27: CDTA Service Area Map



The CDTA was formed by an act of the New York state legislature in 1970. The authority is a “ public benefit organization” with a stated legislative purpose "to provide for the continuance, further development and improvement of transportation and other services related thereto within the Capital District Transportation District by railroad, omnibus, marine and air".

CDTA is governed by a Board of Directors, three from Albany County, and two each from Rensselaer, Saratoga and Schenectady Counties, who are appointed by the Governor and approved by the State Senate. In general, the role of the CDTA Board with regard to service is to approve service changes and new services. Additionally, they are finalizing a TDP which will help establish priorities for service. Goals of the TDP include the following which are in keeping with the increasing focus recognized by CDTA that transit needs to find new ways to ensure quality services to the suburbs can continue:

- Align transit services with demand, with particular attention to potential new markets
- Improve efficiency, effectiveness and the quality of service operations
- Improve existing partnerships and relationships; develop new ones
- Establish service design guidelines and performance monitoring techniques to guide future service direction

In designing the suburban services, several criteria were part of the decision process, including the evaluation of employment related benefits and potential support for transit services, local and municipal support, ability to access external funding sources including Jobs Access/Welfare to Work, and also whether, through their internal planning processes there were patterns of movement which lent themselves to transit usage.

The performance measurement program is relatively simple including the traditional attributes which can be drawn from capturing data on hours, miles and passenger trips. There is heavy reliance on information from the operators regarding other qualitative information.

CDTA began its shuttle services, the Shuttle Bug, Shuttle Bee and Shuttle Fly in 1998. These routes were started using CMAQ funding, and later expansions were funded with JARC and TANF funds. Essentially, they have become part of the regular CDTA family of services and are operated as part of the CDTA annual budget. Organizationally the shuttles are grouped within CDTA’s paratransit division for day-to-day supervision of operations.

These routes are operated using 24 foot minibuses for the necessary flexibility to maneuver in tight locations, as they are operated on a route-deviation basis. Service for the Shuttle Bug operates Monday through Saturday, while the Shuttle Fly operates 7 days per week. The areas served are primarily non residential suburbs. The primary market is commercial and industrial in nature with some interspersed residential areas and institutional land uses, including some elderly housing units. The routes deviate up to a quarter of a mile based either on calls from passengers to the dispatcher who calls the driver. Drivers can communicate with each other through Nextel technology. Calls for deviations can be made in advance as close as up to 5 minutes of a scheduled pickup for a deviation. Passengers can also request specific stops once they board the vehicle, as long as it is within the established deviation zone.

This case study will be looking at two of the CDTA shuttle routes, the Shuttle Bug and the Shuttle Fly.

In passenger surveys, it has been learned that over 80% of riders are commuting to work via the shuttles, that most riders have been using the shuttles for multiple years, and that most ride the service over five days per week.

Transit Service Characteristics – Shuttle Bug and Shuttle Fly

Table H-32: Transit Service Characteristics – Shuttle Bug and Shuttle Fly

Service Characteristics	Route	
	<i>Fly</i>	<i>Bug</i>
% of households or jobs within service area		
Response time (DAR)	Deviations may be prescheduled, called in, or made when boarding the vehicle	Deviations may be prescheduled, called in, made when boarding the vehicle
Number of vehicles in peak service	6	5
Intermodal hubs	Colonie Center	Crossgates
Technology		
- Signal preemption	No	No
- Next bus	Coming	Coming
Vehicle Characteristics		
Vehicle type	Cutaways	Cutaways
Capacity (seats/wheelchair positions)	1 or 2	1
Technology		
- Annunciators	Yes	Yes
- AVL	Magnetic Swipe cards	Magnetic Swipe cards
- Smart Cards		
Route Characteristics		
Headway		
- Peak	20	20
- Off peak	30	30
Average speed	9.3 mph	12.5 mph
Trips per		
- Weekday	96	86
- Saturday	76	24
- Sunday	19	0
Route length (mi/hr)	6 miles	19.5 miles
Service span		
- Weekdays	540a to 1200x	555a to 1155p
- Saturday	650a to 1200x sat	600a to 1150p sat
- Sunday	825a to 628p sun	

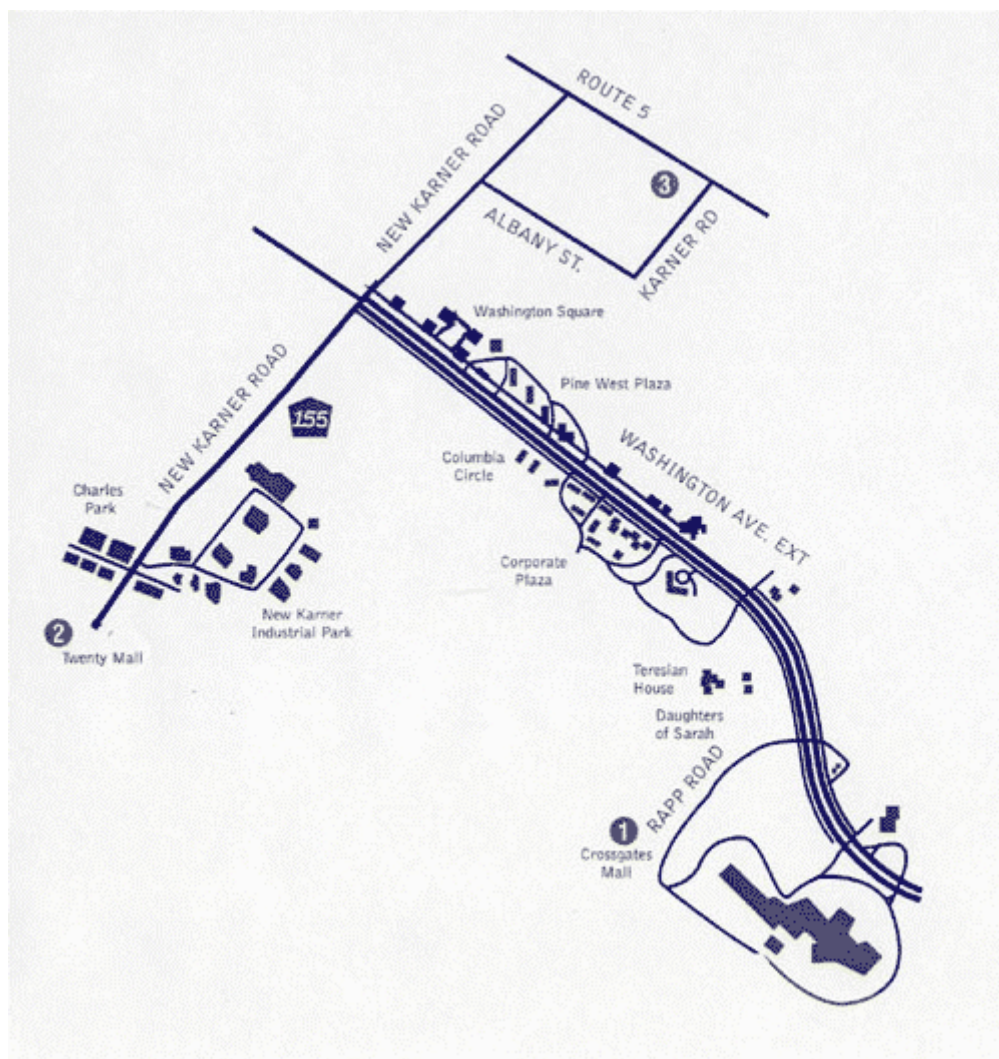
Table H-33: Shuttle Bug and Fly Operating Performance

