STATE PARK & RIDE LOT PROGRAM

FLORIDA DEPARTMENT OF TRANSPORTATION

STATE PARK & RIDE LOT PROGRAM
Planning Manual

Prepared for the
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Notes on 1996 Revisions

This document is a revision of the 1989 State Park and Ride Lot Program Planning Manual, prepared by Frederick R. Harris, Inc., for the Florida Department of Transportation. The major purpose of this revision was to provide the Department of Transportation with an editable digital copy of the Park and Ride Lot Planning Manual and an updated survey of the State Park and Ride Lot System. Where appropriate, certain other minor revisions have been made, as noted below, but this revision does not include a wholesale update and verification of the planning models, equations, and worksheets provided in 1989 Park and Ride Lot Planning Manual.

Revisions to the manual are as follows:

1. Literature revisions: References to manuals, Federal Laws, and FDOT Procedures have been verified and updated where necessary. In particular, references to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Americans with Disabilities Act (ADA) have been added. Where appropriate, the manual has also been updated to include references to the Internet and the World Wide Web.

2. Typographical errors: Typographical errors noted in the 1989 edition have been corrected.

3. Data elimination: The 1989 version included in Chapter 3 a set of data tables describing the characteristics of Park and Ride lot usage in Florida. Due to the age of these data tables, they were no longer considered valid and, with the approval of the Department of Transportation, have been omitted from this revision.

4. Elimination of Roadway Level of Service Definitions: The 1989 version included in Appendix E the Roadway Level of Service Definitions from the Transportation Research Board's Highway Capacity Manual.With the approval of the Department of Transportation, this information has not been reproduced in this version. The user is referred to the Highway Capacity Manual directly for the most current level of service definitions.

This manual is being provided to the Department of Transportation in WordPerfect 5.2 format on CD-ROM, diskette, and paper.

CHAPTER 1: INTRODUCTION

The purpose of this manual is to provide the information necessary for agencies in Florida to plan, implement, and manage park-and-ride facilities. The information contained in the document reflects current practice and is consistent with existing and proposed policies of the Florida Department of Transportation. The use of this manual will establish a standard procedure to be used in evaluations of park-and-ride facilities including:

- Site location studies
- Site size estimation
- Impact assessments
- Project Justification
- Conceptual design
- Development of promotional programs
- Planning of ancillary services
- Performance monitoring and development of improvement plans for existing facilities.

BACKGROUND

The necessity for developing this planning manual resulted from a number of individual events which together have critically impacted the provision of improvements to serve the transportation needs of the State of Florida. The most recent event and one with the most significant impact on park-and-ride development is the current shortfall in funding for transportation improvements. In addition, ISTEA•s emphasis on multimodal transportation makes park and ride programs an important part of the transportation system.

Aside from ISTEA, the limited availability of road construction funding makes it imperative that existing roadways be used as efficiently as possible. Park-and-ride is one of a number of transportation systems which can be managed to make the highest and best use of available transportation funding. Park-and-ride is an attractive improvement when considering the relatively low costs with which it can be implemented. However, to take advantage of this characteristic, procedures are required to guide planners and administrators in park-and-ride facility planning, development, and management.

The second event which threatens to further tax the already tenuous transportation funding situation has been the enactment of the latest Florida growth management regulations. These regulations require the provision of infrastructure concurrent with land use development. This has the potential significant impact of increasing development contribution to the transportation system. Park-and-ride is one of a number of congestion mitigation measures which can help to make this legislation work while not straining the economic viability of Florida•s urban areas. The reason for this is that park-and-ride has the potential of preserving roadway capacities through decreases in demand brought about by carpooling and increased transit usage. These decreases can become significant enough to attract private participation in heavily traveled corridors where major facilities on the order of a Golden Glades or Dadeland Metrorail Station facility can be established. Such facilities can be far less expensive then the cost of added roadway capacity or the loss of development opportunities. This situation also highlights the need for acceptable and practical

planning procedures for park-and-ride facilities.

The third event which recently occurred had a direct impact on developing future park-and-ride facilities in relation to high-occupancy vehicle systems. A 1988 study of certain elements of the I-95 Reconstruction Project in Southeast Florida resulted in threatened cancellation of previously justified construction, and reevaluation and redesign of already programmed facilities. Examination of this experience has led to two conclusions: first, this event resulted from different study methodologies being used in the initial project justification work and the later reevaluation study; and second, the seriousness of the situation could have been effectively reduced if the Department had a clear and consistently applied process for justifying construction of park-and-ride facilities. The preparation of this document conforms to recommendations made by the State•s Inspector General regarding the I-95 project.
The Statewide park-and-ride system consists of approximately 20,000 parking spaces constructed at an estimated cost of $30 to $40 million. This significant investment indicates that more effort is required for monitoring and managing the system. For this to happen, clear and effective management procedures are required in conjunction with increased operations budgets.

STUDY DOCUMENTATION
The material presented in this planning manual was originally produced through the State Park & Ride Lot Program Study, a six-month consultant effort conducted with the Governor•s Energy Office and the Florida Department of Transportation. The results of this study produced this document as well as four working papers. The purpose of the working papers was to provide the technical support for the procedures, information and data provided in this planning manual. The working papers should be consulted if further background information is required. The topics covered in the working papers are as follows:

Working Paper 1: Data Development•Presents procedures and results associated with surveys of park-and-ride lot users conducted at 17 locations around the State, results of a survey of State and local administrators of park-and-ride programs, and an inventory of existing park-and-ride facilities. This paper as referenced in Appendix A as Reference 1.

Working Paper 2: Program Analysis•Presents procedures for evaluating the effectiveness of park-and-ride programs. Provides methods for evaluating program impacts, effectiveness, management strategies, and budgeting. Presents results of Florida and national administrator surveys addressing program evaluations. This paper as referenced in Appendix A as Reference 54.

Working Paper 3: Private Participation•Presents approaches for increasing the participation of the private sector in future development of park-and-ride in Florida. Presents results of Florida and national administrator surveys addressing private participation in park-and-ride. This paper as referenced in Appendix A as Reference 55.

Working Paper 4: Facility Analysis•Presents procedures and information useful to the siting, sizing, designing, justifying, and monitoring of park-and-ride facilities. Presents a recommended

format for justification reports and economic analyses of park-and-ride projects. This paper is referenced in Appendix A as Reference 2.

In addition to the working papers, this Manual was updated in 1996 using information from the District Three FDOT Park and Ride Plan, referenced Appendix A as Reference 56.

REPORT ORGANIZATION

The chapters of this planning manual are organized to follow a logical sequence of planning, development and management of the park-and-ride system. Chapter 2 presents a framework for planning park-and-ride facilities within the present system of transportation planning and project development practiced in Florida. Chapter 3 presents procedures for effectively locating new facilities. Chapter 4 follows with methods for estimating facility demand and computing site size requirements. These methods are the bases for performing impact evaluations and economic assessments which are discussed in Chapters 5 and 6, respectively. Chapter 7 presents design elements which should be considered in designing new facilities and reconditioning existing ones. Chapter 8 presents techniques for promoting facilities to inform the public of their existence and to enhance their usage. Chapter 9 contains considerations for planning ancillary services to established park-and-ride facilities to augment usage. Chapter 10 provides an approach for monitoring existing facilities and a framework for evaluating corrective actions to facilities which are not utilized, underutilized, or over-utilized.

The last two chapters of this document address issues of a higher managerial level than the preceding chapters. Chapter 11 presents procedures for evaluating the effectiveness of State-, District-, and local-level park-and-ride programs. Chapter 12 concludes the main body of the manual with considerations for involving the private sector in park-and-ride development and operation.

The final section of this manual contains the technical appendices. These include a list of references cited in this document (Appendix A), a bibliographic listing of literature referenced during the study (Appendix B), a glossary of terms relevant to park-and-ride (Appendix C), a Statewide facilities inventory (Appendix D) , and materials of use in park-and-ride planning exercises (Appendix E).

Documents in Appendix A will be cited by their citation number in brackets, as in [1].

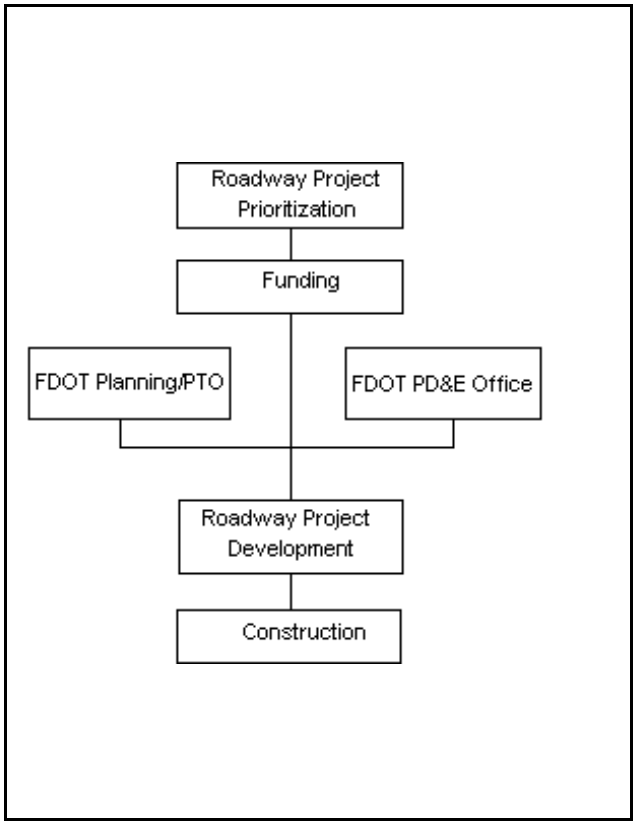


Figure 2-2: Short-Range Park and Ride Implementation

CHAPTER 2: PARK-AND-RIDE PLANNING PROCESS

This chapter presents three processes for planning and implementation park-and-ride facilities within the context of the Florida Department of Transportation. These processes are related to the long-range ideal for park-and-ride planning implementation, short-term integration of park-and-ride planning with the existing operating procedures, and facility level planning.

LONG-RANGE IMPLEMENTATION OF PARK-AND-RIDE PLANNING

Figure 2-1 is a schematic that shows how park-and-ride planning and implementation fits into the Department•s planning and project development process.

Developing Long-range Plan P&R Elements facilitates implementation in two ways. First, park-and-ride projects become eligible to compete with other projects for funds. Second, development review and impact fee ordinances can be amended to target park-and-ride improvements specifically for developer contribution. This feature of developing Long-range Plan P&R Elements is an attractive alternative to roadway expansion and lost or delayed development opportunities.

Prioritization of projects considers a number of factors to establish 5-year work programs and capital improvement programs. Typically, these include need, funding availability and joint participation arrangements. The growth management legislation will influence project prioritization through the need to provide transportation services in unison with development. It will be at this step in the project development process that park-and-ride can benefit the provision of transportation services. In specific situations, park-and-ride improvements can preserve existing roadway capacity which allows for additional development opportunities.

SHORT-RANGE IMPLEMENTATION OF PARK-AND-RIDE PLANNING

Figure 2-2 is a schematic showing how park and ride planning is implemented within the context of the Department•s project development process. The Figure 2-2 process requires the coordination of the preliminary engineering and design (PD&E), planning, and public transportation (PTO) functions within the Department. This coordination should occur at the PL &E review stage of project development.

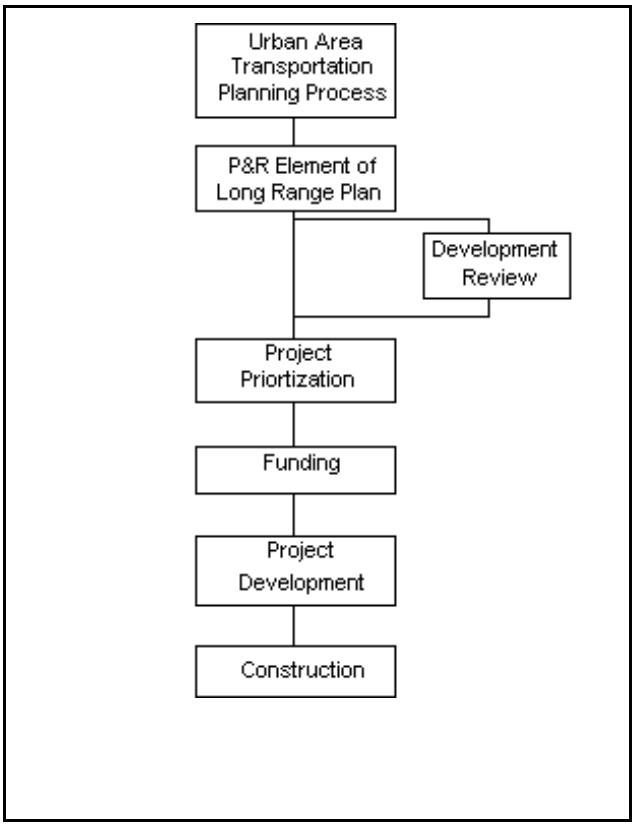


Figure 2-1: Long Range Park and Ride Implementation

potential usage while the forecasted demand will dictate parcel size requirements.

Impact assessments are required to gain public and official acceptance of individual projects. These assessments also provide input to economic evaluations,environmental assessments, and justification required to capture funding for the project under investigation.

In the design stage, specific elements of the facility are developed to safely, conveniently, comfortably, and securely accommodate the eventual users.

The planner/operator should establish a mechanism to promote the facility once it is constructed. The public will need to be made adequately aware of the presence of the facility in order for it to be used. This is particularly

FACILITY DEVELOPMENT PROCESS

The process presented in Figure 2-3 reflects the stages of facility development and management presented in Chapters 3 through 11 of this planning manual. The first stage of the process is systems-level planning which is concerned with identifying subareas and corridors that can support park-and-ride facilities. The primary emphasis of this effort is to reduce adverse travel conditions through the maximum use of park-and-ride.

The second step of the process presented in Figure 2-3 is concerned with identifying sites within those subareas or corridors previously identified to be supportive of park-and-ride. The primary emphasis of project-level evaluation is to identify specific parcels with characteristics which maximize usage and minimize development costs.

Demand estimation and site sizing should occur concurrently with the project-level site evaluations. Parcel locations can effect

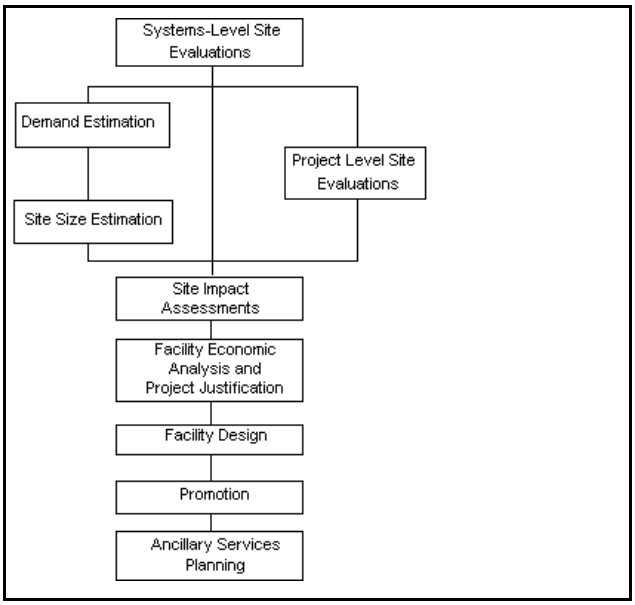


Figure 2-3: Facility Development Process

important for facilities which are located in areas which are not visible to commuters.
Finally, ancillary services should be planned and instituted as required to maximize facility usage. This effort may require coordination with other agencies including public transportation operators.

CHAPTER 3: FACILITY SITE SELECTION

The process of selecting sites for developing a park-and-ride facility is hierarchical in nature. The first level consists of a systems-level planning effort focused on identifying areas which can feasibly support one or more park-and-ride facilities. Project-level planning is performed in the second level of the hierarchy. The focus of the project-level effort is to develop an inventory of candidate lot locations, assess their respective merits, and rank order the sites to develop a priority for implementation.

This chapter presents descriptions of criteria relevant to siting park-and-ride facilities. Included in this is a set of siting criteria relevant to systems- and project-level site selection evaluations. These siting criteria are dependent on the type of facility being planned and developed. The following definitions have been used to categorize Florida park-and-ride lots and the related planning procedures presented below:

Urban Corridor• Lots located along a major commute corridor within an urban area which are typically served by line-haul transit which consists of express bus, urban rail, or commuter rail services. Trip origin patterns tend to be dispersed along the corridor. Trip destination patterns may be dispersed along or concentrated at one end of the corridor.

HOV Corridor• Lots in this category are a subset of the urban corridor. HOV corridor lots are located adjacent to a major commuting highway constructed with high-occupancy vehicle lanes. HOV corridor lots are located and sized to maximize usage of the HOV lanes. They support carpool formation and access to line-haul transit (express buses) using the HOV lanes. Trip origins tend to be dispersed along the corridor. Trip destinations are usually concentrated in a central business district or other major employment center.

Peripheral• Facilities typically located at the periphery or fringe of an intensely developed, highly congested activity center. The definition includes facilities which service activity centers with limited parking and auto access such as auto-free zones, colleges, and universities. The access distances to the lot are typically longer than other type facilities while egress distances from the lot to the activity center are usually shorter.

Urban fringe• Lots located at the fringe of urban development. Trips tend to originate outside or at the outer limits of the urban area while destinations may be concentrated or dispersed within the urban area. Fringe area lots are generally not served by transit, although this is not universally true for all fringe lots.

Remote or Rural• Lots generally located outside the urban area in a rural or small town setting. Trip lengths for both home-to-lot and lot-to-work legs of the commute trip are much longer than for lots of other types.

SYSTEMS-LEVEL SITE SELECTION

The primary concern of systems-level site selection is the identification of areas where park-and-ride is feasible. Systems-level planning for park-and-ride can assist in implementation through the development of long-range park-and-ride elements of urban area transportation plans. This provides opportunities for:

- automatically considering park-and-ride lots during preliminary engineering and design phases of road improvement projects. This is analogous to the current status of bike facilities within the Department.
- developing project priority lists in which park-and-ride lots compete for funding with other types of improvement projects.
- assessing impact fees for lot development.
- capturing federal-aid funds for facility construction.
- developing outlying parking facilities in lieu of downtown parking.
- reserving land for future facilities.

Criteria associated with this level of planning are based on the primary factors affecting lot usage. These primary factors include:

- Planning year residential development within the appropriate service area of the lot.
- Intensity and concentration of planning year employment.
- Distance between major residential areas and employment centers.
- Level of service provided by the planned transportation system.

Table 3-1 presents a listing of criteria and standards appropriate for identifying sites at a systems level of detail. Descriptions of the criteria and standards contained in Table 3-1 are presented in the following.

Table 3-1. Systems-Level Facility Siting Criteria

Lot Type	Criteria	Standards
Urban Corridor	Future corridor level-of-service	Level-of-service E or worse
	Future corridor traffic	50,000 ADT[1]
	Service area dwelling units	>2,000 dwelling units within 2 miles of lot
	Distance from employment center(s)	>10 miles
HOV Corridor	Traffic on feeder route to HOV facility	High volumes, >35,000 ADT
	Feeder road system configuration	Confluence of feeder roads near facility
	Lot spacing	5-10 mile spacing minimum
Peripheral	Parking demand/supply	>1.0
	Activity center circulation	Congested or restricted access
	Activity center access route	Major access route
	Existing parking facilities	Insufficient in area
Urban Fringe	Access corridor to urban area	Arterial with 4 lanes or greater
	Employment concentrations	>10,000 employees per employment center
	Location within urban area	Vicinity of urban area boundary
	Vicinity of shopping centers	< • mile from commute route
Remote	Orientation to urban area	Between 20 and 60 miles from employment centers
	Urban employment	>20,000
	Orientation to service area population	Centrally located
	Available right-of-way	Publicly-owned right-of-way available
	Commute route	< 1 mile from commute route

[1]Based on 100 space facility.

Urban Corridor Lots

The four criteria illustrated in table 3-1 reflect the primary factors influencing lot demand•congestion, demand, and travel distance. The first areas to be identified for park-and-ride facilities are located in highly congested corridors. Identifying appropriate corridors can be performed through reference to an urban area•s Long-Range Plan documentation or urban model output. This information is maintained by the local Metropolitan Planning Organization and/or Florida Department of Transportation District Planning Office. Corridors operating at Levels of Service E or worse in the planning year are suggested as prime corridors for park-and-ride development (see the appendix for level of service definitions).

Future year corridor traffic is an important siting criterion since it can be used to identify those corridors with the highest potential for park-and-ride usage. Of two corridors operating at Level of Service E, the one with the highest design year ADT will be the most attractive for park-and-ride development. The corridor traffic level of 50,000 ADT is suggested as a minimum standard based on the following rationale:

- Corridor traffic is based on support of one 100-space park-and-ride lot operating at 75

percent capacity.

- 15 percent of the corridor•s 24-hour traffic occurs during the AM peak period-the period which 100 percent of the parkers will access the lot.
- One percent of the peak period, work-bound traffic will use the lot.

These first two criteria provide a means of identifying corridors likely to support park-and-ride. The last two criteria for siting an urban corridor lot are provided to identify locations within the corridor which are best for park-and-ride development. These are based on the premises that it is better to locate a lot closer to trip origins (residential areas) and further from trip destinations (employment centers). The 2,000 dwelling units within five miles of a lot location standard is based on standards developed in the Tampa area and findings from the Lot Users Survey [2]. The distance from employment center standard is also based on results from the Lot Users Survey.

HOV Corridor Lots

HOV corridor lots are a subset of the urban corridor category of lots and require special consideration during systems-level siting. The reason for this is that HOV facility design may include a number of park-and-ride lots in the corridor in order to maximize usage of the facility. The planner must, therefore, take lot spacing and its effect on usage of individual lots into account. Parkers tend to use the first lot encountered along their travel path which can result in under-utilization of lots which are too closely spaced.

Sites should be located adjacent to the HOV facility on an access route which carries a significant number of vehicles accessing the highway containing the HOV lanes. 35,000 ADT is suggested as a working minimum amount of traffic. This minimum ADT value should increase as lot spacing decreases.

Locating a park-and-ride facility at the confluence of a number of access routes, if at all possible, is important for a number of reasons. Such a location can experience a significant amount of traffic which can potentially utilize the facility. Further, the confluence area represents a traffic bottleneck which will increase the propensity to use the facility. The most highly used park-and-ride lot in Florida, Golden Glades in Dade County, is located at the junction of five major commuting highways which carry in excess of 370,000 vehicles per day.

Peripheral Lots

Four criteria are critical to the location of activity center peripheral lots. These include future parking supply levels, circulation within the activity center, access routes to the activity center, and location of existing parking facilities. The first criterion determines if, in fact, additional parking is needed in the activity center area. If parking is adequate, further evaluation is probably not warranted unless other objectives are driving the study such as reducing noise and emissions and vehicular travel within the activity center.

The second criterion touches on these same concerns. Auto accessibility to an activity center may

be restricted, either by design or through inadequate street capacity and congestion. Such conditions can be used to identify activity centers where peripheral parking could be effectively used.

The third and fourth criteria are used to determine feasible locations provided that additional parking is needed to service an activity center. Access to the facility is easiest if it is adjacent to major access routes to the activity center. In addition, while the supply of parking for an activity center may be inadequate in general, some areas may already be adequately served. The fourth criterion addresses the distribution of existing parking and suggests that new parking supply is best located in areas of the activity center which are under-supplied.

Urban Fringe Lot

Service area demand and concentrations of employment are factors that determine the usage of an urban fringe lot. Service area demand is reflected in the standard for the first criterion in that the number of lanes for an adjacent roadway can be useful in determining the demand for a parking facility. The criterion concerned with employment concentrations also is an important consideration for judging the demand for a park-and-ride facility. Research has shown that an urban area needs to have sufficient concentrations of employment to support the formation of carpools. 10,000 employees per square mile is considered to be the minimum concentration to support carpooling and is suggested as a working standard [3]. The third and fourth criteria relate to location within the urban area which essentially is the urban fringe. The findings from the survey work indicate that shopping center lots are most applicable in fringe areas [1]. The urban fringe will be different based on the planning year of the study. Near-term planning years would place fringe lots at the current urban fringe. However, long-term studies would place fringe lots in rural areas outside the current urban boundary.

Remote Lots

The success of a remote lot is dictated by the amount of employment located at the destination end and the distance traveled [1]. A facility located 60 miles from the employment center is probably the upper limit that can be expected to produce usage. Twenty miles is suggested as a lower limit only for purposes of facility definition. In some urban areas, 20 miles may still be in the urban area and a lot so located would be considered as an urban fringe or corridor lot instead of a remote facility.

The second criteria in the table relates to demand and indicates that more people will travel from further away as the urban area employment increases. Studies have shown that carpooling increases with employer size and employment concentration [3,4,5]. The 20,000 employment standard is based on relating the Hosford and Bristol User Survey response with the amount of governmental employment located in Tallahassee [56]. This is a working minimum employment level. It is provided as a lower limit of employment for consideration of remote lots to service an urban area. The planner should also give consideration to employment concentrations and numbers of large employers when siting remote lots.

Approximately 50 percent of remote lot users in Florida live within three miles of the lot and about 90 percent come from within 19 miles [1]. This suggests that the remote lot should be centrally

located to the service area population. Most remote lots developed in Florida are located in towns.

Availability of right-of-way is another important factor in lot location. Program administrators in Florida have made effective use of scarce construction dollars by entering into agreements with local governments and by developing lots on existing Department right-of-way. Public parks, city halls, and courthouses are potential locations for publicly provided right-of-way for park-and-ride.

The last criterion relevant to locating remote park-and-ride lots reflects the fact that lot use will be greater if located near a major commute route such as a multilane, divided highway oriented towards an urban area. This provides the opportunity to intercept commuters along their normal travel path. Also, such a location provides for better visibility and awareness of the facility.

PROJECT-LEVEL SITE SELECTION

Site selection at the project level is concerned with identifying sites with attributes that contribute to lot usage. The research has shown that a poorly located lot will not be used. The criteria considered during project-level evaluations strive to maximize the capture of the latent demand for park-and-ride in a particular area. The recommended approach for conducting project-level siting evaluations consists of two steps. The first step is to develop an inventory of candidate sites. This is critical since experience has shown that the first site of choice is often not capable of being developed at implementation time. The inventory can be produced through contacts with local officials and groups, review of aerial photography, and field reconnaissance. All three of these methods should be used in developing the inventory of candidate sites, but at a minimum field investigations should be performed.

The second step consists of rating and ranking the candidate sites. A set of criteria is first established against which each site is to be evaluated. For each site, a point score is assessed for each evaluation criterion based on the comparison of the site•s features against the ideal condition associated with that criterion. All point scores are totaled with the highest scoring site being the most attractive to develop. Project-level siting evaluations are necessarily more detailed than systems-level evaluations; however, the siting criteria are basically the same across all lot types. The most important factors which should be considered include the following:

Right-of-Way• The level of funding for park-and-ride development has forced many agencies to enter into arrangements which result in free contribution of land. Right-of-way costs can very well be more than the construction cost if right-of-way is to be purchased. This factor can be the most important as far as determining implementation feasibility.

Security• This factor is possibly the most critical to determining the success of a lot. Experience in Florida as well as in other areas of the U.S. have shown lots in an area considered safe for both the parker and his vehicle are more frequently used. Lots visible from major arterials are considered more secure than those that are not visible.

Site Size• Size of candidate sites is an important consideration. If large enough sites are not available, a number of smaller lots may need to be developed in an area. Sites which are too

large result in an ineffective expenditure of funds. Required lot sizes can be assessed using factors of 280 to 400 total square feet per space or 108 to 153 spaces per acre. The appropriate factor depends on the size and shape of the site, stall and aisle geometrics, circulation system, and possibly the proportion of small to standard size vehicles if the designated compact parking stalls are to be provided. A factor of 300 square feet per stall is typical for surface lots while 325 square feet per stall is conservative for structures.

Visibility• Sites should be visible from adjacent travel routes. Visibility contributes to motorist recognition of the availability of a park-and-ride lot. Visibility is also a deterrent to vandalism. Landscaping should not obscure the visibility of the facility.

Access•Access to a park-and-ride facility should be as direct as possible. A site must be easily accessible by both automobiles and transit vehicles where transit service is planned. Lots should not divert commuters more than • to • mile out of their normal travel path. Access should be safe with signal control of access points if warranted. Direct access to HOV for other priority facilities has been suggested as being critical to the success of those facilities.

Transit Service• In general, lot usage tends to increase with increasing transit service. Sites are best located along existing transit routes or in areas where transit service is contemplated.

Access Road Congestion• Congestion between the main travel roadway and the park-and-ride facility can discourage lot usage by adding travel time to the trip. Sites are best located where travel time between the main commute roadways and the lot can be minimized.

There are a number of factors that do not impact lot usage but are important considerations. These include the following:

Transit Design Features• This factor is particularly important when considering implementation of a shopping center lot. Transit vehicles may not have been considered in the design of a shopping center. Inadequate turning radii, aisle widths, and pavement design can eliminate a site from further consideration if the site is to serve transit. A good reference for transit-friendly design is Reid Ewing•s Pedestrian and Transit Friendly Design book [57].

Traffic Circulation• Park-and-ride lots will attract additional traffic to the access roadways. Site selection should minimize congestion on these roadways particularly if located in residential neighborhoods.

Bike Access• Easy access to bicycle routes can attract additional users of a facility. While bicycle access was found to be insignificant at the lots surveyed during this study, this criterion is presented for consideration.

Expansion Potential• This criterion is important in situations where future demand is expected to be larger than the size of lot which can initially be constructed due to funding constraints.

A procedure developed by Burns [6] and endorsed for use by AASHTO [7] is useful for rank ordering a number of sites which may be in contention for development. This procedure has application to project programming as well. The procedure is presented in Appendix E and considers both systems- and project-level factors. These factors are organized into the three following categories:

1. Location criteria
2. Site considerations
3. Economic consideration

The factors are evaluated for each lot under consideration and given a score based on how well the individual sites meet the criteria. The point scores are added with the lot with the highest total score being the most attractive.

Experience has shown that point scores for the various sites under consideration may be quite close [8]. Two adaptations are recommended to remedy this. First, criteria receiving the same score should be eliminated. These will tend to be systems-level criteria. For example, it is likely that most sites under consideration will receive the same rating for transit service potential, proximity to major trip generators, user benefits, and orientation to major bottlenecks.

The second adaptation is to assign weighting factors to each criterion. These factors should represent the relative importance of each of the criterion to the site selection. As an example, land acquisition and land cost may be more critical than site visibility in an evaluation. These criteria can be logically assigned higher weights to reflect this importance in the final point scores. It is recommended that a panel of local technical experts be formed to assign weighting factors and determine the value of including each of the various criteria into the evaluation.

CHAPTER 4: DEMAND ESTIMATION AND FACILITY SIZE ESTIMATION

This chapter presents methods for estimating lot demand, and ultimately lot space requirements for urban corridor, peripheral, urban fringe, and remote park-and-ride facilities. In general, methods are provided for two types of application for each lot type: systems-planning applications where quick estimates of demand are required and project planning applications such as required in lot design.

The appendix contains worksheets which should prove useful to the execution of the formulas and procedures presented in this chapter. The material contained in this chapter was originally presented in Working Paper 4: Facility Analysis [2].

ANALYSIS PHILOSOPHY

Scale, complexity and project cost should govern the type of approach used for estimating size requirements for park-and-ride facilities. In most cases, sketch planning techniques based on local travel and socio-economic data are preferred to sophisticated and data intensive modeling techniques. In cases where the capital investment is relatively large, such as large facilities associated with HOV lanes and rail systems, the accuracy of sketch planning techniques can be satisfactorily improved upon with more detailed and current data. As a point of reference, the cost of constructing a moderate size urban park-and-ride lot can be comparable to the cost of improving an urban intersection. The effort expended on determining the size of such a lot should likewise be comparable to the effort expended on the analysis of such an intersection.

Determining the size requirements for a park-and-ride facility consists of the sequential execution of eight steps including:

1. Computing the number of motorists that will utilize the facility.
2. Converting the number of motorists to the number of parked vehicles.
3. Adjusting the number of parked vehicles to account for fluctuations in demand created by daily, seasonal, and economic factors.
4. Computing the maximum accumulation of kiss-and-ride parkers.
5. Computing the number of handicapped spaces required.
6. Converting the number of spaces to an area measure.
7. Calculating additional space requirements for bus facilities.
8. Developing space allowances for landscaping, setbacks, drainage,etc.

The techniques presented below are based on the assumption that the facility will be optimally located and implemented in the area for which size analyses are being performed. Usage will not reach expected levels if a facility is not visible, not promoted, is located in an unsafe area, or has poor access. It is recommended that the aforementioned siting requirements be reviewed to familiarize oneself with the procedures used to locate a park-&-ride facility.

The following descriptions include discussions of the context in which the method can be applied, data requirements and sources, methods of synthesizing data which may not be available or too

costly to compile, and appropriate adjustments which may need to be considered based on the conditions under which the lot is to be implemented.

REMOTE FACILITIES

The estimation of site sizes for remote lots, as practiced in Florida, is based on observations of parking and right-of-way availability [1]. This is an appropriate method for determining lot space requirements since remote lots in Florida tend to be located in areas with low population growth, experience stable utilization, and are typically less than 50 spaces in size equating to a moderately low cost. The recommended approach presented here is based the demand observation technique discussed above and is consistent with approaches currently used in the State.

Application

The demand observation technique is most applicable in areas where population within the lot service area and employment in the destination area are not expected to grow excessively. It is suggested that the further the site is from an urban area, the greater applicability can be placed on this technique.

A concern associated with this technique is that providing a park-and-ride facility in a rural area does not insure its use by those observed to be parking at informal locations. Experience has shown that informal parking continues in spite of the construction of a conveniently located park-and-ride lot [9,10]. This is supported by utilization counts which show that additional promotion and enforcement of illegal parking may be needed to fully develop the latent demand for park-and-ride lots in remote areas.

Data Requirements

The data required for this method are minimal and easily obtained. These data include:

- Observations of actual informal parking.
- Population data at the home end.
- Employment data at the destination end of the work trip.

Methodology

The methodology consists of counting existing informal parking and adjusting this value for growth and expected error. The steps of the process are presented in the following section.

STEP 1: Identify the parking activity surrounding the candidate site•This determines the existing parking requirement and should be performed by an individual or study team familiar with the area, commuting patterns, and the employment or activity centers to which commuters are driving to. Definition of the area in which to perform the parking counts will be highly variable because of roadway configurations, orientation and location of commute routes, and population location.

STEP 2: Select a design year and compute an appropriate growth factor• The easiest factor to compute is based on projections of population within the service area of the lot, employment in the urban area(s) which the lot serves, or a combination of the population and employment projections.

Population forecast data is by far the easiest to obtain since the University of Florida publishes these annually in its Florida Statistical Abstract [1]. Projections are provided in five-year increments for each county in Florida. Unless other conditions prevail, the population growth for the county in which the lot is to be located can be used to base the adjustment of base-year parking.

Future year employment data can be obtained from the FSUTMS urban area data sets for the urban area(s) which the lot will serve, or from the State Department of Labor and Employment Security. If a growth factor based on employment is to be used, the forecaster should not confuse labor force with employment. Labor force statistics pertain to place of residence while employment pertains to place of employment. For this method, data for employment by place of employment is appropriate. The following formula is typically used to combine population and employment growth:

Growth Factor = SQRT[F_{pop} * F_{emp}]

where:

F_{pop} = Population growth factor

F_{emp} = Employment growth factor

STEP 3: Compute the design year parking demand• This computation consists of multiplying the existing number of parkers observed in Step 1 by the growth factor computed in Step 2. This estimate of the future design year parking demand may need to be adjusted based on the experience that estimates at remote lots tend to be overstated. This has been hypothesized to be the result of people not wishing to change their normal habits. As mentioned above, construction of a remote lot will not insure its use by those observed to be parking at unauthorized locations in the vicinity of the new facility. Consideration should be given to adjusting the computed estimate of demand to account for this.

The downward adjustment should be based on local knowledge of public travel behavior and perceptions, potential effectiveness of increased parking enforcement, and amount of citizen requests and complaints associated with facility provision. As a guideline for deriving an appropriate factor, the utilization of remote lots in Florida usually is no more than 30 to 40 parked vehicles.

STEP 4: Convert total parking space requirements to an area measure• This is performed using a factor of 300 square feet per space. This factor includes areas required for parking, circulation, and access. Right-of-way availability often constrains or dictates the size of remote facilities so this step may be inappropriate. However, in situations where right-of-way is being provided at an existing facility such as a city hall or court house, the estimate should also take into consideration parking requirements generated by that facility.

PERIPHERAL FACILITIES

Peripheral park-and-ride facilities are typically designed to supplement parking deficiencies in highly congested or access-restrained activity centers. As such, the size requirements can be determined from estimates of the parking deficiencies of the activity center with considerations for transit usage and the distribution of existing parking supply.

Application

The most important criterion for assessing the size requirements for a peripheral park-and-ride facility, aside from parking deficiency, is the spatial distribution of existing parking supply. Parking facilities which are located too close to each other can result in underutilization even if the activity center as a whole is under-supplied with parking. This concern grows in importance as the size and congestion of the activity center increases.

Another consideration is the availability of shuttle transit service. Such service is highly recommended since it increases the area in which a new parking facility can be constructed and, in turn, increases the opportunity for finding a suitable site. If shuttle transit service is not provided, the parking facility will need to be located within comfortable walking distance of the higher areas of activity within the activity center.

Data Requirements

The data required for computing the size of peripheral facilities include:

1. Traffic analysis zone (TAZ) map of the activity center area
2. Street map of the activity center area
3. Design year employment for the activity center
4. Mode share distribution for home-based work trips to the activity center if available
5. Traffic counts for major arterials accessing the activity center
6. Parking inventory

The TAZ map, design year employment and population can be obtained from the urban area data sets maintained by the area•s Metropolitan Planning Organization (MPO) and/or FDOT District Planning Office. Interpolation may be necessary if the base or planning years of these data are not consistent with those of the sizing analysis.

Traffic counts for the State facilities are available from the FDOT District Office. Counts for county and city facilities are typically available from the county and city governments. In some communities, the MPO or other local agency complies and publishes traffic counts from all jurisdictions with scheduled traffic count programs.

An inventory of parking spaces may need to be performed. Such inventories may already exist and can be obtained by contacting the local parking authority, city and county offices, and MPO. The inventory should concentrate on spaces in public and private surface lots and structures but should also include curb spaces if these are used for work trip parking.

Methodology

The method presented below consists of first calculating the parking requirements for home-to-work trip parking at the activity center based on the activity center employment. The total parking deficiency within the activity center is then computed by comparing the parking demand with the available parking. Estimates of parking demand which can be captured by the new facility are made based on assessments of the site location and distribution of existing parking supply. Finally, site size requirements are computed considering costs of construction and anticipated revenue. The steps for the process of computing size requirements for peripheral facilities are presented below.

STEP 1: Estimate total parking demand for the activity center • This is performed by first identifying the traffic analysis zones contained in the activity center. The •Total Employment• variable contained in the FSUTMS ZDATA files is then accumulated for these zones. The resulting value represents the total base of work trips for the activity center. Total parking demand for work trips on a person-trip basis is computed by subtracting transit usage from the total activity center employment. The local mode split distributions from the urban area models can be used to factor out transit usage. If local data are not available, the mode split data shown in Table 4-1 can be used. These data were developed from the Florida Standard Model documentation [12] and findings from other areas [13,14,15]. Miami•s modal shares should be used for the larger metropolitan area and the Volusia shares for smaller metropolitan area. These two sets of data were calibrated and have been used as the bases for most other urban area mode split models used in Florida.

Table 4-1. Peripheral Park-and-Ride Facility Home-Base Work Mode Share Data

Area Type	Drive Alone	Carpools	Transit
Large Urban Area w/ Rail Transit[1,2]	0.52	0.24	0.24
Large Urban Area w/o Rail Transit[1,3]	0.66	0.17	0.17
Moderate Size Urban Area[4]	0.81	0.12	0.06
Small Urban Area[2]	0.87	0.11	0.02

[1]Reference 13
[2]Reference 14
[3]Reference 15
[4]Reference 12

The vehicle parking demand is then computed by dividing the number of work-purpose person trips by the vehicle occupancy. Local occupancy values should be used and can be found in the urban area model documentation and mode split model setups. Table 4-2 contains vehicle occupancy rates which can be considered for use in lieu of local data.

Table 4-2. Home-Base Work Trip Auto Occupancies (persons per vehicle)

Source	Rate
1986 Dade Survey[1]	1.20
1986 Broward Survey[1]	1.16
1986 Palm Beach Survey[1]	1.18
1985 Hillsboro Survey[2]	1.1
1985 Pinellas Survey[2]	1.1
1985 Pasco Survey[2]	1.2
1983-84 National Survey[3]	1.3

[1]Reference 16
[2]Reference 17
[3]Reference 14

Total parking demand is finally computed by dividing the work trip parking demand by the ratio of work trip and total parking in the activity center. Equation 1 presented in the Step 2 description below is used to compute the total parking demand.

Table 4-3 presents distributions of CBD parking by trip purpose. The proper work trip factor from this table is selected based on the population of the entire urban area in which the study is being conducted.

Table 4-3. Distribution of CBD Parking By Trip Purpose

Urban Area Population	Work (%)	Shopping (%)	Personal Business (%)	Other (%)
< 25,000	21	38	23	18
25,000 - 50,000	21	27	35	17
50,000- 100,000	20	24	31	25
100,000 - 250,000	26	21	34	19
250,000 - 500,000	30	19	33	18
500,000- 1,000,000	47	13	25	15
> 1,000,000	41	10	30	19

(Reference 18)

STEP 2: Determine parking supply deficiency• This value is computed through use of the following formulas:

Total Parking Demand = $[(Emp * (1 - Tshare))/(Occ * R_w)]$ (1)

Parking Deficiency = Total Demand - Supply (2)

where:

Emp = Total activity center employment
Tshare = Proportion of work trips using transit
Occ = Auto occupancy for activity center work trips
R_w = Proportion of parking used for work trip parking

Supply = Existing parking supply from parking inventory

Equation 2 defines a parking deficiency if a positive value is produced. However, a negative value does not necessarily indicate that there is sufficient parking throughout the entire activity center. Subareas within the activity center may be under-supplied and may require additional parking even though Equation 2 produces a negative result.

STEP 3: Compute the maximum number of parking vehicles the facility can capture• This computation is based on the orientation of the parking facility to important access routes to the activity center. The roadway(s) which provide access to the area in which the parking facility is to be located must be identified. Once this is done, the following formula can be used to perform the calculation of the maximum number of parkers which may use the peripheral parking facility:

Maximum Parking Capture = Parking Demand * (V_{adj} / V_{all})

where:

V_{adj} = Traffic volume on the adjacent roadways from which parkers are expected to access the parking facility.

V_{all} = Total traffic volume on commuting arterials and highway accessing the activity center.

STEP 4: Determine parking demand• This is determined by comparing the supply of existing parking in the vicinity of the new facility with the maximum number of potential parkers computed in Step 3. This will require consideration of the final destinations and circulation patterns of parkers within the activity center, as well as the location and amount of existing parking in relation to these destinations and circulation patterns. Admittedly, this will be a subjective assessment so a team approach is recommended.

STEP 5: Determine the facility size requirement• The size requirements for the peripheral facility being planned should consider parking spaces, circulation, access and possibly transit parking areas. The following size formulas can be used to compute site size requirements for surface and structural facilities:

Surface Lot: Size (acres) = (300 * Spaces + 240 * Bus Bays)/43,560

Garage: Size (acres) = (325 * Spaces)/Floors + 240 * Bus Bays)/43,560

SKETCH PLANNING FOR URBAN FRINGE FACILITIES

The methodology presented here is suggested for use in assessing areas for potential urban fringe lot development. This approach may also be used for urban corridor facilities, however, the level of accuracy will decrease with increasing commuting roads in the vicinity of the lot. A much more detailed approach applicable to site size evaluations undertaken during facility design is presented in the following section of this chapter.

The methodology suggested for estimating facility sizes for urban fringe lots is an adaptation of the ITE model [19,20]. This model assumes that parking demand is a function of the amount of traffic

on roadways which are adjacent to the park-and-ride facility. It is a simple technique, requiring only peak period traffic volumes on those roadways considered to provide access to the park-and-ride lot. The model was run using data for a number of Florida urban fringe lots and was found to produce reasonable results.

Application

This approach is best applied in areas where there are a limited number of commuting roadways. The ITE model assumes that commuters will not divert from their normal travel routes and that users come only from commute routes adjacent to the park-and-ride facility. These assumptions are realistic in areas with a very few number commute routes such as in urban fringe areas.

Data Requirements

The data required for the model includes the following data elements:

1. AM peak hour traffic counts in 15-minute increments for those roadways which the lot is expected to attract parkers if available. Total peak-hour counts as well as 24-hour traffic counts with appropriate K (peak hour percentage) and D (peak hour directional distribution) factors can be used if 15-minute counts are not available.
2. Facility type of the commute roadways adjacent to the lot.
3. Area type of the adjacent roadways.

Methodology

The application of the ITE technique for estimating fringe lot demand consists of developing data required by the following formula:

$$DEMAND = a * V_p + b * V_s$$

where:

V_p = Total •design period• traffic on adjacent primary facilities;

V_s = •Design period• traffic on adjacent secondary facility; and

a,b = Diversion factors for traffic on the primary and secondary facilities.

The ITE technique as described in the literature is based on factoring peak period traffic. In the procedure presented below the concept of •design period• traffic was developed and tested at a number of Florida urban fringe lots. The •design period• is that period of time during the peak period which a facility experiences the highest traffic flows. In this application, the design period is equivalent to the peak hour only for facilities carrying over 50,000 ADT. The •design period• concept is believed to be appropriate based on the research which supports the theory that park-and-ride usage is related to congestion levels. This theory is also supported by observations of the time distribution of arrivals which show that most parkers arrive at a facility during a well defined time period [11]. The •design period• concept presumes that motorists traveling during those times of greatest congestion will have a greater propensity to utilize park-and-ride then those traveling at other times.

The steps for the process of computing size requirements for fringe facilities at a sketch planning level of detail are presented in the following.

STEP 1: Collect traffic data for affected roadways•The first step consists of identifying the primary and secondary roadways which are expected to produce parkers. The primary roadway is considered to be the main commuting roadway in the vicinity of the park-and-ride lot. Secondary roadways are commuting routes of lesser importance which are presumed to produce fewer numbers of parkers.

The ideal data consists of 15-minute peak-period traffic counts by direction for the primary and secondary roadways. As an alternative, hourly counts and even 24-hour counts can be used if 15-minute counts are not available. Assumptions concerning peak hour percentages (K factor) and directional distribution of traffic (D factor) will be necessary if peak hour or directional counts are not available.

STEP 2: Determine the design period•The accuracy of the demand estimate is sensitive to the •design-period• traffic. The design period should represent that time in which there is a pronounced peaking of traffic on the facility. It is not necessary that the •design period• equal the conventional peak period or peak hour. A plot of 15-minute traffic or observations of actual traffic flows in the field are useful methods for determining this time period. Table 4-4 presents design period values which were developed in this study for roadways carrying the indicated 24-hour traffic volumes. These can be used in lieu of actual 15-minute counts or traffic observations.

