Appendix A: Reasonable Cost Estimates for Implementing Accessible Over-the-Road Bus Service

The congressional debate on accessibility requirements for over-the-road buses (OTRBs) under the Americans with Disabilities Act (ADA) included conflicting cost estimates for implementing accessible OTRB service. Indeed, it was in large part the confusion over cost figures and the availability of accessibility technologies for OTRBs that prompted Congress to instruct the Office of Technology Assessment (OTA) to conduct this study.[1]

This appendix discusses the costs of implementing accessible OTRB service. OTA develops cost estimates first for equipping a single bus or station and then for an entire OTRB fleet (including allowances for the operator to choose which type of level-change device to implement, i.e., vehicle-based or station-based). Finally, the issues of borrowing funds and appropriate discounting over time are discussed. All cost estimates are based on 1992 data.

Costs of Implementing Accessibility Technologies for One OTRB

OTA classifies the costs of equipping one OTRB into three categories:

1. Capital costs (including the cost of the level-change device, any major repairs involving replacement parts that may be needed as the device ages, and modifications to the OTRB);
2. Maintenance (including routine cycling of the lift and maintenance checks); and
3. Lost revenue (possibly resulting from lost seating or baggage and package storage capacity).

OTA created a spreadsheet model in which these costs were calculated for a single OTRB (whether equipped for use with vehicle-based or station-based level-change devices). In this section, each of these costs will be discussed, as well as those not encompassed by the model. A range of values for the component costs is then presented, and total costs compiled for one OTRB.

Capital Costs

Level-change devices fall into two categories: 1) station-based level-change devices that serve multiple buses at one station, and 2) vehicle-based level-change devices that travel with the OTRB, generally in the luggage compartment or on the passenger deck. Retrofitting, the adaptation of an existing OTRB to

[1] The Committee report for the Americans with Disabilities Act states: "During its hearings on the legislation the Committee heard conflicting testimony on the cost and reliability of wheeled mobility aid lifts or other boarding assistance devices with regard to their use on over-the-road buses. Therefore, before mandating these or any other boarding options in the Act, a thorough study of the access needs of individuals with disabilities to these buses and the cost-effectiveness of different methods of providing such access is required by the Act. ' U.S. Congress, House Committee on Education and Labor, *Lezgislative History of PubIic Law 101-336, The American with Disabilities Act,* Committee Print, Serial No. 102-A, December 1990, p. 249.

make it accessible, is not required by the ADA, so throughout the cost modeling it is assumed that buses will be made accessible when they are purchased or leased (see ch. 1).[2]

For several reasons, ramps are not modeled as the primary level-change devices. First, in late 1992, the only ramp in production or development was designed prior to the passage of the ADA, by Greyhound, and is not likely to meet current ADA standards unless redesigned. Second, it is often difficult to install and use a station-based ramp, given the close proximity of OTRBs parked at stations; thus, the use of ramps may often be infeasible.

In addition to routine maintenance (discussed below), some lifts require overhauls that involve extensive replacement of parts. Such overhauls are much like the major repairs that many automobiles require halfway through their overall lifetimes (e.g., replacing major engine components). OTA considers these overhauls to be capital costs.

Associated with traveler-ready OTRBs (i.e., accessible OTRBs equipped for use with station-based level-change devices) is the use of ramps and boarding chairs in case of emergency. Although on-the-road OTRB breakdowns are not a regular occurrence, they are not uncommon. In this event, the U.S. Department of Transportation (DOT) may require that traveler-ready OTRBs carry a collapsible ramp and boarding chair in order to take persons with mobility impairments off the OTRB or to transfer them to a replacement OTRB. This ramp would not necessarily have to meet ADA requirements for ramps used as routine level-change devices, but it must be safe, reliable, and easy to use. Costs of such an emergency ramp were included in calculations where appropriate.

Whatever the level-change device, an OTRB itself must be fully accessible. These bus accessibility features include two wheeled mobility aid tie-downs (with folding seats for use when the tie-downs are not occupied), an additional door (or a wider main door with additional structural support), the means to communicate with people who have sensory and cognitive impairments, and movable arm rests. Some of the analyses also included accessible restrooms, which were considered an additional bus modification.

Maintenance

As with any mechanical device, station- and vehicle-based lifts require regular service and maintenance. In addition to repairs, this service includes cycling of the lift in order to keep it working properly and to keep operators familiar with its use. Because regular maintenance costs increase over time due to wear and tear on the equipment, OTA assumes that these costs will rise at a predictable rate.

The time required to cycle lifts poses a cost of lost time for drivers/lift operators. The calculations capture this cost through estimates of the time required to cycle the lift and hourly driver wages.

Forgone Revenue

The costs of forgone revenues fall into two categories: those from lost baggage capacity and those from lost seating. If a vehicle-based level-change device or an emergency ramp is carried in the baggage compartment, there will be a loss of baggage space. In some instances, this loss of baggage space could force the OTRB carrier to turn away potential package express customers (posing a cost of forgone revenue) or to make arrangements for baggage left behind, If a level-change device is carried on the passenger deck, or when the use of a wheeled mobility aid tie-down displaces seats, seating capacity is reduced. This reduction may lead to loss of revenue.

A technology under development would allow the vehicle-based lift to ride on the outside of the bus (see ch. 4). If this technology becomes available to OTRB operators, it will result in no loss of revenue due to lift storage.

Because station-based lifts incur no forgone revenue from displaced baggage and seating capacity, only the revenues gained or lost from tie-down usage bear consideration. While at first glance it may appear that station-based lifts are inappropriate for specific stations, OTRB operators might wish to project the costs of forgone revenue on the affected routes when developing their implementation strategy.

Package and Baggage Capacity-Some debate exists over the financial impact of lost baggage and package space. Most bus companies offer a range of package express services at various prices, from "next-bus-out" (literally the package goes out on the

[2] The model also does not include the costs of implementing accessibility technologies when a vehicle is remanufactured.

next bus to the destination-this is the most expensive service), to overnight delivery, to regular package delivery. Thus, among the package express services, there is some flexibility to accommodate full baggage compartments. Only with next-bus-out delivery would there be a problem with a full baggage compartment, and then only if there were no packages in the compartment that could be taken out (e.g., regular delivery packages) to make room for the next-bus-out package. In addition, it is common for bus companies to make arrangements for baggage that must be left behind when baggage compartments fill up, Thus, additional charges for baggage left behind due to the displacement of baggage capacity by a lift arise if the baggage left behind was only that displaced by the accessibility equipment. Otherwise, this baggage would simply be added to the rest of the baggage held over for transport by other means, presumably at a small incremental cost.