Performance – 2003	Route	
	<i>Fly</i>	<i>Bug</i>
Passengers	109,908	147,757
Revenue hours	10,781:09	9568:30:00
Revenue miles	108,841.40	121,973.50
Vehicle hours	15,729	15,543
Vehicle miles	204,261	261,969
Cost/passenger	3.06 *	3.06*
Cost/hour	66.94 *	66.94 *
Cost/mile	5.38*	5.38 *
Subsidy/passenger	2.83 *	2.83 *
Farebox recovery ratio		
On-time performance		
Trip denials	NA	NA
Missed trips	17	33
% of pax requesting deviations	42%	52%

Shuttle Bug

The Shuttle Bug operates on the Washington Avenue Extension service roads, a ridge road corridor connecting the Crossgates Mall and Crossgates Common, the 20 Mall and Route 5 and Karner Road. The Crossgates Mall provides also direct connections between the Shuttle Bug and CDTA Route 155 north or 155 south.

Figure H-28: Shuttle Bug



Service Area Characteristics

Table H-34 summarizes demographic and other information for the service area of the ShuttleBug flex route. The service area is defined as the area within $\frac{3}{4}$ mile of the route, including all deviations. Indicators that correspond to the four D's – density, diversity, design as well as deterrents to driving – are presented. The service area has relatively low population density corresponding to dwellings on $\frac{1}{2}$ to 1 acre lots on average, moderate employment density, and a surplus of jobs compared to residents, suggesting that the area is a net importer of workers from elsewhere in the region. Development patterns of this service area are typical of many suburban areas with relatively poor sidewalk coverage, low street network connectivity, and site designs with large setbacks. There are also no parking costs or transit priority measures in place that enhance transit's competitiveness with the private automobile.

Table H-34: Service Area characteristics of Shuttle Bug

	Characteristic	Shuttle Bug
	Population	
	Service area size (sq. miles)	6.2
	Service area population	16,167
	Population density (per sq. mile)	2,629
DENSITY	Service area households	5,243
	Household density (per sq. mile)	853
	Employment	
	Service area employment	19,999
	Employment density (jobs per sq. mile)	3,252
	Jobs/housing balance	1.2
DIVERSITY	Employment by sector (data not available)	
	Land use (data not available)	
DESIGN	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)	1
	Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)	1
	Urban place in service area	no
DETERRENTS TO DRIVING	Off-street parking costs	no
	Transit priority features	no

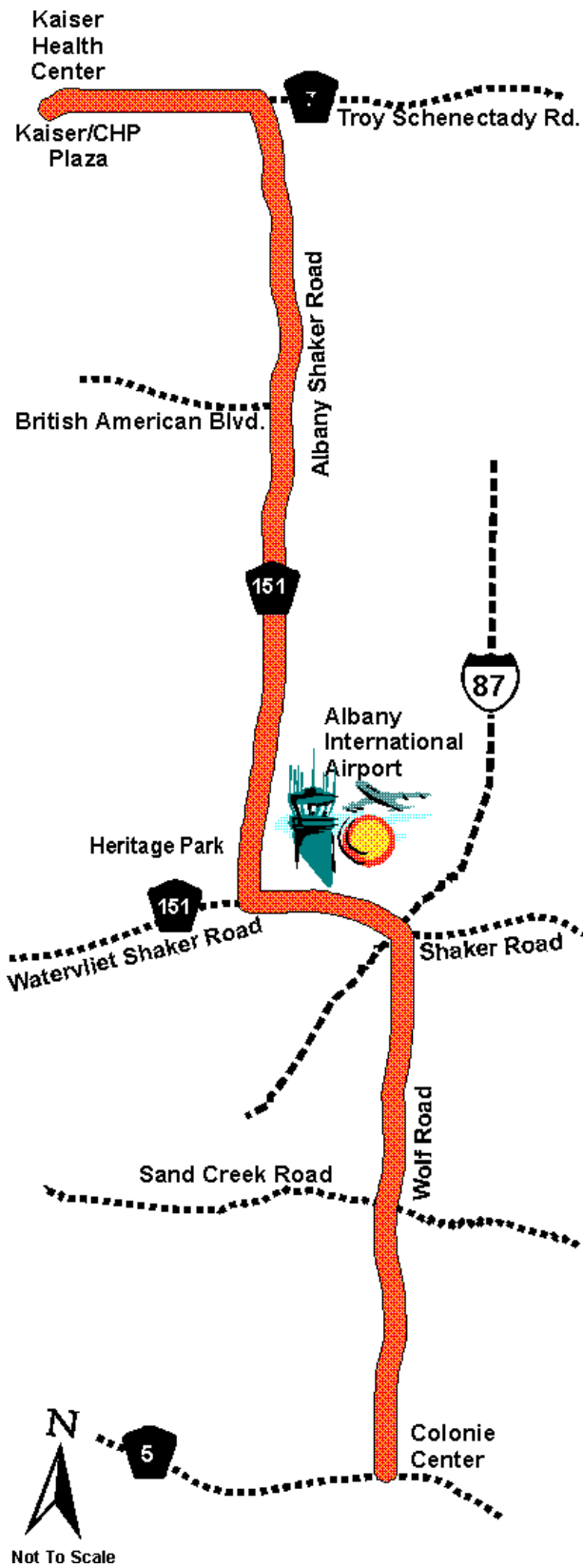
Source: Capital District Transportation Authority

Shuttle Fly

The Shuttle Fly operates between Colonie Center, Albany International Airport and Route 7. The primary connector routes are Wolf Road and Albany Shaker Road. From the Colonie Center, passengers can connect directly with other CDTA routes to and from other destinations on the CDTA Routes 1, 2, 90, 55. Other major employers and destinations on route include the Kaiser Health Center, and the Albany Heritage Park.

The Shuttle Fly gets funding from a non traditional source. Through an agreement with the Town of Colonie, developers who initiate projects in the service area pay a one time mitigation fee into the town in a fund termed the Transportation Demand Management Fund. This fee is provided to CDTA for use in the Shuttle Fly service for either capital or operating expenses, depending on the need. This is a one time fee for the developers.

Figure H-29: Shuttle Fly



Service Area Characteristics

Table H-35 summarizes demographic and other information for the service area of the ShuttleFly flex route. The service area is defined as the area within $\frac{3}{4}$ mile of the route, including all deviations. Indicators that correspond to the four D's – density, diversity, design as well as deterrents to driving – are presented. The service area has relatively low population density corresponding to dwellings on $\frac{1}{2}$ to 1 acre lots on average, moderate employment density, and a surplus of jobs compared to residents, suggesting that the area is a net importer of workers from elsewhere in the region. Development patterns of this service area are typical of many suburban areas with relatively poor sidewalk coverage, low street network connectivity, and site designs with large setbacks. There are also no parking costs or transit priority measures in place that enhance transit's competitiveness with the private automobile.