Table 4-4. Suggested Design Periods

ADT	Design Period
Above 50,000	60 minutes
35,000-49,999	45 minutes
below 35,000	30 minutes

STEP 3: Calculate the design period traffic•If 15-minute counts are available, accumulate these counts as required to derive the traffic flow during the design period. With hourly count data, an assumption of an even distribution of traffic during the hour can be made. If 24-hour counts are used, K and D factors will need to be assumed. Table 4-5 presents typical values for these factors and are provided for use in situations where local data is not available. The Distract PD&E/Programming office should be consulted for the local K and D factors applicable to roadways being considered.

Table 4-5. Generalized K and D Factors

Roadway Class	K	D
Collectors and Local Streets	0.09	0.6
Major and Minor Arterials	0.09	0.6
Suburban Multi-Lane Highways	0.11	0.6
Suburban Freeways	0.09	0.6
Roadway Class	**K**	**D**

Urban Freeways	0.09	0.6
Rural Two-Lane Highways	0.11	0.6
Rural Multi-Lane Highways	0.11	0.6
Rural Freeways	0.11	0.6

(Reference 20)

STEP 4: Estimate the Lot Size•Compute the parking demand for the facility under study using the following formula:

DEMAND = a * V_p + b * V_s

where:

V_p = Total •design period• traffic on adjacent primary facilities

Vs = •Design period• traffic on adjacent secondary facility a = 0.03 representing a capture of three percent of the traffic on the primary facility b = 0.01 representing a capture of one percent of the traffic on the secondary facilities.

The lot size requirements can then be determined by multiplying the demand by an appropriate adjustment factor and dividing the result by 300 square feet per parking space for surface facilities and 325 square feet times the number of floors for structures. It is recommended that the adjustment should provide for at least a 25 percent increase over the demand using the ITE model. This would provide for a planned 80 percent occupancy. The factor may also include adjustments for seasonal variations in traffic counts. These factors can be obtained from the local District Statistics office.

Table 4-6 presents the results of executing the above procedure using actual data. The input consisted of the latest 24-hour counts on the primary and secondary facilities, the default values for the design period, and K and D factors derived from Table 4-5. As can be seen, the procedure provided reasonable estimates of demand as compared to the actual utilization counts provided by the Department.

Table 4-6. ITE Model Test Results Using Florida Data

Location	ADT	K	D	Design Period	Demand Estimate	Observed Usage
Ft Myers SR 82 & Ortiz	V_p = 16,600 V_s = 14,100	0.11 0.11	0.6 0.6	30 30	21	24
Jacksonville SR 13& I-295	V_p = 54,100 V_s = 25,100	0.09 0.11	0.6 0.6	60 30	96	99
Milton US90 & SR 281	V_p = 22,700 V_s = 7,200	0.11 0.11	0.6 0.6	30 30	25	20
Broward County I-75 & Pines Blvd.	V_p = 35,000 V_s = 18,500	0.09 0.11	0.6 0.6	30 30	34	28
Tampa SR 597 & Lakeview	V_p= 19,700	0.11	0.6	30	20	18

DETAILED METHODOLOGY FOR TRANSIT FACILITIES

The methodology presented below is an adaptation of a similar procedure used to estimate the park-and-ride lot size requirements for the I-95 reconstruction project now underway in Southeast Florida [22]. In that work, considerations for HOV facilities, the Tri-County Commuter Rail system, as well as carpooling were required. The procedure incorporates the traditional

transportation planning process and is most •... applicable in any urban area where new or additional change-of-mode fringe parking facilities are under consideration• [23].

Of all the methodologies presented in this chapter for sizing facilities, this is the most complex and rigorous. It will require upward of one-person day to execute. The technical description which follows includes simplifying assumptions so that it can be used in a quicker manner if required.

The procedure can use the urban area transportation data as input and as described in the FSUTMS documentation. It includes the following four steps:

1. Delineate origin and destination market influence areas for the park-and-ride facility and identify the transportation analysis zones contained in each influence area.
2. Estimate total daily person trip interchanges between the origin and destination market influence area.
3. Estimate the proportion of trips that will use line-haul or carpool modes.
4. Estimate the proportion of daily line-haul riders that will use the change-of-mode parking facility.

Application

The site sizing procedure described below is best used in situations where transit influences need to be addressed by the demand estimation procedure. This suggests that the approach is best applied in the planning of significant facilities which will contain hundreds of spaces such as major urban corridor lots, HOV parking facilities, and transit transfer terminals. Any facility study to be reviewed by a Federal reviewing agency should consider using this approach.

Data Requirements

The following list of data includes all data elements which may be required to execute the methodology presented below. Some of the data used in the methodology may not be available or may be too time-consuming to acquire. Consequently, some the data listed serve as alternatives to the preferred data elements. The reader should consult the individual step descriptions to determine exactly which data will be required for her particular application and circumstances. The total list of data includes the following:

- Street map encompassing the service and final destination areas.
- Urban area traffic analysis zone map.
- Dwelling unit and employment data by traffic analysis zone. These data are included in the FSUTMS data sets for the urban area. These data are needed if a trip table is not available.
- Urban area trip generation rates. Required if trip table data area not available.
- Origin-destination person-trip tables generated by the urban area FSUTMS-based model for the design year of the facility.
- Urban area model mode split model coefficients for the modes under consideration.

Methodology

The methodology includes seven steps which relate to defining the lot service and trip destination areas, developing the total interchange of trips between these two areas, computing the share of travel which will be attracted to the park-and-ride facility, and converting this travel share to lot size requirements. These steps are described in the following paragraphs. Alternative data development procedures are also included to provide the user with methods for formulating data which may not be available. Appendix H provides worksheets to simplify and organize the computations.

The most complex set of calculations in the procedure presented below are related to the computation of mode shares performed in Steps 3 through 6. These computations are included in the procedure in order to estimate the impacts on park-and-ride facility size produced by provision of various types of transit services, parking costs, and congestion levels. The procedure is a simplified approach which was developed in lieu of one using the Micro-FSUTMS procedures. It is recommended that the development of such procedures be pursued in a future work effort.

Figure 4-1 presents a schematic of the process for deriving parking requirements at a park-and-ride facility located in an urban transit corridor. The methodology follows the nested logic mode split model formulation. The first step of the process is to determine the primary modal splits for person trips between the origin and destination market influence areas. The primary modes differ by size of urban area. Typically, larger urban areas will have line-haul transit services available while smaller areas will not. Consequently, modeling in larger urban areas requires consideration of a larger number of primary modes than that done in smaller areas.

The second level in the mode split calculations consists of splitting the primary modal shares into submodes. As an example, the primary mode split model determines the proportion of trips which travel by the drive alone auto mode. The secondary mode split model then determines the proportion of drive alone person trips which will utilize a park and ride lot and those which will drive directly to the final destination.

The logit formulation of the mode split model incorporated into the procedure is as follows:

$DU_m = a*IVTT_m + b*OVTT_m + c*PK_m + d*OC_m + Bias_m$

$P_m = EXP(-DU_m) / [\Sigma_{mode} EXP(-DU_m)$

where:

- DU_m = Disutility of mode m
- $IVTT_m$ = In-vehicle travel time for mode m
- $0VTT_m$ = 0ut-of-vehicle travel time for mode m
- PK_m = Parking cost for mode
- OC_m = 0ther out-of-pocket costs such as fares or auto operating cost
- a,b,c,d = Variable coefficients
- $Bias_m$ = Constant for mode m
- P_m = Probability of using mode m
- EXP = Exponential function
- modes = All modes considered at the level of mode split analysis being

performed. Up to seven modes will be useful in larger urban areas while as few as four will be considered in smaller areas.

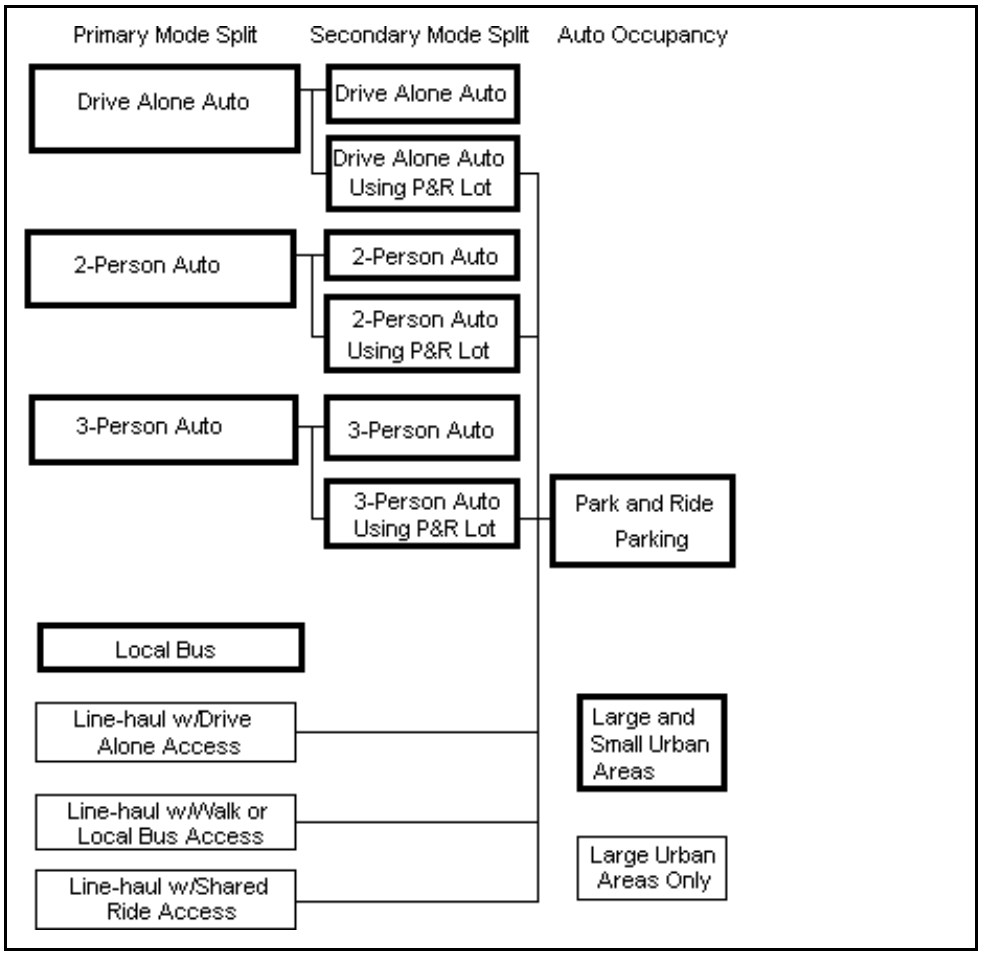


Figure 4: Nested Logit Model

The following step descriptions include alternate data development procedures to provide the user with methods for formulating data which may not be available.

STEP 1A: Delineate the origin market influence area• The literature contains an extensive amount of research reports concerning the delineation of park-and-ride lot market influence areas **[19].** The mathematical formulations which have been developed to describe the shape of the area boundary include parabolas, hyperbolas, circles, semi-circles and ellipses. Most of these formulations are based on home-to-lot travel distance which ignores the influence of traffic congestion on service area and market size. The following concepts should influence the analysis conducted to delineate the origin market influence area for the site under consideration:

A. Common sense should prevail. Both the results of this study and the research findings indicate that parkers travel a limited distance (or time) to access a park-and-ride facility. The tendency will be to define market areas which are too large.
B. Land development patterns, configuration of the access street network, and the level of mobility on that network are the most significant influences on the service area size and shape.
C. Motorists will not travel significant distances out of their normal commuting paths to take

advantage of a park-and-ride facility.

D. Research has shown that upward of 90 percent of park-and-ride lot users in an urban environment live within five miles of the facility.

E. Park-and-ride facilities in close proximity to each other will tend to redistribute parkers and produce only a marginal increase in facility usage.

The recommended procedure for delineating the market influence area begins with computing the maximum distance from the lot to the outside limits of the service area using the following formula:

$$\text{Maximum Access Distance} = (1/60) * \text{Time} * \text{Speed}_{avg} * (1/\text{CFAC})$$

where:

Time = Maximum driving time to lot
Speed = Average home-to-lot operating speed
CFAC = Circuitry factor

Approximately 90 percent of the parkers at urban fringe and corridor lots come from within five miles which equates to about 12 minutes [11]. This is consistent with findings from other areas [19].

The assumption of the average travel speed for accessing the urban fringe and corridor park-and-ride lots should consider the development type and roadway level of service. A value of 25 mph is typically used for trips traveling primarily on arterials. A higher value of 35 mph or more may be appropriate if the lot access trip is made predominantly on limited-access highways. A lesser value would be assumed if access trips are primarily made on local streets.

The circuitry factor is used to convert the length of trip over the road to equivalent airline distance. Typical factors range from 1.1 to 1.3; however, the choice of this factor should be based on review of the access road network and the population distribution in the potential service area.

The perimeter of the estimated core market area should be plotted on a base map using the maximum access distance computed above. The shape and size of this area should be influenced by practical knowledge of local travel patterns, orientation of the access street network, geography, and existing or proposed park-and-ride facilities which can be considered to affect demand for the lot being planned.

Caution should be exercised if two or more park-and-ride lots are in close proximity and share a common market influence area. In such a case, adjustments to the area boundary are required. A characteristic of lot users which should be considered is that the first lot encountered will be used. Further, backtracking will not occur if another facility can be accessed in the direction of travel to the destination.

STEP 1B: Delineate the destination market influence area• Typically, the destination market influence area will comprise areas of significant employment concentrations such as central and

outlying business districts (OBD), large employers, and major office parks. As a rule-of-thumb, concentrations of 10,000 employees per square mile or within a traffic analysis zone can be considered as a lower limit for considering a zone to be in the destination influence area. The employment and zone area data contained in the FSUTMS ZDATA files, in conjunction with the associated traffic analysis zone map can be used to identify the zones to which park-and-riders are destined. The special generator data should also be reviewed to identify other zones which have large employment concentrations.

A quick way of identifying TAZ•s which should be included in the destination market influence area is to sort the FSUTMS ZDATA file containing the employment data on the •TOTAL EMPLOYMENT• and •ZONE• fields. This can be performed using dBASE, DOS SORT, Lotus, or similar microcomputer-based programs containing a sort function; or TSOSORT on the mainframe. Records for the zones considered to be likely destination zones can be extracted, resorted on the •ZONE• field, and printed to generate a simple list of the zones to be considered.

Without these data, local knowledge of employment location patterns, travel patterns from the origin market influence area, and the commuting road network must be relied on to identify the destination areas.

The destination market influence areas identified should be delineated on the TAZ map as well as a street map of the urban area for reference purposes.

STEP 2: Develop the total daily trip interchange volumes between the origin and destination influence areas•Three methods are presented here for developing these interchange volumes. The easiest method requires staff to be knowledgeable in the •nonstandard• application of the FSUTMS micro software or UTPS. The first step is to develop the trip interchange volumes between the origin and destination market areas from the PTRIPS production/attraction file generated by either the micro- or mainframe-based urban area models. Using the micro-based, menu-driven standard approach to executing the FSUTMS program, it is recommended that an additional step be added to the standard DISTRIB.ALL procedure file. This step should execute the REPORT MATRIX program to generate a trip table listing of the home-base work table (Table 1) in the PTRIPS file for those origin zones contained in the origin market influence area. Using UTPS on the FDOT mainframe, a UMATRIX procedure would be used to generate a similar listing. The results should be divided by two since the listings represent production/attraction-formatted trip interchanges.

It will usually suffice to perform the above procedures only on the home-base work trip; however, there may be cases where other trip purposes, such as home-base shopping trips, will significantly contribute to lot demand. In these situations, trip interchange listings should also be extracted from the trip tables associated with these trip purposes.
This procedure should be executed on the PTRIPS table representative of the design year. However, the base year PTRIPS table could be used with an expansion factor applied which represents the growth in the origin and destination areas. The expansion factor can be developed to project the

design year trip interchanges based on the following formula:

$f_{od} = 1 + SQRT(f_o * f_d)$

where:

f_{od} = Composite growth factor for trip interchanges between the origin and destination market areas

f_o = Growth factor for the origin market influence area

f_d = Growth factor for the destination market influence area

It is appropriate to base the origin and destination growth factors in the above equation on population and employment growth between the base and design years.

An alternative method to develop the number of trip interchanges between the delineated origin and destination influence areas can be used in lieu of available trip tables is based on the following formula:

$TRIP_{od} = DU_o * HBW * (Emp_d/Emp_{tot})/2 *(L_{avg}/D_p)$

where:

$TRIP_{od}$ = Trip interchanges between the origin and destination market influence areas

Du_o = Dwelling units in the origin market influence area with one or more autos

HBW = Home-base work trip rate

Emp_d = Destination area employment

Emp_{tot} = Total urban area employment

L_{avg} = Average home-base work trip length

D_p = Average distance between the origin and destination influence areas

The formula defines the number of trips between the origin and destination market influence areas as a function of:

- the total number of home-base work trips generated in the origin influence area,
- the destination area•s share of the total urban area employment,
- the difference between the average trip length from the origin area to the destination area and the average home-base trip length for the entire urban area.

The number of one and two-plus dwelling units contained in the origin market influence area is contained in the ZDATA for the urban area models. Local home-base work trip rates can be used to develop an average HBW trip factor for one and two-plus auto owning households. Average trip lengths for the urban area can be found in the urban area model distribution output. Table 4-7 presents factors which may be applied if trip rate and length data are not available.

Table 4-7. Florida Urban Area Home-Base Trip Data

Urban Area	Person Trips Per Household	Average Trip Length (miles)
Gainesville	1.30[1]	
Jacksonville	1.72[1]	9.6[3]
Lee County	1.14[1]	
Palm Beach	1.46[1]	
Tampa Bay	1.21[1]	9.0[2]
Tallahassee	1.80[1]	6.8[3]
Volusia	1.14[1]	
Pasco	1.08[2]	13.0[2]
Pinellas	1.51[2]	6.1[2]
Dade	1.55[2]	8.0[3]
Broward	1.59[1]	6.0[3]
Palm Beach	1.57[1]	7.1[3]

[1]Reference 24
[2]Reference 17
[3]Reference 25

STEP 3: Estimate the input variables to the mode split model• The input data for the various mode under consideration must be developed. These data relate to in-vehicle travel time, out-of-vehicle travel time, parking cost, and other out of pocket costs. If line-haul transit is being considered, data for up to ten modes will need to be developed. This is consistent with the multi-path transit assignment method described in the FSUTMS documentation [12]. These modes include:

- Drive alone auto
- 2-person carpools
- 3+ person carpools
- Local bus Line-haul transit with walk or local bus access
- Line-haul transit with drive alone auto access
- Line-haul transit with shared ride auto access
- Carpool formed at the park-and-ride facility with drive alone access
- Carpool formed at the park-and-ride facility with 2-person shared ride auto access

  Carpool formed at the park-and-ride facility with 3+ person shared ride auto access

If line-haul transit is not to be considered, data for up to seven modes will need to be generated. This is consistent with the single-path transit assignment method also included in the FSUTMS documentation [12]. These modes include the following:

- Drive alone auto
- 2-person carpools
- 3+ person carpools
- Local bus
- Carpool formed at the park-and-ride facility with drive alone access
- Carpool formed at the park-and-ride facility with 2-person shared ride auto access

- Carpool formed at the park-and-ride facility with 3+ person shared ride auto access

Table 4-8 describes the data requirements for the mode split model and includes data definitions, sources of the data, and typical default values which may apply. Appendix H contains worksheets useful for tabulating the input data to the analysis process presented here.

Table 4-8. Mode Split Input Variables

Variable	Definition	Source	Default
Origin Terminal Time	Time required to leave trip origin zone in minutes	Zonal terminal time in urban model data	1 minute
Walking Time	Average walking time from origin to transit stop in minutes	Estimate based on local land development and bus stop spacing	5 minutes
Waiting Time	Average wait time for bus arrival in minutes	1/2 of published headway, 10 minute maximum	10 minutes
Transfer Time	Average time required to transfer between routes in minutes	1/2 of published headway	5 minutes
Lot Access Time	Time between main line route and park-and-ride facility including parking time in minutes	Based on the distance between mainline route and park-and-ride lot and congestion	Not Applicable
Destination Egress Time	Walking time from last transit vehicle to final destination in minutes	Estimate based on transit stop spacing	5 minutes
Destination Terminal Time	Time travel between last vehicle used and final destination in minutes	Zonal terminal time in urban model data	5 minutes
Drive Time	Time spent in auto from origin to the final destination for auto modes, or from origin to the park-and-ride lots excluding lot access time in minutes	Urban area model skims or speed and delay survey data	Estimate based on trip distance and average travel speed assumptions ranging from 25 to 45 mph based on nature of travel path
Line-haul Run Time	In-vehicle time in line-haul transit vehicle in minutes	Published or proposed schedule	Not Applicable
Local Bus Run Time	In-vehicle time on local bus in minutes	Published or proposed bus schedule	Not Applicable
Tolls	Road and bridge tolls divided by number of occupants in vehicle in dollars	Published toll schedules divided by number of vehicle occupants	Not Applicable
Auto Operating Cost	Perceived costs associated with operating an auto in dollars	Per mile cost of fuel, oil, maintenance, and insurance time trip length	19 cents/mile
Parking Costs	Parking charges at park-and-ride facility and at the destination divided by number of occupants in the vehicle in dollars	Existing or proposed daily parking charge divided by number of vehicle occupants	Not Applicable
Bus/Line-haul Fare	One-way transit boarding charge for local bus and line-haul modes in dollars	Published or proposed fares	Not Applicable
Transfer Fare	Fare to transfer between transit routes or services in dollars	Published transfer charge	Not Applicable

In developing the variable values for the non-park-and-ride auto modes(1, 2, and 3), assume that the travel path is from home directly to the work destination. Data for the local bus mode should also be from home directly to the work destination. The data may not need to be generated for this mode if its share of trips is expected to be insignificant.

Line-haul transit data should include the park-and-ride facility if line-haul service is provided. The model assumes that competing line-haul routes do not exist. If this is not the case, data should be generated for the travel path with the shortest time. A secondary mode split will then need to be executed for the various line-haul modes to split them between the various lines.

If HOV facilities are a consideration in the analysis, the in-vehicle travel time (IVTT) values for the carpool and line-haul modes should include these facilities in the travel path from the origin to destination ends of the morning commute trip. Study of direct access ramps to the HOV facility is performed through use of the out-of-vehicle travel time (OVTT) value. Time to travel back and forth between the mainline commute roadway and the parking facility is added to the OVTT value. Research conducted at various HOV facilities around the country shows that HOV lane usage increases by 50 to 100 percent as a result of direct access ramps [26]. Execution of the model with test data produced results consistent with the following findings.

STEP 4: Compute disutilities for modes under consideration• The following formula is used to compute the disutilities associated with the various modes being considered in the analysis:

$$DUm = 0.015*IVTT_m + 0.14*0VTT_m + 0.021*PK_m + 0.005*OC_m + Bias.$$

where:

DU_m = Disutility of mode m
$IVTT_m$ = In-vehicle travel time for mode m
$0VTT_m$ = 0ut-of-vehicle travel time for mode m
PK_m = Parking cost for mode m
$0C_m$ = 0ther out-of-pocket costs such as fares or auto operating cost
$Bias_m$ = Constant for mode m

The input for the calculations come from the data generated and entered on the worksheets contained in Appendix H. The bias coefficients to be used in the above equation are found in Tables 4-9 and 4-10.

4-9. Bias Coefficients for Primary-Level Mode Split Model

Mode	Bias
Studies in large Urban Areas	
1. Drive Alone Auto	0.00
2. Two-Occupant Auto	1.90
3. Three-Occupant Auto	2.60
4. Local Bus w/ Walk Access	0.45
5. Line-haul w/ Walk or Local Bus Access	1.70
6. Line-haul w/ Drive Alone Access	3.40
7. Line-haul w/ Share-Ride Access	4.25
Studies in Small Urban Areas	
1. Drive Alone Auto	0.00
2. Two-Occupant Auto	2.18
3. Three-Occupant Auto	3.34
4. Transit	1.31

Table 4-10. Bias Coefficients for Secondary-Level Mode Split Model

Mode	Bias
Studies in Large Urban Areas	
1A. Drive Alone Auto Accessing Park-and-Ride Facility	3.40
2A. 2-Occupant Auto Accessing Park-and-Ride Facility	4.25
3A. 3+ Occupant Auto Accessing Park-and-Ride Facility	4.25
Studies in Small Urban Areas	
1A. Carpools from Drive Alone Auto	3.34
2A. Carpools from Two-Occupant Auto	5.52
3A. Carpools from Three-Occupant Auto	6.68

STEP 5: Compute primary-level modal shares• The disutilities computed in Step 4 are input to the following formula to calculate the primary-level modal shares of person trips between the origin and destination market influence areas of the park-and-ride facility under analysis:

$$Pm = EXP(-DU_m)/[_{I=1,\ modes} EXP(-DU_i)]$$

where:

P_m = Probability of using mode m

Du_m = Disutility of mode m

EXP = Exponential function modes = All modes considered as primary modes. Up to seven primary-level modes will be used in larger urban areas while as few as four primary-level modes will be considered in smaller areas.

The disutilities used in the above formula will differ based on the existence of line-haul modes. In

large urban areas in Florida, line-haul modes will typically be included in the analysis. In this case, the disutilities for modes 1, 2, 3, 4, 5, 6, and 7 presented in Table 4-9 will be used in this step. In situations where line-haul modes may not be considered, such as in small urban areas, the disutilities for modes 1, 2, 3, and 4 will be input to the above formula.

STEP 6: Compute secondary-level modal shares• In this step, the modal shares for the primary auto modes calculated in Step 5 are split to determine the number of persons who will use the park-and-ride facility. The input to this step includes the Pm values calculated for modes 1, 2, and 3 in Step 5 and the DUm values calculated for modes 1A, 2A, and 3A in Step 4. These values are input to the following formula:

$$P_{mA} = P_m * EXP(-DU_{mA})/(EXP(-DU_m) + EXP(-DU_{mA})$$

where:

P_{mA} = Probability of using park-and-ride facility for mode m where m is either drive alone auto, 2-person auto, or 3+ person auto modes.

P_m = Probability of using mode m computed from the Step 5 primary level analysis. Mode m is either drive alone auto, 2-person auto, or 3+ person auto modes

DU_{mA} = Disutility of using park-and-ride facility given mode m is used where mode m is either drive alone auto, 2-person auto, or 3+ person auto modes. Computed in Step 4.

DU_m = Disutility of using auto mode m where mode m is either drive alone auto, 2-person auto, or 3+ person auto modes. Computed in Step 4.

STEP 7: Determine parking space requirements• The input to this step includes the:

The number of trips between the origin and destination market influence areas($TRIPS_{od}$)from Step 2.

Mode shares for the auto-accessed line-haul modes (P_6 and P_7) from Step 5.

Mode shares for the three auto modes accessing the park-and-ride facility (P_{1A},P_{2A},and P_{3A}) from Step 6.

These values are input to the following formula to compute the number of spaces required for all-day parking:

$$Spaces = TRIPS_{od} * (P_{1A} + P_{2A}/2 + P_{3A}/3.5 + P_6 + P_7/2.5)$$

where:

$Spaces_0$ = Unadjusted estimate of long-term parking space requirements.

$TRIPS_{od}$ = Number of person trips between the origin and destination market influence areas calculated in Step 2.

P_{1A} = Probability of driving alone to access the park-and-ride facility to form a carpool

P_{2A} = Probability of accessing the park-and-ride facility in a 2-person carpool to form a carpool

P_{3A} = Probability of accessing the park-and-ride facility in a 3+ person carpool to form a carpool

P_6 = Probability of driving alone to access line-haul transit service at the park-and-ride facility

P_7 = Probability of driving in a carpool to access line-haul transit service at the park-and-ride facility

The values of 2, 3.5 and 2.5 used as denominators in the above equation represent default auto occupancy factors for 2-person, 3+ person, and 2+ person carpools, respectively. Local data can be substituted for these values.

Two additional adjustments need to be made to the above value to account for kiss-and-ride access and for planned utilization in the design year. Approximately 10 to 15 percent of park-and-ride facility patrons access the facility via kiss-and-ride [1]. Use of the 10 percent factor is recommended for two reasons. First, all kiss-and-ride vehicles will not be accessing the facility at the same time. Second, overflow parking can use the long-term parking spaces if the space requirement value is under estimated.

In addition, the $Spaces_0$ value represents the total projected number of automobiles accessing the park-and-ride facility. This value should be upwardly adjusted to produce an estimate which results in less than 100 percent utilization in the design year. The design policies of the jurisdiction involved as well as other considerations such as land availability will dictate the proper adjustment to be made. A 25 percent upward adjustment will produce a space requirement estimate representing a planned utilization of 80 percent in the design year.

The estimate of long-term parking requirements can be further adjusted to account for fuel shortage contingencies. As a point of reference, planners in the Tampa area use up to a 100 percent upward adjustment. It must be stressed that this 100 percent factor accounts for planned under-utilization and energy contingencies, and growth in usage over the base year conditions which are used to compute the space requirements,

The following formula can be used to compute the total parking space requirements at the facility being analyzed:

$$\begin{aligned} Spaces &= \text{Long-term spaces} + \text{Kiss-and-ride spaces} \\ &= Spaces_0 * 0.90 * FAC + Spaces_0 * 0.10 \end{aligned}$$

where:

$Spaces_0$ = Unadjusted estimate of long-term parking space requirements.

FAC = Adjustment factor to provide for less than 100 percent utilization

The final computation relates to converting the number of parking spaces required as computed above to the site size requirement. A conversion factor of 300 square feet per space is

recommended for surface lots and 325 square feet per space for parking structures.

These factors account for parking space, circulation, and access area requirements.

CHAPTER 5: IMPACT ASSESSMENTS

This chapter presents procedures for evaluating the impacts associated with individual park-and-ride facilities. These procedures relate to assessing the effects of park-and-ride lot usage on vehicle miles of travel, vehicle emissions, fuel consumption, and travel time. The procedures presented below are based on accepted theoretical concepts. They were developed to be easily and quickly executed by using readily available data. Default values and rules-of-thumb are provided for use when normally used data inputs or local coefficients are not available. The family of procedures are organized by functional lot type and have been reduced to worksheet form. Worksheets for the procedures can be found in the Appendix.

A number of basic travel characteristics drive the estimation of impacts produced by construction of park-and-ride facilities. These include the before and after average trip lengths, operating speeds, and vehicle occupancies. How these attributes change depend on the distributions of lot users who park, get dropped off, and use transit.

A park-and-ride facility contributes to fuel conservation, reduction in vehicle emissions, and reduced travel times through two mechanisms. First, the direct reduction of removing vehicles from the roadway network. This produces reductions in both vehicle trips and vehicle miles of travel (VMT). Second, there are indirect impacts of reduced congestion levels produced by removing vehicles from the roadways connecting park-and-ride facilities with destination areas. The effects of these secondary impacts may not be appreciable in all cases and are likely not long lasting. For example, assuming a fully-occupied fringe lot with 60 spaces (typical size for Florida) and no transit service, only 60 vehicles will be removed from commuting roadways. This reduction in vehicles will have at most an insignificant impact on other users of the commuting roadways. Consequently, it is reasonable to disregard these secondary impacts for fringe and remote lots since these tend to be small and are generally located in areas where traffic flows are not at saturation levels. The basic approach to estimating the impacts of implementing park-and-ride consists of a number of primary steps including:

A. Generation of the basic input data required by the impact estimation approaches including numbers of person trips by mode, average trip distances traveled on arterials and on limited access facilities, average operating speeds on the arterials and freeways assumed to be affected before and after facility construction, and before and after vehicle occupancies.
C. Computation of reduced vehicle miles of travel (VMT).
C. Computation of fuel consumption changes.
C. Computation of vehicle emissions impacts.
C. Computation of changes in travel time.

A number of approaches are provided for deriving the input data including simplifying assumptions based on observed data which can be used to develop systems-level impact estimates. These assumptions are dependent on facility, the urban area size, and the conditions which typically exist.

The appendix contains worksheets that should prove useful to the execution of the formulas and procedures presented in this chapter. The material contained in this chapter was originally presented in Working Paper 4: Facility Analysis [2].

DATA REQUIREMENTS

Table 5-1 presents a summary of the data elements used in the techniques for computing the impacts of remote, urban fringe, peripheral, and urban corridor facilities. As can be seen, the data requirements are minimal and are generally easy to obtain. The most important input will be the demand for the facility under investigation. The demand estimation techniques presented in Chapter 4 can be used to generate these data. The reader is referred to Chapter 4 for descriptions of these techniques.

REMOTE LOT IMPACTS

The primary source of impacts resulting from construction of a park-and-ride lot located in a remote location is the parked vehicles removed from the roadway between the lot and destination area. Impacts resulting from improved traffic flow are considered inconsequential since the small number of vehicles removed from the traffic stream will produce negligible improvements in vehicle speeds.

Table 5-1. Data Requirements

Facility Type	Data Element	Data Source
Remote Lot	Trip egress distance	User survey or assumption based on knowledge of local travel behavior
	Number of parked vehicles	Demand estimation (see Chapter 4)
Fringe Lot	Distance from lot to primary destination	Measured from map or urban area model plots
	Distance and fraction of travel on arterials and freeways	Measured from map or urban area model plots
	Number of parked vehicles	Demand estimation (see Chapter 4)
Peripheral Lot	Arterial traffic volumes within the activity center	Urban area model assignment or traffic count maps
Urban Corridor or HOV Facility Lot	- Average trip length	- Home-base work trip lengths from urban area model or assumptions based on knowledge of local travel behavior
	- Traffic volumes along the corridor to the destination	- Urban area model assignment or traffic count map
	- Distance and fraction of travel on freeways and arterials	- Measured from map or urban area model plots
	- Mode shares	- Demand estimation (see Chapter 4)
	- Auto occupancies for home base work trips	- Urban area model or default value of 1.2 persons per vehicle
	- Auto occupancies for carpools formed at the park-and-ride facility	- Demand estimation (see Chapter 4)

The technique presented below consists of three steps to compute reductions in vehicle miles of travel (VMT), fuel consumption, and vehicle emissions. Impacts in travel time are considered insignificant, so the procedure does not include computations for this variable.

STEP 1: Calculate annual reduction in vehicle miles of travel (VMT) -- The impacts on fuel consumption and vehicle emissions are related directly to the reduction in VMT produced from shifting to higher occupancy vehicles. VMT reduction is developed by simply multiplying the estimated reduction in vehicle trips by the average distance from the lot to the destination area. This is then converted to an annual basis. The following formula produces a positive value for VMT reduction resulting from parked vehicles at a remote facility;

$$\text{VMT (annual)} = L_{avg} * \text{Parked} * 233 * 2$$

where:

VMT	=	Annual VMT reduction.
L_{avg}	=	Average trip length from lot to destination.
Parked	=	Vehicles parked at the remote lot.
233 * 2	=	Daily to annual conversion factor for remote lots times 2 trips per vehicle removed.

STEP 2: Calculate Annual Fuel Savings• The computation of fuel savings consists of multiplying the VMT savings computed in Step 1 by an average per mile fuel consumption rate for the analysis year under study. Table 5-2 should be referenced for these consumption rates. The following formula computes a positive value for annual gallons of fuel saved:

$$\text{Fuel Savings (annual gallons)} = \text{VMT} * \text{Crate}$$

where:

VMT	=	Annual VMT reduction computed in Step 1
Crate	=	Average fuel consumption rate in gallons per mile for the study year under investigation. Refer to Table 5-2.

STEP 3: Calculate Annual Emission Reduction• The computation of the reduction in vehicle emissions consists of multiplying the VMT savings computed in Step 1 by fleet average emission rates for carbon monoxide, hydrocarbons, and nitrogen oxides appropriate for the analysis year under study. The pollutant emission rates are found in Table 5-2.

Table 5-2. Average Fuel Consumption and Emission Rates For Remote Lots

	Fuel Consumption		Vehicle Emissions (grams/mile)		
Planning Year	**Gallons Per Mile**	**Miles Per Gallon**	**CO**	**HC**	**NOX**
1985	0.0476	21.0	35.5	4.5	3.4
1990	0.0380	26.3	22.6	2.9	2.6
1995	0.0364	27.5	16.4	2.1	2.3
2000	0.0362	27.6	13.9	1.4	2.1
2005	0.0362	27.6	13.9	1.4	2.1
2010	0.0362	27.6	13.9	1.4	2.1

(Reference 27,28,29)

The following formulas produce positive values for reductions in annual tons of pollutants:

Reduction in CO (tons/year) = (VMT * E_{co}) / 907,184

Reduction in HC (tons/year) = (VMT * E_{nox}) / 907,184

Reduction in NOX (tons/year) = (VMT * E_{hc}) / 907,184

where:

VMT = Annual VMT reduction from Step 1.

E_{co} = Fleet average carbon monoxide emission rate in grams per vehicle mile. Refer to Table 5-2.

E_{nox} = Fleet average nitrous oxides emission rate in grams per vehicle mile. Refer to Table 5-2.

E_{hc} = Fleet average hydrocarbons emission rate in grams per vehicle mile. Refer to Table 5-2.

907,184 = Converts grams to U.S. tons.

URBAN FRINGE AND URBAN CORRIDOR LOT IMPACTS

The following procedure can be used to estimate impacts for both urban fringe and urban corridor lots. The differences between these two lot types relate to location in the urban area and provision of transit service. Urban corridor lots tend to serve a major destination area while urban fringe lots may service more than one destination area. Urban corridor lots are typically served by transit and often express bus service. Fringe may or may not be served by transit and most likely are not served by express buses.

The following technique accounts for savings resulting from improvement in traffic flows between the park-and-ride facility and the destination market influence areas. This may not be appropriate for moderate size facilities with low estimated usage. Computation of these secondary impacts should be performed only for conditions in which park-and-ride is expected to have a significant

impact on traffic flows. In addition, fuel and emissions impacts related to transit are considered. Calculations related to transit service should not be performed if such service is not provided at the parking facility.

STEP 1: Identify Major travel path(s) from the park-and-ride facility to major destination area(s) -- Significant paths of highway travel from the park-and-ride facility to major destination or destinations must be identified. The following recommendations should be considered for simplifying this process:

- More than one path should be selected only in cases where there is more than one major destination area served by the parking facility.
- Only one path should be identified for each major destination area.
- Only major trunk facilities should be included in the travel paths.

Along with the selection of travel paths, the proportion of carpool vehicle trips using each path should be determined. This information can be developed through the demand estimation procedures presented in Chapter 5, assumptions based on knowledge of local travel behavior, user surveys, or proration based on employment at the destinations.

STEP 2: Segmentation of travel paths and computation of segment data• Since traffic flow effects are considered in this procedure, the travel paths from the park-and-ride facility to each destination area being considered should be divided into segments of similar flow characteristics. The determining factors are level of service and facility type. The segments should be categorized into one of four categories:

- Congested freeway
- Uncongested freeway
- Congested arterial
- Uncongested arterial.

The threshold between congested and uncongested conditions is considered to be the boundary between Levels of Service D and E. Segments operating at levels worse than Level of Service D should be defined as congested while segments operating better than Level of Service E should be defined as uncongested. Level of service definitions can be found in the Appendix. The following guidelines are provided to assist in identifying congested and uncongested roadways segments:

- A congested freeway segment operates under interrupted flow (stop and go traffic) or at average operating speeds under 40 mph.
- An uncongested freeway segment operates under uninterrupted flow at average operating speeds over 40 mph.
- A congested arterial segment operates at average speeds under 40 percent of the posted speed and is characterized by long queues at signalized intersections with numerous intersections in the segment experiencing cycle failures (failure to clear queues in one cycle).
- An uncongested arterial segment operates at average speeds over 40 percent of the posted

speed and is characterized by intersection queues which generally clear within one signal cycle.

C. An arterial under progressive signal control and experiencing a limited number of cycle failures can be considered uncongested.

STEP 3: Develop before and after average operating speeds for congested roadway segments• The computations of fuel consumption, vehicle emissions, and travel time are dependent on the before and after operating speeds of effected roadways. A simplifying assumption is that the changes in traffic volumes produced by a park-and-ride facility only effect congested roadways. This is a reasonable assumption for two reasons. First, the practical change in roadway volumes which can be expected is not large when considered on a per lane basis. To illustrate, 200 vehicles removed in one direction from a four-lane roadway is 100 vehicles per lane. This change in traffic would increase operating speeds by only 3 mph on arterials or freeways operating under uncongested conditions. The second reason is that the small decreases in volumes on congested roadways can produce significant changes in operating speeds. Removing 100 vehicles per lane on a congested roadway can produce an increase in speeds of almost 8 mph.

Two approaches are presented for deriving before and after operating speeds for congested roadway segments identified in Step 2. The first is the more detailed procedure. Speeds are determined by:

1. Subdividing congested segments by number of lanes
2. Calculating the average per lane volume for each congested roadway subsegment in the before and after condition.
3. Deriving the resultant operating speeds from Table 5-3.

A more simplistic approach is to use generic operating speeds for congested segments and generic operating speed changes for decreases in volumes. These generic values are presented in Table 5-4.

STEP 4: Estimate annual VMT reduction by major travel path• The annual reduction in VMT can be derived in a manner similar to the approach presented for remote facilities. It is applied to each highway travel path identified in Step 1. The proportion of travel by path derived in Step 1, the average distance of each path, and the estimate of parking demand projected for the study's planning year are input to the following equation which produces positive values for reduced VMT:

VMT_i (annual) = $L_i * D * P_i * 2 * Afac$

where:

VMT_i	=	Annual reduction in VMT for highway travel path i.
L_i	=	Average distance for highway travel path i.
D	=	Number of parked vehicles projected for the planning year under analysis (see Chapter 5).
P_i	=	Proportion of total parked vehicles traveling via highway travel path i.
2	=	Two trips/day per parked vehicle.
Afac	=	Factor to convert daily VMT reduction to an annual basis. Equals 213 for fringe lots and 233 for urban corridor lots.

Table 5-3. Average Roadway Operating Speeds Based Per Lane Volumes

Volume Per Lane	Freeway Segments(mph)	Arterial Segments (% of Posted speed)	
		Major Arterial	Minor Arterial
700			68%
800			58%
900		63%	49%
1000	55	55%	17%
1100	54	46%	
1200	52	17%	
1300	51		
1400	50		
1500	49		
1600	48		
1700	46		
1800	43		
1900	35		
2000	30		

Note: Assumed design speed of 65 mph and per lane capacity of 2,000 vehicles per hour for freeways, per lane capacity of 1200 vehicles per hour for major arterials, and per lane capacity of 1000 vehicles per hour for minor arterials.
(References 21,30)

Table 5-4. Operating Speeds for Total Volume Reduction (miles per hour)

Total Reduced	Freeway Lanes				Major Arterial Lanes			Minor Arterial Lanes		
Volume	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**1**	**2**	**3**
< 50	30	30	30	30	8	8	8	6	6	6
50	36	36	36	35	17	17	17	13	13	13
100	37	37	36	36	17	17	17	17	13	13
150	40	37	37	36	21	17	17	19	17	13
200	40	40	37	37	21	21	17	20	17	17
250	43	40	40	37	22	21	21	22	19	17
300	43	40	40	40	22	21	21	24	19	17
350	45	43	40	25	22	21	21		20	19
400	45	43	40	40	25	22	21		20	19
450	46	43	43	40	27	22	22		22	19
500	46	45	43	40	27	25	22		22	20
600	47	45	43	43	28	25	22		24	20
700	48	46	45	43		27	25			22
800	48	47	45	45		28	25			24
900	49	47	46	45		28	27			24
1000	49	48	46	45			27			
1200	50	48	47	46			28			
1400	51	49	48	47						
1600	52	50	48	48						
1800	53	50	49	48						

2000	54	51	49	48

(References 21,30)

STEP 5: Estimate change in fuel consumption•Three components must be accounted for to compute the fuel consumption impacts of a park-and-ride facility•fuel savings realized by the automobiles removed from the road, fuel changes realized by automobiles on the roadway which operate at a higher speeds due to removed vehicles, and transit fuel consumption if service is provided to the park-and-ride facility. The first component will be a decrease in consumption since vehicles parked means fuel saved. The second component will most likely be an increase in consumption since fuel efficiency decreases with increasing speed over 30 mph. The second component of fuel consumption change can be ignored if the reduction in traffic produced by the park-and-ride facility can be assumed to have negligible impact on operating speeds. The third component will be an increase in fuel consumption provided the analysis is considering new or increased transit service to the facility.

The following formula computes the change in fuel consumption produced by all sources. A positive value represents a savings in fuel consumption between the future and existing conditions while a negative value represents a net increase in consumption:

Change in Fuel Consumption

(gallons/year) = $2 * Afac * \Sigma_{I=1,segments} [L_i * \{(Crate_{ib}\ TVOL_i)(Crate_{ia} * (TVOL_i - RVOL_i))-(BUSrate_{ia} * BVOL_i)\}]$

where:

- L_i = Length of segment i in miles
- $Crate_{ib}$ = Auto fuel consumption rate for segmenting the before condition. From Table 5-5 for freeway segments and 5-6 for arterial segments.
- $Crate_{ia}$ = Auto fuel consumption rate for segment i in the after condition. From Table 5-5 for freeway segments and 5-6 for arterial segments.
- $BUSrate_{ia}$ = Bus fuel consumption rate for segment i in the after condition. From Table 5-7.
- $RVOL_i$ = Vehicles removed from segment 1 as a result of the park-and-ride facility
- $TVOL_i$ = Total traffic for segment i in before condition
- $BVOL_i$ = Transit volume for segment i.
- 2 = Two trips per day per vehicle
- Afac = Factor to convert daily consumption to an annual basis. Equals 213 for fringe lots and 233 for urban corridor lots.

Table 5-5. Auto Fuel Consumption Rate for Freeways (grams/mile)

Speed (MPH)	1990	1995-2010
30	0.029	0 027
35	0.029	0 027
40	0.029	0.028
45	0.030	0 029
50	0.032	0 031
55	0.033	0.032
60	0.036	0.034

(References 26,28)

Table 5-6. Auto Fuel Consumption Rate for Arterials (grams/mile)

Speed (MPH)	1990	1995-2010
10	0.059	0.057
15	0.046	0.044
20	0.045	0.043
25	0.046	0.044
30	0.046	0.044
35	0.046	0.044
40	0.047	0.045

(References 26,28)

Table 5-7. Average Fuel Consumption and Emission Rates For Transit Vehicles

Speed(mph)	Fuel Consumption Gallons Per Mile	Miles Per Gallon	Vehicle Emissions (grams/mile) CO	HC	NOX
5	0.446	2.2	25.5	7.0	31.0
10	0.251	4.0	22.5	5.6	24.2
15	0.193	5.2	21.3	4.5	22.4
20	0.167	6.0	18.8	3.6	22.6
25	0.156	6.4	14.7	3.1	24.0
30	0.154	6.5	11.4	2.7	25.4
35	0.095	10.5	9.1	2.5	26.6
40	0.108	9.3	7.5	2.2	27.5
45	0.123	8.1	6.3	2.1	28.2

(References 31,32)

STEP 6. Estimate emission reductions• Table 5-8 and Table 5-9 list emission rates for carbon monoxide, nitrogen oxide and hydrocarbons at various speeds for automobiles and transit vehicles. These rates are used in the following formula to compute the annual reduction in emissions expressed in tons. Positive values represent net decreases in emissions between the future and base conditions while negative values represent increases in emissions:

$$\text{CO (annual tons)} = 2 * \text{Afac} * (1/907{,}184) * \Sigma_{i=1,segments} [L_i * \{(COrate_{ib} * TVOL_i) - (COrate_{ia} * (TVOL_i - RVOL_i)) - (BCOrate_{ia} * BVOL_i)\}]$$

$$\text{HC (annual tons)} = 2 * \text{Afac} * (1/907{,}184) * \Sigma_{i=1,segments} [L_i * \{(Hcrate_{ib} * TVOL_i) - (HCrate_{ia} * (TVOL_i - RVOL_i)) - (BHCrate_{ia} * BVOL_i)\}]$$

$$\text{NOX (annual tons)} = 2 * \text{Afac} * (1/907{,}184) * \Sigma_{i=1,segments} [L_i * \{(NOXrate_{ib} * TVOL_i) - (NOXrate_{ia} * (TVOL_i - RVOL_i)) - (BNOXrate_{ia} * BVOL_i)\}]$$

where:

CO = Annual reduction in carbon monoxide in tons.
HC = Annual reduction in hydrocarbons in tons.