Seating Capacity-Seating loss occurs in two ways: 1) when wheeled mobility aid tie-downs are occupied (in early 1993, the only tie-down technologies available required that up to four standard seats be flipped up-and thus rendered unusable—when a wheeled mobility aid tie-down is occupied); and 2) when seats are permanently displaced by a lift stored on the passenger deck. However, there are questions as to how much the lost seating capacity actually translates into a loss of revenue for OTRB operators. The losses are not proportional. For example, there is no revenue loss at all unless an OTRB is nearly full and prospective passengers are denied seating. Even then the revenue from these prospective passengers might not be lost to the system, for they may opt to wait for the next bus. Other mitigating factors include:

- The behavior of OTRB travelers—in particular, the choice by a traveler, when faced with a full bus, whether to travel on another transportation mode (e.g., by train or airplane), to ride at all, or to wait for the next OTRB. Most passengers choose OTRB travel for economic reasons, not for reasons of convenience or comfort (see ch, 2), and it is unlikely that they would choose to travel by another transportation mode. However, it is difficult to quantify how many people may wish to cancel a trip; it is expected that at least some individuals will wait for the next bus, with no loss in revenue to the OTRB operator. Indeed, some may have no choice if they are at a connecting station or awaiting a trip home. If a reservation system were in place, travelers would know in advance when to show up and, as with airline travel, would make accommodations for OTRB schedules. Therefore, taking into account the potential behavior of OTRB travelers reduces the impact of lost seating due to accessibility technologies.
- The provision by the bus company of a second OTRB. Several bus companies claim that if a bus fills up and many people still wish to travel, at that time a second bus will pull up. Thus, if the accessibility features of an OTRB cause the loss of two to eight seats, but *more than that number* were denied access to the first OTRB, a second bus would be needed to accommodate them all in any case.

Therefore, without knowledge of the frequency of a "full bus,' the number of passengers turned away, and how many of these potential passengers choose to go home or to travel on another transportation mode rather than wait for the next bus, it is virtually impossible to calculate accurately the loss of revenue due to lost seating capacity.[3]

However, under most conditions, wheeled mobility aid tie-downs increase the revenue of OTRB operators. Tie-downs serve passengers previously unable to use the OTRB system, and every time the tie-down is used it generates passenger revenue. (When a tie-down is not in use, it displaces no seats and thus no revenue is lost). Only when the bus is full will the displaced seating result in lost revenue. For example, if the tie-down is used 10 times in a year, it will generate 10 fares, Assuming that the bus is full to capacity 10 percent of the time, lost seating will occur on average during only 1 of the 10 tie-down uses. In that case, up to 4 fares will be displaced, leaving at least 6 fares gained by the 10 uses of the tie-down.

Additional Factors-Several additional observations can be made about package and seating displacement:

- On routes where OTRBs travel frequently, it is more likely that the next bus *will be* able to accommodate much of the spillover from a full

[3] OTA attempted to gather such information from several bus companies, but it was not available.

bus, in baggage, package, and seating capacity, Under these conditions, OTRB operators may develop methods to cope with the problems raised by a full bus.

- On routes where OTRBs travel infrequently, it is much less likely that the bus will be full, due to low ridership at these stations. However, if the bus is full, it will be more difficult for OTRB operators to encourage passengers to use the next bus, or to accommodate baggage and packages that must be left behind,

Therefore, on routes that are served by a number of buses, OTRB operators may minimize forgone revenue costs through additional planning and operational methods. However, OTRB operators on routes with a small number of buses traveling in a given day may have less of a chance of those buses being full; if they are, these carriers may have less flexibility to accommodate for lost baggage and package space and lost seating capacity.

Costs Not Included in the Model

This analysis excludes many costs of implementing accessibility technologies on OTRBs. They include training costs; additional fuel charges; costs due to changes in travel times to accommodate lift uses; insurance costs; and loss of passengers sensitive to price, time, and/or crowding.

Training of company personnel is an important feature in the implementation of any accessibility technology. However, private entities operating fixed-route service with any type of vehicle are currently required by the ADA to train personnel to proficiency in how to treat individuals with disabilities with dignity, respecting differences among such persons. These firms will incur training costs irrespective of any changes in the implementation of accessibility technologies, so this analysis includes no training costs. In fact, in the future, when level-change devices are provided for every OTRB, training need no longer consider in such great detail how to carry persons with disabilities up and down OTRB stairs and into seats. Therefore, once DOT regulations are fully implemented, it may be less expensive to train company personnel.

Because level-change devices weigh up to 600 pounds, they decrease the fuel efficiency of an OTRB. In addition, increased idling time to operate a vehicle-based lift may contribute to higher fuel expenditures. OTA found additional fuel costs impossible to quantify, but expects them to be negligible over the lifetime of the OTRB when compared with other costs included in the model.

Scheduling changes or extra time maybe necessary to allow deployment of level-change devices at stations, as well as to add stops at accessible restrooms. While the costs of minor extensions of route times are not expected to be large, they are unquantifiable, and will remain so even as accessibility technologies are introduced.

The costs of insurance rate adjustments will become known as accessibility technologies are introduced, but they are impossible to predict. The implementation of technologies to assist persons with sensory, cognitive, and mobility impairments that do not require the use of a wheeled mobility aid are expected to affect insurance rates very little. Indeed, since most insurance claims are due to falls down the front steps, a lower initial step and additional handrails could decrease the likelihood of claims.

The implementation of technologies for persons who need assistance while boarding an OTRB may affect insurance rates more significantly. However, since carrying is most certainly more dangerous to all parties involved than is the operation of a lift or ramp, it could be reasoned that the introduction of lifts and ramps should not affect rates dramatically.[4] Nevertheless, because it is likely that more persons with disabilities will be riding OTRBs as they become more accessible and because the safety and effectiveness of new technologies must be gauged, insurers may increase their rates for some time until there is more experience with new technologies (see ch. 2). Until then, it is impossible to forecast accurately the additional insurance costs for accessible OTRBs. Therefore, OTA does not include these costs in its

[4] Carrying has been the primary method for persons with severe mobility impairments to board an OTRB. Since OTRB ridership by persons who use wheeled mobility aids is not expected to increase until the introduction of level-change devices and securement positions, the passage of the ADA and the interim regulations for OTRB accessibility have not yet caused a fluctuation in the insurance rates for OTRBs. Jack Burkert, senior vice president, Lancer Insurance Co., Arlington, VA, personal communication% May 1992.

analyses, but notes that they may be significant for some companies, especially in the short term.

OTRB service, especially intercity service, is a low-cost option for public transportation, and OTRB passengers are in general very sensitive to price increases. If the cost of accessibility technologies results in higher fares, then overall ridership might be affected. In particular, while there may be an increase in ridership by passengers with disabilities, there may also be a decrease in the present cohort of riders if passengers decide not to take the bus due to increasing fares. It is difficult to judge how these two factors will affect overall ridership, since the estimates of the number of passengers with disabilities are only ball-park figures, and the potential for price increases at various levels and the effect of such increases on ridership are unknown.[5] At the end of this appendix, this effect is discussed further.

Finally, as persons with disabilities ride on more OTRBs, some OTRBs may be more crowded, and boarding times may increase. A result of the increased load factor and the possible lengthening of some trips could be that some passengers would view the OTRB system as a less desirable form of transport and choose other forms of transportation. While OTA recognizes that this is a potential effect of increased accessibility, this effect is impossible to quantify with available data and OTA does not include it in its analysis.

Cost Data for Fixed-Route Service

Discussed below are each of the items of data in the cost model, their source(s), and, where appropriate, the reason they are incorporated in the model. The figures stated represent 1992 cost values and, in a few cases, a range of values is presented. (For more discussion of the specific technologies mentioned below, see ch. 4.)[6] For some of the variables, no data exist and OTA had to estimate values based on reasonable assumptions.