Table H-35: Service Area Characteristics of Shuttle Bug

	Characteristic	Shuttle Bug
	Population	
	Service area size (sq. miles)	4.7
	Service area population	8,289
	Population density (per sq. mile)	1,752
DENSITY	Service area households	3,131
	Household density (per sq. mile)	662
	Employment	
	Service area employment	15,645
	Employment density (jobs per sq. mile)	3,307
	Jobs/housing balance	1.9
DIVERSITY	Employment by sector (data not available)	
	Land use (data not available)	
	Sidewalk coverage (scale of 1-5, 5 having the highest degree of coverage)	1
DESIGN	Street connectivity (scale of 1-5, 5 having the highest degree of connectivity)	1
	Urban place in service area	no
DETERRENTS TO DRIVING	Off-street parking costs	no
	Transit priority features	no

Source: Capital District Transportation Authority

Summary and Conclusions

These two services indicate how a combination of non-traditional funding sources, such as CMAQ, JARC, TANF and developer fees can initiate services that eventually become part of the system. These services are interesting since they are heavily used by commuters but also include a 40 to 50 percent deviation.

7. BROWARD COUNTY, FLORIDA

Broward County Transit

Margate Community Buses

Broward County Transit provides a full family of transit services in Broward County, Florida, which is located between Palm Beach County to the north and Miami Dade County to the south. The active fleet includes 275 fixed-route buses and 65 community buses, a program that will be described in greater detail below. The fixed-route service carries 34.4 million trips annually and travels over 13.2 million annual miles. The system motto is “The Bus with Mass Appeal” and the mission statement is: “To provide clean, safe, reliable and efficient transit to the community by being responsive to changing needs and focusing on customer service as our highest priority.”

The family of services includes:

- Fixed Route – which accounts for 95% of the riders
- Paratransit
- Community Buses
- Emergency/Evacuation Services
- Free On-demand Minibus Service
- Water Bus Service
- Special Event Transportation

Community Bus Program – Margate

The Community Bus Program began in 1992 and uses a local option sales tax as the funding source which provides vehicles to the communities in the county that have a demonstrated interest and commit to meet the program threshold of five passengers per hour. BCT's community bus service is designed to increase the number of destinations within city limits that residents can access through public transit. All community buses connect to BCT fixed routes, are wheelchair accessible and equipped with bike racks. Twenty-one of the communities within the county are now participating in the program.

With regard to the Margate service, it was one of the first three communities to avail themselves of the service opportunity. Margate runs a local circulator system comprised of four routes using 26-foot medium-duty minibuses with wheelchair lifts that seat 24 passengers. Margate has a total land area of 8.8 square miles and a population of 53,852 residents. Using a quarter mile buffer zone along the Margate Inner City System's four routes, an effective land area of 11 square miles was measured along with a population of 63,510 resulting in a population density of 5,773 persons per square mile. In the quarter mile buffer, the median household income is \$45,697. In terms of people by demographic profiles likely to utilize transit services, the elderly segment of the population is 17.7%. In the Margate Circulator Service area there are 18,597 total owner-occupied units and 6,618 renter-occupied units. Of the owner-occupied units,

8% have no car and 41% have one car in the household. In the renter-occupied housing units, 12.7% have no car and 48% have one car. Route level analysis was conducted for this system as described in the following paragraphs.

Route A

Route A serves to transport residents from dense residential communities of condominiums in the northwestern and central portions of the city, as well as a few lower income single family neighborhoods, to city services in the City Hall area, medical facilities along State Road 7, and significant shopping opportunities such as the Peppertree Plaza and WalMart in the east portion of the city along State Road 7. Half of this route's distance runs along State Road 7, which is a six-lane divided highway. There are sidewalks on both sides, and a few bus shelters, but certainly not at every bus stop. There is a transfer center with larger bus shelters a block and a half west of State Road 7 near city hall where all the Margate circulator buses pass through, though none of them are timed to meet each other at that point. There is a major senior services center at that location named the Focal Point. The southern portion of Route A that runs along State Road 7 is lined by spotty strip commercial uses such as bowling lanes, car repair shops, storage facilities, fast food chain stores, florists, etc. There are no mixed uses along State Road 7 or any other portion of Route A. In the northern portion of Route A near Winfield Boulevard, the commercial uses become newer and better, including some shopping centers with major grocery chain stores and pharmacies. North of Winfield Boulevard there are medical centers and offices. Peppertree Plaza at the intersection of State Road 7 and Sample Road is a more modern shopping complex with grocery stores, restaurants, and a variety of other national and local stores. "Big Box" stores such as WalMart, Lowe's, Target, and Circuit City are located on the route on as it completes a loop just west of State Road 7 near the Sample Road intersection.

The western portion of Route A travels through areas that are virtually entirely residential. With just a small exception as the bus travels through the lower income singles family residential area, the bus is always traveling on 4-lane divided roads with sidewalks and bus shelters near higher density developments. Again, there are no mixed use areas. The densities of the single family home areas that the bus travels though appear to be approximately four units per acre. The multifamily condominiums that are served by Route A are usually three story buildings that I would estimate are no less than 16 units per acre. The Holiday Springs condominium development is built around a golf course. Basically, this is a community that requires one to get in a vehicle to access any ordinary services or retail shopping.

Route A provides service once an hour from 7:30 a.m. to 6:30 p.m. Mondays through Saturdays. The route carries an average of 10.9 passengers per hour.

Route B

Route B is designed to transport residents from the high density Oriole Gardens condominium communities in the southwestern portion of Margate to the same destinations as Route A does along State Road 7. Hence there is no need to describe again the land-use characteristics or major destinations along State Road 7. The southwestern portion of the route operates along four lane divided roads with sidewalks with bus shelters located at major stops serving the various condominium buildings. It is important to note that none of Margate's buses actually enter the condominium properties. The minibuses stay on the major roads and all passengers walk to the stops. Route B passes by a few neighborhood and community retail centers in the southwestern portion of the city that have major grocery chains and other

convenience stores. However, most people would find it difficult to access these areas without a car or bus. Again, there are no mixed-use developments in the city. The densities of the condominiums are no less than 16 units per acre, and the single family areas are typically characterized by four units per acre.

Route B is a somewhat complicated route that is made of three branches. It provides service every half hour along State Road 7, but only once every two hours to the residential communities in the southwestern portion of the city. This route operates from 7:15 a.m. to 6:45 p.m. Monday through Saturday. It also competes with a considerable amount of county bus service that is provided on State Road 7 that operates every 15 minutes. Route B does provide service to an Indian Casino that Route A does not serve north of Sample Road. According to Mark Porrier, manager of the service, virtually no one uses the bus to access the casino. Route B carries an average of 8.8 passengers per hour. It is scheduled to be discontinued in the near future, with its resources to be focused on the southwestern portion of the city.