NOX = Annual reduction in nitrogen oxides in tons.
Li = Lot-to-destination distance for path I.
$COrate_{ib}$ = Automobile CO emission rate for segment i in before condition. From Table 5-8 or 5-9.
$COrate_{ia}$ = Automobile CO emission rate for segment i in after condition. From Table 5-8 or 5-9.
$BCOrate_{ia}$ = Automobile CO emission rate for segment i in after condition. From Table 5-7.
$Hcrate_{ib}$ = Automobile HC emission rate for segment i in before condition. From Table 5-8 or 5-9.
$HCrate_{ia}$ = Automobile HC emission rate for segment i in after condition. From Table 5-8 or 5-9.
$BHCrate_{ia}$ = Transit HC emission rate for segment i in after condition. From Table 5-7.
$NOXrate_{ib}$ = Automobile NOX emission rate for segment i in before condition. From Table 5-8 or 5-9.
$NOXrate_{ia}$ = Automobile NOX emission rate for segment i in before condition. From Table 5-8 or 5-9.
$BNOXrate_{ia}$ = Transit NOX emission rate for segment i in before condition. From Table 5-7.
RVOLi = Vehicles removed from segment i as a result of the park-and-ride facility.
TVOLi = Total traffic for segment i in before condition.
BVOLi = Transit volume for segment i. 2 = Two trips per day per vehicle.
Afac = Factor to convert daily consumption to an annual basis. Equals 213 for fringe lots and 233 for urban corridor lots.
907,184 = Converts grams to U.S. tons.

Table 5-8. 1990 Auto Emission Rates (grams/mile)

Speed (MPH)	Carbon Monoxide	Hydro-Carbons	Oxides of Nitrogen
10	20.81	1.46	1.19
15	14.47	1.04	1.23
20	11.86	0.83	1.38
25	9.82	0.68	1.54
30	8.02	0.55	1.67
35	6.67	0.46	1.77
40	5.88	0.40	1.84
45	5.62	0.37	1.89
50	5.60	0.36	1.97
55	5.10	0.32	2.14
60	3.27	0.23	2.43

(Source: Reference 26,29)

Table 5-9 1995-2010 Auto Emission Rates (grams/mile)

Speed (MPH)	Carbon Monoxide	Hydro-Carbons	Oxides of Nitrogen
10	12.98	1.10	1.05
15	9.02	0.77	1.20
20	7.52	0.61	1.35
25	6.26	0.50	1.50
30	5.11	0.41	1.63
35	4.24	0.34	1.73
40	3.75	0.29	1.80
45	3.62	0.27	1.85
50	3.64	0.26	1.93
55	3.30	0.23	2.09
60	2.01	0.16	2.38

(Source: Reference 26,29)

STEP 7: Calculate travel time savings• Travel time impacts relate to changes in vehicle-hours of travel (VHT) and person-hours of travel (PHT). The initial computation in this procedure consists of calculating the travel times for all travel paths from the park-and-ride facility for car-poolers formed at that facility, highway users not utilizing the park-and-ride facility, and transit vehicles. The following formulas derive these data:

$$Hbtt_i = \Sigma_{i=1,segments} [L_i/Sb_i]$$
$$Hatt_i = \Sigma_{i=1,segments} [L_i/Sa_i]$$
$$Cbtt_i = \Sigma_{i=1,segments} [L_i/Sb_i]$$
$$Catt_i = \Sigma_{i=1,segments} [L_i/Sa_i] + Etime/60$$
$$Tatt_i = \Sigma_{i=1,segments} [L_i/Sa_i] + Etime/60$$

where:

$Hbtt_1$ = Highway travel time for path i in before condition.
$Hatt_i$ = Highway travel time for path i in after condition.
$Cbtt_i$ = Car-pooler travel time for path i in before condition.
$Catt_i$ = Car-pooler travel time for path i in after condition.
$Tatt_i$ = Transit travel time for path i in after condition.
L_i = Lot-to-destination distance for path i.
Sb_i = Average operating speed for path i in before condition.
Sa_i = Average operating speed for path i in after condition
Etime = Excess travel time (waiting, transfer) associated with transit usage in minutes.

The following formulas compute changes in VHT and PHT. Positive values represent reductions in VHT and PHT between the future and base conditions while negative values represent net increases:

Reduction in VHT (annual) = $2 * Afac * \Sigma_{i=1,paths}[TVOL_i * Hbtt_i - (TVOL_i - RVOL_i) * Hatt_i -(Occ_{hbw}/(Occ_a -Occ_{hbw})+l) * CVOL * Catt_i)]$

Reduction in PHT (annual) = $2 * Afac * \Sigma_{i=1,paths}[TVOL_i * Hbtt_i * Occ_{hbw} - (TVOL_i - RVOL_i) * Hatt_i *Occ_{hbw} -(Occ_{hbw}/(Occ_a - Occ_{hbw})+l) * CVOL * Catt_i) * Occ_a - Pass_i * Tbtt_i]$

where:

$TVOL_i$ = Total volume for path i in before condition.
$RVOL_i$ = Volume reduced from path i.
$CVOL_i$ = Vehicles associated with carpools formed at the park-and-ride facility for path i.
CVOLi= RVOL for cases where transit service is not provided.
$Pass_i$ = Transit users for path i.
OCC_{hbw} = Auto occupancy in before condition. Occupancy for home-base work trip is typically used. Default value 1.2 persons per auto.
OCC_a = Auto occupancy in after condition for egressing carpool vehicles. Default value of 3.2 persons per auto can be used [1].
$Hbtt_i$ = Highway travel time for path i in before condition.
$Hatt_i$ = Highway travel time for path i in after condition.
$Catt_i$ = Car-pooler travel time for path l in after condition.
$Tatt_i$ = Transit travel time for path i in after condition.
2 = Two trips/day per parked vehicle
Afac = Factor to convert daily VMT reduction to an annual basis. Equals 213 for fringe lots and 233 for urban corridor lots.

PERIPHERAL LOT IMPACTS

The characteristics of a parking facility located peripherally to an activity center suggests that the associated impacts are related to the reduction in vehicles traveling within the activity center. Since the facility is located so close to the destination of users of the facility, changes in fuel consumption, vehicle emissions, and travel time are considered to be negligible for the origin to parking facility trip segment.

Reductions in VMT may or may not be realized with construction of a peripheral parking facility. This will depend on the proximity of destinations within the activity center, the facility's size, and amount of additional travel required to access the facility. If a peripheral parking facility is located such that it intercepts users along their normal travel paths, then VMT will be reduced as will congestion, fuel consumption, and emissions. However, a peripheral facility can also produce extra travel by users who route around the activity center to access the facility. This can result in higher fuel consumption and emission rates. Such an occurrence has been observed in the Fort Worth area

where over one half of users of a peripheral facility drove extra miles to use it [26]. This suggests that the analysis for peripheral parking facilities must be performed on a case-by-case basis.

The procedure presented below is based on an approach developed by the Federal Highway Administration [33]. The technique is applied for each roadway assumed to experience a change in volumes. Computations are performed to determine the reduction or increase in VMT, changes in operating speeds before and after the volume change, and the resultant impacts on fuel consumption and vehicle emissions. The procedure assumes that changes in travel time are insignificant.

STEP 1: Estimate change in VMT for each roadway to be analyzed• The following formula produces positive values for reductions in VMT associated with a peripheral parking facility:

$$VMT_i \text{ (annual)} = (V_b - V_a) * L_i * 2 * 226$$

where:

VMT_s = Annual VMT change for roadway I
V_b = Before peak period traffic volume on roadway I
V_a = After peak period traffic volume on roadway I
L_i = Length of roadway
2*226 = Converts one-way daily VMT to two-way annual VMT

STEP 2: Estimate reduction in fuel consumption• This calculation consists of multiplying the change in VMT computed in Step 1 by the fuel consumption rate for the roadway under evaluation. This rate is based on the assumed average operating speed for the roadway. The following formula produces positive values for reductions in fuel consumption between the future and existing conditions:

$$\text{Change in fuel consumption (gallons/year)} = VMT_i * (K1 + K2 / S_i)$$

$$S_i < 35 \text{ mph}$$

where:

VMT_i = Change in annual VMT. Value is positive for VMT reduction and is negative for VMT increase.
K1 = Fuel consumption rate based on overcoming rolling resistance. Values found in Table 5-10.
K2 = Fuel consumption based on the idle fuel flow rate. Values found in Table 5-10.
S_i = Average speed in miles per hour over the distance of the roadway i under evaluation.

STEP 3: Estimate change in annual vehicle emissions• This computation is based on multiplying the VMT change computed in Step 1 by the appropriate emission rates based on the study year and the average operating speed. Tables 5-11 to 5-19 contain the vehicle emission rates for various ambient air temperatures and planning years. The following formula computes the annual change in vehicle emissions:

$$\text{Reduction in CO (tons/year)} = (VMT_s * E_{co}) / 907{,}184$$

Reduction in HC (tons/year) = $(VMT_s * E_{nox}) / 907{,}184$
Reduction in NOX (tons/year) = $(VMT_s * E_{hc}) / 907{,}184$

where:

VMT_s	=	Annual VMT saved from Step 1.
E_{co}	=	Average fleet carbon monoxide emission rate in grams per vehicle mile. From Table 5-11, 5-12, or 5-13.
E_{nox}	=	Average fleet nitrous oxide emission rate in grams per vehicle mile. From Table 5-14, 5-15, or 5-16.
E_{hc}	=	Average fleet hydrocarbon emission rate in grams per vehicle mile. From Table 5-17, 5-18, or 5-19.
907,184	=	Converts grams to U.S. tons.

Table 5-10. Fuel Consumption Parameters

YEAR	K1	K2
1989	0.0209	0.430
1990	0.0205	0.421
1991	0.0201	0.415
1992	0.0199	0.410
1993	0.0198	0.407
1994-1997	0.0196	0.404
1998-2010	0.0195	0.403

(Reference 33)

Table 5-11. Carbon Monoxide Emission Rates Year 1990 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	**60**	**80**
5	91	82	76
10	49	44	41
15	34	31	28
20	27	24	23
25	23	20	19
30	19	17	16
35	16	15	14

(Reference 33)

Table 5-12. Carbon Monoxide Emission Rates Year 1995 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	60	80

5	70	63	59
10	38	34	32
15	26	24	22
20	21	19	17
25	17	16	14
30	15	13	12
35	13	11	11

(Reference 33)

Table 5-13. Carbon Monoxide Emission Rates Year 2000-2010 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	**60**	**80**
5	56	50	47
10	30	27	25
15	21	19	18
20	17	15	14
25	14	12	12
30	12	11	10
35	10	9	8

(Reference 33)

Table 5-14. Hydrocarbons Emission Rates Year 1990 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	**60**	**80**
5	7	7	6
10	4	4	4
15	3	3	3
20	3	2	2
25	2	2	2
30	2	2	2
35	2	2	2

(Reference 33)

Table 5-15. Hydrocarbons Emission Rates Year 1995 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	**60**	**80**
5	5	5	5
10	3	3	3

15	2	2	2
20	2	2	2
25	2	1	1
30	1	1	1
35	1	1	1

(Reference 33)

Table 5-16. Hydrocarbons Emission Rates
Year 2000-2010 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	**60**	**80**
5	5	5	4
10	3	3	3
15	2	2	2
20	2	2	2
25	2	1	1
30	1	1	1
35	1	1	1

(Reference 33)

Table 5-17 Nitrogen Oxide Emission Rates
Year 1990 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	**60**	**80**
5	2	2	2
10	2	2	2
15	2	2	2
20	2	2	2
25	2	2	2
30	2	2	2
35	2	2	2

(Reference 33)

Table 5-18. Nitrogen Oxide Emission Rates
Year 1995 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	60	80
5	2	2	2
10	1	1	1
15	1	1	1
20	1	1	1
25	2	2	2
30	2	2	2
35	2	2	2

(Reference 33)

Table 5-19. Nitrogen Oxide Emission Rates
Year 2000-2010 (Grams/mile)

Average Speed (MPH)	Temperature (Fahrenheit)		
	40	60	80
5	2	2	2
10	1	1	1
15	1	1	1
20	1	1	1
25	2	2	2
30	2	2	2
35	2	2	2

(Reference 33)

CHAPTER 6: ECONOMIC ANALYSIS AND PROJECT JUSTIFICATION

This chapter presents a recommended approach to performing economic analyses of park-and-ride improvements. Included is:

- a recommended justification report outline
- a description of relevant measures of cost, benefit, and effectiveness applicable to the justification of park-and-ride improvements
- a suggested framework for performing economic analyses related to park-and-ride

The material presented in this chapter is an abridgment of similar material contained in Working Paper 4: Facility Analysis [2]. That document should be referenced for supporting research findings that are not contained here in this chapter.

The types of improvements for which special justification might be required include:

- Construction of new parking facilities integrated with high-occupancy vehicle facilities
- Retrofitting dir
- Construction of new parking facilities as adjuncts to existing fixed transit systems
- Construction of new parking facilities as adjuncts serving express bus services
- Construction of new individual parking facilities
- Expansion of existing facilities on adjacent right-of-way
- Expansion of capacity through construction of a parking structure
- Expansion of capacity through modification of the existing design
- Expansion of capacity through joint-development options
- Provision of transit services

Justification of HOV-related parking facilities is a special problem. The costs of such facilities will likely include high-priced right-of-way as well as construction and operation. Without the existence of the HOV facility, such construction might not be performed since lower cost alternatives might be available. However, the HOV imposes special constraints on the parking facility which add significantly to the cost. These include proximity to the trunk facility, access improvements, and possibly direct access ramps. However, the parking facility should be considered as a part of a larger system since it has been found that parking facilities are required to produce acceptable usage levels of HOV facilities [34].

Parking facilities related to fixed-guideway transit have proven to be a critical feature to adding patrons to the transit system. Facilities in the northeast corridor are renowned for their high utilization rates. The Dadeland parking facilities in Miami have historically been utilized at over 95 percent of capacity [35]. The problem of justification relates to showing a need for additional parking, the benefit to transit ridership, add the positive impact to highway operations.

Park-and-ride facilities are often used in developing express transit services. The justification process for this type of improvement must consider costs associated with the anticipated transit service as well as those related to the parking facility.

Construction of isolated parking facilities results in higher vehicle occupancies on the roadway and

resultant decreases in VMT and associated user costs. Justification must focus on these types of benefits. The analysis must consider alternatives to construction on a new site including expansion on adjacent right-of-way, garage construction on the existing site, and joint development options.

Providing transit service is an improvement related to increasing lot utilization. Justification must consider operations and maintenance (O&M) costs associated with operating transit vehicles.

THE JUSTIFICATION REPORT

The Justification report for proposed park-and-ride construction projects and related improvements must contain sufficient explanation and data to show the need and purpose of the improvement under consideration. It should consider alternatives to the proposed improvement with associated comparisons of benefit and cost impacts; the relation of the improvement to relevant plans, programs and projects within the impact area; the impacts of the improvements on local transportation systems; and the needs addressed by the improvement.

Applying the findings from the above referenced documents leads to the following recommended report outline:

I. Introduction • Summarizes the purpose, need, benefits, and costs of the project and includes a summary of the organization of the report.

II. Background • Presents the context of the project in relation to the impact area, the existing and future transportation systems, the measures (if any) which have been implemented in the past in the attempt to solve the stated problem which the improvement is to address, and the response of users to similar facilities in the area.

III. Planned Improvements • Descriptions of related transportation improvements and conditions which will have a bearing on the analysis including other commuter parking facilities in the area, highway expansion, and transit services.

IV. Locational Analysis • Pertains to construction on new right-of-way only. Presents the possible locational options for the facility including comparisons of costs and qualitative descriptions of the merits of each.

V. Alternatives • Describes alternatives to the proposed improvement considered in the following presentation of the analysis. Construction alternates should include alternative sites, and construction methods including surface lots and garages.

VI. Demand Analysis • Presents forecasts of utilization in the construction or implementation year and the planning year. Procedures developed in Chapter 4 are relevant to the content of this section of the report.

VII. Benefit/Cost Assessment • Describes the benefits and costs for each alternative under evaluation which are measurable in monetary units.

VIII. Cost Effectiveness Assessment • Describes the impacts of each alternative in terms which can not be quantified in monetary units. Cost-effectiveness measures are presented in terms of amount of improvement per dollar of cost.

IX. Conclusions • Summarizes the need and benefits of the proposed improvement.

BENEFIT, COST AND EFFECTIVENESS MEASURES

This section presents a review of the measures relevant to the analysis of park-and-ride improvements. Table 6-1 presents a listing of cost, benefit, and effectiveness measures which should be considered for inclusion in the justification analysis for park-and-ride improvements. These were developed from the aforementioned documents with consideration for the special features of park-and-ride.

Table 6-1. Benefit, Cost and Effectiveness Measures Relevant to Park-And-Ride Improvements

Improvement	Benefit Measure	Cost Measure	Effectiveness Measure
HOV-Related Facility	Travel time Vehicle operation Accidents	Engineering Construction ROW Maintenance	Auto occupancy Peak-hour highway LOS VMT reduction Air quality Fuel savings
Fixed-Guideway Facility	Vehicle operation Accidents Travel time Transit fares	Engineering Construction ROW Maintenance	Transit readership Peak-hour highway LOS VMT reduction Air quality Fuel savings
Express Bus Facility	Vehicle operation Accidents Travel time Transit fares	Engineering Construction Maintenance Transit O& Transit capital	Transit ridership Peak-hour highway LOS VMT reduction Air quality Fuel savings
Carpool-only Facility	Vehicle operation Accident Travel time	Engineering Construction ROW Maintenance	Auto occupancy VMT reduction Peak-hours LOS Air quality Fuel savings
Expansion on Adjacent ROW	Vehicle operation Accidents Travel time	Engineering Construction ROW Maintenance	Auto occupancy VMT reduction Peak-hour LOS Air quality Fuel savings
Structure on Existing ROW	Vehicle operation Accidents Travel time	Engineering Construction ROW Maintenance	Auto occupancy VMT reduction Peak-hour LOS Air quality Fuel savings
Modification of Existing Design	Vehicle operation Accidents Travel time	Engineering Construction ROW Maintenance	Auto occupancy VMT reduction Peak-hour LOS Air quality Fuel savings
Joint-Development	Vehicle operation Accidents Travel time	Engineering Construction Annual lease Administration	Auto occupancy VMT reduction Peak-hour LOS Air quality Fuel savings
Provision of Transit Services	Vehicle operation Accidents Travel time	Transit capital Transit O&M	Transit ridership VMT reductions Peak-hour LOS Air quality Fuel savings

Note: ROW = Right-of-way O&M = Operation and maintenance

HOV = High-occupancy vehicle LOS = Level of service
VT = Vehicle-miles of travel

Benefit Measures

Benefit measures are measurable items expressed in monetary units. These measures are used in the benefit side of the benefit/cost calculation. Benefit measures are typically expressed in terms of savings in user costs.

Travel Time: This measure consists of the change in user travel time resulting from the implementation of the park-and-ride improvement. Computation of travel time impacts are presented in Chapter 5. Travel time is converted to a dollar value through the use of a value-of-time factor. The value of travel time varies by trip purpose. The value of time for the work trip purpose is appropriate for the analysis of park-and-ride improvements.

Research has shown that a reasonable assumption of the value of commuter travel time ranges from 20 to 40 percent of a traveler's income [361. Assuming an average income of $30,000 per year, the value of commute time ranges from $3 to $6 per hour. A value of $5 per hour is typically used in economic analyses of transportation.

Vehicle Operation: Vehicle operation costs are related to running speed, speed changes, roadway gradient, and degree of curvature of tangent roadways. Parking charges are also included in this cost category in this discussion. Estimating all of these various costs is only recommended for economic studies of HOV facilities. Procedures are contained in the AASHTO Benefit/Cost Manual [37]. Use of per-mile unit operating cost factors are more appropriate for analyzing other park-and-ride improvements. This value can range from 15 to 25 cents per vehicle mile. A value of 20 cents per vehicle mile is appropriate.

Accidents: The cost of accidents relates to the loss of income associated with fatality and injury accidents, and the value of property damage related to property-damage-only accidents. Accident rates by type can be calculated on a VMT basis and equated to cost using recognized values of economic loss for fatalities, injuries, and property damage. 1987 values of economic loss used by the Department included $2,000 per property damage-only accident, $9,300 per injury, and $220,000 per fatality.

Transit fares: Transit fares are associated with using transit and should be added to the user cost of travel. Fare schedules for the local transit property which is anticipated to provide service should be referenced. Preliminary user cost estimates can be based on $1 per person trip using express bus and urban rail service, $2 per person trip using commuter rail service, and $0.50 to $0.75 per person trip using local bus.

Project Costs

Project costs relate to the costs associated with designing, constructing, maintaining and operating the transportation improvements under investigation. For carpool-only park-and-ride facilities,

project costs are associated with the facility. Project costs associated with economic analyses of a HOV facility include costs of constructing and operating the HOV facility as well as the park-and-ride lot. In addition, transit operating and maintenance (O&M) costs are included when transit services are to be considered.

Engineering: Engineering costs relate to preliminary engineering, final design and construction plans and specifications preparation. Associated costs relate to developing design concepts, preliminary layouts, land and aerial surveys, right-of-way appraisals, soils investigations if required, environmental assessments, final design plans, and preparation of construction drawings, specifications, and bid documents. Estimates of this cost category should be developed as a historical percentage of the total design cost. These costs will tend to be a higher percentage for HOV facilities and parking garages while they will be zero for improvements consisting solely of adding transit service. The development of these costs is best derived as a historical percentage of construction costs. This percentage is based on complexity and magnitude of the construction and typically ranges from 10 to 20 percent.

Right-of-Way: Right-of-way costs include purchase price; legal, title, and other fees related to transfer of ownership; administrative costs for negotiation, condemnation, or settlement; business, family, and utility relocation; and demolition. Another cost which can be of considerable magnitude relates to environmental cleanup of hazardous waste. This later cost may be large enough to eliminate a site or project from further consideration. Property values are highly dependent on geography, location within the community, and type of land use. Costs estimates for right-of-way should be obtained from the District Right-of-Way Office.

Construction: Construction costs include supervision, staking, inspection, and testing; facility elements including earthwork, pavement, drainage, embankments, structures, and ramps; landscaping and erosion control; maintenance of traffic; and traffic control devices. The cost basis includes labor, materials, equipment, and contractor overhead and profit margin. The best source for these costs is the preliminary or final engineer's estimate. Alternately, unit construction costs can be developed from historical experience.

The following typical order-of-magnitude unit construction costs are can be used for preliminary cost estimates:

- (•) Garage costs: $6,000 per parking space [35]
- (•) Surface lot costs: $2,000 per parking space [8]
- (•) HOV lanes: $1,000,000 per lane mile [53]
- (•) Direct-access ramps: $10,000,000 per pair of ramps [34]

Maintenance: Maintenance costs include routine and periodic upkeep including patching, striping, painting, drainage clean-out, and landscaping; replacement of pavement, traffic control devices, fences, guardrails, etc. Costs related to maintaining park-and-ride facilities are approximately $60 per space per year.

Operations: Operation costs include utility charges, safety patrols, operation of signals, garbage removal, administration of lease agreements, and traffic surveillance. These costs may be lumped together with maintenance in line with the traditional approach of estimating incremental O&M costs. However, operations costs may be sufficiently large to justify estimating them separately.

Transit Capital: These costs relate to investments in rolling stock. They may also include costs associated with benches and shelters at the park-and-ride facility although these should be treated as part of the construction costs above.

Transit Operations and Maintenance (O&M): The transit O&M costs vary with the level, type, and speed of bus operation. They are typically related to the vehicle-mileage generated by the system. They entail:

- (•) The cost of driver's wages and fringe benefits.
- (•) The costs of vehicle operation, including tires, gasoline, and lubricants.
- (•) The cost of insurance, managerial and administrative labor.
- (•) The costs of vehicle rental or depreciation.
- (•) The transit system's contribution to roadway maintenance and operating cost.

Annual Lease: State and typical local legislation require the State or local agency to enter into a lease agreement to operate a joint-use facility. These costs are typically insignificant. A typical planning estimate is $12 per space per year but varies from case to case.

Effectiveness Measures

Effectiveness measures relate to benefits for which dollar values cannot be assigned. Typically these relate to quality of life attributes such as level of transportation service and environmental impacts. These measures are presented in the justification report to provide an accurate assessment of the full impacts of the alternative improvements.

VMT Reduction: Reduction of vehicle miles of travel (VMT) is an expected benefit of park-and-ride improvements including HOV facilities, parking lots and garages, and transit service provision. It is normally expressed on an annual basis and in units of one million vehicle miles. Reduced VMT is often a stated objective of the transportation plan in a community. VMT reduction is associated with positive benefits including reduced congestion levels, fuel consumption, and

vehicle emissions. It is used as a basis to develop estimates of these benefits.

Auto Occupancy: Increasing average vehicle occupancies is often a transportation system objective for local areas and is expressed in terms of persons per automobile. Typical occupancies for commute trips range from 1.1 to 1.35 persons per vehicle. A value of 1.2 persons per vehicle is typically used in planning studies in Florida.

Increasing occupancies results from shifting person trips from single-occupant vehicles to carpools and transit. Increased occupancies are associated with other system benefits including decreased vehicle miles of travel (VMT), congestion levels, fuel consumption, and pollutant emissions. Park-and-ride facilities can be expected to positively influence increased vehicle occupancies.

Peak-Hour Level Of Service: This measure is expressed by letter ratings ranging from A to F with A representing unrestrained travel conditions, E representing practical capacity, and F representing system failure. Improved level of highway service is typically a stated objective of local transportation plans. Florida's growth management legislation includes Level of Service objectives. Provision of Level of Service C operations, with D operations in critical circumstances are typical objectives. Many urban facilities operate, or are expected to operate, at Level of Service E or F conditions.

Park-and-ride facilities can have a measurable impact on highway Level of Service; however, the facility must be relatively large and highly utilized. Smaller and lightly used facilities will have a negligible impact on highway level of service.

Air Quality: Measures representing impacts on air quality include annual tons of carbon monoxide, hydrocarbons, and nitrogen oxides, all pollutants produced by automobiles and transit vehicles. As with the previously mentioned effectiveness measures, improvements in air quality is a traditional objective included in most local transportation plans.

Fuel Savings: This measure is presented in millions of gallons of fuel saved. This is another objective often included in local transportation plans. Park-and-ride facilities tend to reduce fuel consumption through reductions in vehicles from the road. Larger facilities serving limited-access highways might increase fuel consumption of those vehicles remaining on the road because fuel efficiency decreases with speed increases at operating speeds over 35 mph.

Transit Readership: This measure is presented on an annual basis and may be expressed in millions

for larger systems. Increasing transit readership is an objective of many local transportation plans, particularly those in larger urban areas where adding road capacity is becoming increasingly prohibitive cost-wise. This objective is only relevant to park-and-ride improvements where transit service is planned.

ECONOMIC ANALYSIS OF PARK-AND-RIDE IMPROVEMENTS

The economic analysis of park-and-ride improvements should follow a series of steps. The process contained in the AASHTO Red Book [37] has been adopted by the Department as the prescribed procedure for analyzing construction projects. The series of steps contained in this procedure are presented in the following and include:

- Update cost factors
- Select economy study features
- Describe project characteristics and estimate project costs
- Calculate annual transit operating costs
- Calculate unit user costs and transit user costs
- Calculate user benefits
- Estimate residual value
- Determine present values and economic desirability

Cost Updates

Unit costs associated with users, construction, and operation should be updated to maintain consistency with the Department's latest cost values. AASHTO recommends that these unit costs should be updated approximately every two years or when price levels fluctuate by more than 20 percent [37].

Recommended updating procedures include use of either average or commodity-specific consumer and wholesale price indices to factor base unit rates to the new time basis.

Study Features

Critical features of the economic study include the discount rate, value of travel time, analysis period, and study years. Discount rates are used to compute present values of economic investment and user costs. Typically, a discount rate of 4 to 5 percent is employed for economic study of transportation projects.

As mentioned above, the economic value of time spent commuting is computed through the use of a value-of-time factor. The value of time for the work trip purpose is traditionally used and is particularly appropriate for the analysis of park-and-ride improvements since the associated impacts are realized during commuting hours. The value of commuter travel time has been found to range from 20 to 40 percent of the commuter's income [36]. A value of $5 per hour is typically used in economic analyses of transportation improvements.

The selected analysis period for the study should be consistent with the economic life of the improvement. Different components of the improvement will have differing life cycles. Standard

economic life values used by the Department include 60 years for right-of-way; 40 years for earthwork, drainage systems, and structures; and 20 years for pavements and base course. Life cycle lengths for transit vehicles can be assumed to be 15 years unless better information is available. Table 6-2 presents appropriate economic lives for the types of park-and-ride improvements considered here.

Table 6-2. Economic Life Cycles for Park-and-Ride Improvements

Improvement	Life Cycle
HOV-Related Facility	20+ years
Fixed- Guideway Facility	20+ years
Express Bus Facility	15 years
Isolated Facility	20 years
Expansion on Adjacent ROW	20 years
Structure on Existing ROW	40 years
Modification of Existing Design	15 years
Joint-Development	5 years
Provision of Transit Services	15 years

Note:ROW = Right-of-way
HOV = High-occupancy vehicle

The selection of study years allows for the simplification of estimating the annual values of user benefits and project costs over the length of analysis period. Typically, two years are selected; the base year and some future year. Annual costs are then interpolated between the two study years. A 20 year planning horizon is a traditional future study year. The future planning year should be selected based on considerations of the economic life of the project and the available years of travel forecasts.

Project Description and Costs

The proposed improvement alternatives should be defined in sufficient detail to estimate the project and user costs. Different analysis sections should be identified to estimate costs related to HOV facilities only. Sections should be defined by length, gradients, curvature, and speed change characteristics.

The length of the travel path between the park-and-ride facility and the major destination areas should be identified and segmented into sections representing congested freeway, uncongested freeway, congested arterial, and uncongested arterial roadway. Chapter 5 presents methods for determining these classifications of roadways in computing facility impacts related to travel time, fuel consumption, and vehicle emissions.

The project cost components relevant to the particular improvement alternatives under study are presented in Table 6-1 above. To summarize, these costs are associated with:

- Design
- Right-of-way

- Construction
- Maintenance
- Operation
- Transit capital

Operation and maintenance costs should be expressed on an annual basis.

Transit Costs

Transit costs are treated in two categories: capital costs and operations and maintenance (O&M) costs. The level of transit service and related number of additional vehicles must be defined to derive these costs. This information includes route miles, frequencies, and operating speeds.

Capital costs relate to investments in fixed facilities including rolling stock, benches, shelters, and route signs. Costs associated with HOV lane construction or physical improvements at the park-and-ride facility are included in the project costs discussed in the preceding section. O&M costs relate to operating and maintaining the service to the park-and-ride facility and includes driver wages and fringes, vehicle operations costs, and labor and parts associated with bus maintenance. The following formula, recommended by AASHTO [37], can be used to compute annual operating costs for transit service provided to the park-and-ride facility:

$$\text{Operating Cost (millions)} = 2.37 * Q^{1.1013} * H^{0.785} * S^{-0.862} * \exp(0.002 * P)$$

where:

Q = Annual bus miles
H = Drivers hourly wages and fringe benefits
S = Average running speed in mph
P = Vehicle seating capacity

This equation reduces to the following formula for an assumed wage/fringe rate of $20/hour and 45 seat bus:

$$\text{Operating Cost (millions)} = 27.24 * Q^{1.1013} * S^{-0.862}$$

User Costs

Relevant user costs related to park-and-ride facility improvements include costs associated with travel time, vehicle operation, accidents, parking charges, and transit fares. These costs are required on an annual basis. Data required for these computations are estimates of demand and/or transit usage, average operating speeds, and VMT. Chapters 4 and 5 present methods for computing these data. As mentioned earlier, current cost data should be used when available. Table 6-3 presents default values which may be used in lieu of available local data.

Total annual costs are developed by multiplying the appropriate cost factors times the annual VMT or person hours of travel. These costs are computed for each alternative including the do nothing alternative.

Table 6-3. User Cost Default Values
(1989 dollars)

Cost Element	Value
Travel time[1]	$5/hour
Vehicle operation[2]	$0.20/vehicle mile
Accidents[3]	
•-Freeways	$0.35/vehicle mile
--Arterials	$3.60/vehicle mile

[1]Reference 36
[2]Reference 38
[3]Reference 34

User Benefits

User benefits are defined as the annual savings in travel time, vehicle operation, accident, parking, and transit fare costs which users realize through the implementation of an improvement. This calculation is represented by the following formula:

Benefit (annual) = $UC_0 - UC_1$

where:

UC_0 = Total user costs for Alternative 0 which is typically the do nothing alternative.

UC_1 = Total user costs for Alternative 1

Residual Value

Residual value represents the economic value of an improvement at the end of the analysis period. Residual values will be of concern in relation to parking facility land and rolling stock for the types of park-and-ride improvements considered in this chapter. Any costs associated with disposal of a property should be subtracted from the market value at the end of the analysis period.

The approach for computing residual value is to take the full cost of the land, subtract the disposal costs, and add the proportion of the remaining useful life of structures and earthwork times their cost.

Present Values and Economic Evaluation

The Department procedure for this final step is to bring all costs to an annual basis and compute an annual incremental benefit/cost ratio for each improvement alternative versus the base case alternative. User benefits are expressed on an annual basis. A capital recovery factor (CR) based on the discount rate is used to convert the present worth of construction and equipment to annual basis. An appropriate sinking fund factor (SF) based on the discount rate is applied to convert future residual values to an annual basis. Equations for these factors are as follows:

$$CR = i(1 + i)^n/[(1 + i)^n - 1]$$

$$SF = i / [(1 + i)^n - 1]$$

where:

CR = Capital recovery factor
SF = Sinking fund factor
i = Discount rate
n = Analysis period in years

The annual cost of each alternative is computed as follows:

$PC_i = 0\&M_i + CR * CC_i + SF * RC_i$

where:

PC_i = Annualized total project cost for alternative 1
$0\&M_i$ = Total annual operation and maintenance costs including transit, highway, and park-and-ride facility costs for alternative I
CC_i = Total annualized capital costs including fixed facilities and rolling stock for alternative I
RC_i = Total annualized residual values for all salvageable property and rolling stock at the end of the analysis period for alternative I
CR = Capital recovery factor
SF = Sinking fund factor

The following formula is used to compute the benefit/cost ratio for an improvement:

$B/C_x = UC_x / PC_x$

where:

B/C_x = Benefit/cost ratio for alternative x
Uc_x = Annual user cost for alternative x
PC_x = Annualized project cost for alternative x

An incremental benefit/cost ratio is used to analyze the expenditure of additional increments of capital cost with resultant gain in benefits. This can be performed in situations where several improvement alternates are under consideration. The following formula is used to compute the incremental benefit/cost ratio for two alternatives:

$B/C_{x-y} = (UC_y - UC_x)/(PC_y - PC_x)$

where:

B/C_{x-y} = Incremental benefit/cost ratio for alternative y as compared to alternative x
UC_x = Annual user cost for alternative x
UC_y = Annual user cost for alternative y
PC_x = Annualized project cost for alternative x
PC_y = Annualized project cost for alternative y

CHAPTER 7: CONCEPTUAL DESIGN CONSIDERATIONS

The vast majority of Florida park-and-ride facilities are small. Of non-Metrorail (Dade County) parking facilities, less than six percent have capacities larger than 300 spaces while almost 75 percent have capacities at or under 100 spaces. In addition to this, most park-and-ride facilities are planned for free operation, resulting in facilities that do not cover their own capital, operation and maintenance cost. These situations should not influence the designer to avoid basic design requirements for the purposes of minimizing design and construction costs. The size of economics of a park-and-ride facility do not justify inadequately addressing design-related problems in the facility design.

The facility design should strive for the following objectives:

- Safe and efficient movement of all modes using the facility.
- Accommodation of transit, carpool, vanpool, pedestrians, motorized cycles, and bicycles both on and adjacent to the site as warranted.
- Provision of an adequate number of parking spaces.
- Provision of user comfort and attractiveness.
- Accommodation of elderly and handicapped.

In order to assist in meeting these objectives, the following sections provide a checklist of design features which should be considered the preliminary engineering and design effort for a facility. This material was originally presented in Working Paper 4: Facility Analysis [2].

No attempt is made to provide specific design criteria for park-and-ride lot features such as turning radii, pavement thickness, driveways, median opening, parking space dimensions, etc. References which can be found in the bibliography address design standards and criteria [39,40,41,42,43,44,45,46,47,48,49, 57].

EXTERNAL FEATURES

The design of park-and-ride facilities should consider a number of factors related to the interface between the internal facility operation and the external street network. The external features include:

- Access/egress
- On-street bus stops and pullouts
- Traffic control devices
- Guide signage

Access/Egress Considerations

Table 7-1 presents a number of factors related to the proper design of facility access. These factors have been grouped into categories related to the objectives of a park-and-ride facility design:

- Efficient and convenient access
- Minimal impact on adjacent road operations
- Safety
- Proper design practice

While adequate access was suggested earlier to be an important site selection criterion, the final selection of a site may be influenced by other factors such as available right-of-way. In such situations, the designer will not be working with the ideal conditions so will need to strive to optimize the access design. To effectively do this, a traffic engineering study should be performed to evaluate capacity conditions at potential lot access driveways and at critical locations on adjacent access roadways. During the planning process for the site, estimates of demand by direction of access would be developed. These will provide the traffic engineer with estimates of traffic volumes anticipated to use each segment of the road system under evaluation.

Off-Site Bus Access

The selection of where to locate bus stops, either off-site or on-site should be made only after evaluation of a number of factors which effect the decision. These factors include:

- Lot configuration and loss of parking space.
- Ease of transfer including consideration of the distance from parked vehicles to the bus stop.
- Ease of adding additional time to the operating schedules of those bus routes serving the park-and-ride facility. This aspect of the site design should be closely coordinated with the local transit agency.
- The amount of on-site space which can be used for bus bays, storage areas, drives, shelters, and benches as well as passenger walking and waiting areas.
- The type of stop which could be developed on-street; on-street loading/unloading versus bus pullout. This will be based on the design policies of the constructing authority, operating policy of the bus operator, volume of automobile traffic, location of the stop in relation to nearby intersections, and the frequency of service.
- The amount and cost of right-of-way required and available for development of an on-street pullout.

Table 7-1. Facility Access/Egress Design Factors

Design Factors			
EFFICIENT ACCESS	IMPACTS TO ADJACENT ROADS	SAFETY	DESIGN STANDARDS/PRACTICE
The design should strive to minimize the time to change modes which includes facility access time.	Capacity analyses should be performed to minimize the traffic impacts on the adjacent highway network.	The design should maximize safety for the purposes of protecting the public and reducing liability risks.	Field observation of traffic operations in vicinity of the site should be performed before deciding on access locations and design.
The design should attempt to provide for direct approach and easy entrance and exit to the facility.	The location and design of access driveways should strive to minimize the increase in congestion of adjacent roads served by the lot.	Entrances/exits should be located as to avoid locations near structures, decision points, and termination of lighting].	The number and design of facility exits should be based on a maximum of 300 vehicles per lane per hour.
Whenever possible the facility entrance should be located on the right side of inbound traffic. If this not be possible, special left-turn signals and adequate storage bays should be considered.	Where possible, locate access points with relation to shopping centers, theaters and other land uses with peak trip generation not occurring during peak commute times.	The design should provide for adequate sight distances for entrance, exit and crossing maneuvers[1].	The design should conform with local, FDOT and AASHTO design criteria.
The most efficient access to a facility is via a collector intersecting the adjacent arterial at a signalized intersection. This eliminates the need for driveways and reduces conflicts on the arterial.	The design of entrances/exits should not result in a major conflict point on access roads.	Entrance/exit locations should provide for adequate weaving, merging, and lane change distances.	The AM peak hour is critical for entrance design while the PM peak hour is the critical operating period for exit design.
Access points should be located as to avoid queues from nearby intersections or freeway interchanges.	Do not place entrances/exits near signalized intersections or other points that would cause a conflict.	The location of facility exits related to adjacent intersections should be such that signal control exit can be reasonably installed at later time should such control not be presently warranted.	
The design should accommodate all modes anticipated to access the facility including passenger automobiles, buses, bicycles, and pedestrians. This relates to roadway widths, turning radii and separation of non-vehicular and vehicular traffic.	The design should provide for adequate storage for all entering and exiting movements.	Plane entrances/exits so as to discourage •cutting through• movements.	
For lots over 300 spaces, a minimum of two exits and two entrances is recommended. For lots over 1000 spaces, provision of entrances and exits on two adjacent streets is recommended to reduce traffic congestion and to provide for more efficient dispersment of traffic.	New signal on arterial considered only if shown that there will not be significant delay added to traffic.	The resign should strive for separate access points for the different arrival modes anticipated to use the facility.	
	Entrances should be downstream of signalized intersection.	Separate one-way entrance and exit drives should be considered to reduce conflicts.	

[1](Reference 39).

Table 7-2 presents factors which need to be considered when designing an off-site, on street bus stop. Factors related to on-site development are presented later. The factors presented in Table 7-2 are related to vehicle maneuverability, safety, and design guidelines which should be considered in the conceptual design of the facility.

Table 7-2. Off-Site, On-Street Bus Stop Design Factors

1. Careful consideration of traffic volumes and the effects of stopping buses on traffic flows and roadway capacity must be given when considering having buses stop in the traveled way of a street.
2. Transit operators generally prefer to have the stop located as close as possible to the riders' ultimate destination so the rider does not have to walk long distances or cross the street.
3. Far-side bus stops are preferred from traffic operations and safety standpoints since they provide for greater pedestrian safety, reduce conflicts with right-turning vehicles, and provide for better sight distance conditions particularly at unsignalized intersections.
4. Near-side bus stops are preferred from a transit operations standpoint because loading/unloading operations can coincide with the red phase and it allows for buses to make right turns at the intersection.
5. Mid-block stops may require pedestrian crosswalks and special signals.
6. At least one block should be provided between the stop and the next left turn location.
7. Bus pullouts should be considered for roads with high traffic volumes.
8. Bus pullouts have the advantage of separating the bus from other traffic.
9. Bus pullouts require a minimum and optimum right-of-way of 10 and 12 feet, respectively. Pullouts can be designed in 2,400 to 3,000 square feet of right-of-way.
10. User amenities including benches and shelters should be installed.
11. Route signing should be incorporated into the signing plan. Schedule information signs should be considered. The placing of these signs will need coordination with the local transit agency.
12. On-street bus pullouts require special signing and marking.
13. On-street bus pullouts should not be located in right-turn lanes. Also they should be avoided in curb lanes which carry a heavy volume of right-turning traffic.
14. Drainage should be designed to avoid passengers walking through water to access the transit vehicle.

Traffic Control Devices

Traffic control devices relevant to park-and-ride facilities include signals, regulatory signs, pavement markings, and channelization. The proper control should be developed from traffic engineering analyses of access drives to the facility as well as nearby intersections which will be significantly affected by facility traffic. The design and application of traffic control devices should conform with the Manual on Uniform Traffic Control Devices (MUTCD)[44].

Table 7-3 presents a series of consideration relevant to the design of traffic control devices external to the park-and-ride facility. It is noted that stop signs are the only control devices installed at most of the existing facilities in Florida. This is a function of the size of the lots and their location. However, more elaborate traffic control devices should be considered when designing facilities with large numbers of spaces, higher expected usage, and placed on congested arterials.

Table 7-3. Facility Traffic Control Device Design Factors

1. Traffic signals, traffic signs, pavement markings, and traffic divisional and channelizing islands should be designed in conformance with the latest edition of the Manual on Uniform Traffic Control Devices [44]
2. The planning and design of traffic control devices should be carried out in conjunction with the overall design of the street or highway. The devices and procedures utilized for traffic control should be predicated upon developing uniformity throughout the system and compatibility with adjacent jurisdictions[3].
3. Signals should be considered only after a thorough study of traffic in the area and should be warranted or justified in a manner prescribed in the Manual on Uniform Traffic Control Devices.
4. Timing/phasing adjustments to existing signals may be required to accommodate park and ride traffic.
5. Traffic signals at park and ride facilities are the exception, not the rule.
6. A minimum requirement for park and ride facility is stop signs and stop lines, double yellow centerline, and turn-lane markings for exits onto public roadways.

[3]Reference 39

One consideration particularly relevant to park-and-ride lots is the special traffic control requirements for transit operations. The designer can expect that an operator will not permit a bus to make a left turn across a high-volume arterial into/out of a facility without a traffic signal. Close coordination with the local transit agency is recommended should bus service be desired for a facility.

Guide Signs

Guide signs or park-and-ride facilities act not only to guide users but also to promote the lot. The placement of signs should intercept users on their normal paths and guide them directly to the facility. The signs should be in conformance with the Manual on Uniform Traffic Control Devices [44].

Table 7-4 presents factors which should be considered in developing guide signage plans for park-and-ride facilities.

Table 7-4. Guide Sign Design Factors

1. All guide signs should conform with the latest edition of the Manual on Uniform Traffic Control Devices [44] which incorporates flexibility for signing special situations, services, and inclusion of special logos. However, standard signs should always be used for driver expectancy and for reducing maintenance costs.
2. Location should relate to the influence zone(s) from which potential users are expected to be generated. Location should intercept potential users on their normal travel path and guide them directly to the facility.
3. Signing placement should assume the motorist does not know where he is going. Guide signs should be placed at all decision points, far enough in advance to allow for adequate distance to maneuver to that point.
4. Continuity of guide signing is critical. Guide signs should lead the motorist through decision points to the destination.
5. Guide signs should be placed on all approaches to the facility, even on approaches usually considered to service travel opposite to the predominate direction.
6. Consideration of signing should include concern for the function of the lot. For example, rail stations with park and ride should have park and ride messages on the station guide signs.