- **Capital costs of a vehicle-based lift. The Ricon** Mirage lift, used in OTRBs in Great Britain, is available in the United States for $7,000. More expensive lifts cost up to $17,000 (e.g., the Lift-U III or the MCI 4-Link lift). An intermediate-priced lift is the Stewart and Stevenson Powerlift, costing $8,500 to $12,500. All lifts evaluated by OTA vary in the number of seats and amount of baggage space displaced.[7]

  Although all vehicle-based lifts evaluated by OTA could potentially meet ADA standards, it is conceivable that an OTRB buyer would prefer to purchase one of the more costly lifts for reasons not of function, but as a result of placing a different weight on operational or other factors. Thus, OTA does not always assume that OTRB buyers would choose the least expensive lift option.
- Capital costs of a station-based lift. Adaptive Engineering, Inc., estimates the cost of a station-based lift at $4,500. Adaptive Engineering makes a station-based lift for use with trains and is modifying that lift for use with OTRBs.[8] It was assumed that no maintenance overhaul on the lift is necessary.[9]
- Incremental **cost for outfitting a bus with nonlift accessibility features.** OTA assumed the cost of purchasing a bus with two wheeled mobility aid tie-downs, an additional door (or a wider main door, wide enough to accommodate a person using a wheelchair, scooter, walker, or crutches), the means to communicate with persons who have sensory and cognitive impairments, and movable arm rests, at $5,000 to $7,000

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[5] OTA has found two studies that estimated the demand elasticity in OTRB travel: Don H. Pickrell, "Appendix B, Models of Intercity Travel Demand," *Deregulation and the Future of Intercity Passenger Travel,* John R. Meyer and Clinton V. Oster, Jr. (eds.) (Cambridge, MA: MIT Press, 1987), pp. 257-9; and Michael W. Babcock and H. Wade German, "A Model of the Demand Elasticity for Intercity Bus Travel," *Proceedings-Twenty-Fifth Annual Meeting of the Transportation Research Forum,* Transportation Research Board (cd.), vol. 25, No. 1, 1984, pp. 187-193. However, both studies were based on data from the mid-1980s, and circumstances in the OTRB intercity industry have changed since that time, especially with respect to numbers of points and passengers served and price structures.

[6] All cost data, unless explicitly stated otherwise, are from Econometrics, Inc., "Evaluation of Methods to Provide Accessibility to Over-the-Road Buses and Services,' OTA contractor report, July 31, 1992.

[7] As of early 1993, Neoplan offered an OTRB with a vehicle-based lift as a standard feature. As ADA regulations go into effect, more companies might include lifts as standard features.

[8] As of late 1992, this is the only station-based lift to come to the attention of OTA.

[9] Adaptive Engineering, Inc., claims that no overhauls will be necessary for the lift over its lifetime.

(above that of a conventional OTRB). As discussed above, this cost is not for retrofitting an OTRB, but rather the additional cost to purchase a new bus that is accessible, with either station-based or vehicle-based level-change devices.[10]

- Incremental **cost for a vehicle-based lift stored externally. In** late 1992, a device to externally store a vehicle-based lift was in the preliminary stages of development by Adaptive Engineering, Inc. The best estimate of the incremental cost to house the lift on the exterior of the bus was $1,000. **The** use of an external lift storage device would eliminate baggage or seat loss generated by stowage of the lift. However, several problems are yet to be addressed by this proposed technology, including protection of the lift from extremes of heat and cold, and from dirt and dust accumulation. Such protection might increase the cost of the housing, but no estimates are available.
- **Cost of a vehicle-based emergency ramp and boarding chair.** As discussed above, DOT may require all OTRBs without a vehicle-based lift to carry an emergency ramp. Best Diversified Products sells its ramp for $750 and a boarding chair for $550.
- Cost of an accessible restroom. In late 1992, two accessible restrooms were in production or development: one produced by Neoplan that costs $2,000 in additional bus modifications and permanently displaces three seats; and a prototype made by MCI for a 45-foot coach that is estimated to cost $30,000 in additional bus modifications and permanently displaces seven seats (note that no additional seats are lost due to tie-down occupancy with the MCI restroom). These costs are in addition to lift costs and the costs of other vehicle modifications.
- Rate of maintenance cost increases **per annum.** As lift equipment ages, it is assumed that maintenance costs will rise due to parts wearing out and so forth. From industry and government estimates, OTA derived a rate of 2 percent.[11]
- **Maintenance costs for a bus-based lift in the first year of its operation. This** figure provides the basis from which annual repair costs are calculated. Estimates were derived from pilot project, government, and industry data.[12] The model assumes that the less expensive lifts (e.g., the Stewart and Stevenson and the Ricon Mirage lifts) have $100 first-year repair costs, However, it is assumed that the expensive lift, costing $17,000, has first-year repair costs of $150.
- **Repair costs for a station-based lift in the first year of its operation.** This figure is the analog to the associated figure for vehicle-based lifts. The model assumes a $85 first-year repair cost for the $4,500 lift.
- Life of lifts until an overhaul is needed. As discussed above, it is expected that some lifts will have to undergo an extensive overhaul in order to extend their operating life. The model assumes that the lift can be overhauled once before it must be permanently retired and that the overhaul takes place halfway through the expected lifetime of the equipment. It is further assumed that annual maintenance costs follow the same pattern after the overhaul as they do following the purchase of a new lift. For the manual Stewart and Stevenson lift, available information indicates that no overhauls are necessary. However, for the other vehicle-based lifts, overhaul costs were incorporated into the model.
- Overhaul **costs for station-based and vehicle-based lifts. The** model assumes overhaul costs, when existent, to be one-half of the current cost of a lift excluding vehicle modifications. Due to technological improvement (at 1.5 percent per year above inflation, from historical lift prices), the price of the lifts will fall overtime. Therefore, the cost to overhaul one lift will be less than one-half of its purchase price 10 years earlier.
- **Cost of** OTRB shipping of packages. This figure provides the basis for calculating the cost of lost revenues due to displaced baggage and

10 The costs of retrofitting an existing OTRB are quite similar, however. Bill Hodgson, sales representative, Stewart and Stevenson Power, Inc., Commerce City, CO, personal communication, August 1992.

11 Brian Guthrie, partner, Science and Technology Division, Hickling Corp., Ottawa, Ontario, Canada, personal communication, Sept. 10, 1992.

12 For example, the Denver Regional Transit District reports that its Stewart and Stevenson lifts have each required less than $100 in annual maintenance since they have been in operation.

packages. From available bus parcel industry data, OTA derives a cost per-mile per-100-pounds shipped of 7.5 cents. The model assumes that a vehicle-based lift is comparable to a package of 500 pounds and that the emergency ramp and boarding chair are a package of 200 pounds. The Ricon Mirage and Lift-U III lifts are stored in the baggage compartment and thus may displace luggage and packages. However, the Stewart and Stevenson lift is stowed on the passenger deck and therefore does not occupy baggage space, although it will permanently displace two passenger seats. In addition, a probability estimate was added to the calculations, representing the frequency of an overcapacity baggage compartment.