Route C

Route C operates as a one way loop providing service once an hour. The primary purpose of this route is to take residents from the Holiday Springs and Orioles condominium complexes to the Coral Square Mall, a major shopping mall with a mix of high-end and other stores. At this location, Margate circulator riders can connect with four different Broward County Transit routes as well. The Holiday Springs and Oriole Gardens communities have already been described as three-story multifamily housing developments that have a minimum of 16 units per acre. Route C also goes to the Margate City Hall where it connects with two other BCT routes, as well as routes from neighboring Coconut Creek. Route C serves Palm Lakes Plaza and Holiday Springs Shopping Center where many residents do their grocery shopping. Much of this route travels on Atlantic Boulevard and Riverside Drive which are both six lane divided roads with sidewalks and bus shelters. There are no mixed use communities along this route. In spite of the fact that this route is a one way loop with only once an hour service, it still averages 16.1 passengers per hour. The Coral Square Mall is a major attraction for elderly shoppers as well as employees of the mall who live in Margate. Senior citizens are also access the mall before stores open to exercise by walking through the mall in air conditioning. The route operates from 8:30 a.m. to 6:30 p.m. Monday through Saturday.

Route D

Route D provides once an hour service to the southeastern portions of the city from 7:30 a.m. to 6:30 p.m. This route tends to serve more single family home areas than any of the other three circulator routes in Margate. The roads it operates on vary considerably. State Road 7 and Atlantic Boulevard are six lane divided highways with sidewalks and occasional bus shelters. Southgate Boulevard, Coconut Creek Boulevard, and Banks Road are four lane divided highways with sidewalks and occasional bus shelters. S.W. 6th Street, S.W. 11th Street, S.W. 51st Avenue, Kathy Lane, and Forest Boulevard are all two lane roads with sidewalks, but no bus shelters. The width of the roads reflects the densities and land uses they serve. Where there are six lanes, the land use is primarily commercial and some office uses. Where there are four lanes it is typically multifamily townhomes or duplexes. Where the roads are two lanes, single family residential is predominant.

There are no mixed uses on Route D. There are few major trip attractors. Palm Lakes Plaza offers grocery and pharmaceutical shopping. There is a large strip shopping center at the intersection of Atlantic Boulevard and State Road 7. There is an Education Center on Banks Road. This route averages 9.3 passengers per hour.

Route Summary

Margate Inner-City Transit has been in operation for almost eleven years and now has four distinct shuttle routes. The system charges riders twenty-five cents per trip and has a service span of twelve hours (7 a.m. – 7 p.m.) between Monday and Saturday. The total operating cost for fiscal year 2003-2004 was \$583,285 with 46.5% (\$271,142) being funded by Broward County Transit through proceeds of the county's local option gas tax, 17% (\$99,000) from fare revenues collected, 6.1% (\$36,000) from bus advertisements, 4.1% (\$24,000) from shelter advertisements, and 3.4% (\$20,000) from bench advertisements. The City of Margate funds the remaining 22.8% (\$133,143). Over 200,000 passengers per year (daily average of 639 patrons) are carried on the local circulators. Ridership data provided by Margate Inner-City Transit during 2001-2004 shows the passengers per revenue hour growth (See Figure 4.1).

Other information includes: Bus operators are hired as city employees and the turnover rates are quite low. The current route design originates from technical assistance provided by Broward County Transit at service inception. Subsequent adjustments have been made in terms of addition of new routes and alterations to current routes based on increased demand for such services. The design for Route A is based on its service as a shopper's route to the north end of Margate. Route B (one of two original routes, A being the other) was designed to first cover the south end, but has now been altered due to the presence of routes C and D to run a north-south loop along US 441. Route C emerged due to customer calls for a mall shuttle, providing connections between Holiday Springs, Oriole Gardens, Paradise Gardens, and the Coral Square Mall. Route D serves the south end and typically connects commuters, estimated at 8,000-9,000 within the city to worksites. Route D also has connections to BCT routes (18, 31, and 83) for commuters who transfer to and from the regional system.

Margate Inner City Transit has been able to gain customer feedback about the service via a hotline for patrons where any complaints or compliments about the service can be expressed. The city maintains its fleet of minibuses with its own Public Works Department personnel, performing maintenance on the vehicles every 5,000 miles. The mechanics within the Public Works Department check over 130 items at every maintenance interval. These efforts are aimed at ensuring that the overall quality of service delivery is professional and reliable. Service promotion and marketing for MICT has been in the form of the city's website that posts schedules and maps of the respective routes. Brochures and packets with this information have been sent upon request to prospective riders. There are also continuous meetings with residential condominium communities to discuss the service.

Some unique lessons that have helped to explain the success the circulator system has enjoyed for almost eleven years are listed below:

- Stay on major streets in terms of service especially serving residential areas focusing on higher density condominium developments and higher density commercial land uses.
- Have plastic seats to avoid vandalism losses
- Maintain reliable, customer-friendly service to patrons

-
- Promote advertising on buses, shelters, and benches to gain additional revenue.
 - The major advantage of keeping services in-house is that there is a strong sense of control using city personnel. The additional annual estimated cost of operating the service with in-house personnel is \$65,000 (approximately 13% higher than it would cost to contract for the service), but the city believes it is worth the extra cost.
 - The majority of riders were elderly, and that the consistency of having the same operators on the buses day in and day out is very important to those passengers. Contractors tend to have higher turnover in their drivers' roster than the city of Margate has had, where at least three of the drivers have been with the city for over six years.
 - The bus drivers are the primary customer service personnel. Thus it is critical to any bus system for drivers to have a good attitude, a smile, and the ability to answer questions from passengers with courtesy and respect.

Feedback was gathered from the passengers and bus operators on the circulator system. A total of eighteen passengers responded to questions about reliability, future areas for service improvements, service awareness, and rating the service. Passengers reported their usage frequency as follows: ten indicated they were daily riders (five or six days a week), one patron used the service four days a week, three riders used the service three times a week, and the other four were infrequent users (once a week, every other day, twice a week). Reasons for their usage ranged from the first twelve riders noting they used it to get to and from work (66.7%), one (5.55%) patron was going to school, and five (27.7%) riders were utilizing the service for shopping. Passengers indicated that the drivers were customer service oriented and were very helpful in terms of route schedules, connections within the system, and information about BCT transfers. The passengers surveyed were asked to provide an overall assessment of the service considering all service elements (wait times, reliability, comfort etc.). The average from the eighteen respondents on a ten-point scale was 9.58.