INTERNAL LOT DESIGN

The design of the internal components of a park-and-ride facility will depend on the modes expected to use the facility and the size and configuration of the site. Certain components will have more or less importance depending on the function and use of the facility. As an example, bus stops are generally not needed at remote facilities since bus service is seldom provided in rural areas. Some components may need to be drastically modified from or eliminated all together if the site can not accommodate the ideal design. For instance, landscaping may need to be sacrificed at a site which is barely large enough to accommodate the required number of parking spaces.

The internal components of the park-and-ride facility which should be considered by the designer include the following:

- Site layout and internal circulation
- Parking layout
- Transit terminal facilities
- Pavement and drainage
- Signing/Marking
- Landscaping
- Security
- Boundary Identification
- User amenities

Each of these components are addressed in the following subsections.

Site Layout/Internal Circulation

Internal circulation is one of the most critical elements determining the successful design of a park-and-ride facility. The site layout should provide for safe, rapid parking and related movements, minimization of conflicts between motor vehicles and pedestrians, and optimization of space. Table 7-5 presents the concepts which should be considered by the designer/site planner.

Table 7-5. Internal Circulation Design Concepts

1) Transfer terminals should be located either in a central location with the parking areas for the various user modes surrounding it or at one end with the user mode parking areas extending radially from the terminal.
2) The facilities layout should strive to minimize access/egress times for transit, paratransit, and kiss-and-ride vehicles.
3) The system of circulation produced by the arrangement of parking aisles and stalls should be designed to minimize travel distances, conflicting movements, and number of turns.
4) Major circulation routes which are located at the periphery of the facility minimizes vehicle/pedestrian conflicts.
5) Mixing of automobile and bus traffic should be avoided if possible.
6) One-way, two-lane circulation roads permit passing of stopped transit vehicles and are desirable where buses and autos cannot be separated.
7) The layout of parking areas in regard to closeness to a transfer terminal should be given in order of 1) handicapped, 2) kiss-and-ride and taxis, 3) short-term parking, and 4) long-term parking.
8) The maximum reasonable walking distance is 1000 feet. Longer walking distances may require consideration of additional loading zones.
9) Parking aisles should be oriented to the transfer terminal to provide for convenient pedestrian movement through the facility.
10) Separate facility entrances and exits are preferred. Otherwise, a traffic island or pavement markings separating exiting and entering vehicles should be provided.
11) Generally, no more than 30 spaces should be provided without a cross aisle to move to exits or other parking spaces or to bypass disabled vehicles.
12) Reservoir areas which do not conflict with circulation patterns and parking maneuvers should be provided at exits for storage of exiting vehicles.
13) Circulating roadways should not be located close to exits/entrances to prevent congestion both on- and off-site.
14) Drivers should not be confronted with multiple decisions at the same point in the circulation system.
15) The single-unit bus should be used as the design vehicle for turning radii and circulating roadways unless specifications for an articulated bus are required.

Parking Layout

The parking layout is another critical feature of a successful facility design. The designer will need to address up to four of the following types of parking areas in the site layout:

1) Handicapped parking
C) Kiss-and-ride parking
C) Short-term parking
C) Standard park-and-ride parking

This list provides a hierarchy whereby locational preference on the site is given in the above order. The above four types of parking were found during the survey of Florida park and-ride facilities conducted during this study.

The purpose of providing handicapped parking is for reasons of safety, convenience in accessing the vehicle, and in providing easier access to transfer stations. The handicapped generally require more space around the vehicle to get in and out of it. Also, some handicapped people may suffer great difficulty in traversing distances which the non-handicapped would not give a second thought

to.Handicapped parking is also required under the Americans with Disabilities Act (ADA.)

The layout of handicapped parking must consider the location, number of spaces, space size. The location of handicapped parking spaces should be near transit transfer areas for facilities served by transit. Otherwise, the designer needs to balance convenience to facility access points, convenience in maneuvering the vehicle into and out of the parking space, and the amount of traffic in aisles adjacent to the handicapped spaces. ADA [50] requires that handicapped spaces be located adjacent to facility exits. This is reasonable provided a transfer terminal is not located on the site.

Other factors which must be incorporated into the layout of handicapped parking include:

- No access roads should be crossed by handicapped people in moving from their vehicle to a transfer terminal.
- The handicapped must never be forced to circulate behind parked vehicles.
- Wheelchair ramps and curb ramps must be provided if platforms or curbs must be negotiated by the handicapped.

AASHTO [7] has developed guidelines for selecting the number of handicapped parking stalls demarcated at public transfer facilities. These are presented in Table 7-6. ITE [50] suggests that four percent of the total number of spaces within a facility, with a maximum of nine or 10 should designated for the handicapped. This is comparable to the AASHTO recommendation. The designer should also attempt to conform to local site development codes; however, such codes will seldom address handicapped requirements specifically for park-and-ride facilities.

In sizing handicapped parking stalls, the designer should use a lift-equipped van as the design vehicle. Stall dimensions are contained in local code requirements which should be conformed to. Recommended stall sizes vary and typically range from 9x18 to 10x20. Smaller size stalls should have marked areas between stalls to facilitate access of the vehicle. AASHTO [7] recommends a width of eight feet plus five feet clear zone between vehicles to allow for vehicle access. ITE [50] recommends an 9x18 stall size with four foot strips marked between stalls.

Table 7-6. AASHTO Handicapped Parking Recommendations

Total Parking Spaces	Minimum Handicapped Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2%
over 1000	20 plus 1 for each 100 over 1000

(Reference 7)

Handicapped spaces should be marked with a sign at least four feet high at the head of each stall. Also, the handicapped symbol pavement marking may be provided. The color of handicapped pavement markings is usually white; however, light blue is being used more and more to delineate handicapped spaces. Light blue provides for greater delineation of handicapped parking areas than does the color white.

Kiss-and-ride parking should be located to provide for easy and safe access to the transit terminal or bus loading zone if these exist at the facility. Kiss-and-ride traffic should be separated from transit and normal park-and-ride traffic to the greatest degree possible in order to reduce conflicts and increase safety. Consideration should be given to one-way operation in the kiss-and-ride area as well as for pull-through parking, angled at 45 degrees, and facing in the direction of the transit station.

Short-term parking was found to be given special definition at facilities located in Hillsborough County. Short-term parking areas were located next to kiss-and-ride areas but further away from the transit terminal. The purposes for providing short-term parking at a park-and-ride facility is to promote the use of transit as well as to provide joint use of the facility. Short-term parkers are permitted to use the lot to access nearby establishments; however, their use is controlled by placing a restriction on the amount of time they can park.
Since park-and-ride facilities are typically established to promote commuter usage, the establishment of short-term parking on it's own is questionable. However, provision of such parking may prove beneficial to having the facility accepted by area businesses. In fact, the park-and-ride lot located in Century, Florida (Pensacola area) is looked upon with great pride by the town officials and business community.

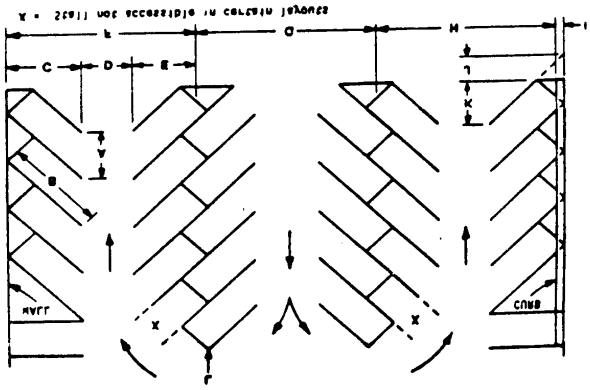
The layout of long-term parking areas can be designed in much the same manner as other parking facilities. The designer should consider maximization of parking spaces, circulation in the parking

area, and parking dimensions. The alignment of parking rows should be in the direction of the longest dimension of the site. This results in less space being used for aisles and more for parking spaces. This becomes less critical as the lot width dimension approaches the lot length dimension for the rectangularly-shaped site.

Generally, 10-degree parking is preferred over angle parking for safety and user convenience reasons [7]. 90-degree parking is generally the most efficient as measured by square feet per space. Aisles should be one-way with angle parking and two-way for 90 degree parking. Parking angles between 75 and 90 degrees should be avoided since it will become difficult to maintain one-way aisle operation. Aisles should be aligned to facilitate convenient pedestrian movement toward the bus loading zone. Aisle lengths should not exceed 400 feet if possible. One-way aisles should favor counter-clockwise circulation. Head-in parking only should be promoted.

Stall sizes should conform to the 9 x 18.5, 90-degree standard or 8 x 16, 90-degree compact dimensions. Figure 7-1 presents dimensions for stall elements for these two standard sizes at various angles of parking. The smaller 8.5 x 16 size can be considered; however, experience has shown that substandard stall and aisle sizes provide a false economy of space since cars will encroach on adjacent spaces making one or more unavailable for use in a given parking row.

Mixing standard vehicle and compact vehicle stall sizes can provide for a greater number of spaces on a site. In order to realize this efficiency, however, compact parking must be given a preference and located in locations convenient to the user. Otherwise, compact cars will be parked in standard size stalls which effectively reduces the number of useful spaces. It should be noted that the trend is to provide only standard size stalls s because of the difficulty of preventing parking of standard sized vehicles in compact spaces.



Parking Layout Dimensions (in feet) for 8-ft. Stalls at Various Angles

Dimension (feet)	Diagram	Angle			
		45°	60°	75°	90°
Stall width, parallel to aisle	A	11.3	8.9	8.3	8.0
Stall length of line	B	16.8	19.1	19.5	18.0
Stall depth of wall	C	12.5	18.2	18.9	18.0
Aisle width between stall lines	D	13.0	13.2	19.2	22.0
Stall depth, interlock	E	13.3	12.5	18.3	18.0
Module, wall to interlock	F	40.2	43.3	57.1	54.0
Module, interlocking	G	38.8	49.4	55.1	54.0
Module, interlock to curb face	H	38.2	45.9	50.3	51.2
Bumper overhang (typical)	I	2.0	2.3	2.2	2.2
Offset	J	4.4	3.4	0.0	0.0
Setback	K	9.2	5.7	4.4	0.0
Cross aisle, one-way	L	15.0	15.0	15.0	15.0
Cross aisle, two-way	—	22.0	22.0	22.0	22.0

Parking Layout Dimensions (in feet) for 9-ft. Stalls at Various Angles

Dimension (feet)	Diagram	Angle			
		45°	60°	75°	90°
Stall width, parallel to aisle	A	15.7	10.4	9.3	9.0
Stall length of line	B	23.0	22.0	20.0	18.2
Stall depth of wall	C	17.2	19.1	19.2	18.2
Aisle width between stall lines	D	13.0	16.0	22.0	26.0
Stall depth, interlock	E	12.3	17.2	18.8	18.2
Module, wall to interlock	F	44.8	52.2	61.3	63.0
Module, interlocking	G	43.8	51.0	61.0	63.0
Module, interlock to curb face	H	43.8	50.3	58.8	60.2
Bumper overhang (typical)	I	2.0	2.3	2.2	2.2
Offset	J	3.3	5.7	0.2	0.0
Setback	K	11.0	8.8	2.0	0.0
Cross aisle, one-way	L	14.0	14.0	14.0	14.0
Cross aisle, two-way	—	24.0	24.0	24.0	24.0

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Figure 7-1. Parking Stall Layout Dimensions
(Reference 7)

Figure 7-1 - (Text Addendum)
Parking Layout Dimensions (in feet) for 8-ft. Stalls at Various Angles

Dimension (feet)	On Diagram	45°	60°	75°	90°
Stall width, parallel to aisle	A	11.3	9.3	8.3	8.0
Stall length of line	B	21.6	19.0	17.3	16.0
Stall depth of wall	C	15.2	16.5	16.9	16.0
Aisle width between stall lines	D	12.0	13.5	19.5	22.0
Stall depth, interlock	E	13.3	15.2	16.3	16.0
Module, wall to interlock	F	40.5	45.2	52.7	54.0
Module, interlocking	G	38.6	43.9	52.1	54.0
Module, interlock to curb face	H	38.5	42.9	50.2	51.5
Bumper overhand (typical)	I	2.0	2.3	2.5	2.5
Offset	J	5.4	2.4	0.5	0.0
Setback	K	9.5	7.2	4.4	0.0
Cross aisle, one-way	L	12.0	12.0	12.0	12.0
Cross aisle, two-way	-	22.0	22.0	22.0	22.0

Parking Layout Dimensions (in feet) for 9-ft. Stalls at Various Angles

Dimension (feet)	On Diagram	45°	60°	75°	90°
Stall width, parallel to aisle	A	12.7	10.4	9.3	9.0
Stall length of line	B	25.0	22.0	20.0	18.5
Stall depth of wall	C	17.5	19.0	19.5	18.5
Aisle width between stall lines	D	12.0	16.0	23.0	26.0
Stall depth, interlock	E	15.3	17.5	18.8	18.5
Module, wall to interlock	F	44.8	52.5	61.3	63.0
Module, interlocking	G	42.6	51.0	61.0	63.0
Module, interlock to curb face	H	42.8	50.2	58.8	60.5
Bumper overhand (typical)	I	2.0	2.3	2.5	2.5
Offset	J	6.3	2.7	0.5	0.0
Setback	K	11.0	8.3	5.0	0.0
Cross aisle, one-way	L	14.0	14.0	14.0	14.0
Cross aisle, two-way	-	24.0	22.0	24.0	24.0

Transit Terminal Facilities

The design of transit transfer terminals within a park-and-ride facility is comprised of two components; the transit vehicle and the passenger. The terminal area should be designed to provide for safe and easy bus operations. Large turning radii should be provided for buses entering and exiting the site. Acute angles should be avoided. Circulation roadways in the terminal area should be two lanes and operated in one direction of travel. A saw tooth design for the bus loading area provides for the easiest operation of buses but is only required for larger terminals with extensive bus service. Reinforced pavement is desirable in the terminal area because of the large wheel loads and higher temperatures.

Passenger amenities which should be considered for the terminal area are shelters, benches, and transit information. Shelters should be provided where bus loadings are heavy, where transit identity is to be promoted, where loading zones are to be located or waiting is to occur, and where the site allows for them [51]. For most park-and-ride lots with transit service, a minimum design will be adequate. However, larger transfer points may require consideration of more significant structures. Shelters at existing Florida facilities range from simple mass-produced plexiglass units to full-scale concrete structures.

Generally, the need for a shelter increases with the demand and the headway between transit vehicles. A rule of thumb is that a shelter is required if 100 or more users per day will transfer to bus and where total person waiting time is greater than 500 minutes [50].

The size of shelter required at a park-and-ride facility is dependent on the maximum accumulation of users at the transfer terminal. Size requirements should be based on eight square feet per person. For conceptual design purposes, the shelter size requirement can be assumed to be 25 square feet per 100 space facility. This is based on the following
assumptions:

- Eight square feet per shelter user.
- The number of kiss and ride drop offs is equivalent to 0.20 times the parking spaces in the facility.
- The average wait time is 10 minutes.

Shelter modules can be purchased in standard sizes of 10 to 12 feet in length, five to seven feet in width, and seven to eight feet in height. These provide 50 to 72 square feet of covered area which is generally adequate for most installations. At larger park-and-ride lots, such as the Golden Glades lot in Miami and the Yukon Street Terminal in Tampa, concrete structures may be considered. Design decisions should be based on the number of vehicles parked at one time, the number of passengers, bus frequency, weather, and funding.

Shelters should be of contemporary design, constructed of highly durable materials, highly visible, provide ample weather protection, and should minimize installation and maintenance cost. The characteristics of shelter design should include the following:

- **Visibility:** Provides for user safety. The user should be able to see an approaching bus from inside the shelter.
- **Accessibility:** Shelters should have a minimum of two access points to provide for convenient access and user safety. Each opening should be at least 2 • feet wide.
- **Appearance:** Shelters should be visually pleasing and blend with the surrounding environment. The logo of the local transit agency should be clearly placed on the shelter.
- **Materials:** Typical construction materials include steel, anodized aluminum, wood, concrete and tile block, reinforced concrete, fiber glass, plastics, and glass. Cost, durability, availability and appearance should guide the decision on construction materials.
- **Modular Construction:** Modular construction facilitates capacity expansion, uniformity of

design, and can reduce costs.

- **Amenities:** Protection from the weather and benches are minimum requirements. Other features can include transit route maps, transit schedules, lighting, telephones, and trash receptacles.

Levinson, et al [51] suggests that a minimum service life for shelters should be 15 years. Typical unit costs range from $35 to $55 per square foot, or approximately $2,500 to $5,000 per unit. Annual maintenance and repair costs can range up to $750 per unit.

Pavement and Drainage

The design of pavements for park-and-ride facilities should conform to the Department's •Greenbook• standards [38]. That document also refers the designer to standards set forth in the following documents:

- FDOT •Flexible Pavement Design Manual• [46] referred to for design of flexible pavements.
- AASHTO •Interim Guide for Design of Pavement Structures• [47] referred to for design of rigid pavements.
- Publications by the Asphalt Institute, Portland Cement Association and the American Concrete Pavement Association for other design standards as determined applicable by the design professional.

The following considerations must be taken into account when designing park-and-ride facility pavement:

- **Drainage:** Must conform to State and local design standards. Standing and flowing water should be avoided in areas where pedestrians walk or stand. Local codes related to on-site retention of storm runoff should be conformed with.
- **Drains:** Should be designed to withstand the maximum expected wheel loadings (transit or maintenance vehicles), be maintenance free, vandal-proof, and have short, narrow openings placed perpendicular to traffic to minimize the hazard to pedestrians and bicyclists.
- **Pavement Types:** Up to three different types of pavements will be needed for a facility. The heaviest load carrying pavement is needed for bus drives, loops, and loading areas. Rigid pavements are recommended for bus layover and loading areas because of the high static wheel loads and high temperatures. Light load carrying pavement is needed for internal circulation roadways, aisles, and kiss-and-ride roadways. The lightest load carrying pavement would be used for car parking areas and bike paths.
- **Widths:** Minimum widths of 12 feet on tangents and 15 feet on curves are recommended for roadways carrying transit vehicles. Minimum widths for bike paths are five feet for one-way paths and eight feet for two-way paths. The maximum design speed for bike paths in a park-ride facility is 10 mph. Refer to the FDOT •Bicycle Facilities Planning and Design Manual• [48] for proper design standards.

Signing/Marking

Within the park-and-ride facility, different types of signing may be required including:

- Guide signs to direct vehicles to kiss-and-ride parking and drop-off areas, handicapped parking, and bicycle paths and parking areas.
- Guide signs to direct traffic to facility exits which is particularly applicable to large lots.
- Regulatory and warning signs to control traffic on roadways particularly at locations where vehicular/pedestrian/bicycle conflicts are anticipated.
- Regulatory signs to prohibit unauthorized use.
- Parking restriction signs including handicapped parking, no parking zones, short-term parking durations, bus stop, tow-away zones, overnight parking prohibition, etc.
- Information signs describing transit information, proper use of the facility, declarations of liability responsibility, or construction funding information particularly if Federal funds were used.
- Information signs indicating the responsible administrating agency which helps to reduce unauthorized use of the facility.
- Information signs identifying specific section of a large lot to facilitate vehicle retrieval.

Recommended practice is to conform with the MUTCD [44] standards to the degree possible. Where particular signs applicable to park-and-ride facilities are not contained in the MUTCD, consistency and conformity to local applications should be practiced.

Pavement markings within the facility are used to control traffic and provide for orderly parking of vehicles. Except for those markings associated with parking, all markings should be reflectorized and conform to MUTCD standards. The types of pavement markings which are applicable to the park-and-ride facility include the following:

- Centerlines, lane separation lines and channelizing lines.
- Stop lines.
- Symbol arrows
- Pedestrian crosswalks.
- Parking space demarcation lines.
- Handicapped parking symbol markings.

Pedestrian Crosswalks may require a higher degree of demarcation than at typical urban intersections. One reason is that pedestrians may be crossing roadways at unexpected locations. Another is that motorist attention may be diverted away from the traveled way because of attempting to locate suitable parking spaces or fellow car-poolers. In addition, more clearly demarcated crosswalks near transit transfer stations on the site help to better define the station, making it a safer facility.

Landscaping

Landscaping is important for aesthetic as well as ecological reasons and helps to better balance the facility in its surrounding environment. Landscaping which creates a park-like environment was

considered important by a FDOT District program administrator. A lot with well-maintained landscaping can increase the perception of security while poorly maintained landscaping will certainly have the opposite effect.

Plantings used at park-and-ride facilities should be clean, long lasting, reasonably decorative, and most of all, hardy. These plants must be able to tolerate shade, wind, pollution, poor water and soil conditions, and exhaust fumes. Plants with wide-spreading thorns or branches which may snag clothing, as well as plants which drop berries or sap that can damage car finishes should not be used. The results of a considerable research effort into landscaping of transit transfer facilities has been published in •Transit Planting: A Manual• [49] and should be utilized in the landscape design for a park-and-ride facility.

- Landscaping should not obscure visibility between the lot and adjacent roadways in order to maximize perceptions of security.
- Landscaping should be compatible with the site's surroundings.
- Plantings and their placement should not interfere with lighting of the facility, the proper placement of traffic control devices, the ability of pedestrians to use the facility, and the safe line-of-sight of motorists.
- Trees provide shade and visual interest, reduce glare, and are less costly to maintain than shrubs and ground cover.
- The design should minimize places where vandals can hide.
- Landscaping is effective for establishing walking patterns within the site.
- Sufficient set back must be provided so that vehicle overhang does not injure or kill the plants or block sprinklers. Also, maintenance can take place while cars are parked.
- Extreme care should be exercised in placing plantings near entrances/exits so that sight distances are not restricted. Plants with limited growth patterns should be used in such areas so that sight distances do not become restricted as the plant matures.
- Swales, berms, and mounds provide a low-cost means for providing screening, delineation, visual interest, and drainage.

Security

Security at park-and-ride facilities is best maximized through the site selection. However, there are a number of design features which can provide for increased security including:

- adequate illumination,
- fencing,
- number and location of access points,
- visibility from adjacent roadways,
- selection of construction materials,
- careful design of landscaping,
- minimizing places for vandals to hide on the site,
- selection of the types of amenities located at the site, and
- control over non-authorized use of the facility, e.g., parking trucks, abandoned vehicles, dumping trash, etc.

Boundary Identification
Boundary identification is important primarily from the standpoint of minimizing unauthorized use of the facility. This is more likely a larger issue for joint use lots than free-standing facilities. Materials which have been used to delineate park-and-ride spaces from adjacent areas include fencing, plantings such as hedges, delineator posts, concrete or bituminous curbs, railroad ties, and concrete bumpers.

User Amenities
Design elements included in the amenities category include trash receptacles, telephones, shelters, bicycle/motorcycle parking areas and newspaper racks. While not considered essential to proper facility design, these elements can improve facility operation and possibly sustain transit patronage [45]. However, there are other considerations which might preclude their installation, namely capital and operating cost constraints and local conditions.

Trash receptacles, while being an inexpensive means of litter control, can also be abused. Such receptacles have been used as an alternative to paid commercial trash removal service. A trash removal schedule would need to be established with the associated cost included in the annual operating budget for the facility. Posting regulatory signs indicating penalties/fines for littering have been found to be generally ineffective [19].

Telephones provided at park-and-ride facilities can be used for emergencies as well as arranging for private auto or taxi pickup. There was some indication from the lot user survey conducted during this study that telephones are a desired amenity. Pay phone service would be provided by Southern Bell at no charge if the facility averages 25 calls per day. The other way free service would be provided is if the local police department requested service and demonstrated a public safety need. Semi-public service can be provided at a cost for other situations. These costs vary by situation but for planning purposes the installation cost of a booth and phone can be considered to be $150 and the monthly fee to be $25.

Shelters may be considered at facilities where kiss-and-ride is expected to be significant. These structures provide shelter during inclement weather for car-poolers who are dropped off at the facility to wait for the carpool vehicle. They can also serve as a central meeting place for a carpool group. For planning purposes, the shelter size requirement can be assumed to be 25 square feet per 100 space facility. This is based on the following assumptions:

- Eight square feet per shelter user.
- The number of kiss and ride drop offs is equivalent to 0.20 times the number of parking spaces in the facility.
- The average wait time is 10 minutes.

A discussion of shelter costs and materials can be found in the •Bus Terminal Facilities• section above.

Where large concentrations of bicycle or motorcycle traffic is expected, the facility design should include storage areas for these types of vehicles. The design of bicycle and motorcycle parking areas should consider identification and accessibility, type of storage racks, lot boundary screening and protection, and provision of locking devices to prevent casual and professional theft. While there are various types of racks on the market, the designer/specifier should be concerned with durability, versatility related to placement, and ease of maintenance in making the final specification. Space requirements should be based on 2 x 5 stalls for bicycles and 3 x 6 stalls for motorcycles. Parking areas should be close to transfer locations since bicyclists will tend to use fences and building posts which are conveniently located over a distant empty parking rack. Racks should be separated from roadways by curbs or barriers to prevent accidental damage from automobiles. The use of lockers in lieu of or to supplement racks has been thought to encourage bicycle access since they provide a higher level of security [7]. This could be an important design feature in highly used facilities since lockers could potentially make more space available for auto parking.

The designer needs to consider newspaper racks from the standpoint of controlling where these devices are placed. The best location is where people will congregate; bus transfer locations and carpool shelters. The design of these areas must account for enough space to accommodate the number of racks to be permitted.

CHAPTER 8: PROMOTION

The impact of promotion on park-and-ride facility use is not well documented; however, it is reasonable to assume that a facility cannot attract users until information about the facility is disseminated. Further, the park-and-ride clientele cannot be considered static due to mode shifts and changes in residence and work place. Consequently, a continuing marketing program for park-and-ride services should be maintained to enhance usage. Promotion of new park-and-ride facilities can increase usage as well as accelerate the rate of growth in usage and transit revenues where service is provided.

The material contained in this chapter was originally presented in Working Paper 4: Facility Analysis [2]. Promotional activities can be categorized into four areas:

- Promotional and informational campaigns to inform the public of a new service or facility.
- Continuing programs of information dissemination to provide the public with the information needed to make use of services and facilities.
- Advertising campaigns conducted to increase the public awareness of the social and personal benefits of a service or facility.
- Special transit pass programs to foster fare prepayment and increase transit usage.

An effective promotion program needs to identify the market and determine the most effective mechanism for communicating the desired information. Relevant promotional techniques for park-and-ride facilities include the following marketing procedures:

- Roadside share-a-ride signs.
- News releases.
- Multi-trip transit pass programs.
- Brochures delivered door-to-door to residents within the service area.
- Public service announcements on radio and TV.
- Newspaper advertisements.
- Posters, bumper stickers, and maps showing the location of lots.
- Transit routes and schedules.
- Posters and billboards.
- Brochures distributed to large employers.
- Employer-coordinated activities.
- Telephone information services.
- Internet and World Wide Web postings on transportation-related bulletin boards
- Direct mail using employee databases

Table 8-1 presents a summary of the contexts in which each of the above techniques are best applied. The table presents these contexts in terms of applicable lot size, locational setting of the lot, and transit service requirements. The lot size requirements identified in Table 8-1 indicate that some techniques are best considered in relation to promoting •large• lots. This measure is difficult

to quantify and is best determined by the agency conducting the marketing effort.

Table 8-1. Application of Park-and-Ride Promotional Techniques

Technique	Lot Size	Setting	Transit Service	Time Scope
Roadside share-a-ridesigns	All sizes	Urban or Rural	Not required	Long term
News releases	Large	Urban or Rural	Not required	Short term
Multi-trip transit pass programs	All sizes	Urban	Required	Long term
Brochures delivered door-to-door to residents within the service area	Large	Urban	Best if provided but not required	Short term
Public service announcements on radio	All sizes	Urban or Rural	Best if provided but not required	Long term
Public service announcements on TV	Large	Urban	Provided	Short term
Newspaper ads	All sizes	Urban or Rural	Not required	Short and Long term
Promotional posters, bumper stickers, and maps showing the location of lots	Large	Urban	Provided	Short term
Transit routes guides and schedules	Large	Urban	Provided	Long term
Posters and billboards	NA	Urban	NA	Short term
Brochures distributed to large employers	Large	Urban or Rural	Best if provided but not required	Long term
Employer-coordinated activities	Large	Urban or Rural	Vanpool program and/or transit established	Long term
Telephone information services	NA	Urban	Not required	Long term
Internet/WWW	All sizes	All	Not required	Long term
Direct Mail	All sizes	All	Not required	Short term

Approximately 40 percent of all Florida facilities have 50 or fewer spaces while 65 percent have 100 or fewer spaces [1]. The guiding principal should be that the technique will be most effective if used for promoting as large a lot as possible. For those techniques where lot size is not applicable, the techniques are used to promote a program, such as carpool matching or transit, where park-and-ride may also be incorporated into the promotional campaign. Locational setting refers to urban versus rural facilities. Some techniques are not effective in rural locations and is the result of a number of factors such as population densities, service area size, and transit service availability.

Generally speaking, the techniques presented in Table 8-1 are most applicable when a facility is served by transit, although this is not always required. Some techniques consist of incorporating park-and-ride promotion into transit or rideshare marketing efforts.
Suggested principals which should guide in the marketing and promotion of park-and-ride facilities are as follows:

- It should not be assumed that the public knows where park-and-ride facilities are located no matter how visible.
- Coordination of promotional efforts with other programs benefits all programs involved. Efforts should be made to coordinate with agencies providing complementary services such as transit agencies, carpool matching programs, transportation management associations, and ridesharing programs.
- Focus the marketing effort on the travel characteristics of the target audience. Employer-directed marketing programs and roadside information signs are based on this strategy.
- Focus the promotion effort on the demographic/socioeconomic characteristics of the target audience door-to-door marketing campaigns and public service announcements on television follow this principle.
- Utilize public information channels established by such organizations as MPO's, transit and transportation authorities, city councils and support committees, as well as the Florida Department of Transportation. Such organizations may publish periodic newsletters for public dissemination and will probably include articles/information related to park-and-ride facilities upon request.
- Promotion efforts should be consistent with the scale of the facility or service. Effectiveness is directly related to facility size and visibility.
- Promotion should incorporate both short- and long-term efforts. Short-term efforts are associated with the initial communications which inform the public of a new facility. Long-term promotion consists of information dissemination directed at continually making the public aware of existing facilities and programs.

The following sections describe the park-and-ride promotion techniques presented in Table 8-1.

ROADSIDE SHARERIDE SIGNS

This technique consists of providing phone numbers for carpool matching, ridesharing, and transit agencies on park-and-ride lot guide signs. This supports the facility operation by informing those most likely to use it about services which attract facility usage**.** Agency/program logos should also be included on the signs.

This can be considered as an effective long-term, low-cost promotional technique which has definite application to Florida. A common practice found throughout Florida is the erection of signs which provide only one function: park-and-ride lot locational guidance, carpool matching services, or rail station locational guidance. No examples of signs with both lot guidance and carpool

matching phone information were found. The Hillsboro Area Regional Transit Authority includes its logo on all park-and-ride facilities serviced by express bus service.

NEWS RELEASES

These are mainly oriented to the opening of a new facility. The size of the facility should be sufficient to be newsworthy. This is a short-term technique intended to inform the public of a new facility. The public information office for the agency involved in the promotion should be consulted on the procedures for involving the press, television, and radio news services.

MULTI-TRIP TRANSIT PASS PROGRAMS

This promotional technique is primarily directed at increasing transit ridership and fare prepayment. Most, if not all transit properties in Florida already operate and advertise such a program. Park-and-ride facilities served by transit can benefit from these programs through the increases resulting from such a program.

A variation of this technique is to institute multi-trip passes offering added discounts for users of those transit routes serving park-and-ride facilities.

DOOR-TO-DOOR CAMPAIGNS

Promotion through direct mail and hand delivery of brochures should be targeted to the service area of the facility. This technique is best applied to promoting corridor and urban fringe lots because the service areas are usually well defined, limited in size, and tend to provide a greater number of users. Approximately 50 percent of the users of such lots come from within two miles of the lot [1]. The campaign should be limited to this area. The technique is less effective in rural locations since the service area is generally very much larger than for urban area lots. In addition, the population base is typically smaller for rural lots than for urban lots. This technique can be used as a one-time promotion of a new facility or on a continuing basis to promote existing facility. The technique can be more effective if incorporated with the promotion of new or existing transit service.

PUBLIC SERVICE ANNOUNCEMENTS

Public service announcements are generally applicable to the promotion of urban park-and-ride facilities because of the transmission areas of television and radio stations. Research conducted in Lincoln, Nebraska found that television advertising is more effective and better remembered than any other form of media campaign, even personal contact at the home [52].

The announcements should address the positive aspects of park-and-ride, carpooling, and transit usage. The target audience needs to be made favorably aware of the benefits, both personal and societal, to attract new users.

Air time is generally very expensive on commercial networks. Such networks may have public information programs provided free or at a nominal cost to public and not-for-profit organizations. Public television and radio also provide air time for public service announcements and should be utilized to the extent possible.

Another cost related to this promotion technique is the cost of making video and audio tapes which are to be played over television or radio. The broadcasting network may provide this free if requested; however, this should not be assumed without investigation.

NEWSPAPER ADS

This technique consists of placing periodic advertisements in syndicated and community newspapers. Costs associated with this technique include ad space and production of art work. The ad should consist of promotional verbiage regarding the park-and-ride program along with the other service provided by the advertising agency (rideshare programs, transit service) and the information phone number. An alternative would be to place an ad with information regarding the location of a newly opened facility. This can be a performed on either a short- or long-term basis depending on the marketing budget.

PROMOTIONAL MATERIALS

These can consist of almost anything imaginable including posters, maps, bumper stickers, caps, tee shirts, pens and pencils, cups, rulers, oversize paper clips, balloons, key rings, etc. Promotional materials are best used in conjunction with special promotional events or employer programs. This technique is normally used on a short-term basis.

Unauthorized placement of bumper stickers on private automobiles should not be practiced since it will result in bad public relations. However, coordinating with local governments and transit agencies to place bumper stickers on their vehicles can be effective.

TRANSIT ROUTE GUIDES/SCHEDULES

This consists of including park-and-ride facility identification on the route guides and schedules for the local transit system. Park-and-ride facilities should be shown on both the individual route guides as well as system maps. Some systems describe locations in the written matter on their system maps but do not depict these locations on the maps.

POSTERS/BILLBOARDS

Posters can be printed and placed in public places such as libraries, government office buildings, parks, etc. Billboard advertising is considered to be a short-term technique because of the cost involved for the art work and billboard rental. Placement of posters and billboards should be in the vicinity of existing park-and-ride facilities.

EMPLOYER PROGRAMS

The use of this technique will be more effective if coordinated with ridesharing promotional programs. The experience with this method is extensive and well documented. The most effective strategy is to target large employers and employers in concentrated employment areas such as business parks and CBD's,

TELEPHONE INFORMATION SERVICE

This consists of providing location information in conjunction with transit route and schedule

information services. Observations have shown that (1) users do find out about the programs.

INTERNET/WWW POSTINGS

More and more information is available on the Internet via the World Wide Web. If a Regional Commuter Assistance Program, TMA, transit operator, or other transportation entity in the Park and Ride service area has a Web site, this site could also be used to post maps and information about the park and ride program.

DIRECT MAIL TO EMPLOYEES

Using the resources of an RCAP or TMA employee database, one can identify potential users of a park and ride system and send them information directly. This can be facilitated through the use of a GIS [56].

CHAPTER 9: PLANNING ANCILLARY SERVICES

The research together with the findings from this study indicate that there are services that can be provided at park-and-ride facilities which can have a positive impact on facility usage. These services include those which are directly related to the facility operation such as feeder bus service, express bus service, transit loading areas, van- and carpool staging areas, and security provision. The ancillary services also include those which can be thought of as providing a support function to the users such as day care services, coffee shops, vendor services, and retail shops. The exact response of travelers to these various services, excepting maybe transit services, is not well understood by the transportation community. However, the general consensus is that they do promote park-and-ride and can augment its use by commuters.

The following sections present considerations for implementing the ancillary park-and-ride facility services mentioned above. The material contained in this chapter was originally presented in Working Paper 4: Facility Analysis [2].

TRANSIT SERVICE

Often, transit service is the primary reason for establishing a park-and-ride facility. Many of the facilities in Miami, Tampa, Jacksonville, and Orlando were established to increase system ridership levels. Observations of lot usage showed that lots served by transit are the highest used facilities in the State [1]. These findings furnish strong support for establishing transit service at park-and-ride lots not currently being served by transit. However, transit service does not automatically mean added facility usage. It is critical that conditions supporting transit are in place in order for increased park-and-ride utilization to be realized.

The evidence indicates that lot usage can increase by 100 percent or more with the provision of transit service between the facility and major employment centers. Findings in Tampa indicate that the maximum demand for carpool-only lots is 30 vehicles while this jumps to 75 to 100 vehicles for lots served by transit [l]**.** Findings from other areas of the United States support these figures. A study of park-and-ride facilities located throughout the country found that the maximum usage of carpool-only lots was 60 vehicles (averaging 20 to 30 vehicles) while facilities served by transit were found to contain parked vehicles numbering 150 or more [26].

Three types of transit services are relevant to park-and-ride facilities•feeder bus service between the home and lot, express service between the lot and work destinations, and shuttle service from activity center peripheral lots to various destinations within the activity center. Feeder service is typically provided to facilities served by line haul modes such as express bus, urban rail, and commuter rail. These types of facilities are typically located in urban corridors. Express bus service has been found to be implemented at both urban fringe and urban corridor lots in Florida. Shuttle service pertains to activity center peripheral parking facilities.

Observations indicate that feeder bus service to a park-and-ride facility served by line-haul transit service accounts for 10 percent of the access trips to such facilities [11]. This suggests that up to a

10 percent increase in line haul transit utilization can be expected from the institution of such service. This marginal increase may not be large enough to institute new service but may be worth limited changes to established routes in the area of the park-and-ride facility.

A doubling of usage cannot be considered an automatic result of establishing line-haul service from the park-and-ride facility. This type of increase can only occur when the conditions supporting transit utilization exist. The conditions which should prevail when considering line-haul service at a facility are presented in Table 3-1 under the urban corridor and HOV corridor lot types. These conditions include a market size supportive of transit, significant employment concentrations, and significant levels of congestion and amounts of traffic.

Shuttle transit services provide access to an activity center from a peripheral parking facility. Shuttle service should be provided when average walking distances are larger than a certain threshold value; typically a few city blocks or less. For an existing peripheral facility, shuttle service should be considered if utilization is low. For a new facility, shuttles should be planned for if it is to serve a geographically large activity center where walking distances are anticipated to be longer than • mile.

Shuttle headways on the order of 10 minutes will be required during commuting hours with longer hours applicable during off-peak hours. All-day service should be planned for at a minimum. Phased implementation related to service coverage can be performed as a way to limit expenditures on the service. Tri County Transit in Orlando has done this with its Meter Eater-Downtown Trolley. The success of the Trolley has resulted in increased coverage being instituted with service being provided to other trip generators such as apartments and retirement institutions located near downtown Orlando.

Coordination with the local transit agency will be required in order to establish service to a facility. There are examples in Florida where lots have been built without such coordination. The results have been no transit service provision, no lot usage, and the ultimate closure of these facilities. It is strongly recommended that coordination take place as early as possible in the planning stages of a facility. This should be done to determine if service can in fact be accommodated by the transit agency and what site requirements must be met.

Site requirements for transit relate to geometries, pavement and access. Adequate turning radii, roadway widths and stop areas must be provided to accommodate the anticipated number of transit vehicles. Pavement structures must support the higher wheel loadings produced by transit vehicles operating at low speeds. Rigid pavements are recommended for the bus stop area.

Access to the facility is possibly more important than design features in determining if transit can be provided on the site. The ideal site will be located on an existing route. It should be recognized that the transit agency will need to revise route schedules to accommodate the new stop. Rerouting a bus route into a facility will add to the scheduled run time because of the time required to access, stop at, and load and unload passengers at the site. This added time can affect transfer coordination

in other parts of the transit system.

In some cases, an existing stop can be eliminated and replaced at the park-and-ride site. The closer the facility is to an existing route, the easier it will be to make these types of adjustments. Also, providing a stop on the existing route and adjacent to the site can eliminate the access time to the lot. However, this option requires the site to be located on the side of the road which carries the morning inbound traffic.

Another consideration related to direct access of transit to the site is the provision of traffic signals. Signals should be provided for vehicles required to make a left turn across a multilane arterial into the site. As a matter of operating policy, Tri County Transit in Orlando will not route a bus so that it will be required to make a non-signal-controlled left turn across a multilane arterial. Coordination will need to be made with the jurisdiction responsible for erecting signal controls in order to achieve this objective.

BUS LOADING AREAS

Bus loading areas should be considered for park-and-ride facilities served by transit. The impacts of constructing formal bus stop areas on facility usage is not well documented and is most likely marginal. One lot in Tampa (Hanley and Commanche) does not have a shelter but was found to be highly used.

Formal bus loading areas are recommended for inclusion in the facility design. Retrofitting requires consideration of the pavement in the area where the stop is to be placed. Rigid pavement should be placed where vehicles are to stop for the loading and unloading operations. Bituminous pavement is suitable for roadways but should be designed to accommodate the wheel loadings of a transit vehicle operating at slow speed.

A bus shelter should be constructed in the bus stop area. Design specifications were presented earlier, and design ideas can be found in FDOT's Pedestrian and Transit Friendly Design manual [57].

VANPOOL/CARPOOL STAGING AREAS

The impact of providing staging areas for vanpools and carpools is not well documented and is considered to have a marginal impact on facility usage. These staging areas consist of a shelter, benches, and adequate space for dropping off passengers. Two conditions should exist for considering the installation of vanpool/carpool staging areas: (1) the facility does not have a transit stop area consisting of shelters and benches, and (2) the facility is large. Existing or planned bus stops can also act as staging areas for vanpools and carpools. Consideration for increasing the capacity of these areas may be required if it is expected that they will be heavily used by vanpool and carpool users.

Installing a vanpool/carpool staging area is most applicable to large facilities since it provides a central meeting place. However, this may be a nonessential improvement since experience has

shown that users tend to meet in prearranged areas in the lot.

SECURITY

Results of the surveys conducted during this study indicated that security is one of a number of critical factors considered in the decision to use a park-and-ride. The best security measure is to locate lots in areas considered to be safe from crime. An interview with the Connecticut DOT indicated that their experience has been that lots with vandalism problems are not used in spite of patrolling. The lowest parking rates at Metrorail stations in Miami are found in those areas considered to have crime problems, and these are patrolled by Metro-Dade Transit security. Based on these findings, it is safe to assume that no reasonable level of security will produce significant increases in park-and-ride facility usage.

Nonetheless, security should be a concern of the facility operator. Arrangements need to be made to insure that security measures are in place and operating at the time of facility opening. Such measures can include closed circuit video cameras, police and security patrols, guards or attendants, and fences. Coordination with the local police or other statutory jurisdiction responsible for security matters needs to occur. It should not be presumed that the local police department will assume security responsibilities at the required levels for a park-and-ride facility.

CHAPTER 10: EVALUATING PERFORMANCE OF EXISTING FACILITIES

The current price and availability of fuel together with the huge need for the limited available transportation revenues has produced a general de-emphasis in park-and-ride programs around the country with the associated low spending levels and manpower allocations [1,54]. This has resulted in the tendency to devote program resources almost totally to new facility development and lease administration. However, as construction resources get scarcer, more active management of existing facilities will need to occur. Management activities will include monitoring and evaluating existing facility usage, identifying measures to improve under-and over-utilization conditions, and considering options such as lot closures and land disposal.

In this chapter, a set of performance measures and associated criteria are presented for use in determining whether a facility is successful, unsuccessful, marginal, or is experiencing operational problems. Department actions related to successful lots include doing nothing and capacity expansion. Actions related to unsuccessful and marginal lots include revision of ancillary services or promotion, lot closure, and lot disposal.

The material contained in this chapter was originally presented in Working Paper 4: Facility Analysis [2].

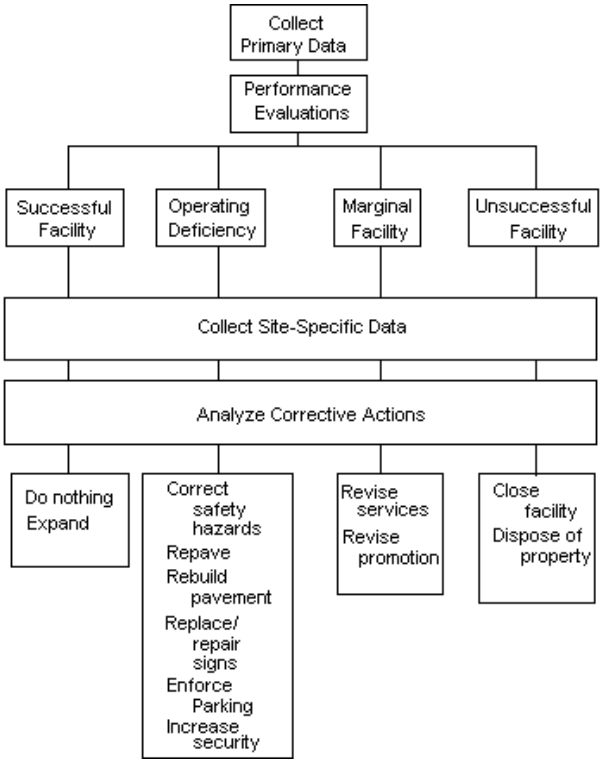

Figure 10-1: Evaluation Process

PROCESS OVERVIEW

Figure 10-l presents an evaluation process for assessing lot performance and determining the resultant actions which might be taken to correct any operating deficiencies. The first step consists of collecting the primary data required to evaluate the performance of individual lots and to make assessments of success levels. These preliminary performance evaluations are performed in the second step of the process. The third process step consists of the collection of additional data. This effort is focused on specific data elements required by the findings of the preliminary facility assessments. The final step of the evaluation process is concerned with evaluating the candidate options for each site considered to need remedial action.

PRIMARY DATA COLLECTION

The primary data collection effort should be part of a continuing performance monitoring program the purpose of which is to assemble basic information which can be used to assess the level of performance of all facilities in the inventory on a continuing basis.

These data are generally assembled by technicians. The specific data elements are summarized in Table 10-1 and include:

- Number of short-term, long-term, and handicapped spaces
- Number of parked vehicles in short-term, long-term, and handicapped spaces
- Number of illegally parked vehicles
- Pavement condition inventory
- Traffic control device inventory
- Number and types of complaints
- Number and types of accidents related to the park-and-ride facility
- Inventory of land use on property adjacent to the site
- Accessibility of facility to transit

The number of spaces and parked vehicles are used to compute facility utilization. The collection of the number of spaces must be carefully performed. Results of the facility inventory work performed during this study showed that all spaces at joint use lots tend to be included in the space counts even though not all spaces are eligible for use by park-and-ride vehicle parking. This has the effect of understating utilization and can give a false reading regarding the level of success of a facility. The field survey technicians will need to be given special instructions in order to obtain the correct number of spaces for these types of facilities.

The suggested frequency for collecting utilization data as shown in Table 10-1 is recommended to determine the fluctuations in usage over the year and to gain an accurate assessment of actual usage. The counts should be scheduled preferably between Tuesday and Thursday but Monday is also acceptable. Counts should not be scheduled for Fridays because utilization has been observed to drop dramatically on this day of the week. It is recognized that some agencies do not collect this information at all since it is not used to evaluate facility performance. One suggestion is to coordinate parking counts with Traffic Statistics so that they can be performed more reasonably at the times that traffic counters are being placed near park-and-ride facilities. A good historical record of parking counts is critical to securing bond financing.