- **Frequency of an overcapacity y baggage compartment. No** data are available on how frequently baggage compartments are full. Assuming that, if baggage compartments are filled, arrangements are made to transport excess baggage, OTA hypothesizes that the frequency of a full baggage compartment where such arrangements are not already being made is roughly 1 percent.[13]
- **Cost of a passenger ticket (no advance purchase). This figure** provides the basis for estimating the cost of forgone revenue from lost seating when a wheeled mobility aid tie-down is occupied or when seats are permanently displaced. From industry passenger ticket information, the cost per-mile per seat is $0.085. The model assumed a joint probability estimate of when a wheeled mobility aid tie-down will be used and the bus is full. Only then may a passenger have to be turned away and the cost of forgone revenue be incurred.
- **Frequency of a full OTRB.** Assuming full capacity on Friday nights, Sundays, and close to holidays, OTA estimated the frequency of a full OTRB at 10 percent.
- **Frequency of a wheeled mobility aid tie-down being occupied.** OTA assumes the frequency of a tie-down being occupied is 5 percent. This figure is derived from estimates of the rate at which persons using wheeled mobility aids will ride OTRBs (0.5 percent, see ch. 3) and of the average occupancy of an OTRB (10 to 15 people).
- **Frequency that a passenger will decide to cancel an OTRB trip when faced with a full bus.** As discussed above, there are few data with which to address this point. OTA assumes that one-third of the passengers will decide to cancel their trips rather than wait for the next bus.
- Time **per week to cycle lift.** It is suggested by manufacturers that the lifts be cycled on a regular schedule, on average, once per week. Under normal conditions, it takes 10 minutes to cycle a lift. The time spent by drivers/operators cycling the lift represents a cost to the industry.
- Hourly **wage for bus drivers. This** figure is used to calculate the implicit cost of cycling lifts. Based on estimates by industry experts, the average hourly wage for drivers is $14.00.
- **Life of OTRBs.** Based on industry experience and forecasts, OTRB manufacturers predict that new OTRBs will operate for 20 or more years. Although OTRB operators may sell their equipment earlier, it is expected that they will recoup the current value of the level-change device in the sale. While OTA recognizes that the resale market may not value the lift at its full worth, it is impossible to predict the value that will be placed on it. In addition, some purchasers of used OTRBs, such as charter and tour companies, will require level-change devices.
- Life **of station-based and vehicle-based lifts.** From industry experience and forecasts, the expected lifetime for various lifts is 20 or more years.
- Number of miles traveled by an OTRB **per year.** Most OTRBs are expected to travel at least 1.5 million miles during their lifetimes. Over 20 years, this translates into 75,000 miles per year.

Results for OTRBs in Fixed-Route Service

The model took into account all of the data discussed above and calculated the total cost over the next 20 years of one accessible OTRB. Several scenarios were used. (See table A-1 for a summary of the results.) One scenario assumed a lift similar to the

[13] Baggage also can be stored in the passenger compartment, providing further flexibility to OTRB carriers in dealing with a full baggage compartment.

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Table A-l—Reasonable Estimates of Cost Outlays for Implementing Various Accessibility Devices and Accessible Restroom Options on an OTRB [a]

	Low-cost traveler-complete OTRB	Medium-cost traveler-complete OTRB	Traveler-complete OTRB with externally mounted lift	High-cost traveler-complete OTRB	Traveler-ready OTRB and lift[b]	Low-cost accessible rest room with lift	High-cost accessible restroom with lift
Lift	$7,000	$10,000	$11,000	$17,000	$6,700	$7,000	$10,000
Vehicle modifications	5,000	5,000	5,000	5,000	5,000	7,000	35,000
Overhaul	3,000	0	0	7,300	0	3,000	0
Maintenance	4,600	4,900	4,900	5,700	2,700	4,600	4,900
Forgone revenue due to lost baggage	5,600	0	0	5,600	2,200	5,600	0
Revenue lessor (gain) due to seating changes	(5,500)	3,000	(5,500)	(5,500)	(5,500)	7,200	24,000
Total	$19,700	$22,900	$15,400	$35,100	$11,100	$34,400	$73,900
Cents per mile	1.3	1.5	1.0	2.3	0.73	2.3	4.9

NOTE: This table does not include the cost of an emergency ramp unless noted otherwise.

[a] See text.

[b] This figure represents 1.2 of the price of a station-based lift (see text) and the cost of an emergency ramp and chair.

SOURCE: Office of Technology Assessment, 1993.

Ricon Mirage vehicle-based lift with a $7,000 capital cost, $5,000 bus modification cost, $100 first-year maintenance cost, overhaul costs, and some baggage displacement (no seats are displaced by the lift itself). All other figures were assumed to be the values presented above. The additional capital and operating costs of this OTRB are on average $20,000 more over 20 years, which translates to 1.3 cents per bus-mile. As with all of the scenarios, if the bus modification costs were $7,000, the cost per mile would increase by 0.13 cents. (Note that none of the figures quoted in this section are discounted. Discounting is discussed below.)

A second scenario assumed a lift similar to the Stewart and Stevenson lift, which requires $10,000 in initial capital costs, $5,000 in bus modification costs, $100 first-year maintenance costs, no overhaul costs, and two permanently displaced seats. It costs on average $23,000 more over 20 years for the additional capital and operating costs for this OTRB, which translates to 1.5 cents per bus-mile.

A third scenario assumed an intermediate price lift that is mounted externally, which incurs a $10,000 initial capital cost for the lift, plus $1,000 to mount the lift externally, $100 first-year maintenance costs, no overhaul costs, and no seats permanently displaced. It costs on average $15,000 more over 20 years for the additional capital and operating costs for this OTRB, which translates to 1.0 cents per bus-mile.

A fourth scenario assumed an expensive vehicle-based lift requiring $17,000 in initial capital costs, $150 first-year maintenance costs, overhaul costs, and baggage displacement. It costs on average $35,000 more over 20 years for the additional capital and operating costs for this OTRB, which translates to 2.3 cents per bus-mile.

A fifth scenario assumed an inexpensive, $4,500 station-based lift with $85 first-year maintenance costs and no overhaul costs. Since it is recommended in chapter 1 that DOT require OTRB operators to employ traveler-ready OTRBs only when all route stops are equipped with station-based level-change devices, OTA has calculated the average number of stations that must be equipped with station-based level-change devices per bus in OTRB fixed-route service. Assuming 5,000 buses in the total pool of vehicles used to provide fixed-route service and 6,000 freed-route stops, the average number of stations that must be equipped per bus is 1.2. (Scenarios with both station-based and vehicle-based level-change devices are discussed below in the presentation of the systemwide calculation s.) It costs on average $11,100 moreover 20 years to operate this OTRB, which translates to 0.7 cents per bus-mile. An emergency ramp is included in the price (which accounts for an overall cost per bus-mile of 0.1 cents) .14

A sixth scenario assumed the installation of an accessible restroom similar to the Neoplan restroom ($2,000, three seats displaced) with a lift similar to the Ricon Mirage Mt. It costs on average $34,000 more over 20 years to operate this OTRB, which translates to 2.3 cents per bus-mile. These figures can be compared to those for the Ricon Mirage lift alone at 1.3 cents per mile.

A seventh scenario assumed the installation of an accessible restroom similar to the MCI restroom ($30,000, seven seats displaced) with a lift similar to the Stewart and Stevenson lift.[15] It costs on average $74,000 more over 20 years to operate this OTRB, which translates to 4.9 cents per bus-mile. These figures cart be compared to those for the Stewart and Stevenson lift alone at 1.5 cents per mile.