The bus operator surveyed on Route A reported that he had been with the system for five years. In a rough estimate of the trip purpose characteristics, the operator indicated that approximately 85% of the users were seniors whose main purpose was shopping, commuters were estimated to be 10% of the riders, and students were 5%. The operator expressed interest in seeing the implementation of service improvements such as incorporating more time for the driver to have breaks and for the air conditioning units to operate more consistently and efficiently. The bus operator on Route B indicated that he had been with the system for five years. The operator's estimate of trip purpose and rider demography was that approximately 70% of the users were seniors whose main purpose was shopping, commuters were estimated to be 20% of the riders, and students were 10%. The operator noted that Sunday service and route expansion would certainly improve the level of service to the community. He estimated that 30% of the riders were transferring from BCT buses and the remaining 70% were intra-city riders. The bus operator on Route C indicated that he had been with the system for four and a half years. The operator's estimate of trip purpose and rider demography was that approximately 75% of the users were seniors whose main purpose was shopping, commuters were estimated to be 12.5% of the riders and students were 12.5%. The operator noted that route expansion and more frequent service would certainly improve the level of service to the community. The bus operator on Route D reported that he had been with the service for two years. His estimate of trip purpose and rider demography was that approximately 75% of the patrons were seniors whose main

purpose was shopping, commuters were estimated to be 5% of the riders, and students were 20%. The operator added that the implementation of Sunday service and more BCT connections would improve and meet the mobility needs of the local residents.

Margate Inner-City Transit's four routes connect with seven BCT routes as well as other municipal local circulators provided by the cities of Coconut Creek and Coral Springs. Some of these connections occur at a modest designated transfer center a half block from city hall.

Looking at the other Community Bus Programs, several managers were asked if their services were successful. Defining "successful" might ordinarily be cause for debate among transit providers. Every one of the managers of the local circulator systems reviewed would state that their services are successful. They believe they are expanding mobility opportunities within their communities for their residents and for those who work in the businesses of their cities. It is being done at little cost to the passengers and their citizens, and they are providing the service at less than half the cost of regional fixed-route transit service. The local circulator routes link to other circulators and the regional transit system, thereby expanding the possibilities for all residents in the county to use transit service. The option of providing local circulators helps free up countywide buses to stay on the major arterials with improved frequency, making regional transit travel more convenient. The local circulators provide opportunities for most of their citizens to access city services and facilities, as well as shopping, recreational, and medical destinations. The availability of these local circulators helps to minimize the expense of door-to-door service for the elderly and disabled, and provides more independence for those who have relied on such service. Businesses that utilize relatively low-cost labor have a reliable way for their work force to get to and from their place of work. Young students who otherwise might have to walk through rush hour traffic to get to school now have a safer alternative. In all of these areas, all of the local circulators are indeed successful. Further, the survey of passengers' attitudes toward the service conducted by the principle investigators of this report resulted in an average rating for all eight local circulators of an impressive 8.95 based on a scale from one to ten, with 10 being outstanding. Hence, existing passengers appear to regard the local circulators as very successful in meeting their needs.

For purposes of this report, "successful" is defined by how many passengers per hour are carried by the local circulator. Broward County is paying for a large portion of the expenses of these services, and it wants to be sure it is investing its funds purposefully. The county has established a minimum goal (five passengers per hour) that every city must reach if it is to continue receiving financial assistance from the county. This performance level clearly makes it more efficient than paratransit, but it is still a relatively low figure for a fixed-route service. In comparison, the county carries approximately 35 passengers per hour on its regional transit system. However, local circulators are not expected to carry as many passengers per hour as regional transit systems. Part of the intent of the local circulators is to use smaller buses that are more neighborhood-friendly and that are able to maneuver more easily in shopping centers and smaller streets. Obviously, smaller buses have less capacity and are not designed for the full rigors of large transit buses that typically stop every few blocks and carry as many as 70 passengers in crush load times.

The eight local circulator systems reviewed in this report carried an average of 14.2 passengers per hour. By almost any standard of productivity, this can be regarded as very successful. For instance, the ridership per hour figures of these local circulators almost matches the performance of Palm Tran, the countywide fixed-route service provider in Palm Beach County. In terms of cost efficiency, the average cost per passenger on the local circulators was

\$2.18 compared to BCT's average cost per passenger of \$1.90, a remarkably competitive rate, particularly when considering paratransit costs approximately \$17 per passenger.

The Correlation between Passengers per Revenue Hour and Transit Utilization Factors

The hypothesized relationships between passengers per revenue hour and such measures as population density, income, the elderly segment of the population, the student-age segment of the population, the number of owner-occupied units, the number of renter-occupied units and car ownership were tested at the route level with data derived from the census blocks which permitted Pearson correlations to be conducted to measure the magnitude and sign of these relationships. The correlation between passengers per revenue hour and income shows clearly that as the level of income declines the passengers per revenue hour rises and this noticeable inverse relationship confirms standard transit utilization theory. The elderly and student age segment are both positively correlated to passengers per revenue hour which also confirms transit utilization, though in this sample set, the relationship is rather minimal to non-significant. However, it is mildly interesting to note that the correlation between student population and transit ridership is stronger than the correlation between elderly and transit utilization. Population density is *highly* positively correlated to passengers per revenue hour in the routes analyzed, so standard transit utilization theory holds firmly in this local circulator setting as well. Owner-occupied housing units had a mild negative correlation to passengers per revenue hour, showing that as the number of owners rose along the routes examined, it is expected that ridership per hour would decline. The number of renter occupied units was slightly positively correlated with passengers per revenue hour though the magnitude of this relationship is too small to be considered a strong factor. The segment of owner occupied units with no car was strongly correlated to passengers per revenue hour. This finding is again consistent with standard transit utilization theory. The segment of owner-occupied units with one car is also positively correlated with passengers per revenue hour. This might be due to the fact that the owner occupied households with only one car have more people in the household with mobility needs that are not being met with a single car. The segment of renter occupied units with no car is positively correlated with passenger per revenue hour, once again consistent with the notion that the absence of personal transportation, especially in the case of persons renting units, implies transit utilization for many trip purposes. The segment of renter occupied units with one car is slightly negatively correlated with passengers per revenue hour, so as renters get personal vehicles, ridership on the shuttle system would decline. This finding might reflect that renter occupied units have fewer people and less travel demand. The chart and correlation matrix below show the results from the statistical analysis.

Table H-36: Broward County Correlation Matrix

Pass. Rev. Hr./Income	-0.57648
Pass. Rev. Hr./Elderly Segment	0.061163
Pass. Rev. Hr./Student Segment	0.090209
Pass. Rev. Hr./Population Density	0.83333
Pass. Rev. Hr./Owner-Occupied	-0.39667
Pass. Rev. Hr./Renter-Occupied	0.036481
Pass. Rev. Hr./Owner-Occupied No Car	0.694742
Pass. Rev. Hr./Owner-Occupied 1 Car	0.380401
Pass. Rev. Hr./Renter-Occupied No Car	0.520486
Pass. Rev. Hr./Renter-Occupied 1 Car	-0.12368

Demographics

It might seem obvious to many that certain demographic characteristics contribute to better transit ridership, but with such limited experience in the provision of local circulators in primarily suburban settings, it was well worthwhile to confirm if normal indicators of transit potential apply to local circulators as they do to regular fixed-route transit service in a more regional setting. As noted above, there is a *very* strong (0.833) positive relationship between transit use and population density for the local circulators that were studied. In short, the higher the density, the higher the transit ridership per hour was for the local circulators. Not too far behind in terms of relationships was the high positive correlation between lack of car ownership and transit use. Perhaps a little surprising was that the relationship was even stronger for owner-occupied dwellings (0.69) without cars versus renter-occupied dwellings (0.52) without cars and transit ridership per hour. It is hypothesized that rental apartments are usually smaller than owner-occupied homes, and there might be more total need for mobility in an owner-occupied dwelling due to more people living in the owner-occupied home. As expected, there was also a strong negative correlation (-0.58) between income and transit ridership per hour. In other words, the higher the income, the lower transit ridership per hour was in the local circulator systems.