Table 10-1. Performance Evaluation Input Data Specification

Data Element	Evaluation Type	Collection Frequency	Unit of Measurement
Spaces by type[1]	Capacity	On file	Number
Parked vehicles by space type[1]	Usage	2 to 4 times annually	Number of vehicles
Illegally parked vehicles	Capacity	2 to 4 times annually	Number of vehicles
Pavement condition	Maintenance	Semiannually	Extent/severity of cracking,potholes, raveling,patching, rutting, spelling, etc.
Traffic control device inventory	Safety	Same frequency as counts	Type and condition both on and off site
Complaints	Capacity, safety, maintenance, illegal parking	Continuing, Summarized annually	Number by type
Accidents related to the facility	Safety	Once per year	Accidents by type
Adjacent property inventory	Expandability	Annually	Land use type and amount
Accessible transit service	Service adequacy	Once per year or as required	Type(s) of service, stop locations

[1]Space types include long-term, short-term, and handicapped

Counts of illegal parking is a subjective assessment. Tell-tale indications include posted for sale signs, commercial vehicles, junk autos, and single vehicles which are conspicuously parked in vacant areas of the park-and-ride facility. Interviews with the maintenance office responsible for the facility can also assist in identifying the incidence of illegal parking.

Pavement conditions data should be collected by trained and experienced evaluators. Assessments will need to be made on the extent and severity of the various factors which can be analyzed to determine maintenance requirements of the base and pavement structures.

The inventory of traffic control devices will actually be used to assess the adequacy of access and internal circulation control and safety. The inventory should include off-site devices which affect vehicles accessing the park-and-ride facility.

A log of complaints should be kept and summarized on an annual or more frequent basis. Such a log can be an effective means of identifying problems at a facility which would otherwise be difficult to identify. A number of different agencies in the locality including county public works,

county and city traffic engineer, as well as different offices within the Department, such as maintenance, traffic operations, and planning may receive complaints. Coordination with these agencies and offices should be effected to attain an accurate assessment of possible problems.

Accident data should be collected on a scheduled, preferably annual basis. These data are used to assess safety problems related to facility access and egress. With the latest change in police reporting requirements, low-value property-damage-only accidents may not be contained in the police reports. Complaints received by the Department may help to isolate safety problems. Interviews with the police department having jurisdiction in the areas where park-and-ride facilities are located can aid in assessing traffic safety problems.

Information related to the types of land use adjacent to the facility will not be needed until after the performance evaluation stage of the process. However, this information should be collected at the time the utilization counts are performed for the sake of efficiency. The inventory should extend up to 1000 feet away from the facility with this distance depending on the location and size of the existing facility. An accompanying sketch is recommended.

The facility should be investigated for transit service. Contacting the local transit agency will provide the most accurate Information. Information required includes the type of transit service provided such as local or express service, and placement of bus stops. Notes regarding bus stop amenities should also be taken. Stop locations both on and adjacent to the site should be noted.

PERFORMANCE EVALUATIONS

Performance evaluations conducted on an annual basis are recommended to assess the level of success of each facility in the system. The results will include the determination that the facility is:

- under-utilized and should possibly be closed or disposed of,
- operating marginally well but could possibly experience higher usage with some modification in supporting facilities or services,
- is operating well but experiences an important deficiency in operation which should be corrected, or
- operating adequately with no further actions required,
- over-utilized and requires corrective action,

Table 10-2 presents performance measures and associated operating standards which are useful in making the above determinations. The intent of this evaluation is to determine if corrective actions are warranted and if further investigations are necessary.

The performance measures suggested at this level of analysis are relatively straight forward since they are used to trigger additional studies as required. In spite of this, those measures shown in Table 10-2 must not be used solely at face value. Percent utilization has been found to not always reflect actual conditions, particularly at joint use lots. Low utilization percentages can result from including non-park-and-ride spaces in the space counts. High utilization percentages can be derived from counting illegally parked vehicles or vehicles associated with use of other services located at

the joint use lot. Every effort must be taken to accurately collect meaningful data at the site.

Table 10-2. Performance Evaluation Criteria

Assessment	Performance Measure	Suggested Operating Standard	Potential Corrective Actions
Unsatisfactory operation	Parked vehicles Percent utilization	<10 vehicles <10 percent	Close Dispose
Marginal operation	Parked vehicles Percent utilization	10-20 vehicles 10-60 percent	Added transit service Transit amenities Added promotion Improve access Improve security
Operating deficiency	Complaints	Number based on nature of complaints	Based on nature of complaints
	Accidents/traffic safety	>1 per year	Traffic engineering measures
	Pavement conditions	Unsatisfactory	Patch, repave or reconstruct
	Signing conditions	Unsatisfactory	Replace, add new signs
	Illegal parkers	>3 per month	Increase enforcement
	Security	>1 incident per year	Increase enforcement
Satisfactory operation	Parked vehicles Percent utilization	>20 vehicles 60-80 percent	
Over-utilized	Percent utilization Facility size	>80 percent >30 spaces	Modify geometrics, striping
			Expand
			Construct on new site

NOTE: See text regarding the use of utilization for facilities which have been Intentionally over-designed.
NOTE: May it also be noted that performance evaluation criteria is dependent on lot type.

Two performance measures, number of vehicles and percent utilization, are suggested for this level of evaluation. Percent utilization alone does not accurately reflect actual operations. For example, low utilization values can be produced at a large facility even though a large number of vehicles are parking. Consequently, the number of vehicles parked combined with percent utilization provides a more realistic assessment of operational performance. These values must be reviewed in the light of agency development policies. Low utilization may be a designed feature of a facility where future

demand is expected to increase or where fuel emergency contingency planning is practiced.

The suggested operating standards shown in Table 10-2 serve as threshold values for determining the operating status of a park-and-ride facility. The investigator must use discretion in using these standards. Conditions at the site as well as the policies of the operating agency must be considered. For example, some jurisdictions consider utilization of only one vehicle enough to keep a facility open and operating. Others believe that only 10 to 20 vehicles using a facility does not warrant corrective actions. In the Tampa area, 100 percent additional capacity is constructed to account for future growth in usage and as a contingency for possible fuel crises.

SITE-SPECIFIC DATA COLLECTION

Following the performance evaluations, additional information will be needed to determine the feasibility of implementing corrective actions at facilities appraised as needing them. This information will be site- and problem-specific and will generally be developed by professional-level staff. Table 10-3 presents the data required which include:

- Projections of facility demand
- Projections of future land use in the market area(s) of the facility
- Costs of right-of-way in the area
- Site design plans
- Transit schedules and system maps
- Level of service conditions on access roads
- Inventory of traffic control devices in vicinity of the site

Table 10-3. Input Data Specification for Site Evaluations

Data Element	Corrective Action	Evaluation
Demand projections	Expansion Closure Disposal	Capacity needs
Land use projections in market areas	Expansion Closure Disposal	Capacity needs
Planned/programmed improvements	Disposal	Coordination of improvements
Right-of-way costs	Expansion Disposal	Expansion cost Value capture
Site design plans	Service modification Facility modification	Circulation adequacy Transit amenities Traffic control
Transit schedules and system maps	Transit service modification	Added usage generated by new/improved service
Traffic operations on access roads	Access modification Safety modification	Road capacity expansion Safety improvements
Traffic control device inventory	Access modification Safety modification Signing improvements	Adequacy of traffic control

Not all of the information shown in Table 10-3 will need to be collected in all situations. This is because the data will be used to assess the feasibility of implementing specific measures at specific park-and-ride facilities. In addition, some of the information, such as facility design plans and inventories of traffic control devices, should already be on file.

Projections of future facility demand and/or land use in the service area of the facility under investigation will be useful in determining future capacity needs. The same concepts and procedures for estimating demand as presented in Chapter 4 above can be used. Detailed projections of lot demand will be the most accurate; however, a simpler approach is to define the market areas (as per Chapter 4) and accumulate the traffic analysis zone data for the current and future years. A simple trend computation can add valuable insight into the potential capacity needs. However, this must be tempered with conditions at the site which may deter use.

An inventory of planned and programmed transportation improvements is needed to determine the future need of the facility under investigation. Such improvements may make an otherwise useless

facility valuable in future years and can aid in the decision to maintain it. Sources of this information includes the area's Transportation Improvement Program (TIP), Long-Range Transportation Plan, and work programs for those jurisdictions which are not included in the local TIP.

Right-of-way cost data will be needed only in circumstances where facility expansion or disposal is being considered. These data will aid in making assessments related to expanding the exiting facility on adjacent property, constructing a new facility on a new site, the potential value return, and the feasibility of a higher and better use of the land.

Site design plans are needed to assess the types and feasibility of geometric and circulation improvements. Final plans or as-built plans should be available and on file.

Transit schedule and coverage information is used to determine the level of transit service and the access provided by transit from the park-and-ride facility to major destination areas.

Congestion on access roads to a park-and-ride facility can be a significant deterrent to utilization. Traffic operations data including traffic counts, intersection layouts, road section and intersection capacities, and signal timing information will be needed to assess congestion levels and their impact on lot usage.

Accident data and traffic control device inventories were recommended earlier to be included in an on-going data collection program. These data will be important in developing solutions to safety and traffic operations problems adjacent to park-and-ride facilities assessed as having operating deficiencies. The required data includes accident information of sufficient detail to produce accident diagrams, and placement and condition of traffic control devices including assessments of visibility and legibility.

ANALYZE SOLUTIONS

This step in the process has two purposes. First is to gain a full understanding of the problems at the facilities assessed as requiring further investigation in the preliminary performance evaluation stage. As mentioned above, problems can range from no utilization to over-utilization and can include operating deficiencies such as hazardous access, poor access, and poor maintenance. The second purpose is to identify feasible solutions to rectify the operating problems at each site. Possible solutions range from do nothing to increased promotion to new construction.

An important initial activity in defining the course of corrective action for a park-and-ride facility was described in the previous section. The fact finding effort concentrated at the site under investigation will most often lead to conclusions concerning the operation of the facility which otherwise would not be understood through a desk survey. Access, security, traffic operations, and safety problems can be better defined through the field investigation.

The tables in this section were developed to aid in the identification of effective actions to execute

in response to site-specific operating problems. These are discussed below in relation to the particular category of problem.

Unsatisfactory Operation

Table 10-4 shows the conditions for those actions appropriate for sites which are so under-utilized that there is no positive course of action to execute. The listed conditions should exist in order to consider closure of a facility. Closing and vacating a facility are significant acts. Any existing users will be negatively, and possibly significantly impacted. Closing a facility acknowledges the useless investment of public funds in developing the site. Vacation means the site can not be used in the future without repurchase at possibly a much higher price. Numerous agencies around the country were found to very infrequently close and almost never dispose of an existing facility because of the preceding considerations [53].

Table 10-4. Conditions for Lot Closure and Disposal

Action	Conditions
Close site and hold for future use	C) Feasible to relocate existing users to a more cost-effective location. C) Demand not expected to increase in the near future. C) Other corrective actions will not produce significant usage increases. C)Alternative uses are implementable. C)Right-of-way required for future improvement project. C)Soft real estate market C)Site size/configuration not suitable for resale.
Dispose of property	C) Low probability of future growth in usage through development or increased congestion. C) Right-of-way not required for future improvements. C) Alternative uses not attractive. C) Commercial/industrial zoning. C) Site size/configuration appropriate for development C) Vandalism/assault problems not correctable. C) Future transit service highly unlikely.

The decision to close a facility should be based on two factors: inability to implement corrective actions which could improve usage and ability to provide alternative parking for any existing users. Once the decision is made to close a facility, the next decision consists of opting to hold the facility in public ownership or disposing of it. If demand is expected to increase in the future or if the property is needed for future transportation improvements, the lot should be held. Use of the facility for other purposes should be considered. For larger lots, partial closure may be an attractive option to full closure. An example is the Yukon Street transit terminal in Tampa. This facility consists of 306 spaces, approximately half of which are fenced off to restrict public access. This closed area of the facility is used by the local transit property and ambulance services for driver training.

Marginal Operation

Table 10-5 shows the actions and related conditions which are appropriate to sites assessed as

having low usage which can be improved. Actions which have been suggested to have a positive impact on usage include:

- New or increased transit usage
- Access improvements
- Increased security
- Construction of transit amenities such as stops and shelters
- Improved promotion

Table 10-5. Conditions for Corrective Actions at Marginally Operating Facilities

Action	Potential Usage Increase	Conditions
Added Transit Service	1/2 to 1 percent increase per 1 percent improvement in frequency Potentially 100 percent increase with new service	Market area supportive of transit. Area planned for express service. Congested access to major destination area. Existing headways greater than 15 minutes.
Access Improvement	50% increase per 5 minute improvement in access times.	Congested access roads to park-and-ride facility. Heavily traveled corridor with major destination area. Site is visible and otherwise appears attractive. Market area not serviced by other park-and-ride facilities.
Transit Amenities	Indeterminable, probably slight	Other improvements planned for facility.
Improved Security	Slight unless full-time security is provided	Security problem exists Peripheral facility adjacent to area with under supply of parking
Promotion	Less than 10 %	In conjunction with special transit promotion programs. Characteristics of origin market influence area supportive of park-and-ride. Congested commuting corridor.

The effects of transit amenities are uncertain but are thought to be slight. It is suggested that the best approach is to implement such improvements in conjunction with other actions such as new transit services, promotional events, or lot beautification.

The conditions shown in Table 10-5 should exist to consider the associated corrective actions for improving usage of a facility assessed as marginal in the preliminary performance evaluations. Two of the actions shown in the table have an indeterminate impact on usage and are probably negligible. The findings of the survey work conducted during this study indicated that a facility with a security problem will most likely never be used to its full potential unless full-time security is provided. It has been found that crime will only temporarily decrease with added patrolling. The best implementation appears to have the facility placed on the normal patrol route of the local enforcement agency so that it receives frequent patrolling every day. It must be assumed that crime will approach the previous levels once patrolling has been curtailed or discontinued.

Critical Operating Deficiency

Operating deficiencies at otherwise satisfactory park-and-ride facilities include security, pavement and traffic control device maintenance, accidents, poor circulation, and illegal parking. Some of these problems are associated with increased liability exposure and should be corrected at the earliest opportunity. Identification of these problems will come from analysis of the field data as well as from complaints for users and neighbors.

Over-Utilization

Table 10-6 presents a set of actions which should be considered for responding to over utilization of a park-and-ride facility. Over-utilization can discourage usage because of the uncertainty of finding a parking space. Except in very limited situations, the motoring public will not significantly increase vehicle occupancies to access a lot in response to over-use. Table 10-6 defines the conditions and consideration related to each of 15 possible actions related to providing additional capacity to an over-used facility. Some actions will not add significantly to capacity but may be acceptable as a result of low additional capacity needs and cost considerations.

Actions related to revising parking fees requires that fees can be legally adjusted. Bonded facilities may not have this option available. In addition, these actions should be implemented as a means to shift parkers to near-by, under-utilized facilities. It is better to reduce fees at the near-by facility in concert with promoting the lower fees as compared to raising fees at the over-used lot.

An important consideration of constructing a new facility is the feasibility of providing transit service. Coordination with the local transit agency will be required to determine if such services are possible. Similar service as exists at the over-crowded facility should be instituted at the new one.

Table 10-6. Over-Utilization Solution Evaluation Matrix

Solution Alternative	Cost	Added Capacity	Lot Size	Existing Design Features	Right-of-way Conditions	Other Conditions
Eliminate Illegal Parking	Low	< 5%	Small	na	na	Illegal Parking exists
Reduce Stall Widths	Low	< 5%	Small	>=9' wide stalls	na	Adequate aisle widths (28' optimal)
Standard-size To Compact-size Stall Conversion	Low	Up to 10% w/ 50% converted	Moderate to large	No compact-size stalls	na	Large percentage of compacts
Reorient Stalls From Angle To 90-Degrees	Low	< 8%	Large	Angle parking exists	na	
Replace Design Features With Stalls	Low	5 to 20%	Moderate to large	Berms, aisle end islands adequate for conversion	na	
Reduce Parking Charges at Competing Facilities	Low	Large	Moderate to large	na	na	Adjustment of charges legal
Increase Parking Charge	Low	Large	Moderate to large	na	na	Adjustment of charges legal
Reorient Aisles to Long Dimension of Lot	Low	10 to 20%	Moderate to large	na	na	Length/width ratio > 1.5
Reduced Parking Charge for Arriving Carpools	Low	Moderate	Large	na		Adjustment of charges legal
Preferential Parking for Carpools	Low capital High operating	Low	Large	na	na	Best used where attendant fee collection exists
Satellite Parking with Shuttle Service	Capital low to high, operating moderate	Large	na	na	Affordable ROW available	Rail service at site New site near home end of trip
Expand on Adjacent Land	High	10+%	na	na	Affordable ROW available	Acceptable soil conditions
Expand Within Existing Right-of-Way	High	1O+%	na	na	ROW Available	Acceptable drainage conditions
New Site	Low to high	10+%	na	na	Affordable ROW available	Near existing facility Good access and visibility
Structure on Existing Site	Very High	50+%	Large	na	na	Site size and configuration

CHAPTER 11: PROGRAM PERFORMANCE EVALUATIONS

This chapter presents a set of performance measures relevant to monitoring a park and ride program. Procedures for estimating these measures as well as descriptions of input data and data sources are also presented. The performance measures presented herein are useful for:

- assessing impacts and user benefits produced by the program,
- monitoring progress in constructing park and ride lots,
- assessing program effectiveness,
- assessing lot maintenance needs, and
- preparing annual budget requests.

The material contained in this chapter was developed from Working Paper 2: Program Analysis [54]. Reference to that document should be made for the supporting research that is not included here.

A performance matrix is presented in Table 11-1 that considers the program level and the area of application. Program levels include statewide, district and local scopes of responsibility. Application areas include impact assessment, program assessment, management, and budgeting. Easily applied procedures for calculating the performance measures in this matrix are described. These procedures are consistent with the systems-level of analysis to which they apply.

The evaluation measures and procedures presented below were developed from surveys of local, regional and state programs in Florida; interviews with program administrators in other parts of the country; and findings from the literature.

The performance measures relate to four basic application areas which include assessment of program impacts, program effectiveness, program management, and program budgeting. The following sections presents the contexts in which program-level performance evaluations are performed. These are followed by a table of performance measures applicable to program-level evaluations.

APPLICATION AREA DESCRIPTIONS

The following descriptions address the issues that are typically considered during program evaluations. These issues relate to four categories of application including:

- Assessments of impacts accrued by the program
- Assessments of program effectiveness
- Management of program components including production, maintenance, and liability
- Program budget preparation

These application areas vary by the level of government in which the evaluation is being considered. The Statewide Park & Ride Program is primarily concerned with funding, statewide impacts and benefits, improving coordination within the Department, management, and technical

support. The FDOT District offices tend to be concerned with facility development and management. Local transit agencies are concerned with issues related to enhancing ridership and productivity of the transit system.

Impact Assessments

These evaluations are performed to understand the level of impact that the park-and-ride program has on transportation operations, economic factors, and the environment. Relevant performance measures relate to the objectives of the agency in which the evaluations are performed. These objectives can relate to increasing transit usage, reducing vehicle miles of travel, increasing auto occupancies, decreasing fuel consumption, increasing carpool formation, attaining air quality standards, and many others. Typical questions which might be addressed by impact assessments at the program-level include:

- How many commuters are benefiting from facilities provided by the program systemwide?
- What are the state- or district-wide impacts resulting from the program?
- Have increases in auto occupancy been realized as a result of the program?
- What systemwide air quality impacts have been produced?
- What savings in fuel consumption have been realized systemwide?

Program Assessment

These evaluations are aimed at assessing the effectiveness of the park-and-ride program. Since effectiveness is the primary issue, performance measures must relate to dollar expenditures or some other unit of program cost. Typical questions which are addressed include:

- What level of production is the program achieving?
- What level of benefit is the program achieving?
- What benefits have accrued from the accomplished production?
- How effective has the production been?
- What are the benefits of one implementation action over another?

Management

Performance measures applied to program management evaluation should reflect management-related concerns like production and productivity of the various operating components of the program including:

- Production levels
- Maintenance production
- Liability costs
- Inter- and intra-agency coordination
- Security

Budgeting

As mentioned in the discussion of the survey results, justification of park-and-ride program budgets is generally not performed. Typically, the only justification consists of defining the functions of the existing positions and specifying the related labor costs. This type of budgeting process will possibly change in the future, either as the result of more funds becoming available or from

additional funding constraints. Additional funding creates a need to determine the actual positions which should be added to the budget and the benefit which accrues from them**.** Imposition of funding cutbacks requires additional justification to maintain current staffing levels.

PERFORMANCE MEASURES

Table 11-1 presents a set of performance measures relevant to program-level analyses. The table shows the application area, scope of analysis, input data required, and source of data for each performance measure. The use of these measures would generally be on a systemwide basis. For example, computation of vehicle miles of travel for assessing the impacts associated with a program would be computed based on all facilities in Florida, the District, or the local area depending on whether the Statewide, District or local park and-ride agency is performing the evaluation. In spite of this, the identified measures relevant to impact assessments could also be applied at a facility level of analysis. However, site-level analyses should be performed at a much greater degree of detail then that proposed here for program-level evaluations.

Table 11-1. Program Performance Measures

Measure	Application Area	Scope of Application	Information/Data	Information/ Data Source
Annual VMT reduction	Impact assessment	Statewide District Local	Parked vehicles by lot type Lot/destination average trip lengths	Inventory/ survey See Table 11-2
Annual user cost savings	Impact assessment	Statewide District Local	VMT reduction Operating cost per VMT	Calculated See Table 11-2
Change in vehicle occupancy	Impact assessment	Statewide District Local	Parked vehicles Before/after pervehicle occupancies Lot/destination mode shares	Inventory/ survey See Table 11-2 See Table 11-2
Annual fuel savings	Impact assessment	Statewide District Local	VMT reduction Avg. fuel consumption rates	Calculated See Table 11-3
Annual emissions reduction	Impact assessment	Statewide District Local	VMT reduction Avg. emission rates	Calculated See Table 11-3
Increase in transit ridership	Impact assessment	Statewide District Local	System ridership P&R route ridership	Local transit agency Local transit agency
Increase in transit revenue	Impact assessment	District Local	System revenue P&R route revenue	Local transit agency Local transit agency
Value of accidents reduced	Impact assessment	Statewide District Local	VMT reduction Avg. accident rate by type Avg. economic value by accident type	Calculated Florida Department of Transportation rates Fatality =$220,000, Injury =$9,300, PDO =62,000
Lives saved	Impact assessment	Statewide District Local	VMT reduction Fatalities per VMT	Calculated FDOT rates
Annual VMT reduction per program dollar	Program assessment	Statewide District Local	Lots by type Lot/destination avg. trip by lot type Before/after auto occupancies	Inventory See Table 11-2 See Table 11-2
Annual user cost savings per program dollar	Program assessment	Statewide District Local	VMT reduction Operating cost per VMT Program costs	P&R implementation office P&R implementation office P&R implementation office
Annual fuel savings per program dollar	Program assessment	Statewide District Local	VMT reduction Avg. fuel consumption rate Program costs	Calculated See Table 11-3 P&R implementation office
Annual emissions reduction per program dollar	Program assessment	Statewide District Local	VMT reduction Avg. emission rates Program costs	Calculated See Table 11-3 P&R implementation office

Table 11-1. Program Performance Measures (Continued)

Measure	Application Area	Scope of Application	Information/Data	Information/ Data Source
Increase in transit ridership per program dollar	Program assessment	Statewide District Local	System ridership P&R route ridership Program costs	Local transit agency Local transit agency P&R implementation office
Increase in transit revenue per program dollar	Program assessment	Statewide District Local	System revenue P&R route revenue Program costs	Local transit agency Local transit agency P&R implementation office
Change in passengers per revenue mile	Program assessment	Statewide District Local	System ridership P&R route ridership System revenue miles Route revenue miles	Local transit agency
Value of accidents reduced per program dollar	Program assessment	Statewide District Local	VMT reduction Avg. accident rate by accident type Avg. economic value by accident type Program costs	Calculated See Table 11-2 See Table 11-2 P&R implementation office
Dollar value of programmed P&R projects	Budgeting	District Local	Work program TIP	Agency programming office MPO
Lease administration man-hours	Budgeting	District Local	Internal estimates	Responsible agency
Number of congested corridors with P&R application	Budgeting	District	Adopted Planning documents	MPO, RPC or other local planning agency
Areas considered for express bus implementation	Budgeting	Local	Internal assessments	Responsible agency
Programmed spaces per program dollar	Budgeting	District Local	Work program Past production history vs. program budgets	Internal records
Programmed facilities per program dollar	Budgeting	District Local	Work program Past production history vs. program budgets	Internal records

Measure	Application Area	Scope of Application	Information/Data	Information/ Data Source
Per space cost of facility development	Production management	District Local	Construction costs Lease costs	Construction management office Operations/ budget/fiscal office
PD&E roadway projects reviewed by P&R office	Production coordination management	Statewide District	Number of projects reviewed and not reviewed at PD&E stage	Programming Internal records
Percent of total PD&E projects reviewed by P&R office	Production coordination management	Statewide District	Number of PD&E projects reviewed and not reviewed	Programming Internal records
Number of JPA's signed	Implementation management	Statewide District Local	Number of signed JPA's	Contracts office
Total and per space value of claims	Risk management	District Local	Value of paid claims Number of spaces	Budget/fiscal office Inventory
Total and per space number of claims	Risk management	District Local	Number of paid claims Number of spaces	Budget/fiscal office Inventory
Total and per space tons of mix used in facility rehabilitation	Maintenance management	District Local	Maintenance records Number of spaces in system	Maintenance office Inventory
Distribution of spaces by pavement condition index	Maintenance management	District Local	Condition indices Number of spaces	Maintenance office Inventory
Number of unauthorized parkers on existing facilities	Maintenance management	District Local	Counts	Office responsible for counts
Maintenance cost of illegal parking in unauthorized locations	Maintenance management	District Local	Maintenance costs	Maintenance office
Number of police reports by incident type	Security management	District Local	Police reports	Police department

NOTE: TIP = Transportation Improvement Program
P&R = Park-and-ride
MPO = Metropolitan Planning Organization
RPC = Regional Planning Council
PD&E = Project Development and Environmental

NOTE: P&R = Park-and-ride
PD&E = Project Development and Environmental
JPA = Joint participation agreement

The data specified in Table 11-1 reflects the high level at which program evaluations are performed. These data are easily collected, easy to understand, and are input to computation processes which can be executed quickly and simply using system averages instead of site-specific data. The justification for this approach and level of analysis is time. As an example, the computation of statewide fuel savings associated with park-and-ride implementation would be prohibitively time consuming if site-specific computations were conducted. Such computations would include determinations of the change in operating speeds from each lot to final destination, the trip length from each lot to associated destination, fuel consumption rates at the before and after operating speeds, and the resultant impacts on fuel consumption. A more appropriate approach for program-level evaluations would be to use easily acquired data, such as number of parked vehicles which should be contained in an up-to-date inventory, and to apply average trip lengths and fuel consumption rates.

As can be seen, the data source column for a number of performance measures refers to Tables 11-2 and 11-3 which are presented below. These tables contain statistics derived from observation of actual lot use in Florida [1]. The statistics consist of system average trip lengths, vehicle occupancies, vehicle operating costs, mode shares, and accident rates classified by lot type; and average fuel consumption and vehicle emission rates.

Table 11-2. System-Average Trip Lengths, Occupancies and Operating Costs for Park-And-Ride Facilities

	Urban Corridor	Peripheral	Urban Fringe	Remote
Auto Occupancies (persons/vehicle):				
Before HBW	1.20	1.20	1.35	1.35
After home to lot	1.14	1.15	1.28	1.17
After lot to work	3.17	2.43	3.21	4.17
Average Trip lengths (miles):				
Home to lot	3.3	12	3.3	7.9
Lot to work	17.2	1	16.1	33.1
Auto Operating Cost ($/1000 Vehicle miles):	206	204	206	134
Annualization Factor:	233	226	213	233
Mode Shares from Lot to Work Destination:				
Carpools	5 or 20[1]	38	64	100
Transit	20 or 80[1]	62	36	0
Accident Frequency (per million VMT):[2]				
Fatality[3]	0.026[4]	0.032	0.0264[4]	0.019
Injury[3]	1.838[4]	2.650	1.8384[4]	1.025
Property-damage-only	10.276[4]	16.523	10.276[4]	4.028

(Reference 1 unless noted)

[1]For lots with transit service. Use 100 percent carpools for facilities not served by transit. Use 5% carpool/95% transit for rail lots. Use 20% carpool/80% transit for express bus lots.

[2](Reference 31)

[3]Values represent number of person involved, not accidents.

[4]Assumes 50% freeway travel and 50% arterial travel.

Table 11-3. System-Average Fuel Consumption and Vehicle Emission Rates

Planning Year	Fuel Consumption (Gallons/1000 VMT)	Vehicle Emissions (Tons/million VMT) CO	HC	NOX	TOTAL
1985	48	39	5	4	48
1990	38	25	3	3	31
1995	36	18	2	2	23
2000	36	15	2	2	19
2005	36	15	2	2	19
2010	36	15	2	2	19

(Reference 2)

The following definitions are provided for categorizing lots by functional type:

- **Urban Corridor**•Lots located along a major commute corridor within an urban area which are served by line-haul transit such as express bus, urban rail, or commuter rail services. Trip origin patterns tend to be dispersed along the corridor. Trip destination patterns may be dispersed along or concentrated at one end of the corridor.

- **Peripheral**•Facilities typically located at the periphery or fringe of an intensely developed, highly congested activity center. The access distances to the lot are typically longer than other type facilities while egress distances from the lot to the activity center are usually shorter.

- **Urban Fringe**•Lots located at the fringe of urban development. Trips tend to originate outside or at the outer limits of the urban area while destinations may be concentrated or dispersed within the urban area. Fringe area lots are generally not served by transit.

- **Remote or Rural**•Lots located outside the urban area generally in a rural or small town setting. Trips lengths, for both home-to-lot and lot-to-work legs of the commute trip are much longer than lots of other types.

Most of the performance measures presented in Table 11-1 can be computed in a straight forward manner. However, calculating values of a number of these measures should be explained. These are primarily related to the impact assessment measures. Procedures for computing these are presented in the concluding sections of this chapter.

VMT Reduction

The VMT reduction value is used to compute a number of other performance measures including those related to user cost savings, fuel consumption, vehicle emissions, value of accidents, and fatalities. The approach proposed here starts with totaling the number of parked vehicles by lot type. These totals are then multiplied by the average trip lengths from lot to destination for each lot

type. The average trip lengths are found in Table 11-1. This product is then converted to an annual amount using the annualization factor for each lot type as shown in Table 11-1. The formula for this computation is as follows:

$VMT_i = 2 * Parked_i * L_i * Afac_i$

System VMT reduction $= \Sigma_{I=1,lot\ types} VMT_i$

where:

VMT_i = VMT reduction for lots of type I
$Parked_i$ = Number of parked vehicles in lots of type I
L_i = Average lot-to-destination distance for lot type I
$Afac_i$ = Annualization factor for lot type i from Table

User Cost Savings

The computation of user cost savings consists of calculating the savings in vehicle operating costs. The approach does not consider costs saved through avoidance of parking fees or costs incurred such as transit fares and parking fees. The approach is simply to multiply the annual VMT reduction for each lot type as computed by the above method by the average operating cost as found in Table 11-2.

The formula for this computation is as follows:

$Cost_i = VMT_i * Opcost_i$
Systemwide User Cost Savings $= \Sigma_{i=1,lot\ types} Cost_i$

where:

$Cost_i$ = Annual cost savings for users of lot type i
VMT_i = Annual VMT reduction for lots of type i
$Opcost_i$ = Average vehicle operating cost for vehicles parked at lots of type i as found in Table 11-2

Change In Vehicle Occupancy

This performance measure relates specifically to a stated Florida Transportation Plan objective. The user must be careful to subdivide lots into those with and without transit service. The following sequence of formulas compute the change in vehicle occupancies:

$Cocc_i = [l/(Mt_i/20 + Mc_i/Aocc_i)] - Bocc_i$ for Mti > 0 for Mti = 0
$Ppc_i = (Mc_i/Mt_i)/[\{(BOCC_i/AOCC_i)/(1-Bocc_i/Aocc_i)+1\}+Mc_i/Mt_i] = 1$
$Egress_i = Parked_i * Bocc_i * [Ppc_i/(Aocc_i-Bocc_i)] +(l-Ppc_i)/20$
Change in Vehicle
Occupancy $= \Sigma_{i=1,lot\ types}(Cocc_i * Egress_i)/\Sigma_{i=1,lot\ types} Egress_i$

where:

$Parked_i$ = Number of parked vehicles in lots of type I

$Aocc_i$ = Auto occupancy of car-poolers from lot to work for lot type i. Refer to Table 11-2 for default values.

$Bocc_i$ = Before auto occupancy for lot type i. Refer to Table 11-2 for default values.

$Cocc_i$ = Change of occupancy for lot type i.

$Egress_i$ = Number of egressing carpools and transits vehicles from lots of type i.

Ppc_i = Proportion of parkers that are carpool passengers.

Mt_i = Transit mode share from lot to work destination for lot type i. Refer to Table 11-2 for default values.

Mc_i = Carpool mode shares from lot to work destination for lot type i. Refer to Table 11-2 for default values.

Annual Fuel Savings

The computation of annual fuel savings is based on the VMT reduction computed above. Average fuel consumption rates from Table 11-3 are used. The following formula computes annual fuel savings:

Annual fuel savings = $Frate_y$ * VMT reduction/1,000 (gallons)

where:

$Frate_y$ = Average fuel consumption rate in gallons per 1,000 vehicle miles from Table 11-3.

Annual Emission Reductions

The computation of annual emission reductions is based on the VMT reduction as computed above. Average emission rates from Table 11-3 are used. Rates are provided by pollutant. The appropriate rate would be selected based on the type of analysis being performed. For example, only hydrocarbon rates would be used for computing emission credits in non attainment areas for ozone. The following formulas compute annual emission reductions:

CO reduction (annual tons) = CO_y * VMT reduction/1,000,000

HC reduction (annual tons) = HC_y * VMT reduction/1,000,000

NOX reduction (annual tons) = NOX_y * VMT reduction/1,000,000

Total reduction (annual tons) = $TOTAL_y$ * VMT reduction/1,000,000

where:

Co_y = Average emission rate in tons per million vehicle miles from Table 11-3.

HC_y = Average emission rate in tons per million vehicle miles from Table 11-3.

NOX_y = Average emission rate in tons per million vehicle miles from Table 11-3.

$TOTAL_y$ = Average emission rate in tons per million vehicle miles from Table 11-3.

Value of Accident Reduction

This computation is based on multiplying the VAT reduction by lot type by average accident frequencies found in Table 11-2. The computation produces number of fatalities, number of injuries, and number of property-damage-only (PDO) accidents. These values are then equated to economic values based on FDOT's standard rates of $220,000 per fatality, $9,300 per injury, and $2,000 per PDO accident. The following equations compute accident-related statistics:

$$\text{Fatalities} = \Sigma_{i=1,\text{lot types}}(FAT_i * VMT_i/1{,}000{,}000)$$
$$\text{Injuries} = \Sigma_{i=1,\text{lot types}}(INJ_i * VMT_i/1{,}000{,}000)$$
$$\text{PDO Accidents} = \Sigma_{i=1,\text{lot types}}(PDO_i * VMT_i/1{,}000{,}000)$$

Economic value of accident reduction (annual dollar value) =

220,000 * Fatalities + 9,300 * Injuries + 2,000 *PDO accidents

where:

FAT_i = Fatalities per million vehicle miles of travel for lot type I from Table 11-2

INJ_i = Injuries per million vehicle miles of travel for lot type i from Table 11-2

PDO_i = Property-damage-only accidents per million vehicle miles of travel for lot type i from Table 11-2

VMT_i = Accumulated vehicle miles of travel for lots of type i

CHAPTER 12: PRIVATE PARTICIPATION

This chapter presents a catalog of techniques for involving the private-sector in the development and operation of park-and-ride facilities. The catalog provides a description of each technique including:

- The purpose of the action including facility development, provision of ancillary services, and funding
- Responsibilities of the Department in using the technique
- Description of participating entities
- Types of facilities to which the technique is applicable
- Potential benefits which can result from the action
- Barriers to utilizing the technique
- Identification of agencies which have experience in the use of the technique

The material contained in this chapter is an abridgment of information presented in Working Paper 3: Private Participation [55]. That document contains supporting research information not presented here.

The catalog is presented from the perspective that the techniques are applied to reduce the financial burden of the Department. Local agencies may also make use of the catalog with the caveat that their perspective will most likely be different than FDOT's and will require some changes to the descriptions to represent that perspective.

The majority of the techniques presented in the following pages are applicable to development of new facilities. A few are presented which are more applicable to other purposes such as generating construction revenues and providing ancillary services which can promote usage of existing facilities.

Some of the techniques have formidable barriers to their effective use in Florida. Such barriers include gaining organized labor endorsement and passing amended development ordinances. In addition, certain conditions must exist for effective use of the technique. These conditions are described.

Not all techniques are appropriate for all types of facilities. For example, formation of a parking authority can only work in areas where parking fees can be assessed which implies application to CBD or similar peripheral faculties.

Table 12-1 summarizes the most important information concerning the implementation of each of the techniques presented in the catalog. The table shows the purpose of application, assessments of the implementation potential resulting from legal and institutional barriers, and qualitative appraisals of the potential cost savings in utilizing each of the techniques presented.

Table 12-1. Private Participation Techniques Summary

Technique	Application	Implementation Potential	Legal Barriers	Institutional Barrier	Potential Public Cost Reduction
Joint use of shopping center lot	Facility development	High	Minimal	Moderate	Significant
Joint use with compatible private use	Facility development	High	Minimal	Moderate	Significant
Joint use of local agency facility	Facility development	High	Minimal	Moderate	Significant
Joint use on non-profit land	Facility development	High	Minimal	Moderate	Significant
Sale of surplus right-of-way	Facility development	Moderate to high	Minimal	Moderate	Significant
TMA	Facility financing, development, operation	Low to moderate	Moderate	Considerable	Moderate to significant
General partnership	Facility financing development operation	Low to moderate	Moderate	Considerable	Moderate to significant
Developer land contribution	Facility development	Low to moderate	Considerable	Moderate	Moderate to significant
Off-site parking substitution	Facility financing, development	Moderate to high	Moderate	Moderate	Moderate
Impact fees	Facility financing	Moderate to high	Moderate	Moderate	Moderate to significant
Parking condos	Facility financing, development	Low	Moderate	Considerable	significant
Parking authority	Facility financing, development operation	Low	Moderate	Considerable	Significant
Contract with private transit provider	Provision of amenities	Low	Considerable	Considerable	Moderate
Vendors permits	Provision of amenities	High	Moderate	Moderate	Slightly negative
Preferential HOV parking credits	Provision of amenities	High	Moderate	Moderate	No reduction

Technique	**JOINT USE OF SHOPPING CENTER PARKING LOT**
Concept	Existing shopping center is approached to negotiate use of part of parking area for park-and-ride. Implementing agency provides improvements and pays nominal lease amount.
Purpose	Facility development.
Department Responsibilities	Design, physical improvements
Shopping Center Responsibilities	Maintenance of public parking area may or may not be negotiated.
Benefits	Very low cost of implementation for Department. Questionable monetary benefit for shopping center. Most significant benefit for shopping center related to providing public service.
Applicable Facilities	Urban fringe most applicable. Urban corridor appropriate setting but more difficult to implement.
Special Considerations	1) Requires lease agreement and possible payment of added premium to shopping center liability policy. 2) Shopping centers that are best located for reducing congestion are generally successful and do not wish to cooperate. 3) Shopping centers which are typically the easiest to deal with are those with low patronage or newly developed. These facilities tend to be located in urban fringe areas.
Barriers to Effective Implementation	1) Shopping centers are generally difficult to deal with, and are uncooperative. 2) Shopping center may not have been originally designed for transit which would preclude transit access to the site.
Agency Contacts	Metro-Dade Transit Agency Jacksonville Transportation Authority Hillsborough Area Regional Transit Authority Tri County Transit (Orlando) LeeTran (Fort Myers) West Florida Regional Planning Council District VII PTO

Technique	**JOINT USE WITH COMPATIBLE PRIVATE DEVELOPMENT.**
Concept	Existing development is approached to negotiate use of part of parking area for park-and-ride. Implementing agency provides improvements and pays nominal lease amount. Development is of type which has adequate parking during daytime hours.
Purpose	Facility development.
Department Responsibilities	Design, construction, physical improvements.
Participant Responsibilities	Provides land and maintenance.
Benefits	Very low implementation cost for Department. Slight Operation cost related to nominal lease amount. Slight monetary benefit for development through lease. Most significant developer benefit related to public service provision.
Applicable Facilities	No restriction.
Special Considerations	1) Types of compatible land uses include movie theaters, bowling alleys, drive-in theaters, dinner restaurants or other uses with predominantly night-time business patterns. 2) Bars have been used but may not be the best affiliation from an appearance standpoint. Restaurants may fall into this category as well. 3) Lease agreement is required. Lease terms may require Department to pay for added liability premium.
Barriers to Effective Implementation	Short-term leases cannot be entered in to if improvements are made such as a regulatory sign or vehicle stops. Developers tend to not want to sign long-term leases.
Agency Contacts	Michigan Department of Transportation

Technique	**JOINT USE OF LOCAL AGENCY FACILITY**
Concept	Local government provides land to construct parking of which part is agreed to be used for park-and-ride. Alternately, local government agrees to allow use of existing facility. Local government provides maintenance while the Department constructs or improves.
Purpose	Facility development.
Department Responsibilities	Design, construction, physical improvements.
Participating Agency Responsibilities	Land and maintenance provided by government agency including city/county offices, city halls, courthouses, community colleges, parks, schools, libraries, etc.
Benefits	Low Department cost since right-of-way purchase is not required. Community receives improvement to public facility at nominal cost.
Applicable Facilities	No restriction. Technique appears to be most often used in rural areas. Public facilities needing paved parking are likely located in rural areas.
Special Considerations	1)Design must include enough spaces to accommodate the needs of both the public facility and the park-and-ride operation. 2)Requires joint-participation agreement. 3)Urban area sites will probably not need significant improvements. Effort will be largely related to negotiating use of existing, improved facilities. 4)Types of applicable public facilities include city halls, courthouses, government offices, parks, schools, libraries, community colleges. 5)Potential for parking conflicts if public facility has high daytime use.
Barriers to Effective Implementation	None other than the limited number of opportunities.
Agency Contacts	Metro-Dade Transit Agency Hillsborough Area Regional Transit Authority District III PTO District VII PTO West Florida Regional Planning Council

Technique	**JOINT USE ON LAND PROVIDED BY NONPROFIT ORGANIZATION**
Concept	Nonprofit organization is approached to negotiate use of part of parking area for park-and-ride. Implementing agency provides improvements and pays nominal lease amount.
Purpose	Facility development
Department Responsibilities	Design, construction, physical improvements.
Participant Responsibilities	Land and maintenance provided by fraternal organization, private college/university, or similar nonprofit organization with adequate daytime parking supply.
Benefits	Low implementation cost for Department. Slight monetary benefit to nonprofit through lease value with greater benefit if improvements are made by the department. Most significant benefit related to providing public service.
Applicable Facilities	No restriction.
Special Considerations	1)Types of organizations include private colleges/universities, fraternal organizations. 2)Lease or use agreement is required. 3)Sites may not be adequately located or sized. 4)Lease terms may require Department to pay premium for added liability coverage.
Barriers to Effective Implementation	Lease terms must be consistent with State legislation and/or local laws.
Agency Contacts	Southeast Michigan Area Regional Transit Michigan Department of Transportation

Technique	**SALE OF SURPLUS RIGHT-OF-WAY**
Concept	Government unit negotiates park-and-ride lot construction in terms of sale of surplus right-of-way.
Purpose	Facility development.
Department Responsibilities	Sells surplus right-of-way of interest to developers, and negotiates park-and-ride facility as sale terms for reduced sale price.
Participant Responsibilities	Purchases land and constructs parking facility in conjunction with new development.
Benefits	Liquidation of surplus property and construction of facility at no cost since land has already been purchased. Developer acquires value property at reduced price.
Applicable Facilities	No restrictions but most applicable to urban corridor lots in attracting development.
Special Considerations	1) Parcel size must be large enough to support development. 2) Access will likely be a problem and will need to be resolved.
Barriers to Effective Implementation	Availability of parcels of sufficient size and location to attract development. Concurrency in congested corridors.
Agency Contacts	Michigan Department of Transportation

Technique	**TRANSPORTATION MANAGEMENT ASSOCIATION**
Concept	Nonprofit group of employers, property owners, developers, and government established to pool resources to address community transportation problems including parking.
Purpose	Facility development.
Department Responsibilities	Ex-officio member of management board providing technical guidance and possible funding contributions to construction.
Participant Responsibilities	Supports solution initiatives, finances improvements, provides transit services if any, and provides funding for operation of the technical staff.
Benefits	Takes advantage of strengths of both the public and private agencies involved to implement transportation improvements.
Applicable Facilities	Peripheral facilities to major activity centers.
Special Considerations	1) Well defined area with significant congestion and parking problems. 2) Growth area.
Barriers to Effective Implementation	Area transportation problems need to be perceived as being significant enough to form the association.
Agency Contacts	Westshore Transportation Management Association (Tampa) Orlando Transportation Management Association District V PTO District VII Planning

Technique	**GENERAL PARTNERSHIP.**
Concept	Public/private partnership utilizing the best attributes of each partner to establish parking facilities with maximum benefit to all parties.
Purpose	Facility development.
Department Responsibilities	Land acquisition and possibly capitalization of facilities.
Participant Responsibilities	Developer group buys facilities back from State as development comes on line.
Benefits	Department cost related only to land costs. Developers benefit from depreciation and equity of structures.
Applicable Facilities	Structured peripheral parking to a major activity center.
Special Considerations	1) Needs to be located near growth area where development can be expected to contribute. 2) Developer cooperation must exist to form the management committee. 3) Congested activity center with parking problems.
Barriers to Effective Implementation	Formation of the partnership must be accomplished. Florida law does not allow the Department to be •paid back• in the manner suggested here. Will probably local government involvement to gain full benefit of possible financing arrangements.