Thus, in summary, the additional costs to purchase and operate a traveler-complete OTRB (i.e., an accessible OTRB with a vehicle-based lift) are generally 1.3 to 2.3 cents per bus-mile (and might go down to 1.0 cents per mile if the externally mounted lift becomes available), while additional costs for a traveler-ready OTRB and a proportional number of station-based lifts (with emergency ramps) are 0.6 cents per bus-mile, Accessible restrooms increase the costs by 1.0 to 3.4 cents per bus-mile.

Results for OTRBs in Charter and Tour Service

For charter and tour service, the demand for accessible service determines the number of accessible OTRBs required. However, even with the demand figures for accessible charter and tour service derived in chapter 3, the resulting requirements for OTRB purchases are impossible to gauge since the impacts on a specific company are dependent on local demand. In addition, very little operational data exist for charter and tour companies.

If a charter and tour company purchases a new bus with a vehicle-based lift and an accessible Neoplan restroom, the additional cost over the 20 year lifetime of the bus might run $17,000 for capital expenditures, and $4,600 for maintenance costs. Since this bus can be expected to run an average of 1.5 million miles over its 20 year lifetime, the cost per bus-mile would be 1.4 cents per mile.

However, this figure does not include costs due to forgone revenue. Due to the complexity of charter and tour pricing schemes, OTA is unable to place a value on lost seating and baggage capacity. Thus, it is impossible to calculate the costs due to revenue losses. However, they are expected to be greater per bus than for fixed-route companies, since charter and tour companies operate OTRBs at capacity for a higher percentage of the time than do freed-route operators.

Sensitivity y Analysis

In order to determine the sensitivity of these costs to changes in the model variables, a sensitivity analysis was performed. This procedure consisted of changing each variable over a range of values and examining the effect on total costs. From two base models (the first and fifth scenarios above, i.e., the Ricon Mirage lift and the low-cost station-based lift), only one variable was changed at a time; all other variables were held constant. The range for each variable was determined on a case-by-case basis. No attempt was made to rank the variables in order of the effect on the total cost calculations of varying each one. Rather, variable ranges were chosen to illustrate the potential effects on total cost of changing the input variables, The results are summarized in table A-2.

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14 Another scenario assumed an expensive, $7,)() station-based lift with $120 first-year maintenance costs, and overhaul costs of one-half the current price. (Note that no such station-based level-change device is currently in development.) The ratio of stations to OTRBs is assumed to be the same as above. Thus, it costs on average $14,000 (undiscounted, see below) moreover 20 years to operate this OTRB, which translates to 0.9 cents per bus-mile. Again, an emergency ramp adds $1,300 to the price in the first year, which increases the per bus-mile cost by 0.1 cents.

15 MCI plans to produce its 45-foot accessible coach with an accessible restroom and an option for a Stewart and Stevenson Powerlift. Norman Littler, coordinator, Regulatory Relations, MCI, Ltd., Winnipeg, Manitoba, Canada, personal communication, August 1992.

Table A-2—Sensitivity Analysis[a]

Variable	Range of variable	Variation In total costs
Cost of a bus-based lift	$7,000-17,000	Up to 70 percent
Frequency of a package encountering a full baggage compartment	0.5-2.0 percent	Up to 50 percent
Cost of a passenger ticket (no advance purchase)	$0.06-0.11	15-50 percent
Incremental cost for outfitting bus with non lift accessibility features	$5,000-7,000	10-40 percent
Time per week to cycle lift	5-15 minutes	14-35 percent
Cost of a station-based lift	$4,500-7,000	Up to 30 percent
Maintenance cost for a station-based lift in the first year of its operation	$50-120	Up to 23 percent
Cost of package shipping	$0.05-0.10 per-mile per 100 pounds	Up to 20 percent
Frequency of a tie-down being occupied and potential passengers being turned away	0.1-0.2 percent	2-11 percent
Rate of maintenance cost for a bus-based lift in the first year of its operation	$100-150	Up to 5 percent

a See text for a description of the sensitivity analysis.

SOURCE: Office of Technology Assessment, 1993.

Costs of Implementing Accessibility Technologies for a Fixed= Route OTRB Fleet

The results presented above for one accessible bus can be used to infer the implementation costs of a completely accessible OTRB fleet. OTRB operators will purchase accessible OTRBs when the need arises and funds are available. Thus, buses will be phased in over time as other buses are retired. Before the fleet is fully accessible, the additional cost per bus-mile for the entire fleet of buses will be less than that for one accessible bus. As more of the fleet becomes accessible, the additional cost per bus-mile for the entire fleet will approach the figures cited above.

However, under the proposed accessibility requirements presented in chapter 1, OTRB operators can choose to purchase traveler-ready or traveler-complete OTRBs (or some combination). Their choice will depend on the nature of their OTRB system. For example, operators in urbanized areas with many express buses (such as in the Northeast Corridor) will benefit more from station-based technologies than will operators in rural areas with many small stops. To model the effect of this choice, OTA performed case studies of two States and one U.S. region: 1) the rural State of Montana; 2) the both urban and rural State of Alabama; and 3) the largely urban region of Connecticut, Massachusetts, and Rhode Island. OTA examined the implementation of accessibility at a statewide level, because data on individual companies are scarce. However, analysis using statewide data illustrates the important factors that individual bus company owners must consider when complying with future OTRB regulations.

As a result of the freedom of OTRB operators to design their own implementation schemes, countless scenarios could develop. However, OTRB owners will attempt to minimize their overall costs. As a result, station-based lifts will most likely be placed in stations with frequent stops by many OTRBs, and vehicle-based lifts will be carried on OTRBs that make many stops at places with limited service. In order to keep the size of the model manageable, OTA selected three potential schemes for analysis:

1. Use of station-based lifts at all stations and no vehicle-based lifts. OTA recognizes that this scheme is unrealistic because not every stop can be outfitted with a station-based lift. However, it was included as a reference point for judging other schemes.
2, Use of vehicle-based lifts on all OTRBs and no station-based lifts.
3. Use of station-based lifts in stations with 10 or more OTRB stops daily (large stations), and vehicle-based lifts on OTRBs that make at least

one stop at a smaller station. Clearly, the fulcrum of the choice, here 10 stops daily, is a decision that will be made by providers based on prices and individual preferences.

When the specific results of the model are discussed, these three schemes are referred to as "all traveler-ready OTRBs, ' ' all traveler-complete OTRBs," and ' 'mixed.

Three additional factors must be added to the calculations to model the phase-in of accessible service for the case study areas. First, although OTA recognizes that industry replacement patterns vary, for the purposes of these calculations OTA assumes that OTRBs are purchased on a regular schedule, i.e., the same number of buses per year. For example, if the case study area uses 100 OTRBs, 5 will be purchased each year for 20 years (and thereafter).

Second, as with any product involving research and development (R&D) in its production, OTRB lifts will presumably fall in price as production increases (and R&D costs are recouped) and the technology becomes more efficient. Some technology development has already occurred, especially in response to public sector demand. From an analysis of historical lift prices (adjusted for inflation) during transit lift development, OTA assumes a conservative 1.5 percent rate of technological improvement.

Finally, these calculations assume that operators purchase accessibility technologies without borrowing funds and that profit in any given year is either reinvested in the firm (through capital expenditure), paid out as dividends to stockholders, or used to reduce financial liabilities. In other words, profits are not invested in interest-bearing holdings. Below, this assumption is revisited. Furthermore, since the cost model spans more than 20 years, and several schemes are investigated, it is necessary to include discount costs in order to form a basis of comparison. At this point, however, the discount rate is ignored, and only cash outlays are investigated.