There is little surprise then, that transit ridership per hour was most successful in the City of Lauderhill. While the average passengers per hour for all five routes in Lauderhill was 22.0, two of the routes came close to carrying 30 passengers per hour. In Lauderhill, the population per square mile is 8,179, easily the highest among the eight city circulator systems reviewed. The median household income is \$32,070, which is among the lowest of all eight city systems reviewed. Lack of car ownership (9.9% of the owner-occupied dwellings and 12.1% of the renter-occupied dwellings) was above average, but not extraordinarily so. It is interesting to note that the City of Dania service area has virtually the same median household income as Lauderhill's service area, a similar percentage of renter households without cars, and a better headway (40 minutes versus 45) than most of the Lauderhill routes. However, Dania's population density is only 3,272 persons per square mile, and realizes a local transit circulator ridership per mile that is slightly less than one-third that of Lauderhill. In fact, the listing of cities in order of passengers per mile follows quite closely to the listing of the cities by their population densities, regardless of other demographic characteristics.

Table H-37: Broward County Demographic Characteristics

Community	Population Density	Household Median Income	Owner HH without car	Renter HH without car	Service Frequency	Fare	Service Span	Days of Service	Contract	Pass. Per Hour	# of Connecting Routes
Dania Beach	3,272	\$32,043	5.4%	19.6%	40 Minutes	Free	9 am – 5 pm	M-F	Yes	7.05	7
Cooper City	3,317	\$69,995	2.1%	8.3%	60 Minutes	Free	8 am – 4 pm	M-S	No	5.48	4
Coral Springs	5,548	\$52,946	3.9%	11.5%	60 Minutes	Free	8 am – 6 pm	M-F	Yes	12.38	6
Lauderdale Manors	6,542	\$29,417	8.0%	32.9%	60 Minutes	Free	6:30 am-6:30pm	M-F	Yes	16.0	2
Margate	5,773	\$45,697	8.0%	12.7%	60 Minutes	\$.25	7 am – 7 pm	M-S	No	11.54	9
Plantation	4,920	\$45,272	7.0%	12.0%	45 Minutes	Free	7 am – 4:30 pm	M-F	Yes	6.47	13
Miramar	4,434	\$44,786	6.8%	12.4%	60 Minutes	\$.25	6:45 am – 6:55 pm	M-F	No	7.2	8
Lauderhill	8,179	\$32,070	15.0%	20.0%	45 Minutes	Free	6:30am-6:55 pm	M-F	Yes	22.0	13

This case study has found that the local circulators are being used by senior citizens today. There is also anecdotal evidence that these services are being used by some of the passengers that might otherwise have relied on door-to-door paratransit service. The surprising finding is that the percentage of senior passengers is in almost all cases far lower than what might have been originally expected. If any segment of the population constitutes a higher percentage than all others among passengers, it appears to be the teenage student segment. Perhaps this should not have been a major surprise. In Florida, school systems do not provide bus service to students who live within two miles of their school. Prior to the institution of community buses, these students would either walk, ride bikes, be driven by their parents to their schools, or take a county bus if it made sense. However, traffic in Broward County can be challenging for pedestrians, particularly at major intersections. Heat and humidity also make walking or biking during certain school months very uncomfortable. Parents with certain work shifts might not be able to conveniently drop their children off or pick them up at schools. County buses might not get near enough to school sites located in communities, and they charge \$.60 to ride. Consequently, many students use the community bus to get back and forth to school. This has created a number of challenges for the community bus programs.

Student passengers have contributed significantly to the passenger count on local circulators, in that sense contributing to the success of these services. However, many of the community bus managers noted substantial problems with the loads of students they carry. Four of the cities in this report cited severe capacity problems either in the morning or in the afternoon due to tremendous numbers of students. Minibuses are not designed to carry large loads, and due to liability concerns, most of the cities adopt policies of not allowing standees. Large groups of students trying to board buses when school lets out can result in pushing and shoving as they compete for limited seating on the bus. One technique employed by or being considered by a number of these cities is to relocate the bus stop nearest the school. By just modifying the route slightly and moving the stop a block or two away from the school, some cities have succeeded in substantially reducing the loads boarding at these stops nearest the schools. One city has used its spare bus and flexible part-time employee to provide tripper service on school days to accommodate the extra demand in the morning.

There have also been instances of difficulties occurring by teenagers acting rowdy and negatively impacting senior riders. These descriptions of teenage behavior should not be regarded as highly threatening to the success of the community bus services. Apparently turnover among bus operators is fairly low. The cities are taking a variety of steps to deal with these challenges, and it appears that they are, for the most part, being successful. Clearly the student ridership helps the community meet its minimum requirement of carrying five passengers per hour. Most cities accept that the service is public, and that the families with children appreciate the mobility the circulators provide for their children.

Another surprise, given the relatively limited hours of service of many of the circulators, was the number of passengers using the local circulators to get to work. The clear majority of these passengers appeared to be service personnel working in places such as restaurants or department stores who made relatively low wages. The availability of a *free* or near-free transportation service was very valuable to them.

Other Factors

Demographic conditions certainly contributed heavily to an impressive rate of 22 passengers per hour in Lauderhill, even though most of the headways on the five routes are an

awkward and relatively infrequent 45 minutes. In addition, the City of Lauderdale also enjoys proximity to a significant regional bus transfer center at the Lauderdale Mall, where connections can be made with five county bus routes, many of which provide frequent service to major destinations. The fact that the local circulator connect with BCT service and with neighboring city circulators expands opportunities to get to and from employment opportunities. In the words of one of the city's circulator managers, "The connections give everyone more reasons to use the service". The availability of connections does not guarantee high ridership. For instance, Plantation enjoys connections with 10 BCT routes, three other city circulators, and the presence of two major BCT transfer centers to make transfers more convenient. However, their ridership is among the lowest of the eight cities reviewed in this report. The city's relatively high income, lower density, and higher car ownership works against a higher passenger per hour figure.

The effect of service span on ridership is difficult to analyze. All cities that offer service at least 10 hours a day enjoy double-digit passengers per hour, with the exception of Miramar. Miramar has similar demographic characteristics to Plantation, noted above, that make increasing productivity more challenging. All cities that offer less than 10 hours of service a day carry fewer than 10 passengers per hour. However, it would appear that the cities that have the better transit demographics would still outperform the other cities even if their hours were more limited.

Fares

Unfortunately, the universe of data dealing with fares is quite limited. Two of the eight local circulators charged a \$.25 fare. Margate enjoys a passenger per hour productivity of 11.54, while Miramar was experiencing ridership of 7.2 passengers per hour. Miramar has recently instituted a fare-free experiment, and it will be interesting to see if ridership increases substantially. Some of the cities might also wish to consider charging a fare if capacity becomes a critical issue for them.