Technique	**DEVELOPER CONTRIBUTES LAND THROUGH DEVELOPMENT ORDINANCE MANDATES.**
Concept	Large development dedicates land for park-and-ride facility through local development review requirement. Construction is negotiated or is responsibility of local regulatory government.
Purpose	Facility development.
Department Responsibilities	Will depend on development ordinance. Can range from no involvement to design and construct depending on the situation. Land will be in local government control and will require joint participation agreement for Department involvement.
Participant Responsibilities	Dedicates land specifically for park-and-ride facility through platte/site plan review process. Development of scale to support the future facility.
Benefits	At a minimum, price of land eliminated from public development cost. Potential to have entire cost of project supported by the developer but is contingent on the development ordinance and negotiations. Developer receives site approval. Other potential benefits include reduced road improvement assessments, satisfaction of concurrency requirement, or impact fee credits depending on the situation and ordinance.
Applicable Facilities	Normally urban fringe facilities since most development occurs in that area. Any area where the development is of a scale to require the dedication
Special Considerations	1) Must be able to technically support relationship between development size and ability to support the park-and-ride facility. 2) May need to include transit service expansion as justification for requiring land dedication for park-and-ride. This will provide an incompatibility between when the development has been built out enough to support transit and when the developer demands service that he has provided land for. 3) Most applicable to the larger urban areas with a major activity center, significant development occurring or anticipated, and significant roadway congestion, i.e., Miami, Orlando, Jacksonville.
Barriers to Effective Implementation	Development ordinance will need to be amended and adopted. Parking facility becomes responsibility of the local government where the development is located. Potential conflict with FDOT's implementation goals.
Agency Contacts	Hillsborough Area Regional Transit Authority

Technique	**OFF-SITE PARKING SUBSTITUTION.**
Concept	Parking requirements for new development are reduced in lieu of developer providing or funding parking off-site.
Purpose	Facility development, funding.
Department Responsibilities	Potentially none depending on situation. Collection and use of impact fees responsibility of local government. JPA will be needed to involve the Department in construction.
Developer Responsibilities	Local review agency reduces site parking requirement. Developer contributes to parking trust fund or builds off-site parking. Some areas require developer provided shuttle service for off-site parking facilities located further away than walking distance.
Benefits	Lower cost development of facility. Developer receives site approval. Reduced parking requirement means more feasible area for site. Potential concurrency benefits for the developer through reduction of traffic on congested roadway.
Applicable Facilities	Typically peripheral parking for major activity center.
Special Considerations	1) Only applicable to growth areas of the community since development is supporting the effort. 2) Potential delayed construction do to time required to collect funds from all developments. 3) Best applied where development will consist of one very large employer with enough employees to support a facility on its own.
Barriers to Effective	Local government must amend/adopt development review ordinance.
Implementation Agency Contacts	City of Orlando Bureau of Planning and Zoning City of Orlando Traffic Engineering City of Sacramento Planning Department Sacramento County Planning Department Atlantic County (New Jersey) Transportation Authority City of Los Angeles Zoning Department

Technique	**DEVELOPER IMPACT FEE ASSESSMENTS.**
Concept	New development supports park-and-ride through payment of impact fee assessments. Basis of assessment can include cost of park-and-ride facilities or may only be based on roadway improvement costs.
Purpose	Facility financing.
Department Responsibilities	Potentially none but depends on situation. Collection and use of impact fees responsibility of local government. JPA will be needed to involve the Department.
Participants Responsibilities	Local government collects impact fee from developer. Fee calculation may include cost of the park-and-ride facility if stipulated in impact fee ordinance. Local government may likely need to provide transit service to support the justification of the impact fee.
Benefits	Funding provided by private development. Time for accrual of total fees will be long which suggests that expedited construction might not occur. Government will still need to capitalize the construction.
Applicable Facilities	Normally urban fringe facilities since most development occurs in that area; however, may apply to any facility where development is still occurring.
Special Considerations	1) Government may still need to capitalize construction due to the •pay out• schedule dictated by the pace of development in the community. 2) Must develop a formally-adopted park-and-ride facilities plan. At a minimum, park-and-ride facility costs must be included in Long-Range Plan road costs upon which impact fees are assessed. 3) Technical justification required to support the market area around the facility where the fees will be assessed. 4) Must technically support the relationship between the fee and benefit from park-and-ride. 5) Planned facilities should be located where a reasonable cost can be assessed.
Barriers to Effective Implementation	Must amend/adopt impact fee ordinance. Must technically justify relationship between assessment and benefit to the payee. May need to formerly adopt park-and-ride facilities plan as part of Long-Range Plan depending on the ordinance provisions.
Agency Contacts	Hillsborough County Planning and Zoning Broward County Office of Planning Palm Beach County

Technique	**PARKING CONDOMINIUMS**
Concept	Parking spaces at transit terminals are reserved through joint public/private development of parking with Individual spaces being sold to parkers.
Purpose	Facility development and financing.
Department Responsibilities	Similar to other joint development projects. Combines with private investors/developers to plan, design, condemn, and construct parking at transit terminals.
Participant Responsibilities	Depends on arrangement but can include all functions as specified above for the Department plus financing, management, and sales.
Benefits	Most of the entire parking facility cost is paid by the ultimate users of the provided improvement through payment of true cost of construction. Reduces the required number of •public• parking spaces, resulting in lower public-side cost.
Applicable Facilities	Rail stations with large parking shortage. Peripheral parking garages to CBD's with parking shortage.
Special Considerations	1) Limited experience in the application of this technique. Public may not be supportive of the concept if prices are not competitive. 2) Has been identified with rail systems in the Northeast. Miami appears to be the only location where this approach can be applied to rail. 3) Downtowns with severe parking shortages are attractive. 4) UMTA Suburban Mobility Parking Initiative grants available for technical and capital assistance.
Barriers to Effective Implementation	Investor acceptance may be low since this is a new and largely untested approach to joint development initiatives. Will need to institute parking restrictions in areas to make the approach more attractive.
Agency Contacts	Urban Mass Transportation Administration

Technique	**ESTABLISH PARKING AUTHORITY TO DEVELOP PARKING FACILITIES**
Concept	A public agency with bonding authority is established with powers to bond, condemn, construct and manage parking facilities in a defined area.
Purpose	Financing and operation of parking facilities.
Department Responsibilities	None.
Participant Responsibilities	Local unit of government establishes separate authority to administer parking in a defined area.
Benefits	Bonding to capitalize development of facilities.
Applicable Facilities	Peripheral facilities adjacent to major activity center.
Special Considerations	1) Requires situation where parking fees can be set at a level to support the bonding. 2) Applicable to situations where the parking supply is particularly acute and requires a dedicated staff outside the normal government operation to alleviate the supply problem. 3) Large activity centers.
Barriers to Effective Implementation	Requires establishing another unit of government with bonding capacity.
Agency Contacts	Downtown Tampa Parking Authority

Technique	**CONTRACT WITH PRIVATE PROVIDER FOR TRANSIT SERVICES.**
Concept	Private transit provider supplies service to commuter lot at a reduced cost compared to locally supplied service.
Purpose	Enhance services to parking facility.
Department Responsibilities	Provision of operating and capital funds in support of local transit operators.
Participant Responsibilities	Contracts with private provider and provides financing. Contractor provides express bus or shuttle service.
Benefits	Reduced cost to transit operator in providing service to facility.
Applicable Facilities	Urban corridor lots where commuter-type transit services are applicable.
Special Considerations	1) Corridor not presently served by transit. 2) Larger urban area where charter commute providers can operate profitably.
Barriers to Effective Implementation	Conflicts with transit union and Federal Section 13 requirements.
Agency Contacts	Metro-Dade Transit Authority Dallas Area Regional Transit Authority Southern California Rapid Transit District

Technique	**USER PERMITS TO VENDORS AT PARK-AND-RIDE LOTS.**
Concept	Increase facility usage through provision of ancillary support services such as catering trucks, flower sellers, etc.
Purpose	Provision of amenities to increase usage.
Department Responsibilities	Grants use permits to vendors wishing to do business at parking facilities.
Participant Responsibilities	Licensed vendors provide services at facilities during commuting hours. Requires coordination with local government issuing business licenses.
Benefits	Improves facility amenities at little cost. May create problems with local retail establishments near the site.
Applicable Facilities	No restrictions other than large facilities will be the most attractive to the vendors.
Special Considerations	1) Special permission required for joint use lots. 2) Facilities large enough to provide sufficient business to vendor. 3) Consideration for local businesses which may already be providing services to be dispensed by vendors.
Barriers to Effective Implementation	Enabling legislation needs to allow for use of State property for private gain. Local establishments may contest competition from vendors.

Technique	**REDUCTION IN REQUIRED SPACES FOR PROVISION OF HOV PARKING AT DESTINATION.**
Concept	Create demand for carpools by giving preferential parking at destination.
Purpose	Increase usage of existing facilities.
Department Responsibilities	None.
Participant Responsibilities	Local government provides space allowances through development review process. Developer designates carpool only parking- spaces in a preferred location.
Benefits	Developer benefits from reduced parking requirement. Provides impetus to form carpools which may result in higher usage of facilities.
Applicable Facilities	Facilities in major travel corridor.
Special Considerations	1) Requires extraordinary conditions to produce significant increases in lot usage. 2) Should be packaged with other initiatives such as ridesharing promotion to gain significant impact. 3) Needs to be applied over a significant area to produce noticeable impacts.
Barriers to Effective Implementation	Amendments/adoption of development ordinances and zoning codes will need to be made.
Agency Contacts	City of Sacramento Planning Department Sacramento County Planning Department Village of Schaumburg, Illinois City of Seattle Department of Construction and Land Use City of Roseville (California) Planning Department

TECHNICAL APPENDICES

The following technical appendices present technical information referred to in the main body of this manual or the working papers. These appendices are organized as follows:

Appendix A	References
Appendix B	Bibliography
Appendix C	Glossary
Appendix D	Florida park-and-ride lot inventory
Appendix E	Site selection evaluation methodology
Appendix F	Lot survey materials
Appendix G	Analysis worksheets

APPENDIX A
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This appendix contains a list of reference documents cited in this manual. Appendix B contains the complete bibliography of literature used during the State Park & Ride Lot Program Study.

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APPENDIX C
GLOSSARY

Access - the street system providing access to a parking facility, sometimes involving several streets, particularly if one-way.

Adequate rate covenant - often required in revenue bond financed projects; guarantees the operator will charge adequate rates to produce revenue necessary to cover principal and interest payments.

Aisle, driving - the traveled path through a parking facility between one or two rows of parked vehicles.

Allocation model - a mathematical model used to determine the percentage of parking space to be used by all-day, short-term, and other parkers.

Angle, parking - the angle at which the parking stall extends from the edge of the parking bay, usually ranging from 50 to 90 degrees.

Angle, stall - see Angle, parking.

Approach traffic - using approach streets to a parking facility.

Auto-free zone - an area, usually in or near downtown, where vehicular traffic is severely limited or completely restricted.

Automated parking facility - a facility operated by automatic parking equipment rather than by employees.

Automatic controls - equipment such as ticket dispensers, card readers, and parking gates used in an automated facility.

Automatic pre-cashiering - automatic prepayment machines located in or near a parking facility for the purpose of permitting the prepayment of parking fees before the patron retrieves his vehicle from the parking stall.

Average length of stay - average length of time vehicles are parked in a particular facility.

Back-in stalls - parking spaces into which the vehicle is backed from the driving aisle.

Bay - a parking facility unit that has two rows of parking stalls and a central aisle.

Building area - that portion of a lot or land parcel on which a building can be constructed.

Building code - local ordinances controlling the building methods and component requirements for construction of various types.

Bumper - a wheel stop placed at the front of a parking stall to keep the vehicle from striking walls or extending beyond the specified parking area.

Bus and carpool lanes, preferential lanes, or HOV lanes - a form of preferential treatment in which lanes on streets and highways are reserved for the exclusive use of high occupancy vehicles.

Busway - a roadway designed for exclusive or predominant use by buses in order to improve bus movement and travel times.

CBD - the central business district or downtown area of a community.

Capacity, facility - the number of vehicles that can be accommodated in any given parking facility under a particular type of operation.

Capacity, roadway - the capacity, in terms of vehicles that can be accommodated per day or per hour on any given street or roadway.

Capture rate - the percentage of vehicles passing a transfer facility that would be induced to use the facility.

Car size classifications - designation of vehicles by size: subcompacts, compacts, intermediate, standard, and luxury.

Car width - in relation to a parking stall; most U.S. cars now range from 60 to 80 inches in width.

Carbon monoxide (CO) - a colorless, odorless, poisonous gas emitted from vehicle exhausts.

Carbon monoxide detectors - devices used to measure the concentration of CO and emit warnings if harmful levels are reached.

Carpool - any vehicle, usually an automobile, carrying two or more occupants, including the driver, or a group of people sharing automobile transportation.

Catchment zone - a term used to define the market area for a specific site or corridor.

CBD fringe - that portion of a municipality immediately outside the CBD in which there is a wide range in type of business activity, generally including small commercial, light industrial, warehousing, automobile service activities, and intermediate strip development, as well as some concentrated residential areas.

CCTV - see closed-circuit television.

Change of mode - the transfer from one form of transportation to another.

Channelization - construction of islands or barriers, usually on roadways, to assist in control of traffic flow patterns.

Circular ramp - a ramp between floors of a parking facility whose center line is circular.

Circulation - traffic flow pattern, such as two-way or one-way, for an on-street system or off-street

parking facility.

Clear height - clear vertical height inside a parking structure; usually 7 feet is a desirable minimum.

Clear-span facility - a parking structure with vertical columns on the outside edge of the structure and a clear span between columns, making it unnecessary for vehicles to maneuver between columns.

Closed-circuit television - a system providing security in parking facilities by the use of TV cameras that cover portions of the facility.

Code requirements - the parking facility requirements contained in a community's codes that affect zoning and construction, as well as plumbing, electrical, and similar specialties.

Commuter parking - parking areas, usually specially designated, for users of mass transportation or carpool operations.

Commuter shed - a term used to define the market area for a particular park-and-ride facility or travel corridor.

Compact car - a small car, usually less than 15 feet in overall length and 72 inches in width.

Contract documents - the design plans and specifications for construction of a facility.

Contract parking - long-term or specified-term parking arranged in advance, usually on a fixed fee basis.

Construction cost data - information which includes current cost for individual construction components and that forms the basis for preparation of project cost estimates.

Cordon count - the simultaneous counting of all traffic at strategic points entering and leaving a given area such as a CBD. Corridor - a broad geographical band that identifies a general directional flow of traffic. It may encompass a number of streets and highways and transit route alignment.

Cost, operation and maintenance - the cost of operating and maintaining a facility, including staff charges, utilities, insurance, supplies, and repairs. Such costs are deducted form gross revenue.

Cost per stall - the costs of a facility divided by the number of parking stalls.

Cost per square foot - the cost of a facility divided by the number of square feet in the facility.

Cost, project - the total cost of a facility, including land, construction, engineering fees, contingency costs, and any unusual charges.

Coverage, debt service - the ration of revenue less all facility operating and maintenance costs, divided by the required annual payments for principal and interest; usually expressed as a percentage.

Curb distance - the straight-line distance required along a curb for a parking stall-and varying in length depending upon the stall angle.

D factor - directional distribution of peak hour traffic on a two-way roadway. Usually stated as the proportion or percentage of two-way traffic operating in the dominant direction.

Delay - the time lost by a person, a vehicle during travel and due to circumstances which impede the desirable movement of traffic. It is the travel time difference between congested and free-flow travel times.

DHV - design hour volume (a volume of traffic selected as the basis for design criteria of a facility).

Demand - the number of potential customers for a parking facility or parking system.

Demand/Supply - a ratio of parking demand (vehicles) and parking supply (spaces) that indicates an excess or shortage of available space.

Depreciation - a percentage of the value of an improvement deducted each year for wear and tear.

Design/build system - a system in which a single entity is responsible for both the design and construction of a facility, often involving the fast-track method of construction; also referred to as design/construct.

Design standards - a set of criteria established to define the design characteristics of a parking facility.

Destination - the end point of a single trip such as home, school, work, or church. Diameter, ramp - the measurement from outside wall to outside wall across a circular ramp.

Dimension, stall - the length and width of a parking stall.

Discharge time - the time required to empty a parking facility of parked vehicles.

Double striping of parking lots - the practice of separating adjacent parking stalls using two stripes separated by 2 to 4 feet of pavement. Thus, each stall has a double stripe between it and adjacent stalls.

Duration - the length of time a vehicle is parked; average length of time all vehicles are parked in a particular facility.

Emissions - gases and particular matter that pass through the exhaust system of a vehicle.

Environmental impact - measurement of the environmental consequences of a parking facility in terms of air, noise, and water pollution levels that are generated by the facility.

EPA - the Environmental Protection Agency, charged by the Congress with developing and enforcing environmental regulations.

Express bus - a conventional bus which minimizes stops between origin and destination using an HOV facility or in mixed traffic on freeways or arterials.

Financial feasibility - determination of a project's potential economic success.

Financing - means of providing funds for a parking facility through private capital, public sale of general obligation or revenue bonds, special assessment or tax district funds, leases, not-for-profit associations, or a combination of these various sources.

Flat rate fee - a set amount charged for parking for a specific period of time such as an hour, a day, or a month.

Floor area - the area of a floor, measured by length times width; in some cases, the total floor area of a facility.

Flow system - the traffic flow pattern in a parking facility such as one-way, two way, or reverse flow.

Fringe parking - the term fringe parking refers to any parking facility located outside of an activity center such as a central business district.

Functional design - the design of a structure or facility which increases its overall efficiency and provides maximum user acceptance; a parking concept plan showing traffic flow, stall geometry, and other features that determine the interior design of parking facilities.

General obligation bonds - bonds sold by a public agency to finance public improvements and which guarantee the full faith and credit of the agency regarding repayment.

Grade - the degree of incline or slope in a ramp or floor of a parking structure.

Gross area - the entire area of a building, usually measured in square feet or square meters.

Half bay - a parking facility unit that has one row of car stalls and a central aisle.

Head-in - parking system where vehicles park front first in the parking stall.

Headroom - the vertical clearance in a parking structure, usually about 7 feet.

Headway - this is the time interval between successive vehicles crossing a point on the roadway.

Helical ramp - a spiral or circular ramp.

Herringbone - a pattern for the layout of parking spaces with alternate rows set at oblique angles to one another.

High occupancy vehicle (HOV) - motor vehicles carrying more persons than Just the driver. It could be a bus, car or van used for pooling, or any other motor vehicle that meets the minimum occupancy requirements, generally two, three, four or more, specified for a particular location or area.

High turnover - a parking facility with a high rate of turnover or high number of vehicles per space per day.

Hydrocarbons - compounds containing hydrogen and carbon that result from the operation of an internal combustion engine.

Intermediate - a mid-sized car, between a compact and a full-sized car.

Inventory spaces - total number of parking spaces available in a facility or in a parking system.

Island - a raised area in a roadway, driveway, or parking facility, used to control or direct traffic flow.

K factor - percentage of 24-hour traffic on a roadway traveling during the peak hour

Kiss-and-ride (passenger load and unload) - the transfer mode whereby a transit or commuter passenger is driven to or picked up from his or her first transit terminal point in a private vehicle driven by another person who does not originate or terminate the trip at the terminal.

Lane control signal (red/green) - illuminated signal lights positioned over exit lanes to indicate when the lane is open (green) or closed (red) to traffic.

Lane width - width of a lane, expressed in feet.

Level of service - a descriptive measure of the quality and quantity of transportation service provided which incorporates finite measures of quantifiable characteristics such as travel time, travel cost, number of transfers, etc.

License plate inventory - periodic recording of all vehicle license plate numbers in a parking facility in order to determine length of stay and prevent fraud by patrons claiming lost tickets.

Life safety code - a recently developed code aimed at guaranteeing adequate requirements for new construction.

Locator, parking space - signs or other means of helping motorists locate their vehicles when they return to a parking facility.

Long-term parking - vehicles parked for at least half a day or longer.

Lot design - the layout of a parking lot in terms of physical features.

Market area or target market area - this is the imaginary irregular fan shaped area radiating away from the CBD with the apex of the fan located slightly closer to the CBD than the park-and-ride parking lot. It is from this area patrons for a park-and-ride facility originate.

Metered parking - parking controlled as to time and fee by meters or numbers at each space; see slot boxes.

Mode of access - the form of transportation used to access a transfer facility. Modes typically used in transportation planning studies include walk, drive-alone auto, shared-ride auto, kiss-ride, park-ride, bus transit, and rail transit.

Mode share - percentage of person-types using particular mode of travel.

Mode split analysis - estimation of the amount of travel by travel mode.

Mode of travel - means of reaching a destination including walking, riding transit, driving a car, and being a car passenger.

Module - a portion of a parking facility, usually a bay containing a central aisle and two rows of parking spaces. _

Modular width - the unit width, in feet, of a module.

NFPA - the National Fire Protection Association, a professional association involved in the promotion of fire safety.

NPA - the National Parking Association, a professional association representing the parking industry.

Occupancy rate - the rate at which a given parking facility or a parking system is occupied, on an hourly, daily, or annual basis.

O&M Costs - operation and maintenance costs; the costs, usually expressed in terms of annual amounts, to operate, staff, and maintain a parking facility.

Parallel parking spaces - spaces designed parallel to the curb of a street, a lot, or a parking structure wall.

Parking angle - the angle formed by a parking stall and the wall or center line of the facility, ranging from 90 degrees (perpendicular) to 30 degrees.

Parking bay - the section of a parking facility containing an aisle and one or two rows of parking spaces.

Parking inventory - a tabulation of the number of parking spaces available in a given area categorized by curb or off-street spaces, public or private use, or by other classifications.

Parking load - the total number of space hours used during a given period of time. Its peak is reached at peak accumulation, when capacity is used to its fullest extent.

Peak period - period of maximum parking activity; can be by the hour, day of week, or seasonal.

Peripheral lot - Facilities typically located at the periphery or fringe of a major activity center. Access distances to the lot are typically longer while egress distances from the lot to the final trip destination are usually shorter than other facility types.

PHT - person-hours of travel.

Practical parking capacity - this is after less than the available parking capacity by from 5 to 15 percent. This is related to time wasted in driving, parking maneuvers, time searching for a space and

encroachment. Caused by misplacement of vehicle in the stall.

Queue - a waiting line of vehicles, e.g. traffic at-a signal or buses at a park-and -ride facility.

Ramp - an inclined portion of a parking structure; can be for travel purposes only, or can also provide parking spaces on one or both sides.

Ramp, express - a ramp, usually extending several floors or levels, for direct exit from the facility.

Ramp, garage - a garage or deck composed entirely of ramped floors connected at various levels.

Remote lot - Lots generally located outside the urban area in a rural or small town setting. Trip lengths for both home-to-lot and lot-to-work legs of the commute trips are much longer than lots of other types.

Reservoir space - storage space within a parking facility for vehicles entering or exiting (also called queue area).

Revenue projection - a projection of revenue anticipated from a parking facility or system.

Ridesharing - any form of group travel in autos, vans or special service buses.

Scissors design - a design format in which ramped floors are situated opposite one another like the blades of scissors; also called double leaf.

Search pattern - the flow pattern through a parking facility of vehicles in search of available parking spaces.

Search time - the time required to find an available space.

Short-term parking - parking for a short period of time, usually less than four hours.

Shuttle bus - local bus used to transport passengers between parking facilities or other terminals and major generators.

Simulation model - a mathematical model developed to simulate the use of a given improvement, in this case, a parking facility.

Site - the area on which a parking facility or other improvement is constructed.

Site characteristics - the physical features of a site such as shape, area, topography, soil conditions, and access.

Site location analysis - an investigation of a given site and the determination of its usability for particular purposes.

Space count - total number of spaces in a facility or system.

Special tax district - an area defined by ordinance where special taxes can be imposed to fund

improvements such as parking.

Stall - the area, usually marked with distinguishing lines, in which one vehicle is to be parked; a parking space.

Stall depth - length of the stall.

Stall width - width of the stall.

Striping - painted lines delineating stalls and circulation patterns.

Storage capacity - see Reservoir space.

Study period - the time during which the study is being conducted which could be only one or more parts of a day or all day.

Subcompact - a very small vehicle, smaller than a compact.

Subscription commuter service - a service in which routes and schedules are prearranged for riders who sign up for service in advance.

Superelevation - the banking of a curved roadway or ramp to improve vehicle handling.

Trip purpose - the primary purpose of a person making a trip. Typical purposes include shopping, work, and business.

TSM (transportation system management) - the operation and coordination of all phases of the transportation system to provide more efficient and effective use of existing transportation services and facilities.

Turning radius - the pavement or ramp width necessary to permit a vehicle to complete a turning maneuver.

Turnover - the number of vehicles using a given space or facility each day.

Turnpike Corridor - Lots located along the Florida Turnpike in Broward County (Fort Lauderdale). This corridor is a major commuting corridor within a highly developed urban area and is not served by line-haul transit. Trip origin patterns tend to be dispersed along the corridor. Trip destination patterns are primarily concentrated at the Miami end of the facility but are also dispersed to a lesser degree along the corridor.

Unsatisfied demand - the number of vehicles that cannot be accommodated in a parking facility or system.

Urban Fringe - Lots located at the fringe of urban development. Trips tend to originate outside the urban area while destinations tend to be dispersed within the urban area. Fringe area lots are generally not served by transit, although they may be.

Urban Transit Corridor - Lots located along a major commute corridor within an urban area which are served by line-haul transit such as express bus, urban rail, and commuter rail services. Trip origin patterns tend to be dispersed along the corridor. Trip destination patterns may be dispersed along or concentrated at one end of the corridor.

Utilization - the percentage of a parking facility's capacity that is occupied under average conditions. Usually Implied as the maximum percentage of capacity used under average conditions. Sometimes expressed as a percentage greater than 100 percent when lots are saturated and illegal space use in occurring.

Utilization counts - counts of parked vehicles at a facility.

Vehicle counter - a device used to count vehicles entering and leaving a facility.

Vehicle detector - a device intended to sense the presence of a vehicle in a traffic lane.

VHT - vehicle-hours of travel.

VMT - vehicle miles of travel; the total vehicle miles of travel within any parking facility.

Walking distance - the approximate distance patrons will walk between a parking facility and traffic generators.

Walk-ins - People using a park-ride lot that walk in to use public transportation.

Wearing surface - the topmost layer of any pavement.

Wheel load - the added load in a parking structure created by the parked vehicle (live load).

Wheel stop - a bumper or block placed at the head of a parking stall to restrain the vehicle from moving forward.

Work trip - a trip from home to work or from work to home.

Zoning - the regulation of land use, on a parcel or area basis, by local ordinance.

APPENDIX D: FLORIDA PARK-AND-RIDE LOT INVENTORY

This appendix section presents an inventory of existing park-and-ride facilities located in Florida. This inventory provides a resource of information useful to further evaluations of park-and-ride. The inventory was initially based on the September 30, 1988 State Park & Ride Lot Quarterly Report inventory compiled by the Department's Central Office of Public Transportation in Tallahassee and was expanded upon through additional information provided by the Department's District offices and local agencies with park-and-ride ministerial responsibilities. Additional and more accurate information was obtained through a series of site visits conducted by the Florida Institute for Marketing Alternative Transportation. The site visits began in June of 1996 and concluded in late July of 1996. The inventory is as complete as was possible to make it during the Study effort which produced this Planning Manual; however, it should be recognized that there are holes in the data including missing facilities. The inventory should provide a good base upon which to produce a complete listing of all facilities in the State. Of course, the inventory will be out of date a year from the date of this report. An on-going updating process is required to maintain the usefulness of the inventory. The format of the information presented below was originally adopted from the State Park & Ride Lot Quarterly Report inventory format. That format has been expanded upon to provide a more formal presentation of additional information concerning maintenance and construction responsibility, services, and functional lot type. The later data element is important to the execution of a number of the evaluation methodologies contained in this planning manual. The format of the inventory includes the following data elements:

- Spaces available
- Spaces utilized and percent utilization
- Comments concerning operation, special services, status, and special conditions
- Location including FDOT District, County, area and nearest landmark

The following table presents a synopsis of the inventory, showing the number of facilities organized by district.

Summary of Lot Inventory by District

DISTRICT	NUMBER OF FACILITIES
1	5
2	22
3	15
4	23
5	6
6	25
7	18
TOTAL	114

Visit Date	MON 6/24/96	MON 6/24/96	MON 6/24/96	MON 6/24/96	MON 6/24/96
Visit Time	8:45 a.m.	9:45 a.m.	10:45 a.m.	1:00 p.m.	3:30 p.m.
District	1	1	1	1	1
County	Lee	Lee	De Soto	Polk	Polk
County Site #	1	2	1	1	2
Area	Ft. Myers	Ft. Myers	Arcadia	Bartow	Lakeland
Location	Summerlin Sq.	SR 82 & Ortiz	SR 70 & SR 35	US 17 & CR 559	I-4 & SR 33
Maintained By	Shopping Center	FDOT	FDOT	FDOT	FDOT
# Handicapped*					2
# Spaces	see comments	30	22	24	30
# Used	5	0	13	0	5
% Used	see comments	0.00%	59.09%	0.00%	16.67%
Security	OK	OK	OK	OK	OK
Pavement	OK	under water	OK	OK	OK
Debris	OK	No	No	No	No
Signing	No	Yes	No	Yes	Yes
Fencing	No	No	No	No	Yes
Bus svc.	Yes, shelter	No	No	No	No
Access	OK	OK	OK	OK	OK
Illegal parking	No	Yes, on roadside	No	Yes	No
Comments	located in shopping center and spaces not marked; could not determine who were park and ride users.	lot is flooded, not visible from road		1 Truck Rig for sale, 1 truck in grass	

***Included in # Spaces Count**

Visit Date	WED 6/13/96	WED 6/13/96	WED 6/13/96	WED 6/13/96	WED 6/13/96	WED 6/13/96
Visit Time	12:00 p.m.	12:30 p.m.	1:00 p.m.	1:02 p.m.	1:05 p.m.	1:15 p.m.
District	2	2	2	2	2	2
County	Duval	Duval	Duval	Duval	Duval	Clay
County Site #	1	2	3	4	5	1
Area	Jacksonville	Jacksonville	Jacksonville	Jacksonville	Jacksonville	Jacksonville
Location	Dunn & Monaco	Normandy & I-295	Cedar Hills,	Blanding & West	Ricker & 103rd	Wells & Blanding Target
Maintained By	Shopping	Shopping Center	Shopping Center	Shopping Center	Shopping Center	Shopping Center
# Handicapped*						
# Spaces	see comments	see comments	see comments	see comments	see comments	see comments
# Used	2	0	0	12	0	5
% Used	see comments	see comments	see comments	see comments	see comments	see comments
Security	OK	OK	OK	OK	OK	OK
Pavement	OK	OK	OK	OK	OK	OK
Debris	No	No	No	No	No	No
Signing	No	No	No	No	No	No
Fencing	No	Yes	No	No	No	No
Bus svc.	Yes	Yes	Yes	Yes	Yes	Yes
Access	OK	OK	OK	OK	OK	OK
Illegal parking	No	No	No	No	No	No
Comments	Located in shopping center; unclear which spaces are P&R.	Located in shopping center; unclear which spaces are P&R.	Located in shopping center; unclear which spaces are P&R.	Located in shopping center; unclear which spaces are P&R.	Located in shopping center; unclear which spaces are P&R.,	Located in shopping center; unclear which spaces are P&R. Orange Park flyer express, new lot.

***Included in # spaces**

Visit Date	WED 6/13/96	WED 6/13/96	WED 6/13/96	WED 6/13/96	WED 6/13/96	WED 6/13/96
Visit Time	1:30 p.m.	1:40 p.m.	2:10 p.m.	2:20 p.m.	2:30 p.m.	2:45
District	2	2	2	2	2	2
County	Clay	Clay	Duval	Duval	Duval	Duval
County Site #	3	2	6	7	8	9
Area	Jacksonville	Jacksonville	Jacksonville	Jacksonville	Jacksonville	Jacksonville
Location	Kingsley & Mound DQ	Kingsley & Blanding Kmart	SR 13 & Marbon	SR 13 & I-295	SR 13 & Old St. Augustine Kmart	Philips & Butler
Maintained By	Shopping Center	Shopping Center	Shopping Center	Shopping Center	Shopping Center	Shopping Center
# Handicapped*	see comments	see comments	see comments	0	see comments	see comments
# Spaces	see comments	see comments	see comments	84	see comments	75
# Used	6	4	see comments	41	1	0
% Used	na	na	see comments	48.81%		
Security	OK	OK	OK	OK	OK	OK
Pavement	OK	Ok	Not yet	OK	OK	OK
Debris	No	No	Yes	No	No	No
Signing	OK	No	Not yet	Yes	No	Yes
Fencing	No	No	Not yet	No	No	No
Bus svc.	Yes	Yes	Not yet	Yes	Yes	Yes
Access	OK	OK	OK	OK	OK	OK
Illegal parking	No	No	No	No	No	No
Comments	Express service on road behind SC. Orange Park flyer express. Could not distinguish P&R spaces from SC spaces	Orange Park flyer express. Could not distinguish P&R spaces from SC spaces	New lot under construction, will have service.	Some cars parked in shade, not in spaces, great location	Could not distinguish P&R spaces from SC spaces	New, as of April 1995, bus enters lot.

***Included in # spaces**

Visit Date	WED 6/13/96	WED 6/13/96	WED 6/13/96**	WED 6/13/96	Not Seen
Visit Time	3:00 p.m.	3:15 p.m.	3:20 p.m.	3:30 p.m.	Not Seen
District	2	2	2	2	2
County	Duval	Duval	Duval	Duval	Duval
County Site #	10	11	12	13	14
Area	Jacksonville	Jacksonville	Jacksonville	Jacksonville	Jacksonville
Location	Arlington & Southside	Monument Pointe & St. Johns Winn Dixie	Skyway Terminal, 1-10, I-95, JTA	Gary & Hendricks under I-95 overpass	Winn Dixie - US 17 & Timuquana
Maintained By	Shopping Center	Shopping Center	FDOT	FDOT	Shopping Center
# Handicapped*	see comments	see comments	see comments	0	see comments
# Spaces	see comments	see comments	see comments	78	see comments
# Used	2	10		0	18
% Used	na	na	na	0.00%	see comments
Security	OK	OK	OK	OK	
Pavement	OK	OK	OK	OK	
Debris	No	No	No	No	
Signing	Yes	Yes	Yes	No	
Fencing	No	No	Yes	Yes	
Bus svc.	Yes	Yes	Yes	Yes	
Access	OK	OK	OK	OK	
Illegal parking	No	No	Yes	No	
Comments	P&R part of Shopping Center lot; unable to determine P&R users. Bus enters Regency Sq. mall by Sears	New lot. P&R part of Shopping Center lot; unable to determine P&R users.	Some parking on street outside of fenced lots.	Bus outside fenced area, dark, leaking, from I-95 overpass	David Martin of JTA gave average usage of lot, Orange Park, flyer express

***Included in # spaces**

Visit Date	6/14/96	6/14/96	6/14/96	6/14/96	6/14/96
Visit Time	1:15 p.m.	1:25 p.m.	1:40 p.m.	1:50 p.m.	2:45 p.m.
District	2	2	2	2	2
County	Alachua	Alachua	Alachua	Alachua	Alachua
County Site #	2	4	1	3	5
Area	Gainesville	Gainesville	Gainesville	Gainesville	Gainesville
Location	Museum Rd. & Hume Hall	Hull Rd. near SR 24, fine arts lot	Museum Rd. & Woodlawn	Museum Rd. & Center Dr.	Archer & 16th
Maintained By	University & FDOT	University & FDOT	University & FDOT	University & FDOT	University & FDOT
# Handicapped*	see	0	0	0	0
# Spaces**	see	618	438	153 or 362	232
# Used		20	see comments	see comments	see comments
% Used		3%			
Security		OK	OK	OK	OK
Pavement		OK	OK	OK	OK
Debris		No	NO	No	No
Signing		Yes	No	No	No
Fencing		No	No	No	No
Bus svc.	Yes	Yes	Yes	Yes	Yes
Access		OK	OK	OK	?
Illegal parking		No	No	No	
Comments	70 spaces on ground, garage built over P&R, UF shuttle, city bus service	UF shuttle (no summer service), only lot listed on map and sign designating P&R	UF shuttle, city bus service on fraternity row, lot expanded. P&R not designated, so could not determine usage.	City bus service only, lot expanded. P&R not designated, so could not determine usage.	UF shuttle only, difficulty finding lot. P&R not designated, so could not determine usage.

***Included in # spaces**

****counts provided by Greg Dubois at UF parking**

Visit Date	7/12/95	7/13/95	7/13/95	7/13/95
Visit Time	11:10 a.m.	10:35 a.m.	1:35 p.m.	2:15 p.m.
District	3	3	3	3
County	Leon	Gadsden	Liberty	Liberty
County Site #	1	1	2	1
Area	Tallahassee	Gretna	Hosford	Bristol
Location	Bannerman & Thomasville	City Hall on US 90	SR 65 at Hosford Elem/Jr. High School	SR 20 at Liberty Co. High School
Maintained By	FDOT	City	County	County
# Handicapped*	0	0	0	0
# Spaces	20	17	61	17
# Used	4	12	14	8
% Used	20.00%	70.59%	22.95%	47.06%
Security	OK	OK	OK	OK
Pavement	OK	OK	OK	OK
Debris	No	No	No	No
Signing	Yes	Yes	Yes	Yes
Fencing	No	No	No	No
Bus svc.	No	No	No	No
Access	OK	OK	OK	OK
Illegal parking	No	No	No	No
Comments				

***Included in # spaces count**

Note: This set of visits took place last year for the District 3 East Park and Ride Plan.

Visit Date	TU 6/11/96	TU 6/11/96	TU 6/11/96	TU 6/11/96	TU 6/11/96	TU 6/11/96
Visit Time	11:00 a.m.	12:30 p.m.	12:35 p.m.	1:50	2:30	2:45
District	3	3	3	3	3	3
County	Jackson	Holmes	Holmes	Okaloosa	Santa Rosa	Santa Rosa
County Site #	1	1	2	1	2	1
Area	Campbellton	Ponce de Leon	Ponce De Leon	Holt (Galiver)	Pace	Milton
Location	Water Tower	US 90 E. & Westville	City Hall	US 90 & CR 189	US 90 & SR 281	US 90 & CR191A
Maintained By	City	City	City	FDOT	FDOT	FDOT
# Handicapped*	0	0	1	0	0	
# Spaces	18	10	12	15	44	15
# Used	5	1	5	1	13	2
% Used	27.78%	10.00%	41.67%	6.67%	29.55%	13.33%
Security	OK	OK	OK	OK	OK	OK
Pavement	Needs	Good	Good	Good	Good	Needs paving,
Debris	No	No	No	No	No	Yes, litter
Signing	Yes	Yes	Yes	Yes	Yes	Yes
Fencing	No	No	No	No	No	No
Bus svc.	No	No	No	No	No	No
Access	OK	OK	OK	OK	OK	OK
Illegal parking	No	No	No	No	Yes	Yes
Comments			Staff park in back, not at P&R		1 boat, 3 cars for sale	1 car for sale, cars at tree

***Included in # Spaces**

Visit Date	WED 6/12/96	WED 6/12/96	WED 6/12/96	WED 6/12/96	WED 6/12/96
Visit Time	8:45 a.m.	9:10 a.m.	10:45 a.m.	1:50 p.m.	4 p.m.
District	3	3	3	3	3
County	Escambia	Escambia	Escambia	Walton	Jackson
County Site #	3	2	1	1	2
Area	Pensacola	Pensacola/Bellview	Century	Freeport	Grand Ridge
Location	Mariner Mall	Pine Forest & 9 Mile	Courthouse	City Hall	Town Hall
Maintained By	Shopping Mall	FDOT	County	City	City
# Handicapped*		0	0	2	0
# Spaces	see comments	8	13	32	can't tell
# Used	0	1	5	3	0
% Used	na	12.50%	38.46%	9.38%	na
Security	OK	OK	OK	OK	OK
Pavement	OK	Needs paving,	OK	Needs striping	Needs paving,
Debris	No	No	No	No	No
Signing	Yes	Yes, not on main rd.	Not internally	Not internally	Yes, misleading/Not
Fencing	Yes	No	No	No	No
Bus svc.	No	No	No	No	No
Access	OK	OK	OK	OK	OK
Illegal parking	No	Yes	No	Yes	No
Comments	Mall is closed, lot not used	12 cars parked near trees or at gas station	Some spaces taker back	2 staff cars, sign not on main road	Not on US 90 but on 69

***Included in # spaces**

Visit Date	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96
Visit Time	4:35pm	4:44pm	4:20pm	1:30pm	1:45pm	1:10pm
District	4	4	4	4	4	4
County	Palm Beach	Palm Beach	Broward	Palm Beach	Palm Beach	Palm Beach
County Site #	6	2	1	3	4	5
Area	Boca Raton	W. Palm Beach	Deerfield Beach	Delray Beach	Boynton Beach	Lake Worth
Location	Commerce Blvd.	I-95 & Congress Ave	Hillsboro Blvd. & NW 12 Ave.	I-95 & W Atlantic Ave	Hypoluxo & High Ridge	Lake Worth Rd & I-95
Maintained By	FDOT	FDOT	FDOT	FDOT	FDOT	FDOT
handicapped#	2	11	14	6	10	5
# Spaces	57	419	102	107	88	84
# Used	52	27	57	31	37	34
% Used	91.23%	6.44%	55.88%	28.97%	42.05%	40.48%
Security	Good	Minimal	Good	Good	Good	Good
Pavement	Good	Excellent	Good	Good	Excellent	Good
Debris	None	Minimal	None	None	None	Minimal
Signing	Good	Excellent	Good	Good	Good	Good
Fencing	None	Yes	Good	None	None	Good
Bus/Train svc.	Yes	Bus only	Yes	Yes	Yes	Partially
Access	OK	Good	Good	OK	Good	Good
Illegal parking	None	None	None	None	None	None
Comments	Nice facility, very well maintained	Brand new facility, not in existing data, has six bus			Site is currently being expanded, should increase in size by 3 to 4 times	Three shelters on site but has little lighting

***Included in # spaces count.**

Visit Date	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96
Visit Time	2:00pm	2:18pm	2:36pm	2:45pm	3:15pm	4:05pm
District	4	4	4	4	4	4
County	Broward	Broward	Broward	Broward	Broward	Broward
County Site #	2	3	4	5	6	10
Area	Ft. Lauderdale	Ft Lauderdale	Ft. Lauderdale	Ft. Lauderdale	Margate	Pompano Beach
Location	Airport Trirail Ravenswood Rd	Broward & I-95	I-95 & Commercial	Cypress Creek Rd & Andrews	US 441 & Atlantic	NW 8 Ave & Sample Rd
Maintained By	FDOT	FDOT	FDOT	FDOT	FDOT	FDOT
# Handicapped*	2	18	2	5	0	11
# Spaces	195	397	86	373	82	272
# Used	118	2	9	136	4	56
% Used	60.51%	0.50%	10.47%	36.46%	4.88%	20.59%
Security	Very good	Excellent, on duty guard	Good	Minimal	Poor	Good
Pavement	Good	Excellent	Good	Excellent	Acceptable	Excellent
Debris	Minimal	None	Minimal	None	Minimal	None
Signing	Good	Excellent	Good	Good	Poor	Good
Fencing	Excellent	Excellent	Good	Partially	None	None
Bus/Train svc.	Yes	Yes	Bus only	Bus only	Bus only	Yes
Access	Good	Good	OK	Good	Poor	Good
Illegal parking	None	None	None	None	None	None
Comments		Very well maintained lot			Hard to find lot must go through shopping center or Boston Market to access	Well maintained

***Included in #**

Visit Date	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96**	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96
Visit Time	12:00pm	12:48pm	4:50pm			
District	4	4	4	4	4	4
County	Broward	Broward	Palm Beach	Broward	Broward	Broward
County Site #	8	9	1	7	11	12
Area	Hollywood	Pembroke Pines	West Palm Beach	Coconut Creek	Coral Springs	Davie
Location	I-95 & Hollywood	CB Smith Park	West Palm Beach Trirail	Turnpike & Sample Rd.	Coral Springs Mall Sample & University	Turnpike & SR 84
Maintained By	FDOT	FDOT	FDOT	closed	Shopping Center	closed
# Handicapped*	8	3	0			
# Spaces	181	71	see comments	see comments	see comments	see comments
# Used	132	10	15			
% Used	72.93%	14.08%	na			
Security	Fair	Good	Minimal			
Pavement	Good	Good	None			
Debris	Minimal	Minimal	None			
Signing	Good	Good	Good			
Fencing	Partially	Yes	None			
Bus/Train svc.	Yes	None	Yes			
Access	Good	OK	Good			
Illegal parking	None	None	15			
Comments		Picnic area, shelter, and volleyball court	No real parking spaces, all users parked on shoulder of the road	Site no longer exists	Unable to determine specific lot site. Assumed that users could park anywhere in shopping center so an accurate count could not be made	Site no longer exists

***Included in #**

Visit Date	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96	TH 6/20/96
Visit Time	9:05 a.m.	9:42 a.m.	10:10 a.m.	11:00 a.m.	2:00 p.m.	2:30 p.m.
District	4	4	4	4	4	5
County	Broward	Broward	Broward	Broward	Broward	Orange
County Site #	closed	13	14	closed	closed	1
Area	Hollywood	Margate	Margate	Pompano Beach	Tamarac	Orlando
Location	Turnpike & Hollywood	Banks Rd. & Atlantic	NE 27th Ave & Atlantic	Turnpike & Hammondsville	Turnpike & Commercial	SR 50 & Dean
Maintained By	closed	Shopping Center	Shopping Center	closed	closed	FDOT
# Handicapped*	see comments	see comments	see comments	see comments	see comments	1
# Spaces	see comments	see comments	see comments	see comments	see comments	39
# Used						24
% Used						61.54%
Security		Poor	Poor			OK
Pavement		Good	Good			OK
Debris		Minimal	Minimal			No
Signing		Poor	Poor			Yes
Fencing		None	None			No
Bus/Train svc.		Bus Only	Bus Only			Nearby SC
Access		OK	OK			OK
Illegal parking		None	None			Yes
Comments	Site no longer exists	Unable to make an accurate count because lot is located in shopping center	Unable to make an accurate count because lot is located in shopping center	Site no longer exists	Site no longer exists	Good loc. Near east - west Expy

***Included in #**

Visit Date	TH 6/20/96	TH 6/20/96	FRI 6/21/96	FRI 6/21/96	FRI 6/21/96	WED 7/17/96
Visit Time	2:50 p.m.	3:20 p.m.	10:00 a.m.	3:00 p.m.	3:00 p.m.	9:15am
District	5	5	5	5	5	6
County	Orange	Orange	Volusia	Orlando	Orlando	Dade
County Site #	2	3	1	4	5	1
Area	Bithlo	Orlando	Deltona	Orange	Orange	Homestead
Location	SR 50 & SR 419	SR 15 & BeeLine	I-4 & Dirkson Blvd.	Centroplex I	Centroplex II	Harris Field SW 312th St. & US 1
Maintained By	FODT	FDOT	FDOT	FDOT	FDOT	City
# Handicapped*	5	1	0			
# Spaces	80	15	50	421	336	4
# Used	19	9	41			86
% Used	23.75%	60.00%	82.00%	38%	48%	0
Security	OK	OK	OK	OK	OK	0%
Pavement	OK	OK	OK	OK	OK	OK
Debris	No	No	No	No	No	Good
Signing	Yes	Yes	No	Yes	Yes	Minimal
Fencing	No	No	No	No	No	None
Bus svc.	Yes, bench	No	No	Yes	Yes	Yes
Access	OK	OK	OK	OK	OK	None
Illegal parking	No	No	No	No	No	OK
Comments		Good sign on		Downtown	Downtown	Not sure if correct lot