Results of the Case Studies

Within the State of Montana, in late 1991, an estimated 39 OTRBs traveled daily among 109 stations. Only three of these stations had over 10 stops daily-at Billings, Butte, and Missoula. No OTRBs traveled among these stations exclusively.

The results of two runs of the cost model are presented here for the Montana case study. The first presents a lower bound on costs for implementing accessible service, and it includes Ricon Mirage lifts as the vehicle-based lift option with $4,500 station-based lifts. (No emergency ramps were assumed and all figures are not discounted.) The costs for this run are $760,000 over the first 20 years for the all traveler-ready OTRB scheme, $540,000 for the mixed scheme, and $520,000 for the all traveler-complete OTRB scheme.

The second run presents an upper bound on costs, and it includes the expensive vehicle-based lift option (which displaces baggage capacity), with $7,000 station-based lifts and with emergency ramps required. The all traveler-ready OTRB scheme totals $1.2 million over the first 20 years, the mixed scheme amounts to $990,000, and the traveler-complete OTRB scheme totals $970,000.

Within the State of Alabama, in late 1991, approximately 105 OTRBs traveled daily among 124 stations. Twenty-four of these stations had at least 10 stops daily; they included stops at the cities of Birmingham, Montgomery, and Mobile, but also stops in smaller towns with high fixed-route ridership or that served as transfer locations. Thirty-one OTRBs traveled only among the large stations, and 74 of the OTRBs made at least one stop daily at a smaller station.

As with the Montana case study, two runs are presented. The first lower bound scenario results in costs for the all traveler-ready OTRB scheme for the entire State of Alabama over 20 years of $1.0 million. The mixed scheme amounts to $1.4 million, and the entirely traveler-complete OTRB scheme totals $1.6 million over 20 years.

The second run presents an upper bound on costs. The all traveler-ready OTRB scheme totals $1.8 million over 20 years, the mixed scheme amounts to slightly less than $2.5 million, and the traveler-complete OTRB scheme totals $2.7 million.

Within the tri-State area of Connecticut, Rhode Island, and Massachusetts, in late 1991, approximately 419 OTRBs traveled daily among 170 stations. Of these stations, 117 had at least 10 stops daily; 331 OTRBs traveled only among these stations, and 88 of the OTRBs made at least one stop daily at a smaller station.

As with the two previous case studies, two scenarios were developed using the cost model. The first, less expensive scenario results in costs of the all traveler-ready OTRB scheme for the entire tri-State area over

20 years of $2.1 million, the mixed scenario amounts to $2.9 million, and the entirely traveler-complete OTRB scenario totals **$6.3 million over 20 years.**

The second run presents an upper bound on costs, and it includes the expensive vehicle-based lift option (which displaces baggage capacity), with $7,000 station-based lifts and with emergency ramps required. The all traveler-ready OTRB scheme totals $4.3 million for the entire tri-State area over 20 years, the mixed scheme amounts to $5.7 million, and the traveler-complete scheme totals $12 million.

Thus, OTA **finds that operator choice in where to place traveler-ready and traveler-complete vehicles is an important factor in minimizing costs.** By analyzing their route structure to determine which scenario is most cost-effective, operators can lessen their total costs.

Although the all traveler-ready OTRB scheme was least costly in some of the above calculations, there are significant disadvantages to the all traveler-ready OTRB scheme relative to the other two. Most notably, some stations (e.g., Moose's Sport Shop in Camden, Alabama) may lack the facilities to house station-based lifts; where lift housing is possible, OTRB providers may have to pay ''rent' to the station property owner. In addition, some station-based lifts are costly to remove from a station in the event that an OTRB stop is to be dropped from the system or to be converted into a stop that is served by OTRBs with vehicle-based lifts. Conversely, a vehicle-based lift is a variable cost since it can be transported from station to station. These costs of flexibility are difficult to quantify and therefore are not included in the model. However, OTA feels that these costs are significant and should be considered when interpreting the results. Indeed, OTA **finds it will often be impossible to outfit all stations with station-based accessibility technologies, due to space and other considerations. Thus, in some cases, although outfitting all stations with station-based lifts or ramps may be the least costly on paper, it may not be feasible or preferable.**

Restrooms

If an OTRB is not equipped with an accessible restroom that can be used by all persons aboard the bus without any aid that is not normally used in their daily lives, then the OTRB may make frequent stops (e.g., every 1 1/2 to 2 hours) to allow persons with disabilities aboard the bus to use accessible restroom facilities. Although it is impossible to compare the costs of providing an accessible restroom to adding stops along a route, some data from the case studies may be useful to explore the issue of restroom accessibility.

In Alabama, among all the routes that are run in a given day, an estimated 59 intervals between stops are longer than 1 1/2 hours, 49 are longer than 2 hours, only 3 are longer than 3 hours, and none are longer than 4 hours. In all cases, additional stops could be made at stations that are already used by the bus company. As of September 1991, slightly under 800 stops were made daily in Alabama. For comparison, at most 50 buses must be equipped with accessible restrooms to ensure that all routes with intervals longer than 1 1/2 hours between stops provide accessible restroom service en route, and at most 40 buses must be equipped to ensure that all routes with stops longer than 2 hours apart provide accessible restroom service en route.

Similarly for the other two case study areas:

- Daily in the State of Montana, at most 8 buses (out of 39) travel more than 1 1/2 hours between stops; 8 additional stops at existing stations would be necessary to fill the gaps. At most five buses travel longer than 2 hours between stops; five additional stops at existing stations would be needed to fill the gaps.
- In the tri-State region, at most 159 buses (out of 419) travel daily between two stops longer than 1 1/2 hours apart; 201 additional stops at existing stations would be needed to fill the gaps. (On Sundays, two more buses travel between stops that are longer than 1 1/2 hours apart; two additional stops would be required to shorten the length between the stops.) For an interval of 2 hours, at most 96 buses travel between stations and would require a total of 96 additional stops (at existing stations) to fill the gap.

Including the Cost of Money and Discount Rates

The term "the cost of money" is used to refer to the monetary value placed on resources expended or forgone when borrowing/lending money. Specifically, this discussion will investigate factors affecting the real cost (including opportunity costs) to OTRB operators in creating an accessible OTRB system as directed by DOT regulations stemming from the ADA.

It is necessary to make several explicit assumptions before beginning theoretical and practical analysis of the cost of money. Although some of these assumptions are clearly not founded in reality, they will be employed for the time being and then relaxed later in the discussion,

- Transaction costs, particularly of borrowing, are negligible.
- Capital markets are perfect, i.e., borrowing and lending occur at the same rate. For the time being, a (risk-free) rate of 10 percent is assumed. Therefore, discounting will occur at a rate of 10 percent,
- The tax burden is the same regardless of the financial method(s) used to purchase the accessibility technologies.
- There exists no return to capital (for the OTRB operator) on the purchased accessibility technologies.
- All methods of raising funds---g.,., bonds, bank borrowing, equity-result in the same ends for the OTRB operator (the borrower). For ease of discussion, it is assumed that coupon bonds are the method used.