Summary and Conclusions

Based on the experience of the eight community bus services, including the Margate routes, it appears that the factors that contribute to the success of regional fixed-route transit services also apply to local circulators. Demographic factors such as population density, car ownership, and median household income have high correlations with transit use at the local circulator level as they do with regional transit service. One interesting trend was that senior passengers constituted a smaller percentage of local ridership. The younger age cohorts are engaged in more activities and travel more than seniors. There is also indication that there is a larger demand for local circulators among service employees than had been expected. It also shows the profound demand there is among students who do not own cars.

8. DENVER, COLORADO

Regional Transportation District

The Regional Transportation District provides mass transit to the Denver metro area. In 1969, the Colorado General Assembly determined that public transit was a necessary part of the growing Denver metropolitan area. The Assembly found that public sector involvement was the best method to ensure the continuation of this vital component. Thus, the Regional

Transportation District was created as a political subdivision of the state effective July 1969 “to develop, maintain, and operate a public mass transportation system for the benefit of the inhabitants of the District.”

District boundaries now include Jefferson, Boulder and Denver counties, most of the city and county of Broomfield, and the urbanized portions of Adams, Douglas and Arapahoe counties. Nearly 2.4 million people or approximately 55% of the population of the State of Colorado, reside within RTD’s 2,326 square mile service area.

Since 1983, a fifteen member board of directors, who are elected by their constituents to serve four-year terms, has governed the District. There are approximately 165,000 voters per district director. The District Board is responsible for setting policy, overseeing the agency’s budget, and establishing short and long term transit goals in concert with local, state and federal agencies.

Figure H-30: Denver RTD Map



The agency employs over 2,400 men and women, making it one of the largest employers in the seven county area. Besides its administrative offices in the Denver, RTD has four operating facilities, including two in Denver, one in Aurora and one in Boulder. Two operating facilities were closed in 2003, the Longmont and the York Street facilities. The RTD operates more than 170 bus routes, with more than a thousand vehicles, and a light rail line and is in the process of significantly expanding the total system based on a recently passed referendum called Fastracks.

Regarding service to its suburban areas, the RTD operates an extensive family of services, including a network of commuter lines as well as a number of local circulation services or call-n-Rides. Unlike several of the other case studies, which focus on one or two services, and, in particular, extensive information regarding proximate land-use activities, the information presented regarding RTD includes all the call-n-Ride and regional express routes in order to provide more operating information on a system that also includes extensive service standards and performance measurement.

Service Standards

Background

From a productivity perspective, the Denver RTD includes analysis of ridership and subsidy per passenger. The standards are based on the least productive ten percent of routes (within a given route classification) for each of the two standards indicated above and the least productive 25 percent of the combined measures. New services are expected to achieve the appropriate productivity standards after six months of operation.

The RTD goal is to develop a family of services that augment and supplement other services within the family. The performance measures include productivity (passengers/hour or passengers/trip) and cost effectiveness (subsidy/passenger). The standards also include a minimum service frequency, ensuring that equivalent coverage is provided within the family of services – the criteria are separated for fixed-route and demand-responsive services – with a minimum of three peak trips for express or regional service, for example. There is an additional criterion for express service requiring that the first and last trips must have boardings equal to or greater than 50 percent of the standard. The 2003 service standards are shown below.

Table H-38: Denver RTD Year 2003 Standards

	Subsidy/Boarding			Boardings/Hour		
	Average	10% Max	25% Max	Average	10% Min	25% Min
CBD Local	\$3.03	\$7.45	\$ 5.34	30.7	16.2	23.1
Urban Local	\$3.98	\$10.16	7.22	23.8	12.4	17.9
Suburban Local	\$8.76	\$16.55	12.84	13.8	5.6	9.5
call-n-Ride	\$15.43	\$26.14	21.18	4.2	2.2	3.1
Express	\$6.67	\$14.02	10.52	27.2	9.6	18.0
Regional	\$7.50	\$15.79	11.84	17.8	10.7	14.1
skyRide	\$4.06	\$5.63	4.88	18.9	15.2	17.0
Vanpool	\$1.19	N/A	N/A	5.2	N/A	N/A

The RTD also includes area coverage standards that recognize that varying portions of the service area have varying demographic characteristics compared with the Central Business District. For example, there are criteria that vary based on densities of 3 to 12 residents and employees per acre and those in excess of 12 residents and employees per acre (which also recognizes the land-use influence we have analyzed in significant detail in other case studies). In addition, the District has adopted a farebox recovery ratio of 30 percent which includes all revenue sources and all costs, including a local share on the depreciation of assets. The inclusion of depreciation is somewhat unique, and results in what initially appear to be low farebox recovery and high subsidy per rider data. The RTD also takes into consideration the impacts on the transit dependent population and effects of route modifications on people with disabilities and associated system costs.

Call and Ride Routes

Service/Route Characteristics

Denver RTD operates nine call-n-Ride (cnR) routes in its service area. These are: curb to curb; limited to a specific geographic area; designed to supplement existing services or access points within the service area; and use smaller vehicles. The services typically operate 6 AM to 8 PM, Monday through Friday, although six of the services also operate on Saturdays and one operates on Sunday. Customers can reserve rides as much as two weeks in advance or as soon as an hour before traveling. The service includes the use of cell phones and, to a large degree, the scheduling of the customers and ability to deliver the service is based on the ability of the call-n-Ride operators. The coverage is typically 6 to 10 square miles, with 2 to 4 persons per acre and 1 to 3 employees per acre.

As indicated above, the RTD has an extensive Service Standards program that includes continual analysis of routes including the call-n-Ride services. The cnR services were developed both as replacements for low productivity fixed-route operations as well as new services in growing suburban areas. For example, one of the fastest growing suburban areas is the Gateway call-n-Ride, which began operating on January 6, 2003. The cnR serves the Green Valley Ranch community, Majestic Commerce Center and the Airport/40th park-n-Ride. Current service is available on weekdays - 6:30 am to 7:00 am and on Saturdays - 9:00 am to 6:00 am. Gateway's primary market has been for customers to connect with fixed-route services at the Airport/40th park-n-Ride, travel to the Majestic Commerce Center and travel within the Green Valley Ranch area.

Staff had analyzed the need for additional resources to provide Green Valley Ranch with an adequate level of service equal to the demand. The Gateway cnR has consistently increased in ridership on a monthly basis since its inception. While the average call-n-Ride performs at 3-5 passengers per hour, Gateway had been averaging 12.6 passengers per hour. This number has far exceeded a reasonable passenger per hour standard to the point of affecting the quality of existing service to the residents of Green Valley Ranch. The cnR has experienced extremely high operator turnover due to the demand of the service. Unlike a fixed route, the cnR thrives on operator consistency since they must learn the area in detail and the travel patterns of the customer. The demand has caused a drop in customer satisfaction as the operator can not respond in a timely and efficient manner to the customer's request. The service delivery problems brought on by heavy passenger usage has resulted in RTD receiving numerous customer complaints from the residents of Green Valley Ranch. Numerous attempts to fix the cnR have

been attempted: A. the Gateway service area was reduced by discontinuing service to the Single Tree community. B Worked with the city to have 40th Ave extended from the park-n-Ride to Tower Rd. This extension has been done on a temporary basis. C. Added additional service to the Route 45 serving Green Valley Ranch. D. Established a pm flex route for the call-n-Ride to simplify the pickups and drop-offs. Unfortunately, none of these changes have lessened customer demand for the call-n-Ride. The cnR's uniqueness and the relative ease to access a wide variety of transit routes at the park-n-Ride have made this cnR a monumental success that can not keep up with the current demand.