***Included in # Spaces**

Visit Date	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96
Visit Time	9:40am	9:50am	10:00am	10:30am	11:10am	11:30am
District	6	6	6	6	6	6
County	Dade	Dade	Dade	Dade	Dade	Dade
County Site #	1	3	2	4	5	6
Area	SW Dade	SW Dade	SW Dade	Kendale Lakes	Kendale Lakes	Kendale Lakes
Location	Tpk Ext. 11 & SW 216th	Tpk Ext 13 & SW 186th St.	Tpk Ext 16 & SW 152nd St.	Hammocks Town Center 104th & 154 St.	SW 157th & 72nd Ave	Sunset & SW 117th Ave
Maintained By	Turnpike	Turnpike	Transit Agency	Shopping Center	Shopping Center	Shopping Center
# Handicapped*	0	0	0	8	4	8
# Spaces	?	?	?	?	21	?
# Used	0	1	15	?	8	?
% Used	0%			?	38.10%	?
Security	Minimal	Minimal	Minimal	Good	Good	Good
Pavement	Acceptable	Acceptable	Acceptable	Good	Excellent	Excellent
Debris	Minimal	Minimal	Minimal	None	None	None
Signing	None	None	Yes	None	None	None
Fencing	None	None	None	None	None	None
Bus/Train svc.	None	None	Bus only	Bus only	Bus only	Bus only
Illegal parking	None	None	None	None	None	None
Access	Good	Good	Good	Good	Good	Good
Comments	Not maintained at all,	Not	Spaces	Unable to make an	Needs signs to tell	Unable to make accurate

***Included in #**

Visit Date	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96
Visit Time	12:00pm	12:15pm	12:30pm	12:45pm	1:05pm	1:15pm
District	6	6	6	6	6	6
County	Dade	Dade	Dade	Dade	Dade	Dade
County Site #	7	8	9	10	11	12
Location	Coral Way & SW 122 Ave	113th & 104th	Metro Dade CC 107th & 100th	SR 874 & SW 88th St.	SW 87th Ave & Sunset Dr.	West Lake Plz Sunset & 157th Ave
Area Maintained By	Kendale Lakes Shopping Center	Kendale Lakes FDOT	Kendale Lakes Community	Kendall FDOT	Kendall FDOT	Kendale Lakes Shopping Center
#	4	0	12	0	0	8
# Spaces	see Comments	144	see Comments	25	77	see Comments
# Used	see Comments	16	see Comments	0	0	see Comments
% Used	see Comments	11%	see Comments	0%	0%	see Comments
Security	Good	Good	Good	Minimal	None	Good
Pavement	Good	Excellent	Excellent	Poor	Acceptable	Excellent
Debris	None	None	None	Excessive	Excessive	None
Signing	None	None	None	None	None	None
Fencing	None	None	None	Yes	Yes	None
Bus/Train svc.	Bus only	Bus only	Bus only	Bus only	Bus only	Bus Only
Access	Good	Good	Good	Good	OK	Good
Illegal parking	None	None	None	None	None	None
Comments	2 Bus stops on roadside, good access but no designated area for Park & Ride lot so accurate count was not possible	New facility not in existing data, has small bus shelter.	Assumed that users can park anywhere on campus lot and take bus from there, so an accurate count could not be made.	Abandoned, poorly maintained. Goodwill truck parked there taking up spaces	Lot in very poor condition, lighting non-existent, debris, everywhere, spaces destroyed	No designated area for Park & Ride lot within shopping center so an accurate count could not be made

***Included in #**

Visit Date	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96	WED 7/17/96
Visit Time	2:43pm	3:00pm	3:30pm	3:45pm	4:05pm	4:21pm
District	6	6	6	6	6	6
County	Dade	Dade	Dade	Dade	Dade	Dade
County Site #	Metrorail Map	Metrorail Map	Metrorail Map	Metrorail Map	Metrorail Map	Metrorail Map
Location	Dadeland S Metrorail Station	Dadeland N Metrorail Station	S. Miami Metrorail Station	University Metrorail Station	Douglas Rd Metrorail Station	Coconut Grove Metrorail Station
Area	Miami	Miami	Miami	Miami	Miami	Miami
Maintained By	MDTA	MDTA	MDTA	MDTA	MDTA	MDTA
#	21	32	15	7	4	5
# Spaces	1404	1963	1798	293	440	199
# Used	1350	1406	836	109	147	53
% Used	96%	72%	46%	37%	33%	27%
Security	Excellent	Excellent	Excellent	Average	Minimal	Minimal
Pavement	Excellent	Excellent	Excellent	Good	Good	Good
Debris	None	None	None	Minimal	Minimal	Excessive
Signing	Good	Good	Good	Good	Good	Good
Fencing	None	None	None	None	None	None
Bus/Train svc.	Yes	Yes	Yes	Yes	Yes	Yes
Access	Good	Good	Good	OK	Good	Good
Illegal parking	None	None	None	None	None	None
Comments	Big parking garage	Big parking garage	Big parking garage			

***Included in #**

Visit Date	WED 7/17/96	WED 7/17/96	WED 7/17/96	THUS 7/18/96	THUS 7/18/96	THUS 7/18/96
Visit Time	4:30pm			8:44am	9:00am	9:15am
District	6	6	6	6	6	6
County	Dade	Dade	Dade	Dade	Dade	Dade
County Site #	Metrorail Map	Metrorail Map	Metrorail Map	Metrorail Map	Metrorail Map	Metrorail Map
Area	Miami	Miami	Miami	Site A	Hialeah	Miami
Location	Vizcaya Metrorail Station	Overtown Metrorail Station	Culmer Metrorail Station	Miami Airport Tri-rail SE14 St. & SE 9 Terrace	Okeechobee Metrorail Station	Hialeah Metrorail Station
Maintained By	MDTA	MDTA	MDTA	FDOT	MDTA	MDTA
# Handicapped*	3		see comments	2	24	5
# Spaces	91	35		64	1081	316
# Used	24	29		52	589	81
% Used	26%	83%		81%	54%	26%
Security	Minimal			Minimal	Excellent	Average
Pavement	Good			Good	Excellent	Good
Debris	Minimal			Minimal	None	Minimal
Signing	Good			Good	Good	Good
Fencing	Yes			None	None	Partially
Bus/Train svc.	Yes			Yes	Yes	Yes
Access	OK			OK	Good	OK
Illegal parking	None			None	None	None
Comments		Could not find site but used data from Oct '95 FDOT report	Site no longer exists	Has 4 shelters, hard to find from main road	Parking garage. About 200 spaces were closed on the upper level and were not counted when calculating # of spaces and % occupied	

***Included in #**

Visit Date	MON 6/24/96	MON 6/24/96	MON 6/24/96	MON 6/24/96	MON 6/24/96	MON 6/24/96
Visit Time	4:15 p.m.	4:30 p.m.	4:50 p.m.	5:18 p.m.	6:16 p.m.	9:29 a.m.
District	7	7	7	7	7	7
County	Hillsborough	Hillsborough	Hillsborough	Hillsborough	Hillsborough	Hillsborough
County Site #	1	2	3	4	5	6
Area	Dover	Brandon	Brandon	Brandon	Mango/Seffner	Tampa
Location	SR 60 & Dover	Sadie & Pinewood	Bryan & Bl'dale	US 301 & Expy	US 92 & SR 579	I-275 & Yukon
Maintained By	FDOT	County	Church	Church	FDOT	Transit Agency
# Handicapped*		2	4		8	3
# Spaces	14	116	63	111	85	306
# Used	4	15	22	3	0	4
% Used	28.57%	12.93%	34.92%	2.70%	0.00%	1.31%
Security	OK	OK	OK	OK	OK	OK
Pavement	OK	OK	OK	OK	OK	OK
Debris	No	No	No	No	No	No
Signing	Yes	Yes	No	No	Yes	Yes
Fencing	No	No	No	Yes	No	Yes
Bus svc.	No	Yes	Yes	No	Yes	Yes
Access	OK	OK	OK	OK	OK	OK
Illegal parking	No	No	No	Yes	No	No
Comments	needs striping	parking in shade, not designated spaces	parking in shade, not in spaces	2 school busses	after hours visit	needs striping

***Included in # Spaces**

Visit Date	TU 6/25/96	TU 6/25/96	TU 6/25/96	TU 6/25/96	TU 6/25/96	TU 6/25/96
Visit Time	9:55 a.m.	10:45 a.m.	10:55 a.m.	11:35 a.m.	11:50	12:25 p.m.
District	7	7	7	7	7	7
County	Hillsborough	Hillsborough	Pasco	Hillsborough	Hillsborough	Hillsborough
County Site #	7	8	1	9	10	11
Area	Temple	Lutz	New Port Richie	Citrus Park	Carrollwood	W. Carrollwood
Location	City Hall & 56th	US 41 & Crystal Lake	SR 54 & US 41	Gunn Hwy.	Casey & Gunn	Ehrlich & Shaw
Maintained By	City	Church	County	FDOT	FDOT	Shopping Center
# Handicapped*	6	1		4	2	3
# Spaces	167	147	na - on grass	120	150	157
# Used	51	16	0	4	4	11
% Used	30.54%	10.88%	na	3.33%	2.67%	7.01%
Security	OK	OK	OK	OK	OK	OK
Pavement	OK	OK	None	OK	OK	OK
Debris	No	No	No	No	No	No
Signing	Yes	Yes	No	Yes	Yes	Yes
Fencing	No	No	No	partial	No	No
Bus svc.	Yes	Yes	No	Yes	Yes	Yes
Access	OK	OK	OK	OK	OK	OK
Illegal parking	Yes	No	No	Yes	No	No
Comments	1 commercial truck parked	some spaces are 15-minute parking, some day care/school vans	all cars confirmed to be sheriff's or emer. Mgmt.'s	1 car for sale, at Co. park & fire station	needs striping, has landscaping by power plant 12 spaces 15 minute	8 visitor spaces

***Included in # Spaces**

Visit Date	TU 6/25/1996	TU 6/25/1996	TU 6/25/1996	TU 6/25/1996	TU 6/25/1996	TU 6/25/1996
Visit Time	12:50 p.m.	1:20 p.m.	2:30 p.m.	3:50 p.m.	4:20 p.m.	4:45
District	7	7	7	7	7	7
County	Hillsborough	Hillsborough	Pinellas	Pinellas	Pinellas	Pinellas
County Site #	12	13	1	2	3	4
Area	N. Carrollwood	Town-n-Country	Clearwater	Clearwater	Largo	St. Petersburg
Location	Dale Mabry & N. Lakeview Dr.	Hanley Rd. & Comanche	US 19 near Curlew	McMullen Booth Rd. & SR 60, S of Drew	SR 688 & 125 Ulmerton Road	22nd Ave. N & 19th St. N near I-275
Maintained By	Transit Agency	Church	FDOT	County	County	County
# Handicapped*	4	3	0	5	1	0
# Spaces	174	103	42	149	43	31
# Used	7	17	18	1	11	16
% Used	4.02%	16.50%	42.86%	0.67%	25.58%	51.61%
Security	OK	OK	OK	OK	OK	OK
Pavement	OK	OK	OK	OK	OK	OK
Debris	No	No	No	No	No	No
Signing	Yes	Yes	Yes	No	Yes	Yes
Fencing	No	No	No	No	No	No
Bus svc.	Yes	Yes	Yes	No	Yes	No
Access	OK	OK	OK	OK	OK	OK
Illegal parking	No	No	Yes	No	Yes	Yes
Comments		4 spaces for staff cars	sheriff's office closed lot, used for cop car storage, Co. Courthouse still there though	no bus after bridge built, now called Bayside Family Church	Local bus on Ulmerton, 1 not in parking space	1 car for sale, 1 comm. truck

***Included in # Spaces**

APPENDIX E
SITE SELECTION EVALUATION METHODOLOGY

This appendix contains technical material related to the evaluation and rank ordering of a number of park-and-ride sites. This material was taken from the AASHTO Design Guide for HOV and Public Transfer Facilities [6].

Guide for the Design of High Occupancy Vehicle and Public Transfer Facilities

Published by the American Association of State Highway and Transportation Officials.
General Offices located at 444 North Capitol Street, N.W. Suite 225 Washington, D.C. 20001
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Appendix A
PRIORITY RATING OF PARK-AND-RIDE SITES

It is important to recognize that the methodology presented is offered for assistance to those agencies or individuals having the responsibility for selecting transfer facilities. The specific factors used, as well as values_ assigned to the rating system, may vary, depending on local conditions or other situations that arise in the site selection process. Those using the rating system should feel free to use other factors o. rating values as desired. A point rating system for each factor from zero to ten is used for simplicity with the higher rating being desirable. It may also be desirable that the user apply a weight multiplier to the factors selected for consideration.

There are many factors influencing the decision to implement a park-and-ride facility, including geographic, economic and human elements, as well as the people moving capability of transportation facilities. Each of the factors should be reviewed for applicability to the local area.

The major elements covered are based on information gathered from those agencies currently operating park-and-ride facilities and reference sources used to develop this manual. The rating chart (Figure A-l) covers the major criteria and factors which are used to develop the priority ratings of sites to determine, from best available data, which sites in a given corridor or zone appear to offer the best chance for success and investment of funds to implement park-and-ride facilities.

The primary categories of factors may be classified as follows:

1. Location Criteria
2. Site Considerations
3. Economic Considerations
4. Potential User Costs and Time

Figure A-1

		Site 1	Site 2	Site 3
Location Criteria	Within Dense Corridor			
	Tranist Service Potential			
	Proximity to Freeway Bottleneck			
	Visibility of Site			
	Distance to CBD or Activity Center			
	Access Convenience			
	Local Traffic Circulation			
	Commuter Driving Distance			
	Congestion - Site to Freeway			
	Bike Route Access			
	Total			
Site Considerations	Impact on Local Community (Adjacent)			
	Number of Parking Spaces			
	Expansion Potential			
	Parking Capacity - Adjacent Streets			
	Parking Security			
	Total Points			
Economic Considerations	Land Cost			
	Ease of Land Acquistion			
	Development Cost			
	Total Points			
	Grand Total			
Potential Users Cost	Driving Cost			
	Parking Cost			
	Transit Cost			
	Total Cost			
Potential Users Time	Driving Time			
	Waiting Time			
	Transit Time			
	Walking Time			
	Total Time			

The last category, Potential User Costs and Time, is not used directly in the rating system, but does provide additional information that may prove of value in the site selection process.
The following guidelines address each factor in Figure A-l that should be considered. The list of factors may be reduced or increased, depending on the availability of data and local conditions.

Location Criteria
These factors relate to good or bad location features of a site based on the experience of park-and-ride sites that have already been implemented in various locations.

A. *Within a Dense Corridor* If the potential site is within a dense corridor, the distance from the major artery or freeway is the measuring value, with closeness to the artery the most desirable feature. Use the following guide for reference in your rating:

Along Major Artery	*Within Mile Of Major Artery*	*Within Mile Of Major Artery*
10 Points	8 Points	6 Points

B. Transit Service Potential If the site is near an existing transit line, this is a desirable feature. Use the following guide for reference in your rating:

Along Transit Line	*Within Mile of Transit Line*	*Within Mile of Transit Line*
10 Points	8 Points	6 Points

C. Outside Major Artery Bottleneck Desirable sires should be located immediately upstream from a bottleneck, to reduce vehicular traffic inbound through the bottleneck. Use the following guide for reference in your rating (distance relates to proximity upstream from arterial congestion).

Within Mile	*Within One Mile*	*Within Two Miles*
10 Points	8 Points	6 Points

D. Visibility of Site In order to attract users to a park-and-ride lot, the site should be visible from the freeway or major arterial used by the commuter. Use the following guide for reference in your rating:

Clearly Visible	*Partially Visible*	*Not Visible*
10 Points	8 Points	O Points

E. Distance to CBD or Activity Center Sites should be located more than one mile from the central business district or activity center, as commuters will normally accept walking distances less than one mile. However, if sites are too remote from the central business district or activity center, they also will not generate sufficient users, and transit service will not be economically feasible. Use the following guide for reference in your rating: (Keep in mind that metropolitan population areas over 1.5 million may have acceptable sites greater than 10 miles removed).

1-3 Miles	*5 Miles*	*10 Miles*
10 Points	8 Points	5 Points

F. Site Access Convenience A potential site should have good access (ingress and egress) from the roadway adjacent to the site in order to encourage use of the lot. In the case of new potential sites, it may be possible to design for good access. whereas existing sites under consideration have more limited options Use the following guide for reference in your rating:

Excellent	*Good*	*Fair*
10 Points	8 Points	6 Points

G. Other Park-and-Ride Competition If a site is too close to another *existing* park-and-ride facility, it will either attract commuters from that site, or not generate sufficient users to make the site a worthwhile investment. Use the following guide for reference in your rating:

No Competition	*Possible Competition*	*Definite Competition*
10 Points	7 Points	4 Points

H. Local Traffic Circulation A brief traffic engineering study should be performed to assure that the additional traffic generated can be accommodated with minimum disruption to the present traffic condition during anticipated peak hour usage. Use the following guide for reference in your rating of local traffic circulation:

Excellent	*Good*	*Fair*
10 Points	8 Points	6 Points

I. Commuter Driving Distance Previous experience indicates that 50 percent of park-and-ride commuters drive less than five miles from their home to the site and approximately 90 percent drive less than ten miles. Use the following guide for reference in your rating:

1-3 Miles	*4- 5 Miles*	*7-10 Miles*
10 Points	8 Points	6 Points

J. Traffic Congestion Site to Major Arterial or Freeway Ability of the commuter to reach the site from the freeway (or the return trip) is a measure of the attractiveness of any potential site. Traffic signals on the route to the site are the normal cause of delay that can be measured, but other congestion causing factors may also be used. Use the following guide for reference in your rating:

No Traffic Signals	*1-2 Traffic Signals*	*3 Traffic Signals*
10 Points	8 Points	6 Points

K. Bike Route Access Bicycle commuters may play a significant role in site selection. If so, the proximity of a bicycle route to the site should be considered. Use the following guide for reference in your rating:

Bike Route At Site	*Bike Route Within 1 Mile*	*Bike Route Within 3 Miles*
10 Points	*8* Points	6 Points

Site Considerations

A number of site consideration factors must be reviewed that are pertinent to selecting the best sites suited to park-and-ride, including: the negative impact on the local community, the size of the site and possible need for expansion, the extent of parking on adjacent streets and security.

A. Adverse Impact on Local Community Certain local communities are very sensitive to additional traffic generators being placed in their environment, while others tend to be enthusiastic toward energy/fuel conservation or traffic congestion relief measures. Use the following guide for reference in your rating:

Minimal	*Some*	*Serious*
10 Points	8 Points	3 Points

B. Land Area Number Parking Spaces This factor may or may not be necessary as a pertinent measure of the site selection evaluation process. However, if the number of site options is limited, there may be a considerable variation in the amount of land area available for possible use at each site. Use the following guide for reference in your rating:

Sufficient To Meet Demand	*50 or Less Parking Spaces*
10 Points	5 Points

C. Site Expansion Potential In certain park-and-ride programs, a successful facility will cause the parking demand or usage to exceed the original site parking capacity. When this is a factor worthy of consideration in comparing sites, the expansion capability should be investigated. Use the following guide for reference in your rating:

Excellent	*Good*	*Fair*
10 Points	8 Points	6 Points

D. Parking Capacity Adjacent Streets A survey of daytime parking capacity on adjacent and nearby streets should be made to determine whether potential users might prefer to park on existing streets and walk to a transit stop, rather than use a park-and-ride facility. Available parking is therefore a detriment to park-and-ride. Use the following guide for reference in your rating:

No Parking Available	*Some Parking Available*	*Considerable Available*
10 Points	7 Points	4 Points

E. Parking Security If a driver must risk the chance of vandalism or car theft, a site with this potential problem either will not be desirable, or will require fencing and gates or possibly an attendant. Use the following guide. for reference in your rating:

No Need For Added Security	*Fence and Gate Needed*	*Attendant Needed*
10 Points	7 Points	4 Points

Economic Considerations

These factors may be the most critical in your choice of park-and-ride sites, depending on available source of capital funding for construction of a new site, or possibly the time required to acquire land for a new site.

A. Land Cost It is relatively simple to compare site cost when an opportunity to use publicly owned land is compared with the purchase of private land. When comparing several sites that require land purchase, the value of land in each area will vary. It is left to the individual or agency to make this determination. Use the following guide for reference in your rating:

Lease Or	*Medium*	*High*

No Cost	*Cost*	*Cost*
10 Points	8 Points	5 Points

B. *Ease of Land Acquisition* Time to acquire and develop a site may also be an important factor when considering the need for park-and-ride implementation. Use the following guide for reference in your rating:

Less Than	*Six*	*12*
3 Months	*Months*	*Months*
10 Points	7 Points	4 Points

C. *Develop Cost* *A* comparison of developmental costs for each site should be made. Use the following guide for reference in your rating.

Existing	*Minimal*	*Substantial*
Developed Site	*Cost*	*Cost*
10 Points	*7 points*	*4 points*

Procedure

The above factors can be rated and summarized to make a direct comparison of potential park-and-ride sites. You will note that several factors have been weighted to a limited extent, and assigned lower point values because of the general degree of importance of the factor.

However, no attempt is made within this rating system to weigh all the various factors according to importance because in some metropolitan areas certain factors may have more significance than the same factors in other areas. The rater should feel free to apply weighted values if in his opinion one factor should carry more importance than another.

Potential User Costs and Time

These factors are not included in the point rating methodology for site comparison since their values (user cost and time) are not easily translated into the point rating system with a simple estimated value. However, each factor is directly related to the site selection process and deserves consideration. Cost and lime factors are therefore included in Figure *A* for comparison purposes.

A. *User Costs* Three components make up the total direct costs to the user: driving, parking and transit costs.

1. Driving Cost Estimate vehicle operating cost for the average trip distance from home to the park-and-ride site and return.
2. Parking Cost A charge for parking at the park-and-ride facility is *not* recommended. No parking cost should be necessary, unless parking demand in the local community or central business district warrants some minimal charge.
3. Transit Cost Use the fare structure of the local transit operating agency.

B. User Time

1. Commuter Driving Time This is the time from the commuter's home to the park-and-ride site. The following guide should be used for reference:

0-1 Mile	*2-5 Miles*	*6-10 Miles*
5 Minutes	6-10 Minutes	11-20 Minutes

2. Waiting Time This should usually be one-half the transit vehicle headway time. A suggested headway range is five minutes minimum and a desirable 10 minutes maximum. If waiting time exceeds I5 minutes, it is likely that published transit schedules may be necessary.

3. Transit Time is the time from the park and ride lot to the central business district or activity center. The following guide may be used for reference:

0-1 Mile	*2-5 Miles*	*6-10 Miles*
5 Minutes	6-15 Minutes	16-30 Minutes

4. Walking Time is the time from termination of the transit trip at the central business district or activity center to the office or destination.

Using a four feet per second average walking speed and an average city block length of 30() feet' an estimate of *100 seconds per block* may be used. This also include an average delay for traffic signals.

Summary

The methodology presented herein offers many subjective measures. It, therefore, is intended primarily as a guide and quick reference to those factors believed to be essential to the site selection process with a reasonable degree of assurance of implementing a successful park-and-ride facility. It is also recognized that more advanced knowledge and experience will produce better methods of site comparison. However, in the meantime, the priority rating method can be used and modified as necessary to satisfy local conditions.

Also, it should be recognized that these factors are most useful when comparing sites which have a similar ridership potential. Given that the modal split for each of the sites being considered is close, the site selection process should identify those sites which will attract the greatest number of riders, have a reasonable cost, and at the same time have a favorable impact on the community.

APPENDIX F. LOT SURVEY MATERIALS

This appendix contains forms for use in conducting lot user and lot condition surveys. These forms were used during the Lot User Survey conducted during this study.

FDOT PARK & RIDE LOT USER SURVEY
MORNING SURVEY FORM

LOT: _____ DATE: _____
Good morning. I am conducting interviews of users of this lot for the FDOT. Your answers will assist in the future planning, construction and operation of park and ride lots to better serve Florida commuters. May I please ask you a few questions concerning your use of this lot today?

Where did your trip begin? CITY _____
ADDRESS/ INTERSECTION _____
Is this your home? YES NO (circle one)
About how long did it take you to get here? _____ minutes

Where will your trip end? CITY_____
ADDRESS/INTERSECTION_____
Is this your home? YES NO (circle one)

Time to travel from here to where your trip will end? _____ minutes

What is your occupation?_____

Is your home a single family (detached) dwelling unit? YES NO (circle one)
How many people of driving age are in your household?_____
How many vehicles in running condition are kept atyour home?_____

Arrival Mode _____ AUTO _____ BUS _____WALK _____ BIKE _____OTHER

If auto, did you __ DRIVE ALONE __ SHARE A RIDE __GET DROPPED OFF

If a shared ride, how many were in the vehicle with you? _____

How many times per week do you use this lot?_____

Departure Mode ___ CARPOOL ____BUS ___OTHER (Specify)_____
___ VANPOOL ____ RAIL

If pool vehicle, how many others ride with you?_____

Why do you use this lot? _____

Trip Purpose: ___ WORK ___ OTHER (Specify)

How did you hear about this park and ride lot ? _____

How did you make this trip before you found out about this lot?
____ DIDN'T MAKE TRIP ____DROVE ALONE ____CARPOOLED
____ USED TRANSIT ____OTHER (Specify) _____

What do you think about this lot? Overcrowded? Unsafe?

Access Problems? Better advertised? Better signage?

Other comments? (Use back to record response if necessary)
_____

_____
Thank you for participating in this survey. Have a good day.

FDOT PARK & RIDE LOT USER SURVEY
AFTERNOON SURVEY FORM

LOT: _____ DATE: _____
Good afternoon. I am conducting interviews of users of this lot for the FDOT. Your answers will assist in the future planning, construction and operation of park and ride lots to better serve Florida commuters. May I please ask you a few questions concerning your use of this lot today?

Where did your trip begin? CITY _____
ADDRESS/ INTERSECTION _____
Is this your home? YES NO (circle one)

About how long did it take you to get here? _____minutes
Where will your trip end? CITY_____
ADDRESS/INTERSECTION_____
Is this your home? YES NO (circle one)

Time to travel from here to where your trip will end? _____ min

What is your occupation?_____

Is your home a single family (detached) dwelling unit? YES NO (circle one)

How many people of driving age are in your household? _____

How many vehicles in running condition are kept at your home?_____

Arrival Mode ___ CARPOOL ____BUS ___ VANPOOL ____ RAIL ____ OTHER (Specify)_____

If pool vehicle, how many others ride with you?_____

Departure Mode: _____ AUTO _____ BUS _____WALK _____BIKE _____OTHER

If auto, did you __ DRIVE ALONE __ SHARE A RIDE __GET DROPPED OFF
If a shared ride, how many were in the vehicle with you? _____
How many times per week do you use this lot? _____

Why do you use this lot? _____
Trip Purpose: ___ WORK ___ OTHER (Specify)

How did you hear about this park and ride lot ? _____

How did you make this trip before you found out about this lot? ____ DIDN'T MAKE TRIP
____DROVE ALONE ____CARPOOLED ___ USED TRANSIT ____ OTHER (Specify)

What do you think about this lot? Overcrowded? Unsafe?

Access Problems? Better advertised? Better signage?
Other comments? (Use back to record response if necessary)
_____

_____
Thank you for participating in this survey. Have a good evening.

PARKING ACCUMULATION SURVEY

LOT:
DATE:

TOTAL MARKED SPACES:

TIME	OCCUPIED SPACES	NOTES
6:30 am		
6:45		
7:00		
7:15		
7:30		
7:45		
8:00		
8.15		
8:30		
8:45		
9:00		

LOT INVENTORY SHEET

SKETCH

NUMBER OF SPACES: _____

SECURITY:_____
_____

PAVEMENT:_____
_____

SIGNING:_____
_____

FENCING:_____
_____

BUS STOPS/SERVICE:_____

ACCESS:_____

ILLEGAL PARKING: _____

COMMENTS:_____
_____
_____

FLORIDA DEPARTMENT OF TRANSPORTATION
PARK-AND-RIDE USER SURVEY

Dear Park-and-Ride User:
Due to upcoming design revisions in the Turnpike rebuilding project, several Park-and-Ride lots need to be relocated.

Please answer the following questions so that we may better serve your needs when choosing an alternate site. All answers are confidential. Thank you for your cooperation.

1. Which Park-and-Ride lot are you currently using?

   _____Sample Road & Turnpike
   _____Hammondsville Road & Turnpike
   _____Commercial Blvd. & Turnpike
   _____Sunrise Blvd. & Turnpike
   _____Hollywood B1vd. & Turnpike
   _____Other (please specify)

2. Approximately how many times per week do you use a Park-and-Ride lot? _____

3. Do you carpool? ___ Yes ___ No

   If so, with how many other people? _____

4. When using the Park-and-Ride lot, do you then use the Turnpike for your carpooling trips?
   ___Yes ____ No

5. What are the two nearest cross streets to your residence? In what city?_____

6. Why do you use Park-and-Ride lots? _____
_____
_____
_____

7. Please provide any other comments on back of paper.

ONCE AGAIN, THANK YOU VERY MUCH

Please mail to: Allison C. Smith, PTO,
Department of Transportation, 760 SW 24 St., Ft. Laud., FL 33315

Figure 4. District IV Turnpike Questionnaire

APPENDIX G. ANALYSIS WORKSHEETS

This appendix contains worksheets for use in executing the demand estimation and impact assessment procedures presented in this planning manual. The following four tables provide an index to the worksheets.

WORKSHEETS FOR DEMAND ANALYSIS

WORKSHEET	TITLE
D-1	Demand estimation for remote lots
D-2	Demand estimation for urban fringe lots and small area corridor lots without transit
D-3	Alternative method for developing total daily trip interchanges for corridor lots
D-4	Mode split input data for corridor lots with transit
D-5	Modal disutilities for large urban area corridor lots
D-6	Primary-level mode shares for large urban area corridor lots
D-7	Secondary-level modal shares for large urban area corridor lots
D-8	Parking space requirement for large urban area corridor lots
D-9	Modal disutilities for small urban area corridor lots with transit
D-10	Primary-level modal shares for small urban area corridor lots with transit
D-11	Secondary-level modal shares for small urban area corridor lots with transit
D-12	Parking space requirements for small urban area corridor lots with transit
D-13	Demand estimation for peripheral lot

WORKSHEETS FOR FUEL CONSUMPTION AND EMISSION IMPACT ANALYSIS

WORKSHEET	TITLE
I-1	Impact analysis for remote lots
I-2	Impact analysis for peripheral lots
I-3	Annual VMT reductions for urban fringe and corridor lots
I-4	Segment-level fuel consumption change for urban fringe and corridor lots
I-5	Summary fuel consumption changes for urban fringe and corridor lots
I-6	Changes in daily segment-level carbon monoxide emissions
I-7	Summary carbon monoxide emission changes for urban fringe and corridor lots
I-8	Changes in daily segment-level hydrocarbon emissions
I-9	Summary hydrocarbon emission changes for urban fringe and corridor lots
I-10	Changes in daily segment-level nitrogen oxide emissions -
I-11	Summary nitrogen oxide emission changes for urban fringe and corridor lots

WORKSHEETS FOR TRAVEL TIME IMPACT ANALYSIS

WORKSHEET	TITLE
T-1	Travel time elements for path segments of urban fringe and corridor lots
T-2	Summary of travel time elements for highway paths of urban fringe and corridor lots
T-3	Daily path VHT and PHT reductions for urban fringe and corridor lots
T-4	Annual reduction in VHT and PHT for urban fringe and corridor lots

WORKSHEETS FOR SYSTEM PERFORMANCE ANALYSIS

WORKSHEET	TITLE
P-1	VMT reduction
P-2	User cost savings
P-3	Change in average vehicle occupancy
P-4	Annual fuel savings and emission reductions
P-5	Value of accident reduction

WORKSHEET APPLICATION REFERENCE TABLE

Facility Level	Demand Analysis	Fuel Impacts	Emissions Impacts	Travel Time Impacts	VMT Reduction	User Cost Savings	Change in Occupancy	Accident Impacts
System-Wide		P-4	P-4		P-1	P-2	P-3	P-5
Remote	D-1	I-1	I-1		I-1			
Peripheral	D-13	I-2	I-2		I-2			
Large Area Corridor	D-3 D-4 D-5 D-6 D-7 D-8	I-4 I-5	I-6 I-7 I-8 I-9 I-10 I-11	T-1 T-2 T-3 T-4	I-3			
Small Area Transit Corridor	D-3 D-4 D-9 D-10 D-11 D-12	I-4 I-5	I-6 I-7 I-8 I-9 I-10 I-11	T-1 T-2 T-3 T-4	I-3			
Urban Fringe and Small Area Non-transit Corridor	D-2	I-4 I-5	I-6 I-7 I-8 I-9 I-10 I-11	T-1 T-2 T-3 T-4	I-3			

WORKSHEET D-1 DEMAND ESTIMATION REMOTE LOT

Data Required:
1. Count of actual informal parking.
2. Population growth data at the home end and the employment growth data at the destination end.

Definitions:

POP_d	Design year population at the home end.
POP_c	Current year population at the home end.
EMP_d	Design year employment at the destination end.
EMP_c	Current year employment at the destination end.
F_{pop}	Population growth factor.
F_{EMP}	Employment growth factor.
OIP	Observed informal parking.

1. Compute Population and Employment Growth Factors:
   A. Population Growth Factor = (_____ / _____) = _____
   POP_d POP_c F_{pop}

   B. Employment Growth Factor = (_____ / _____) = _____
   EMP_d EMP_c F_{EMP}

2. Compute the Design Year Parking Demand:
   Design Year Parking Demand = (1+ _____) * SQRT(_____ * _____) = _____
   OIP F_{pop} F_{pop} F_{emp}

WORKSHEET D-1

WORKSHEET D-2 DEMAND ESTIMATION URBAN FRINGE LOTS AND SMALL AREA CORRIDOR LOTS WITHOUT TRANSIT

Data Required: Traffic volume counts for the adjacent primary and secondary facilities, preferably 15-minute counts so the design period can be identified.

Definitions:

- ADT_p Two-way average daily traffic for the primary facility.
- ADT_s Two-way average daily traffic for the secondary facility.
- K Peak hour percentage. Refer to Table 4-5.
- D Directional distribution of traffic. Refer to Table 4-5.
- DP Design Period, the pronounced peak traffic period, identified from the 15 minute traffic counts or suggested value from Table 4-4.

1. Convert AADT Traffic Volume to the Design Period Volume, if 15-minute counts are not available

   A. Convert primary facility AADT to Design Period Volume =

   _____ * _____ * _____ * _____ / 60 = _____

   ADT_p K D DP V_p

   B. Convert secondary facility AADT to Design Period Volume =

   _____ * _____ * _____ * _____ / 60 = _____

   ADT_s K D DP V_s

2. Estimate the Parking Demand

   Parking Demand = 0.03 * _____ + 0.01 * _____ = _____

   V_p V_s

WORKSHEET D-2

WORKSHEET D-3 ALTERNATIVE METHOD FOR DEVELOPING TOTAL DAILY TRIP INTERCHANGES FOR CORRIDOR LOTS

Data Required:

1. Dwelling units in the origin market influence area, from FSUTMS data sets.
2. Employment data from FSUTMS data sets.
3. Average home-base work trip length from local urban model if available.

Definitions:

$TRIP_{od}$ Trip interchanges between the origin and destination market influence areas.

DU_o Dwelling units in the origin market influence area with one or more autos. See STEP 1A in Detailed Methodology for Transit Facilities. Section, Chapter 4.

EMP_d Destination area employment, tallied from FSUTMS data set for those zones in the destination market influence area specified by following the STEP 1B in Detailed Methodology for Transit Facilities Section, Chapter 4.

HBW Home-base work trip rate from urban model or Table 4-7.

EMP_{tot} Total urban area employment by summing employment of all TAZ zones in the urban area model.

L_{avg} Average home-base work trip length from urban model trip distribution output or use Table 4-7.

D_p Average distance between the origin and destination influence areas. Measured from maps.

Compute Trip Interchanges

Person Trip Interchanges:

$TRIP_{od}$= _____ * _____ * (_____ / _____) / 2 * (_____ / _____) = _____

DU_o HBW EMP_d EMP_{tot} L_{avg} D_p $Trip_{od}$

WORKSHEET D-3

WORKSHEET D-4 MODE SPLIT INPUT DATA FOR CORRIDOR LOTS WITH TRANSIT

Mode	Variable	In Vehicle Travel Time (minutes)	Excess Time (minutes)	Out of Pocket Costs (dollars)	Cost (dollars)
1. Drive-Alone Auto	Origin terminal time				
	Drive time				
	Destination terminal time				
	Tolls				
	Parking cost				
	Out operating cost				
	Total				
1A. Drive Alone auto accessing park-and-ride facility	Origin terminal time				
	Travel time to lot				
	Lot access time				
	Lot park cost per occupant				
	Wait time				
	Lot to destination driving time				
	Destination egress time				
	Tolls				
	Parking cost				
	Auto op cost				
	Total				
2. Two-Occupant Auto	Origin terminal time				
	Drive time				
	Destination terminal time				
	Toll charge/occupant				
	Parking cost/occupant				
	Out operating cost/occupant				
	Total				

Mode	Variable	In Vehicle Travel Time (minutes)	Excess Time (minutes)	Out of Pocket Costs (dollars)	Cost (dollars)
2A. 2-occupant carpool accessing park-and-ride facility	Origin terminal time				
	Travel time to lot				
	Lot park cost per occupant				
	Lot access time				
	Wait time				
	Lot to destination driving time				
	Destination egress time				
	Toll charge/occupant				
	Dest. park cost per occupant				
	Auto op cost per occupant				
	Total				
3. Three-Occupant Auto	Origin terminal time				
	Drive time				
	Destination terminal time				
	Tolls charge/occupant				
	Parking cost/occupant				
	Out operating cost/occupant				
	Total				
3A. 3+ occupant carpool accessing park-and-ride facility	Origin terminal time				
	Travel time to lot				
	Lot park cost per occupant				
	Lot access time				
	Wait time				
	Lot to destination driving time				
	Destination egress time				
	Dest. park cost per occupant				
	Auto op cost per occupant				
	Total				

Mode	Variable	In Vehicle Travel Time (minutes)	Excess Time (minutes)	Out of Pocket Costs (dollars)	Cost (dollars)
4. Local Bus with Walk Access	Walk time				
	Wait time				
	Bus run time				
	Transfer time				
	Destination egress time				
	Bus fare				
	Transfer charge				
	Total				
5. Line Haul with Walk or Local Bus Access[1]	Walk time				
	Wait time				
	Bus run time				
	Transfer time				
	Destination egress time				
	Local bus fare				
	Line haul fare				
	Line haul run time				
	Total				
6. Line Haul with Drive Alone Auto Access[1]	Origin terminal time				
	Drive time				
	Tolls				
	Park cost				
	Auto operating cost				
	Lot access time				
	Wait time				
	Line haul travel time				
	Line haul fare				
	Destination egress time				
	Total				

[1]Note: Data for modes 5 and 6 are required for larger urban area model only

Mode	Variable	In Vehicle Travel Time (minutes)	Excess Time (minutes)	Out of Pocket Costs (dollars)	Cost (dollars)
7. Line Haul with Share Ride Auto Access[1]	Origin terminal time				
	Drive time				
	Park cost per occupant				
	Auto op cost per occupant				
	Lot access time				
	Wait time				
	Line haul travel time				
	Line haul fare				
	Destination egress time				
	Total				

[1]**Note: Data for mode 7 are required for larger urban area model only**

WORKSHEET D-4 (Continued)

WORKSHEET D-5 MODE DISUTILITIES FOR LARGE URBAN AREA CORRIDOR LOTS

Data Required: Worksheet D-4 Mode split input data for Corridor lots.

Definitions:

IVTT	In-Vehicle Travel Time.	OC	Other costs
OVTT	Excess Time.	DU_i	Disutility of Mode i.
PK	Out of Pocket Cost.		

Calculate Primary Level Mode Disutilities

1. Drive Alone Auto:
   DU_1= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +0.00 =_____
   IVTT OVTT PK OC DU_1
2. Two-Occupant Auto:
   DU_2= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +1.90 =_____
   IVTT OVTT PK OC DU_2
3. Three-Occupant Auto:
   DU_3= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +2.60 =_____
   IVTT OVTT PK OC DU_3
4. Local Bus W/ Walk Access:
   DU_4= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +0.45 =_____
   IVTT OVTT PK OC DU_4
5. Line Haul W/ Walk or Local Bus Access:
   DU_5= .015 *_____ +.14 *_____ +.021 * _____ +.005 * _____ +1.70 =_____
   IVTT OVTT PK OC DU_5
6. Line Haul W/ Drive Alone Access:
   DU_6= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +3.40 =_____
   IVTT OVTT PK OC DU_6
7. Line Haul W/ Share-Ride Access:
   DU_7= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +4.25 =_____
   IVTT OVTT PK OC DU_7

WORKSHEET D-5 (Continued)

Calculate Secondary Level Mode Disutilities

1. Drive Alone Auto Accessing Park-and-Ride Facility:

   DU_{1A}= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +3.40 =_____

   IVTT OVTT PK OC DU_{1A}

2. Two-Occupant Auto Accessing Park-and-Ride Facility:

   DU_{2A}= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +4.25 =_____

   IVTT OVTT PK OC DU_{2A}

3. Three-Occupant Auto Accessing Park-and Ride Facility:

   DU_{3A}= .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +4.25 =_____

   IVTT OVTT PK OC DU_{3A}

WORKSHEET D-5

WORKSHEET D-6 PRIMARY-LEVEL MODAL SHARES FOR LARGE URBAN AREA CORRIDOR LOTS

Data Required: Mode disutilities from Worksheet D-S.

Definitions:

DU_i	Disutility of mode i.
P_i	Probability of using mode i.
NE_i	Exponential of Negative DU_i
SNE	Sum of all NE_i's

Compute Exponential of Negative Disutilities for Primary Level Modes and Sum

1. Exponential of negative DU_1: $EXP(-DU_1)$= EXP(- _____) = _____
   (Drive Alone Auto) DU_1 NE_1

2. Exponential of negative DU_2: $EXP(-DU_2)$= EXP(- _____) = _____
   (Two-Occupant Auto) DU_2 NE_2

3. Exponential of negative DU_3: $EXP(-DU_3)$= EXP(- _____) = _____
   (Three-Occupant Auto) DU_3 NE_3

4. Exponential of negative DU_4: $EXP(-DU_4)$= EXP(- _____) = _____
   (Local Bus W/ Walk Access) DU_4 NE_4

5. Exponential of negative DU_5: $EXP(-DU_5)$= EXP(- _____) = _____
   (Line Haul W/ Walk or Local Bus Access) DU_5 NE_5

6. Exponential of negative DU_6: $EXP(-DU_6)$= EXP(- _____) = _____
   (Line Haul W/ Drive Alone Access) DU_6 NE_6

7. Exponential of negative DU_7: $EXP(-DU_7)$= EXP(- _____) = _____
   (Line Haul W/ Share-Ride Access) DU_7 NE_7

---

8. SUM $\Sigma_{I=1,7}\ EXP(-Du_i)$ = _____
   SNE

WORKSHEET D-6 (Continued)

Compute-Primary Level Modal Shares

1. Modal Share of Drive Alone Auto: P_1 = _____ / _____ = _____
   NE_1 SNE
2. Modal Share of Two-Occupant Auto: P_2 = _____ / _____ = _____
   NE_2 SNE
3. Modal Share of Three-Occupant Auto: P_3 = _____ / _____ = _____
   NE_3 SNE
4. Modal Share of Local Bus W/ Walk Access: P_4 = _____ / _____ = _____
   NE_4 SNE
5. Modal Share of Line Haul W/ Walk or Local Bus Access: P_5 = _____ / _____ = _____
   NE_5 SNE
6. Modal Share of Line Haul W/ Drive Alone Access: P_6 = _____ / _____ = _____
   NE_6 SNE
7. Modal Share of Local Bus W/ Share-Ride Access: P_7 = _____ / _____ = _____
   NE_7 SNE

WORKSHEET D-6

WORKSHEET D-7 COMPUTE SECONDARY-LEVEL MODAL SHARES FOR LARGE URBAN AREA CORRIDOR LOTS

Data Required: Mode disutilities from Worksheet D-5 and the primary modal shares from Worksheet D-6.

Definitions:

DU_{iA}	Disutility of secondary level mode iA.
NE_{iA}	Exponential of negative DU for mode iA.
P_{iA}	Probability of using a particular mode iA.
iA	Notations for secondary level modes, i=1 to 3.

Compute Exponential of Negative Disutilities for Secondary Level Modes

1. **Exponential of negative DU_{1A}:** $EXP(-DU_{1A}) = EXP(-\underline{\quad}_{DU_{1A}}) = \underline{\quad}_{NE_{1A}}$
   (Drive Alone Auto Accessing P&R Facility)

2. **Exponential of negative DU_{2A}:** $EXP(-DU_{2A}) = EXP(-\underline{\quad}_{DU_{2A}}) = \underline{\quad}_{NE_{2A}}$
   (2-Occupant Auto Accessing P&R Facility)

3. **Exponential of negative DU_{3A}:** $EXP(-DU_{3A}) = EXP(-\underline{\quad}_{DU_{3A}}) = \underline{\quad}_{NE_{2A}}$
   (3+ Occupant Auto Accessing P&R Facility)

Compute Secondary Level Modal Shares

1. **Modal Share of Mode 1A:** $P_{1A} = \underline{\quad}_{P_1} * \underline{\quad}_{NE_{1A}} / (\underline{\quad}_{NE_1} + \underline{\quad}_{NE_{1A}}) = \underline{\quad}_{P_{1A}}$
   (Drive Alone Auto Accessing P&R Facility)

2. **Modal Share of Mode 2A:** $P_{2A} = \underline{\quad}_{P_2} * \underline{\quad}_{NE_{2A}} / (\underline{\quad}_{NE_2} + \underline{\quad}_{NE_{2A}}) = \underline{\quad}_{P_{2A}}$
   (2-Occupant Auto Accessing P&R Facility)

3. **Modal Share of Mode 3A:** $P_{3A} = \underline{\quad}_{P_3} * \underline{\quad}_{NE_{3A}} / (\underline{\quad}_{NE_3} + \underline{\quad}_{NE_{3A}}) = \underline{\quad}_{P_{3A}}$
   (3+ Occupant Auto Accessing P&R Facility)

WORKSHEET D-7

WORKSHEET D-8 COMPUTE PARKING SPACE REQUIREMENT FOR LARGE URBAN AREA CORRIDOR LOTS

Data Required:
1. Number of person trips between the origin and destination market influence areas calculated from Worksheet D-3, or Step 2 in Detailed Methodology for Transit Facilities Section, Chapter 5.
2. Worksheet D-6 and Worksheet D-7.

Definitions:

$Spaces_o$	Unadjusted estimate of long-term parking space requirements
$TRIPS_{od}$	Number of person trips between the origin and destination market areas.
Occ_2	Occupancy for Two-Occupant Auto. Default value of 2 occupants/vehicle can be used.
Occ_3	Occupancy for Three-Occupancy Auto. Default value of 3.5 occupants/vehicle can be used.

Other elements are defined on the source worksheets.