Borrowing v. Funds On Hand

In previous cost estimates, it was assumed that OTRB operators have the financial ability to purchase accessibility devices as they are needed-that no borrowing is necessary. Now the scenario is investigated where OTRB operators have only enough funds to pay for operating expenses on the new accessibility devices. All funds needed for capital expenses (accessibility technology purchase and overhaul) must be obtained with 10-year debt in the form of coupon bonds.

Regardless of the method used to finance the purchase of a good (in this case, a capital good), the true cost to the firm is the same. The word “true” is highlighted in order to emphasize the inclusion of opportunity costs in this analysis. In any economic analysis, it is necessary to include all implicit costs of forgone earnings-referred to as opportunity costs. In addition, the term “firm” is emphasized since this analysis looks only at costs to the firm, therefore ignoring social costs and implications beyond the immediate impacts on the firm. For example, the discussion disregards the facts that: 1) borrowing by the firm (the OTRB operator) may crowd out other firms from the borrowing market (a cost incurred outside of the firm); and 2) borrowing may increase the return demanded by the market for additional borrowing by the firm.

Under the above assumptions, the true cost of a good is the same regardless of the method used to purchase it. For example, suppose that DOT has mandated an OTRB operator to purchase a level-change device, a capital good. This hypothetical level-change device costs $100, earns no return to capital, and depreciates fully in 1 year. The OTRB operator can borrow funds for 1 year at a rate of 10 percent. Through the concept of opportunity cost, the true cost to the OTRB operator of purchasing this accessibility technology is the potential value of the funds used for the purchase-i. e., what the funds could have been worth if invested in the most profitable option available.[16]

Assume first that, as in the earlier analysis, the OTRB operator has sufficient funds on hand for purchasing accessibility technologies. If the firm invested the $100, in 1 year the funds would be worth $110 in nominal terms, or $100 when discounted. If the accessibility technologies were purchased, the OTRB operator would have zero funds and assets at the end of the year, since the accessibility technology depreciates fully in value in 1 year. The difference between these two figures is the opportunity cost of the accessibility technology-$1 10 in nominal terms (actual expenditures), or $100 when discounted. Now, assume the OTRB operator out of financial necessity borrows funds to purchase the accessibility technology. It will spend $110 ($100 on principal plus $10 in interest) at the end of the year to pay off its lender. On the other hand, if the firm borrowed nothing and purchased nothing, it would have zero dollars at the

16 In this discussion, the terms “invest’ or “investment’ refer to internal (intra-company) investment, such as buses or buildings, not external investment, such as stocks or bonds.

end of the year. 17 The difference between these two figures is the opportunity cost-$110 in nominal terms, or $100 when discounted. This cost is the same as the earlier case in which the firm had sufficient funds on hand. Therefore, OTA concludes that the true cost of purchasing an accessibility technology is the same regardless of the financing method **used.**

Moreover, it is apparent that the real value of the **money spent when borrowing is simply equal to the nominal value of the outlays in** purchasing the accessibility technology (both are $100). As a result, the cost figures calculated previously represent the true (opportunity cost included) cost of purchasing an accessibility technology.

Imperfect Capital Markets

Earlier, it was assumed that capital markets are perfect-that borrowing and lending occur at the same (risk adjusted) rate. However, in some real markets, there is an interest rate spread between borrowing and lending rates.

If there exists an interest rate differential in which borrowing rates are greater than (comparable-risk) lending rates, the discount rate will be less than the rate of interest on borrowing. Therefore the above theories will not hold that: 1) a good will cost more when purchased with borrowed funds; and 2) the real value of money spent will be greater than the nominal value of outlays. The amount that these costs are greater will be proportional to the interest rate spread. However, determining g the size of this spread can be difficult.

Due to the vague interpretation of the concept of risk adjustment, one can justify the use of several "risk-adjusted' rates of borrowing. In December 1992, the only traded bond of an OTRB operator carried a Standard and Poors' B rating and a current nominal yield of 10.5 percent. Yields on U.S. Treasury notes (T-notes) are generally regarded as a conservative estimate of the market risk-adjusted lending rate. In late 1992, T-notes with comparable maturity to the OTRB operator's bond carried a nominal yield of approximately 7.0 percent. Therefore, if the 10.5 percent yield on the OTRB corporate bond is regarded by the borrower (the OTRB operator) as being a risk-adjusted rate,[18] the borrower will see a 3.5 percent difference in borrowing and lending rates.

However, if the OTRB operator views default on the bond as possible, the risk-adjusted borrowing rate (in the eyes of the OTRB operator) will fall proportional to the probability of default. Therefore, if default is likely, the risk-adjusted rate on borrowing will be close to the risk-adjusted rate on lending and the rate differential will be small.

Similarly, several positions can be taken in determining an empirical estimate of the risk-adjusted lending rate. It is safe to assume that the rate on Treasury notes and bonds represents the market value on risk-free lending. Therefore, we can assume this rate to be the risk-adjusted rate that OTRB operators could receive on investments. This methodology corresponds to that outlined by the Office of Management and Budget (OMB).[19] In late 1992, the 10-year nominal yield was approximately 7.0 percent.

In economic analysis, the discount rate (proxied by a lending rate, in this case) theoretically represents the return that an investor could earn on alternative investments. Therefore, for OTA's purposes, the discount rate should represent the risk-adjusted rate of return that OTRB operators can earn on internal investments. This rate of return should be equal to (if not greater than) the rate at which OTRB operators borrow money.[20] Referring to the numbers quoted above, since OTRB operators are willing to borrow at 10,5 percent, one can infer that internal investments earn, at a minimum, 10.5 percent return.[21] Following

17 It may appear, at first, that the OTRB operator does not really have the option of investing the $100 (as in the first case) Or opting to borrow nothing and spend nothing (as in the second case) since the purchase of the accessibility technology is mandated. However, the operator does have, for example, the option of selling assets in order to raise the necessary funds.

18 This Position can be justified by ass uming that the OTRB operator views the bond as a contractual obligation that takes priority over all other debt, equity, or investments.

19 Office of Management and Budget (OMB), Circular No. A-94, revised Oct. 29, 1992.

20 Again, this assumes that the operator sees little chance Of default on the bond/loan.

21 It would be irrational to borrow at a higher rate than one expects to receive (risk-adjusted) on the capital purchased with the borrowed funds.

Table A-3-Comparison of Borrowing and Funds On-Hand, Including Discounting

	Low-cost traveler-complete OTRB	Medium-cost traveler-complete OTRB	Traveler-complete OTRB with externally mounted lift	High-cost traveler-complete OTRB	Traveler-ready OTRB and lift[b]	Low-cost accessible restroom with lift	High-cost accessible restroom with lift
Funds on-hand	$20,000	$23,000	$15,000	$35,000	$11,000	$34,000	$74,000
cents per mile	1.3	1.5	1.0	2.3	0.73	2.3	4.9
Funds on-hand discounted	18,000	21,000	15,000	31,000	11,000	29,000	66,000
cents per mile	1.2	1.4	1.0	2.1	0.73	1.9	4.4
Borrowed capital funds	30,000	33,000	27,030	56,000	19,000	49,000	110,000
cents per mile	2.0	2.2	1.8	3.7	1.3	3.3	7.3
Borrowed capital funds discounted	22,000	25,000	20,000	39,000	15,000	34,000	81,000
cents per mile	1.5	1.6	1.3	2.6	1.0	2.3	5.4

NOTE: This table does not include the cost of an emergency ramp unless noted otherwise.