Thus staff recommended extending the current weekday service hours from 6:30am-7:00pm to 5:30am-8:00pm and adding an additional weekday bus and this recommendation has been implemented as shown in the map below, resulting in two zones of service. It will be interesting to track the ability of the two operators to coordinate and assess the overall impact of this service modification.

Figure H-31: Call and Ride Map



The 2003 operating data for all cnR services is listed below.

Table H-39: Denver RTD Service Performance for Call and Ride Routes

RTD Service Performance Data 2003								
Route	Standards Class	Farebox Revenue	Operating Costs	Total Boardings	In-Service Hours	Net Subsidy	Subsidy per Boarding	Boardings per Hour
Brighton	call-n-Ride	\$7,119	\$248,525	20,061	3,719	\$241,405	\$12.03	5.4
Broomfield	call-n-Ride	\$2,442	\$245,619	12,349	3,684	\$243,177	\$19.69	3.4
Evergreen	call-n-Ride	\$13,861	\$524,570	27,730	7,799	\$510,709	\$18.42	3.6
Gateway	call-n-Ride	\$3,774	\$233,247	25,504	3,641	\$229,473	\$9.00	7
Interlocken	call-n-Ride	\$1,065	\$272,243	16,707	4,194	\$271,178	\$16.23	4
Longmont	call-n-Ride	\$3,295	\$356,180	11,868	5,097	\$352,886	\$29.73	2.3
Louisville	call-n-Ride	\$3,998	\$268,645	21,382	4,195	\$264,647	\$12.38	5.1
Superior	call-n-Ride	\$2,351	\$246,181	15,079	3,685	\$243,830	\$16.17	4.1
Thornton	call-n-Ride	\$0	\$22,386	631	359	\$22,386	\$35.48	1.8
Subtotal/Weighted Average		\$37,904	\$2,417,595	151,311	36,371	\$2,379,692	\$15.73	4.2
Standard Deviation							\$8.13	1.5
Minimum at 10% or better: Average +/- 1.28 * Std Dev							\$26.14	2.2
Minimum at 25% or better: Average +/- .67 * Std Dev							\$21.18	3.1

As indicated above, the Gateway service has maintained a strong demand for service to date and all of the established services. Also listed below is a chart that shows those cnR services that fall within the 10% thresholds established by RTD. This indicates that the Thornton and Longwood services do not achieve the standard and are thus candidates for reconsideration. This chart further confirms the efficiency and effectiveness of the Gateway service.

Regional Express Services

Another component of the RTD family of services is the regional express network. These services typically have higher operating speeds, using the highway and freeway network, with less frequent stops and emphasis on providing connections to the metropolitan areas (not exclusively serving the CBD). Fares are also typically higher, with a maximum cash fare of \$3.75 for one-way travel at a maximum monthly pass of \$135. The 2003 operating data for these services are:

Table H-40: RTD Service Performance Data 2003

RTD Service Performance Data 2003								
Route	Standards Class	Farebox Revenue	Operating Costs	Total Boardings	In-Service Hours	Net Subsidy	Subsidy per Boarding	Boardings per Hour
	Regional	2641888	7023238	1115084	44789	4381351	3.93	24.9
CC	Regional	34328	598239	18387	2508	563911	30.67	7.3
CV	Regional	278361	1435408	111877	6144	1157047	10.34	18.2
DD	Regional	285917	1697892	108398	10621	1411975	13.03	10.2
E	Regional	145037	635436	56056	2318	490399	8.75	24.2
F	Regional	74171	285973	30994	1369	211801	6.83	22.6
G	Regional	194450	882635	80769	5897	688184	8.52	13.7
H	Regional	244154	1025486	95354	3596	781332	8.19	26.5
J	Regional	67555	401203	28212	1843	333649	11.83	15.3
L	Regional	539357	2098437	219844	14558	1559080	7.09	15.1
M	Regional	531202	1868999	221818	14037	1337797	6.03	15.8
N	Regional	229105	815061	82096	6673	585956	7.14	12.3
P	Regional	356193	2237904	160032	8216	1881711	11.76	19.5
R	Regional	136781	844019	54367	4094	707238	13.01	13.3
S	Regional	46947	549377	19779	2596	502431	25.4	7.6
T	Regional	198485	1010242	68852	6243	811757	11.79	11
U	Regional	86717	972525	42141	3788	885807	21.02	11.1
W	Regional	147602	982557	60512	4257	834955	13.8	14.2
Y	Regional	37478	135787	10669	983	98309	9.21	10.9
Z	Regional	118362	636591	45475	3507	518229	11.4	13
Subtotal/Weighted Average		6394090	26137010	2630716	148037	19742920	7.5	17.8
Standard Deviation							6.47	5.5
Minimum at 10% or better: Average +/- 1.28 * Std Dev							15.79	10.7
Minimum at 25% or better: Average +/- .67 * Std Dev							11.84	14.1

Similar to the productivity chart for cnR services, the RTD also has tracked the productivity of the regional services. In addition, the route origins and destinations are listed below. The chart indicates that routes CC (Coal Creek/Wondervu), S (Denver/East Boulder) and U (Pine Junction/Conifer/DTC) fall outside the 10% threshold. On the other hand, Route B (Boulder/Denver) has the lowest subsidy and among the highest ridership per hour of all the regional services.

Summary and Conclusions

RTD uses a systematic approach to developing and analyzing suburban services, including call and Ride and Regional Express. However, the use of minimum service provision thresholds adds substantial flexibility to the process. This combination of standards mixed with flexibility appears to be a hybrid of other case study performance evaluations, which have ranged from virtually no performance measurement standards to strict adherence to established standards. Although each locale has differing policy goals, the RTD potential flexibility may be a good compromise methodology. The two service programs discussed above demonstrate an ongoing financial commitment to suburban services.

Table H-41: Denver RTD Express Route Origins/Destinations

Route B Boulder / Denver
Route BOLT Boulder / Longmont
Route CC Coal Creek / Wondervu
Route CV Pine Junction / Conifer / Denver
Route DD Boulder / Colorado Blvd
Route E Evergreen / Denver
Route F 28th Street / Market Street
Route G Golden / Boulder
Route H 28th Street/ Civic Center
Route J Longmont / East Boulder / CU
Route L Longmont / Denver
Route N Nederland / Boulder
Route P Franktown / Parker / Denver
Route R Brighton / Denver
Route S Denver / East Boulder
Route T Boulder / Greenwood Plaza
Route U Pine Junction / Conifer / DTC
Route W Wagon Rd / DTC / Meridian
Route Y Lyons / Boulder
Route Z Evergreen / Aspen Park / Denver