Compute Unadjusted Estimate of Long-Term Parking Space Requirements

1. **Trips for Mode 1A =** _____ * _____ = _____
   (Drive Alone Auto Accessing P&R Facility) $TRIPS_{OD}$ P_{1A}

2. **Trips for Mode 2A =** _____ * _____ / 2 = _____
   (2-Occupant Auto Accessing P&R Facility) $TRIPS_{OD}$ P_{2A}

3. **Trips for Mode 3A =** _____ * _____ / 3.5 = _____
   (3+0ccupant Auto Accessing P&R Facility) $TRIPS_{OD}$ P_{3A}

4. **Trips for Mode 6 =** _____ * _____ = _____
   (Line Haul W/ Drive Alone Access) $TRIPS_{OD}$ P_6

5. **Trips for Mode 7 =** _____ * _____ / 2.5 = + _____
   (Line Haul W/ Share-Ride Access) $TRIPS_{OD}$ P_7

---

6. **Compute $Spaces_O$:** _____
   Note: The default vehicle occupancy factors of 2, 3.5 and 2.5 can be substituted for the locally available data.

WORKSHEET D-8

WORKSHEET D-9 MODE DISUTILITIES FOR SMALL URBAN AREA CORRIDOR LOTS WITH TRANSIT

Data Required: Worksheet D-4 Mode split input data for corridor lots
Definitions: IVTT In-Vehicle Travel Time. OVTT Excess Time.
PK Out of Pocket Cost. OC Other Costs.

Calculate Primary Level Mode Disutilities

1. Drive Alone Auto:
   DU_1 = .015 *_____ +.14 *_____ +.021 *_____ +.005 *_____ +0.00 =_____
   IVTT OVTT PK OC DU_1

2. Two-Occupant Auto:
   DU_2 = .015 *_____ + .14 *_____ +.021 *_____ +. 005 *_____ + 2.18 = _____
   IVTT OVTT PK OC DU_2

3. Three-Occupant Auto:
   DU_3 = .015 *_____ + .14 *_____ +.021 *_____ + .005 *_____ +3.34 = _____
   IVTT OVTT PK OC DU_3

4. Transit:
   DU_4 = .015 *_____ + .14 *_____ + .021 * _____ + .005 *_____ + 1.31 = _____
   IVTT OVTT PK OC DU_4

Calculate Secondary Level Mode Disutilities

1. Carpools from Drive Alone Auto:
   DU_{1A} = . 015 *_____ + . 14 *_____ + .021 * _____ + .005 *_____ + 3.34 =_____
   IVTT OVTT PK OC DU_{1A}

2. Carpools from Two-Occupant Auto:
   DU_{2A} = .015 *_____ +.14 *_____ + .021 *_____ +.005 *_____ + 5.52 = _____
   IVTT OVTT PK OC DU_{2A}

3. Carpools from Three-Occupant Auto:
   DU_{3A} =. 015 *_____ + .14 *_____ + .021 *_____ + .005 *_____ + 6.68 =_____

	IVTT	OVTT	PK	OC	DU_{3A}

WORKSHEET D-9

WORKSHEET D-10 PRIMARY-LEVEL MODAL SHARES FOR SMALL URBAN AREA CORRIDOR LOTS WITH TRANSIT

Data Required: Mode disutilities from Worksheet D-9

Definitions:

DU_i	Disutility of mode i.	P_i	Probability of using mode i
NE_i	Exponential of negative DU_i	SNE	Sum of all NE_i s

Compute Exponential of Negative Disutilities for Primary Level Modes and Sum

1. **Exponential of negative DU_1:** (Drive Alone Auto) $EXP(-DU_1) = EXP(-\underline{\quad}_{DU_1}) = \underline{\quad}_{NE_1}$
2. **Exponential of negative DU_2:** (Two-Occupant Auto) $EXP(-DU_2) = EXP(-\underline{\quad}_{DU_2}) = \underline{\quad}_{NE_2}$
3. **Exponential of negative DU_3:** (Three-Occupant Auto) $EXP(-DU_3) = EXP(-\underline{\quad}_{DU_3}) = \underline{\quad}_{NE_3}$
4. **Exponential of negative DU_4:** (Transit) $+ EXP(-DU_4) = EXP(-\underline{\quad}_{DU_4}) = \underline{\quad}_{NE_4}$

---

5. **Sum** $\Sigma_{i=1,4} EXP(-DU_i) = \underline{\quad}_{SNE}$

Compute Primary Level Modal Shares

1. **Modal Share of Drive Alone Auto:** $P_1 = \underline{\quad}_{NE_1} / \underline{\quad}_{SNE} = \underline{\quad}$
2. **Modal Share of Two-Occupant Auto:** $P_2 = \underline{\quad}_{NE_2} / \underline{\quad}_{SNE} = \underline{\quad}$
3. **Modal Share of Three-Occupant Auto:** $P_3 = \underline{\quad}_{NE_3} / \underline{\quad}_{SNE} = \underline{\quad}$
4. **Modal Share of Transit:** $P_4 = \underline{\quad}_{NE_4} / \underline{\quad}_{SNE} = \underline{\quad}$

WORKSHEET D-10

WORKSHEET D-11 COMPUTE SECONDARY-LEVEL MODAL SHARES FOR SMALL URBAN AREAS CORRIDOR LOTS WITH TRANSIT

Data Required: Mode disutilities from Worksheet D-9 and the primary modal shares from Worksheet D10.

Definitions:

DU_{iA}	Disutility of secondary level mode iA.
NE_{iA}	Exponential of negative DU for mode iA.
P_{iA}	Probability of using a particular mode iA.
iA	Notations for secondary level modes, i=1 to 3

Compute Exponential of Negative Disutilities for Secondary Level Modes

1. **Exponential of negative DU_{1A}:** $EXP(-DU_{1A}) = EXP\left(-\frac{_____}{DU_{1A}}\right) = \frac{_____}{NE_{1A}}$
   (Carpools from Drive Alone Auto)

2. **Exponential of negative DU_{2A}:** $EXP(-DU_{2A}) = EXP\left(-\frac{_____}{DU_{2A}}\right) = \frac{_____}{NE_{2A}}$
   (Carpools from Two-Occupant Auto)

3. **Exponential of negative DU_{3A}:** $EXP(-DU_{3A}) = EXP\left(-\frac{_____}{DU_{3A}}\right) = \frac{_____}{NE_{3A}}$
   (Carpools from Three-Occupant Auto)

Compute Secondary Level Modal Shares

1. **Modal Share of Mode 1A:** $P_{1A} = \frac{_____}{P_1} * \frac{_____}{NE_{1A}} / \left(\frac{_____}{NE_1} + \frac{_____}{NE_{1A}}\right) = \frac{_____}{P_{1A}}$
   (Carpools from Drive Alone Auto)

2. **Modal Share of Mode 2A:** $P_{2A} = \frac{_____}{P_2} * \frac{_____}{NE_{2A}} / \left(\frac{_____}{NE_2} + \frac{_____}{NE_{2A}}\right) = \frac{_____}{P_{2A}}$
   (Carpools from Two-Occupant Auto)

3. **Modal Share of Mode 3A:** $P_{3A} = \frac{_____}{P_3} * \frac{_____}{NE_{3A}} / \left(\frac{_____}{NE_3} + \frac{_____}{NE_{3A}}\right) = \frac{_____}{P_3}$
   (Carpools from Three-Occupant Auto)

WORKSHEET D-11

WORKSHEET D-12 COMPUTE PARKING SPACE REQUIREMENT FOR SMALL URBAN AREA CORRIDOR LOTS WITH TRANSIT

Data Required:
1. Number of person trips between the origin and destination market influence areas calculated from Worksheet D-3, or Step 2 in Detailed Methodology for Transit Facilities Section, Chapter 5.
2. Worksheet D-11.

Definitions:

$Spaces_o$	Unadjusted estimate of long-term parking space requirements.
$TRIPS_{od}$	Number of person trips between the origin and destination market areas.
Occ_2	Occupancy for Two-Occupant Auto. Default value of 2 occupants/vehicle can be used.
Occ_3	Occupancy for Three-Occupancy Auto. Default value of 3.5 occupants/vehicle can be used.

Other elements are defined on the source worksheets.

Compute Unadjusted Estimate of Long-Term Parking Space Requirements

1. **Trips for Mode 1A** = _____ * _____ = _____
   (Carpools from Drive Alone Auto) $TRIPS_{od}$ P_{1A}

2. **Trips for Mode 2A =** _____ * _____ /2 = _____
   (Carpools from Two-Occupant Auto) $TRIPS_{od}$ P_{2A}

3. **Trips for Mode 3A =** _____ * _____ /3.5 = + _____
   (Carpools from Three-Occupant Auto) $TRIPS_{od}$ P_{3A}

---

4. **Compute $Spaces_o$:** _____

Note: 1. The default vehicle occupancy factors of 2, 3.5 and 2.5 can be substituted for the locally available data.

WORKSHEET D-12

WORKSHEET D-13 DEMAND ESTIMATION PERIPHERAL LOT

Data Required:
1. Activity center employment from urban model ZDATA file.
2. Home-base work mode share data from urban model if available.
3. Home-base work vehicle occupancy data from urban model if available.
4. Activity center parking inventory from local parking authority.

Definitions:

EMP	Total activity center employment.
Tshare	Proportion of work trips using transit. Use local data or Table 5-1.
Occ	Auto Occupancy for activity center work trips. Use local data or Table 5-2.
R_w	Proportion of parking spaces used for work trip parking. See Table 5-3.
Supply	Existing Parking supply.
PD	Parkinq Deficiency.
V_{adj}	Traffic volume on the adjacent roadways from which parkers are expected to access the parking facility
V_{all}	Total traffic volume on commuting arterials and highways accessing the activity center

Compute Parking Deficiency

1. Total Parking Demand = [(_____ * (1 -_____)) / (_____ * _____)] =_____
EMP Tshare Occ R_w

2. Subtract Supply: - _____
Supply

3. Parking Deficiency = _____

_____
PD

Compute Maximum Parking Capture

Maximum Parking Capture = _____ * (_____ /_____) =_____
PD V_{adj} V_{all}

WORKSHEET D-13

WORKSHEET I-1 IMPACT ANALYSIS FOR REMOTE LOTS

Data Required:
1. Parking demand from Worksheet D-1.
2. Average trip length from lot to destination, from the survey or assumption based on knowledge of local travel behavior.

Definitions:

VMT_s Annual VMT reduction.
L_{avg} Average trip length from lot to destination.
PV Estimated vehicle parked at the remote lot.
C_{rate} Average fuel consumption rate in gallons per mile for the study year under investigation. Refer to Table 6-2.
E_{co} Fleet average carbon monoxide emission rate in grams per vehicle mile. Refer to Table 6-2.
E_{nox} Fleet average nitrogen oxide emission rate in grams per vehicle mile. Refer to Table 6-2.
E_{hc} Fleet average hydrocarbon emission rate in grams per vehicle mile. Refer to Table 6-2.

Compute Annual Vehicle Miles of Travel (VMT) Reduction

1. **Annual VMT Reduction =** _____ * _____ * 233 * 2 = _____ Vehicle Miles
   L_{avg} PV VMT_s

Commute Annual Fuel Savings and Emission Reductions

1. **Annual Fuel Savings =** _____ * _____ = _____annual gallons
   VMT_s C_{rate}

2. **Annual CO Emission Reduction =** _____ * _____ / 907,184 = _____ tons/year
   VMT_s E_{co}

3. **Annual NOX Emission Reduction** = _____ * _____ / 907,184 = _____ tons/year
   VMT_s E_{nox}

4. **Annual HC Emission Reduction =** _____ * _____ / 907,184 = _____ tons/year
   VMT_s E_{nox}

WORKSHEET I-1

WORKSHEET I-2 IMPACT ANALYSIS FOR PERIPHERAL LOTS

Data Required: Arterial traffic volumes within the activity center from either the urban area model assignment or traffic count maps.

Definitions:

VMT_i	Annual VMT change for roadway i.
V_b	Peak period traffic volume on roadway i for before condition.
V_a	Peak period traffic volume on roadway i for after condition. _
L	Length of roadway i.
K1	Coefficient value from Table 6-10.
K2	Coefficient value from Table 6-10.
S_a	Average Speed in miles per hour over the distance of the roadway i.
E_{co}	Average carbon monoxide emission rate in grams per vehicle mile. Refer to Table 6-11 to 6-13.
E_{nox}	Average nitrogen oxide emission rate in grams per vehicle mile. Refer to Table 6-17 to 6-19.
E_{hc}	Average hydrocarbon emission rate in grams per vehicle mile. Refer to Table 6-14 to 6-16.

Compute Annual Vehicle Miles of Travel (VMT) Reduction

1. Annual VMT Reduction = (_____ - _____) * _____ * _____ * 226 * 2 =_____ Vehicle Miles
   V_b V_a L PV VMT_i

Compute Annual Fuel Consumption and Emission Changes

1. Annual Fuel Consumption Changes = _____ * (_____ + _____ / _____) = _____ annual gallons
   VMT_i K1 K2 Sa < 35 MPH

2. Annual CO Emission Changes = _____ * _____ / 907,184 =_____ tons/year
   VMT_i E_{co}

3. Annual NOX Emission Changes = _____ * _____ / 907,184 =_____ tons/year
   VMT_i E_{nox}

4. Annual HC Emission Changes = _____ * _____ / 907,184 =_____ tons/year
   VMT_i E_{hc}

WORKSHEET I-2

WORKSHEET I-3 ANNUAL VMT REDUCTIONS FOR URBAN FRINGE AND CORRIDOR LOTS

Data Required:
1. Park-and-ride lot size from demand estimation, average distance for each highway travel path measured from map.
2. Proportion of total parked vehicles traveling via each highway path. See Step 2 in Urban Fringe and Urban Corridor Lot Impacts Section, Chapter 6.

Definitions:

VMT_j Annual reduction in VMT for highway travel path j.
D Number of parked vehicles projected for the planning year. From Worksheet D-2.
L_j Average distance for highway travel path j.
P_j Proportion of total parked vehicles traveling via highway travel path j.
AF Annualization Factor, 213 for urban fringe lots and 233 for urban corridor lots
j j = 1 to n, n is the number of major travel path for a lot.

Estimate Annual VMT Reduction by Major Travel Path(s)

1. Annual VMT reduction for Path 1: 1 (j) : _____ (L_1) * _____ (D) * _____ (P_1) * 2 * _____ (AF) = _____ (VMT_1) Vehicle Miles

2. Annual VMT reduction for Path 2: 2 (j) : _____ (L_2) * _____ (D) * _____ (P_2) * 2 * _____ (AF) = _____ (VMT_2) Vehicle Miles

3. Annual VMT reduction for Path 3: 3 (j) : _____ (L_3) * _____ (D) * _____ (P_3) * 2 * _____ (AF) = _____ (VMT_3) Vehicle Miles

4. Annual VMT reduction for Path 4: 2 (j) : _____ (L_4) * _____ (D) * _____ (P_4) * 2 * _____ (AF) = _____ (VMT_4) Vehicle Miles

5. Annual VMT reduction for Path 5: 2 (j) : _____ (L_4) * _____ (D) * _____ (P_5) * 2 * _____ (AF) = _____ (VMT_5) Vehicle Miles

6. Total VMT reductions: **S $VMT_{j=1 \text{ to } 5}$** **= _____ Vehicle Miles**

WORKSHEET I-3

WORKSHEET I-4 SEGMENT LEVEL FUEL CONSUMPTION CHANGES FOR URBAN FRINGE AND CORRIDOR LOTS

Fuel Path No. _____

Segment No. _____ to Segment No._____

Data Required: Length and traffic volume on segment of highway path.

Definitions:

FC_{pi} Fuel consumption change for Path p, Segment i.

L_i Length of segment i, path p in mile.

$Crate_{ib}$ Auto fuel consumption rate for segment i, path p ~ r before condition. From Table 6-5 or Table 6-6.

$Crate_{ia}$ Auto fuel consumption rate for segment i, path p for after condition. From Table 6-5 or Table 6-6.

$Busrate_{ia}$ Bus fuel consumption rate for segment i, path p for after condition. From Table 6-7.

$RVOL_i$ Vehicles removed from segment i, path p. (Equal to $D * P_j$ specified on Worksheet I-3).

$TVOL_i$ Total traffic for segment i, path p for before condition, from urban area model assignment or traffic count map

$BVOL_i$ Transit vehicle volume for segment i, path p, from bus schedule

AF Annualization Factor. 213 for urban fringe lots or 233 for urban corridor lots

1. Fuel Change for Path _____ Segment _____ =

2* _____* _____* {(_____* _____)+ [_____* (_____- _____)] - (_____* _____)}= _____

AF L_i $Crate_{ib}$ $TVOL_i$ $Crate_{ia}$ $TVOL_i$ $RVOL_i$ $BUSrate_{ia}$ $BVOL_i$

2. Fuel Change for Path _____ Segment _____ =

2* _____* _____* {(_____* _____)+ [_____* (_____- _____)] - (_____* _____)}= _____

AF L_i $Crate_{ib}$ $TVOL_i$ $Crate_{ia}$ $TVOL_i$ $RVOL_i$ $BUSrate_{ia}$ $BVOL_i$

3. Fuel Change for Path _____ Segment _____ =

2* _____* _____* {(_____* _____)+ [_____* (_____- _____)] - (_____* _____)}= _____

AF L_i $Crate_{ib}$ $TVOL_i$ $Crate_{ia}$ $TVOL_i$ $RVOL_i$ $BUSrate_{ia}$ $BVOL_i$

4. Fuel Change for Path _____ Segment _____ =

2* _____* _____* {(_____* _____)+ [_____* (_____- _____)] - (_____* _____)}= _____

AF L_i $Crate_{ib}$ $TVOL_i$ $Crate_{ia}$ $TVOL_i$ $RVOL_i$ $BUSrate_{ia}$ $BVOL_i$

WORKSHEET I-4

WORKSHEET I-5 SUMMARY FUEL CONSUMPTION CHANGES FOR URBAN FRINGE AND CORRIDOR LOTS

Data Required: Use Worksheet I-4 to compute the fuel change on each segment of a highway path. Transfer the results to this sheet segment by segment for summing up totals.

Fuel Changes (gallons/year) Segment No.	Path 1	Path 2	Path 3	Path 4	Path 5	
1	_____	_____	_____	_____	_____	
2	_____	_____	_____	_____	_____	
3	_____	_____	_____	_____	_____	
4	_____	_____	_____	_____	_____	
5	_____	_____	_____	_____	_____	
6	_____	_____	_____	_____	_____	
7	_____	_____	_____	_____	_____	
8	_____	_____	_____	_____	_____	
9	_____	_____	_____	_____	_____	
10	+_____	+_____	+_____	+_____	+_____	
Total of Each Path	_____	+_____	+_____	+_____	+_____	=_____ Grand Total

WORKSHEET I-5

WORKSHEET I-6 CHANGES IN DAILY SEGMENT-LEVEL CARBON MONOXIDE EMISSIONS

CO Path No. _____

Segment No. _____ to Segment No. _____

Data Required: Length and traffic volume on segment of highway path.

Definitions:

CO_{ip} Daily segment carbon monoxide change on the path i, in grams.

L_i Length of segment i in miles

$COrate_{ib}$ Automobile CO emission rate for segment i, path p for before condition. From Table 6-8 or 6-9.

$COrate_{ia}$ Automobile CO emission rate for segment i, path p for after condition. From Table 6-8 or 6-9.

$BCOrate_{ia}$ Bus CO emission rate for segment i, path p for the after condition. From Table 6-7.

$RVOL_i$ Vehicles removed from segment i, path p. (Equal to D * P' specified on Worksheet I-3).

$TVOL_i$ Total traffic for segment i, path p for before condition, from urban area model assignment or traffic count map.

$BVOL_i$ Transit vehicle volume for segment i, path p, from bus schedule

1. Daily CO Reduction for Path _____ Segment _____ =

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $COrate_{ib}$ $TVOL_i$ $COrate_{ia}$ $TVOL_i$ $RVOL_i$ $BCOrate_{ia}$ $BVOL_i$

2. Daily CO Reduction for Path _____ Segment _____ =

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $COrate_{ib}$ $TVOL_i$ $COrate_{ia}$ $TVOL_i$ $RVOL_i$ $BCOrate_{ia}$ $BVOL_i$

3. Daily CO Reduction for Path _____ Segment _____ =

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $COrate_{ib}$ $TVOL_i$ $COrate_{ia}$ $TVOL_i$ $RVOL_i$ $BCOrate_{ia}$ $BVOL_i$

4. Daily CO Reduction for Path _____ Segment _____ =

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $COrate_{ib}$ $TVOL_i$ $COrate_{ia}$ $TVOL_i$ $RVOL_i$ $BCOrate_{ia}$ $BVOL_i$

WORKSHEET I-6

WORKSHEET I-7 SUMMARY CARBON MONOXIDE EMISSION CHANGES FOR URBAN FRINGE AND CORRIDOR LOTS

Data Required: Use Worksheet I-6 to compute daily carbon monoxide reductions for each segment on a highway path. Transfer the results to this sheet segment by segment for summing up totals.

Data Element: AF Annualization Factor. 213 for urban fringe lots or 233 for urban corridor lot.
DGT_{CO} Daily grand total of CO emission changes, in grams.

CO Emission Reductions (Grams)

Segment No.	Path 1	Path 2	Path 3	Path 4	Path 5
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____
8	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____
10	+_____	+_____	+_____	+_____	+_____
Total of Each Path	_____	+_____	+_____	+_____	+_____ = _____ Grand Total

Total Annual CO Emission = _____ * _____ /907,184= _____ tons
AF DGT_{co}

WORKSHEET I-7

WORKSHEET I-8 CHANGES IN DAILY SEGMENT-LEVEL HYDROCARBON EMISSIONS

HC Path No._____

Segment No. _____to Segment No._____

Data Required: Length and traffic volume on segment of highway path.

Definitions:

HC_{ip} Daily segment hydrocarbon change on the path i, in grams

Li Length of segment i in miles.

$HCrate_{ib}$ Automobile HC emission rate for segment i, path p for before condition. From Table 6-8 or 6-9.

$HCrate_{ia}$ Automobile HC emission rate for segment i, path p for after condition. From Table 6-8 or 6-9.

$BHCrate_{ia}$ Bus HC emission rate for segment i, path p for the after condition. From Table 6-7.

$RVOL_i$ Vehicles removed from segment i, path p. (Equal to $D * P_j$ specified on Worksheet I-3).

$TVOL_i$ Total traffic for segment i, path p for before condition, from urban area model assignment or traffic count map.

$BVOL_i$ Transit vehicle volume for segment i, path p, from bus schedule.

1. Daily HC Reduction for Path _____Segment _____=

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $HCrate_{ib}$ $TVOL_i$ $HCrate_{ia}$ $TVOL_i$ $RVOL_i$ $BHCrate_{ia}$ $BVOL_i$

2. Daily HC Reduction for Path _____Segment _____=

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $HCrate_{ib}$ $TVOL_i$ $HCrate_{ia}$ $TVOL_i$ $RVOL_i$ $BHCrate_{ia}$ $BVOL_i$

3. Daily HC Reduction for Path _____Segment _____=

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $HCrate_{ib}$ $TVOL_i$ $HCrate_{ia}$ $TVOL_i$ $RVOL_i$ $BHCrate_{ia}$ $BVOL_i$

4. Daily HC Reduction for Path _____Segment _____=

2 * {_____* (_____* _____)+ [_____* (_____- _____)] - (_____* _____)} = _____

L_i $HCrate_{ib}$ $TVOL_i$ $HCrate_{ia}$ $TVOL_i$ $RVOL_i$ $BHCrate_{ia}$ $BVOL_i$

WORKSHEET I-8

WORKSHEET I-9 SUMMARY HYDROCARBON EMISSION CHANGES FOR URBAN FRINGE AND CORRIDOR LOTS

Data Required: Use Worksheet I-8 to compute daily hydrocarbon reductions for each segment on a highway path. Transfer the results to this sheet segment by segment for summing up totals.

Data Element: AF Annualization Factor. 213 for urban fringe lots or 233 for urban corridor lots.
DGT_{hc} Daily grand total of HC emission changes, in grams.

HC Emission Reductions (Grams)

Segment No.	Path 1	Path 2	Path 3	Path 4	Path 5
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____
8	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____
10	+_____	+_____	+_____	+_____	+_____
Total of Each Path	_____	+_____	+_____	+_____	+_____ = _____ Grand Total

Total Annual HC Emission = _____ * _____ /907,184= _____ tons

AF DGT_{hc}

WORKSHEET I-9

WORKSHEET I-10 CHANGES IN DAILY SEGMENT-LEVEL NITROGEN OXIDE EMISSIONS

NOX Path No. _____

Segment No. _____ to Segment No. _____

Data Required: Length and traffic volume on segment of highway path.

Definitions:

NOX_{ip}	Daily segment nitrogen oxides emission change on the path i, in grams.
Li	Length of segment i in miles.
$NOXrate_{ib}$	Automobile NOX emission rate for segment i, path p for before condition. From Table 6-8 or 6-9.
$NOXrate_{ia}$	Automobile NOX emission rate for segment i, path p for after condition. From Table 6-8 or 6-9.
$BNOXrate_{ia}$	Bus NOX emission rate for segment i, path p for the after condition. From Table 6-7.
$RVOL_i$	Vehicles removed from segment i, path p. (Equal to D * P` specified on Worksheet I-3).
$TVOL_i$	Total traffic for segment i, path p for before condition, from urban area model assignment or traffic count map.
$BVOL_i$	Transit vehicle volume for segment i, path p, from bus schedule.

1. Daily NOX Reduction for Path _____ Segment_____ =

2* {_____* (_____* _____)+ [_____ * (_____- _____)] - (_____* _____)} = _____

L_i $NOXrate_{ib}$ $TVOL_i$ $NOXrate_{ia}$ $TVOL_i$ $RVOL_i$ $BNOXrate_{ia}$ $BVOL_i$

2. Daily NOX Reduction for Path _____ Segment_____ =

2* {_____* (_____* _____)+ [_____ * (_____- _____)] - (_____* _____)} = _____

L_i $NOXrate_{ib}$ $TVOL_i$ $NOXrate_{ia}$ $TVOL_i$ $RVOL_i$ $BNOXrate_{ia}$ $BVOL_i$

3. Daily NOX Reduction for Path _____ Segment_____ =

2* {_____* (_____* _____)+ [_____ * (_____- _____)] - (_____* _____)} = _____

L_i $NOXrate_{ib}$ $TVOL_i$ $NOXrate_{ia}$ $TVOL_i$ $RVOL_i$ $BNOXrate_{ia}$ $BVOL_i$

4. Daily NOX Reduction for Path _____ Segment_____ =

2* {_____* (_____* _____)+ [_____ * (_____- _____)] - (_____* _____)} = _____

L_i $NOXrate_{ib}$ $TVOL_i$ $NOXrate_{ia}$ $TVOL_i$ $RVOL_i$ $BNOXrate_{ia}$ $BVOL_i$

WORKSHEET I-10

WORKSHEET I- 11 SUMMARY NITROGEN OXIDE EMISSION CHANGES FOR URBAN FRINGE AND CORRIDOR LOTS

Data Required: Use Worksheet I-10 to compute daily nitrogen oxide reductions for each segment on a highway path. Transfer the results to this sheet segment by segment for summing up totals.

Data Element: AF Annualization Factor. 213 for urban fringe lots or 233 for urban corridor lots.
DGT_{no} Daily grand total of NOX emission changes, in grams.

NOX Emission Reductions (Grams)

Segment No.	Path 1	Path 2	Path 3	Path 4	Path 5
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____
8	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____
10	+_____	+_____	+_____	+_____	+_____
Total of Each Path	_____	+_____	+_____	+_____	+_____ = _____ Grand Total

Total Annual NOX Emission = _____ * _____ /907,186 = _____ tons

AF DGT_{nox}

WORKSHEET I-11

WORKSHEET T-1 TRAVEL TIME ELEMENTS FOR PATH SEGMENTS OF URBAN FRINGE AND CORRIDOR LOTS

Data Required:Segment-level travel time and speed. See Step 7 in Urban Fringe and Urban Corridor Lot Impacts Section, Chapter 6.

Path:_____

Definitions:

$Hbtt_{pi}$	Highway travel time for segment i, path p for before condition.
$Hatt_{pi}$	Highway travel time for segment i, path p for after condition.
$Catt_{pi}$	Carpooler travel time for segment i, path p for after condition.
$Tatt_{pi}$	Transit travel time for segment i, path p for after condition.
L_{pi}	Length of segment i, path p in mile
Sb_{pi}	Average travel speed on segment i, path p for before condition.
Sa_{pi}	Average travel speed on segment i, path p for after condition.
Etime	Excess time, from Worksheet D-4.

Segment _____

1. **Highway before condition travel time:**= _____ / _____= _____
   L_{pi} Sb_{pi} $Hbtt_{pi}$
2. **Carpooler travel time in before condition:** $Hbtt_{pi}$= $Cbtt_{pi}$
3. **Highway after condition travel time:** = _____ / _____= _____
   L_{pi} Sa_{pi} $Hatt_{pi}$
4. **Carpooler travel time in after condition:**= (_____ / _____) + (_____ / 60)= _____
   L_{pi} Sa_{pi} Etime $Catt_p$
5. **Transit travel time in after condition:** $Catt_p$ = $Tatt_p$

Segment _____

1. **Highway before condition travel time:**= _____ / _____= _____
   L_{pi} Sb_{pi} $Hbtt_{pi}$
2. **Carpooler travel time in before condition:** $Hbtt_{pi}$= $Cbtt_{pi}$
3. **Highway after condition travel time:** = _____ / _____= _____
   L_{pi} Sa_{pi} $Hatt_{pi}$
4. **Carpooler travel time in after condition:**= (_____ / _____) + (_____ / 60)= _____
   L_{pi} Sa_{pi} Etime $Catt_p$
5. **Transit travel time in after condition:** $Catt_p$ = $Tatt_p$

WORKSHEET T-1

WORKSHEET T-2 SUMMARY OF TRAVEL TIME ELEMENTS FOR HIGHWAY PATHS OF URBAN FRINGE AND CORRIDOR LOTS

Data Required: Use Worksheet T-1 to calculate the travel time elements for each segment on a path. Then transfer the results to this worksheet for summing up totals. Use one worksheet for each path.

Data Element:

$Hbtt_p$ Highway travel time for path p in before condition.
$Hatt_p$ Highway travel time for path p in after condition.
$Catt_p$ Carpooler travel time for path p in after condition.
$Tatt_p$ Transit travel time for, path p in after condition.

Path:_____

Segment	$Hbtt_p$	$Hatt_p$	$Cbtt_p$	$Catt_p$	$Tatt_p$
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____
8	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____
10	+_____	+_____	+_____	+_____	+_____
					+_____
Total	_____	+_____	+_____	+_____	$Tatt_p$
	$Hbtt_p$	$Hatt_p$	$Cbtt_p$	$Catt_p$	

WORKSHEET T-2

WORKSHEET T-3 DAILY PATH VHT AND PHT REDUCTIONS FOR URBAN FRINGE AND CORRIDOR LOTS

Data Required: Worksheet T-1 and Worksheet T-2

Definitions: $TVOL_p$ Total volume for path p in before condition.

$Hbtt_p$ Highway travel time for path p for before condition. from Worksheet T-1.

$RVOL_p$ Volume Reduced from path p, equal to $D*P_j$ on Worksheet I-3.

$Hatt_p$ Highway travel time for path p for after condition, from Worksheet T-1.

OCC_{hbw} Auto occupancy for before condition. Occupancy for home-base work trip is typically used. Default value is 1.2 persons per auto.

Occ_a Auto Occupancy for after condition for egress carpool vehicles. Default value of 3.2 persons per auto can be used.

$CVOL_p$ Vehicles associated with carpools formed at the park-and-ride facility for path p. $CVOL_p = RVOL_p$.

$Catt_p$ Carpool travel time for path p for after condition, from Worksheet T-2.

$Tatt_p$ Transit travel time for path p for after condition, from Worksheet T-2.

Path: _____

1. Daily Vehicle-Hours of Travel Reduction:

VHT_p= [_____* _____- (_____ -_____) * _____ - (_____ / (_____- _____) + 1) * _____* _____] * 2 = _____

$TVOL_p$ $Hbtt_p$ $TVOL_p$ $RVOL_p$ $Hatt_p$ Occ_{hbw} Occ_a Occ_{hbw} $CVOL_p$ $Catt_p$ VHT_p

2. Daily Person-Hours of Travel Reduction:

PHTp= [_____* _____* _____- (_____- _____) * _____* _____- (_____ / (_____- _____) + 1) *_____* _____) * _____ - _____ * _____] * 2 = _____

TVOLp Hbttp OCChbw TVOLp RVOLp Hattp Occhbw Occa Occa Occhbw CVOLp Cattp Occa Passp Tattp PHTp

WORKSHEET T-3

WORKSHEET T-4 ANNUAL REDUCTION IN VHT AND PHT FOR URBAN FRINGE AND CORRIDOR LOTS

Data Required: Use Worksheet T-3 to calculate the daily VHT and PHT reductions for each path. **Use** one worksheet T-4 for each path. Transfer VHT and PHT of all paths to this worksheet for summing up annual total VHT and PHT reductions.

Definitions: AF Annualization factor, equals 213 for urban fringe lots and 233 for urban corridor lots.

Path	**VHT_p**	**PHT_p**
1	_____	_____
2	_____	_____
3	_____	_____
4	_____	_____
5	_____	_____
6	_____	_____
7	_____	_____
8	_____	_____
9	_____	_____
10	+_____	+_____
Total Daily Reductions	_____	_____
Multiply Annualization	*_____	*_____
Total Annual Reductions	_____	_____

VHT (annual) PHT (Annual)

WORKSHEET T-4

WORKSHEET P-1 VMT REDUCTION

Data Required: Number of parked vehicles at each urban corridor lot.

Definitions:

VMT_c	Annual VMT reduction for urban corridor lots
VMT_p	Annual VMT reduction for peripheral lots
VMT_f	Annual VMT reduction for urban lots
VMT_r	Annual VMT reduction for remote lots
$Parked_i$	Daily parked vehicles at lot I of each lot type
L_c	Average lot-to-destination distance for urban corridor lot. Default value is 17.2 miles
L_p	Average lot-to-destination distance for peripheral lot. Default value is 2 miles.
L_f	Average lot-to-destination distance for urban fringe lot. Default value is 16.1 miles.
L_r	Average lot-to-destination distance for remote lot. Default value is 33.1 miles.

1. VMT Reduction for Urban Corridor Lots:

VMT_c= 2 * 233 * _____* (_____+_____+ _____+ _____+ _____+
L_c $Parked_1$ $Parked_2$ $Parked_3$ $Parked_4$ $Parked_5$

_____+ _____+ _____+ _____+ _____+)= _____
$Parked_6$ $Parked_7$ $Parked_8$ $Parked_9$ $Parked_{10}$ VMT_c

2. VMT Reduction for Periperal Lots:

VMT_p= 2 * 226 * _____* (_____+_____+ _____+ _____+ _____+
L_p $Parked_1$ $Parked_2$ $Parked_3$ $Parked_4$ $Parked_5$

_____+ _____+ _____+ _____+ _____+)= _____
$Parked_6$ $Parked_7$ $Parked_8$ $Parked_9$ $Parked_{10}$ VMT_p

3. VMT Reductions for Urban Fringe Lots:

VMT_f= 2 * 213 * _____* (_____+_____+ _____+ _____+ _____+
L_f $Parked_1$ $Parked_2$ $Parked_3$ $Parked_4$ $Parked_5$

_____+ _____+ _____+ _____+ _____+)= _____
$Parked_6$ $Parked_7$ $Parked_8$ $Parked_9$ $Parked_{10}$ VMT_f

WORKSHEET P-1 (continued)

4. VMT Reductions for Remote Lots:

$VMT_r = 2 * 233 *$ _____* (_____+_____+ _____+ _____+ _____+
L_r $Parked_1$ $Parked_2$ $Parked_3$ $Parked_4$ $Parked_5$

_____+ _____+ _____+ _____+ _____+)= _____
$Parked_6$ $Parked_7$ $Parked_8$ $Parked_9$ $Parked_{10}$ VMT_r

5. System VMT Reduction = _____+ _____+ _____+ _____= _____
VMT_c VMT_p VMT_f VMT_r

WORKSHEET P-1

WORKSHEET P-2 USER COST SAVINGS

Data Required: Worksheet P-1 VMT Reduction

Definitions:

VMTc	Annual VMT reduction for urban corridor lots
VMT_p	Annual VMT reduction for peripheral lots
VMT_f	Annual VMT reduction for urban lots
VMT_r	Annual VMT reduction for remote lots
$Opcost_c$	Average vehicle operation cost for vehicles parked at urban corridor lot. Default value $0.206 / vehicle miles can be used.
$Opcost_p$	Average vehicle operation cost for vehicles parked at peripheral lots. Default value $0.204 / vehicle miles can be used.
$Opcost_f$	Average vehicle operation cost for vehicles parked at urban fringe lots. Default value $0.206 / vehicle miles can be used.
$Opcost_r$	Average vehicle operation cost for vehicles parked at remote lots. Default value $0.134 / vehicle miles can be used.

Systemwide User Cost Savings:

$$\underline{\quad\quad}_{VMT_c} * \underline{\quad\quad}_{Opcostc} + \underline{\quad\quad}_{VMT_p} * \underline{\quad\quad}_{Opcost_p} + \underline{\quad\quad}_{VMT_f} * \underline{\quad\quad}_{Opcost_f} + \underline{\quad\quad}_{VMT_r} * \underline{\quad\quad}_{Opcost_r} = \underline{\quad\quad}$$

WORKSHEET P-2

WORKSHEET P-3 CHANGE IN AVERAGE VEHICLE OCCUPANCY

Data Required: Parked vehicle counts

Definitions:

$Parked_i$ Number of parked vehicles in lot type i, i = cb, cr, p, f, and r.

$Aocc_i$ Auto occupancy of car-poolers from lot to work for lot type i, i = cb, cr, p, f, and r. (Refer to Table 11-2 for $Aocc_i$ values.)

$Bocc_i$ Before auto occupancy for lot type i, i = cb, cr, p, f, and r. (Refer to Table 11-2 for $Bocc_i$ values.)

$Cocc_i$ Change for occupancy for lot typ i, i = cb, cr, p, f, and r.

$Egress_i$ Number of egress carpool and transit vehicles from lot i.

Ppc_i Proportion of parkers that are carpool passengers. Calculated based on the formula:

$Ppc_i = (Mc_i/Mt_i) / [\{Bocc_i / Aocc_i)/ (1-Bocc_i / Aocc_i) + 1\} + Mc_i / Mt_i]$, if $Mt_i > 0$. Or $Ppc_i = 1$ for $Mt_i + 0$. See the last page of this worksheet for the formula derivations.

$Total_i$ Total number of a park and ride lot's users, including drivers and passengers picking up carpooling passengers.

$Drive_i$ Driving carpool vehicles from a lot to it final work destination.

Mt_i Transit mode share from lot to work destination (see Table 11-2.)

Mc_i Mode shares of carpools from lot to work destination (see Table 11-2.)

cb Notation for urban corridor lots with bus service.

cr Notation for urban corridor lots with rail service.

p Notation for peripheral lots.

f Notation for urban fringe lots.

r Notation for remote lots.

WORKSHEET P-3 (continued)

Summarize Total Parked Vehicles for Each Type of Lots

Lot No.	Urban Corridor w/bus	Urban Corridor w/rail	Peripheral	Urban Fringe	Remote
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____
8	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____
10	_____	_____	_____	_____	_____
Total	_____	_____	_____	_____	_____
	$Parked_{cb}$	**$Parkedc_r$**	**$Parked_p$**	**$Parked_f$**	$Parked_r$

WORKSHEET P-3 (continued)

Compute Change of Occupancy for Each Type of Lot

$Cocc_{cb}$ = [1 / (_____ / 20 + _____ / _____)] - _____ + _____
Mt_{cb} Mc_{cb} $Aocc_{cb}$ $Bocc_{cb}$ $CCocc_{cb}$

$Cocc_{cr}$ = [1 / (_____ / 20 + _____ / _____)] - _____ + _____
Mt_{cr} Mc_{cr} $Aocc_{cr}$ $Bocc_{cr}$ $CCocc_{cr}$

$Cocc_{p}$ = [1 / (_____ / 20 + _____ / _____)] - _____ + _____
Mt_{p} Mc_{p} $Aocc_{p}$ $Bocc_{p}$ $CCocc_{p}$

$Cocc_{f}$ = [1 / (_____ / 20 + _____ / _____)] - _____ + _____
Mt_{f} Mc_{f} $Aocc_{f}$ $Bocc_{f}$ $CCocc_{f}$

$Cocc_{r}$ = [1 / (_____ / 20 + _____ / _____)] - _____ + _____
Mt_{r} Mc_{r} $Aocc_{r}$ $Bocc_{r}$ $CCocc_{r}$

Compute Number of Egress Vehicles

$Egress_{cb}$ = _____* _____ * [_____ / (_____- _____) + (1- 0.168)/ 20] = _____
$Parked_{cb}$ $Bocc_{cb}$ Ppc_{cb} $Aocc_{cb}$ $Bocc_{cb}$ Ppc_{cb} $Egress_{cb}$

$Egress_{cr}$ = _____* _____ * [_____ / (_____- _____) + (1- 0.033)/ 20] = _____
$Parked_{cr}$ $Bocc_{cr}$ Ppc_{cr} $Aocc_{cr}$ $Bocc_{cr}$ Ppc_{cr} $Egress_{cr}$

$Egress_{p}$ = _____* _____ * [_____ / (_____- _____) + (1- 0.235)/ 20] = _____
$Parked_{p}$ $Bocc_{p}$ Ppc_{p} $Aocc_{p}$ $Bocc_{p}$ Ppc_{p} $Egress_{p}$

$Egress_{f}$ = _____* _____ * [_____ / (_____- _____) + (1- 0.507)/ 20] = _____
$Parked_{f}$ $Bocc_{f}$ Ppc_{f} $Aocc_{f}$ $Bocc_{f}$ Ppc_{f} $Egress_{f}$

$Egress_{r}$ = _____* _____ * [_____ / (_____- _____) + (1- 1.000)/ 20] = _____

$Parked_r$	$Bocc_r$	Ppc_r	$Aocc_r$	$Bocc_r$	Ppc_r	$Egress_r$

WORKSHEET P-3 (continued)

Compute Systemwide Change in Average Vehicle Occupancy

Change in Vehicle Occupancy =

(_____ * _____ + _____ * _____ + _____ * _____ + _____ * _____ + _____ * _____ +) /

$Ccob_{cb}$ $Egress_{cb}$ $Cocc_{cr}$ $Egress_{cr}$ $Cocc_{p}$ $Egress_{p}$ $Cocc_{f}$ $Egress_{f}$ $Cocc_{r}$ $Egress_{r}$

(_____ + _____ + _____ + _____ + _____) = _____

$Egress_{cb}$ $Egress_{cr}$ $Egress_{p}$ $Egress_{f}$ $Egress_{r}$

Formula Derivation for the Proportion of parkers that are carpool passengers

Base Equations

$Bocc_i * Drive_i + Ppc_i * Parked_i * Bocc_i = Mc_i * Total_i$ (1)

$(1 - Ppc_i) * Parked_i * Bocc_i = Mt_i * Total_i$ (2)

$(Bocc_i * Drive_i + Ppc_i * Parked_i * Bocc_i) / Drive_i = Aocc_i$ (3)

Derivations

From Equations (1) and (2)

$Drive_i + Ppc_i * Parked_i + (Mc_i / Mt_i) * (1 - Ppc_i) * Parked_i$ (4)

From Equation (3)

$Drive_i = [Ppc_i * (Bocc_i / Aocc_i) * Parked_i] / [1 - (Bocc_i / Aocc_i)]$ (5)

From Equations (4) and (5)

$[Ppc_i * (Bocc_i / Aocc_i) / (1 - (Bocc_i / Aocc_i)] + Ppc_i = (Mc_i / Mt_i) * (1 - Ppc_i)$ (6)

From Equation (6)

$Ppc_i = (Mc_i / Mt_i) / [{ (Bocc_i / Aocc_i) / (1- Bocc_i / Aocc_i) + 1 } + Mc_i / Mt_i]$

WORKSHEET P-3

WORKSHEET P-4 ANNUAL FUEL SAVINGS AND EMISSION REDUCTIONS

Data Required: Worksheet P-1 VMT Reduction

Definitions:

Fratey	Average fuel consumption rate in gallons per 1,000 vehicle miles. See Table below.
CO_y	Average emission rate in tons per million vehicle miles. See Table below.
HC_y	Average emission rate in tons per million vehicle miles. See Table below.
NOX_y	Average emission rate in tons per million vehicle miles. See Table below.
$TOTAL_y$	Average emission rate in tons per million vehicle miles. See Table below.

1. Annual Fuel savings = _____ * _____ / 1,000 = _____ gallons
   $Frate_y$ VMT Reduction

2. Annual CO reduction = _____ * _____ / 1,000,000 = _____ tons
   CO_y VMT Reduction

3. Annual HC reduction = _____ * _____ / 1,000,000 = _____ tons
   HC_y VMT Reduction

4. Annual NOX reduction = _____ * _____ / 1,000,000 = _____ tons
   NOX_y VMT Reduction

System Average Fuel Consumption and Vehicle Emission Rates

Planning Year	Fuel Consumption (Gallons/1000 VMT)	Vehicle Emissions (tons/million VMT) CO	HC	NOX	Total
1985	48	39	5	4	48
1990	38	25	3	3	31
1995	36	18	2	3	23
2000	36	15	2	2	19
2005	36	15	2	2	19
2010	36	15	2	2	19

WORKSHEET P-4

WORKSHEET P-5 VALUE OF ACCIDENT REDUCTION

Data Required: Worksheet P-1

Definitions:

VMTi	Annual VMT reduction for lot type i, i=c, p, f, r, and A.
FATi	Fatalities per million vehicle miles of travel for lot type i, i=c, p, f, r, and A.
INJi	Injuries per million vehicle miles of travel for lot type i, i= c, p, f, r, and A.
PDOi	Property-Damage-Only accidents per million vehicle miles of travel for lot type i, i=c, p, f, r, and A.
c	Urban corridor lot notation.
p	Peripheral lot notation.
f	Urban fringe lot notation.
r	remote lot notation.
A	All park-and-ride lots.

1. Fatalities = (0.026 / FAT_c * _____ / VMT_c + 0.032 / FAT_p * _____ / VMT_p + 0.026 / FAT_f * _____ / VMT_f + 0.019 / FAT_r * _____ / VMT_r) / 1,000,000 = _____ / FAT_A

2. Injuries = (0.026 / INJ_c * _____ / VMT_c + 0.032 / INJ_p * _____ / VMT_p + 0.026 / INJ_f * _____ / VMT_f + 0.019 / INJ_r * _____ / VMT_r) / 1,000,000 = _____ / INJ_A

3. PDO Accidents = (0.026 / PDO_c * _____ / VMT_c + 0.032 / PDO_p * _____ / VMT_p + 0.026 / PDO_f * _____ / VMT_f + 0.019 / PDO_r * _____ / VMT_r) / 1,000,000 = _____ / PDO_A

4. Economic Value of Accident Reduction (annual dollar value) =

$220,000 * _____ / FAT_A + $9,300 * _____ / INJ_A + $2,000 * _____ / PDO_A = $_____

WORKSHEET P-5