[a] See text.

b This figure represents 1.2 of the price of a station-based lift (see text) and the cost of an emergency ramp and chair.

SOURCE: Office of Technology Assessment, 1993.

this argument, borrowing and lending rates should be equal, and thus the rate differential will be zero.[22]

In all, it is uncertain whether or not there exists a significant interest rate spread. For the sake of finding an upper bound on costs, the results discussed below and presented in table A-3 follow the assumption that risk-adjusted rates are 10.5 percent for borrowing and 7.0 percent for lending, thus, allowing for the greatest interest rate differential.

Other Factors

Throughout the discussion, it has been assumed that there is no return to capital for mandated accessibility devices. However, it is fairly clear that the existence of accessibility devices will attract some number of new OTRB passengers who were either unable or unwilling to use OTRBs before, The additional revenues from these new passengers will decrease the net costs of accessibility devices, regardless of the financing method(s) used. These revenues are captured explicitly (i.e., through revenue estimates rather than through rate of return) in all outlay and cost estimates. In addition, the access of more persons to OTRB transportation represents a return for society as a whole. However, since this discussion is intended to focus only on OTRB operators, this social return is ignored.

It has also been assumed that the OTRB operator will raise funds through the sale of coupon bonds. Although this need not be the case, any other method of raising funds will have the same results. Other possible schemes for raising funds are: bank loans, term bonds (similar to a bank loan in that principal is paid off progressively rather than at the bond's maturity), and equity. The theory of arbitrage provides a solid justification as to why all methods are comparable, provided that capital markets operate freely and efficiently. If there exists a financial advantage in one debt system over another, there will

22 In the case that the expected return is greater than the borrowing rate, the differential will be negative, and thus borrowing will be *less* expensive than paying with funds on-hand.

exist arbitrage, which will be quickly eliminated by an efficiently operating market mechanism.

Transaction costs of borrowing have been assumed to be negligible throughout this discussion, and there is no reason to believe them to be otherwise. Relative to the incremental costs of outfitting an OTRB with accessibility devices (upward of $40,000), the fees charged by brokers and the costs to the operator of issuing bonds and accounting for payments are nominal.[23]

Discussion of Methodology and Results

Cost estimates for accessibility devices, presented earlier in this appendix, all assume that OTRB operators have sufficient funds on-hand to pay capital and operating costs of accessibility technologies when the costs arise. In addition, although the figures are adjusted to represent 1992 dollars, they are not discounted for time preference or opportunity cost, Therefore, the earlier cost estimates should be regarded as estimates of real dollar *outlays*, not real costs. The following discussion outlines: 1) the methodology used to convert these outlays to approximate cost figures; and 2) assumptions and methodology for estimating outlays and costs under the premise that the OTRB operator has sufficient funds on-hand for operating expenses only, and not for capital expenses (i.e., the OTRB operator must borrow in order to purchase and overhaul accessibility devices).

The theoretical purpose of discounting real figures, as discussed above, is to place a monetary value on opportunity cost. A driving force behind the concept of opportunity cost is the preference of investors and businesses to acquire goods and capital sooner rather than later. As applied to costs (rather than revenues and acquisitions), the process of discounting attempts to place a monetary value on the fact that businesses prefer to postpone costs so that money can be either invested or kept liquid in case a more important cost arises. As a result, the process of discounting expenditures makes an expenditure incurred in the future cost less (in discounted terms) than an expenditure incurred today.

As discussed above, the yield on 10-year Treasury notes is to be used as the lending rate, and therefore the discount rate. However, since the previous cost estimates are quoted in real 1992 dollars, a real discount rate is needed to convert these figures to present discounted value. The 7.0 percent yield cited above is a nominal yield (i.e., including inflation). To convert this to a real yield, inflation must be subtracted. Following the methodology outlined in OMB Circular A-94, the real yield on 10-year Treasury notes is 3.6 percent.[24] As a result, this 3.6 percent rate was used to discount the "real outlays" figures to find a present discounted value estimate for "real costs" as presented in table A-3.

In order to estimate real outlays and costs if the OTRB operator were to borrow all capital (presumably due to financial necessity), OTA explicitly calculated the yearly principal and interest payments that would be incurred by an OTRB operator. As in the discussion above, it was assumed that the borrowing would be in the form of a 10-year coupon bond with a 10.5-percent coupon rate. Using the same methodology as for the discount rate, a real coupon rate of 7.07 percent was calculated. This figure was then used to estimate real (1992 dollar) incremental outlays to be borne by an OTRB operator when purchasing one bus under the assumption of borrowing, as presented in table A-3.

In the manner discussed above used to convert real outlays to real costs in the case that the OTRB operator has sufficient funds on-hand, OTA estimated the real costs to the OTRB operator if all capital expenses were financed with borrowed funds. As before, a real discount rate of 3.6 percent was used, yielding the estimates presented in table A-3.

23 S. far, it has been assumed that tax policy treats all methods of financing capital investment equally. However, if OTRB operators were to be *given tax* credits or allowed to take deductions for interest payments on loans/bonds used to finance capital, the cost of capital using borrowed funds will become less expensive relative to the cost of using out-of-pocket funds. Whether this occurrence would make it absolutely less expensive for OTRB operators to borrow funds instead of using funds on-hand is unclear, since it depends on other assumptions about interest rates and the like. Nonetheless, a tax credit or deduction for interest payments will surely make borrowing less expensive relative to the case in which no tax deduction is permitted.

24 Office of Management and Budget, op. cit., footnote 19, states that inflation forecasts should be derived from the Gross Domestic Product price deflator estimates as cited in the fiscal year 1993 Federal budget. The long-term (greater than 5-year) estimate of inflation is 3.2 percent. OTA recognizes that there is considerable debate about discount rate values and that OMB's estimates are only one attempt to determine appropriate rates.

The Effect of Potential Price Increases on Overall Ridership

As discussed above, OTRB companies may choose to pass the costs of accessibility technologies on to passengers in the form of price increases. The number of passengers choosing not to travel on OTRBs due to these price increases can be estimated. However, the estimates rely on data that are sketchy at best, so the effect of increased prices was not included in the model. A hypothetical calculation of the effect of price increases can nevertheless help to illustrate the issue.

Useful data that are available include: 1) there were roughly 31 million passengers who used fixed-route OTRB service in 1990; and 2) the operating costs per mile for fixed-route OTRBs total approximately $2.00. Above, it is also estimated that providing accessible OTRBs may cost about 2-cents per mile, or an increase of 1 percent over previous operating costs.

Data that are not well-known include the way that a change in the price of a ticket will affect demand. In general, however, since the population of OTRB passengers is disproportionately poor compared with the rest of the population, it is safe to hypothesize that a price increase could result in a decrease in overall ridership. For example, if we assume that a l-percent increase in the price of a ticket will reduce demand by 1 percent, then a l-percent change in the price of a ticket due to the cost of providing accessible service will decrease ridership by roughly 310,000 trips (or 1 percent of 31 million trips).

Thus, if OTRB companies pass the costs of accessibility onto passengers in the form of fare increases, then significant numbers of passengers may choose not to ride OTRBs in fixed-route intercity service. Since most OTRB passengers have low incomes, increases in OTRB fixed-route fares due to the implementation costs of accessibility could disproportionately affect those Americans who are poor.