FARE IMPLEMENTATION ANALYSIS

EXECUTIVE SUMMARY

Chapel Hill Transit (CHT) transitioned from charging fares to operating fare free in 2002. Shortly after this change, ridership began to increase and ultimately grew from approximately 3.5 million to nearly 7 million between 2002 and 2012. CHT credits this growth—in part—to its decision to operate fare free. CHT has not collected fares since 2002; therefore, the agency does not have capital or administrative systems in place to charge a fare.

However, financial constraints have led CHT and the CHT Partners[1] to re-evaluate the potential benefits and costs associated with re-instituting fares, including:

- Policy and administrative implications associated with charging a fare
- Estimated capital and operating costs and benefits
- Expected ridership and revenue impacts raised by different fare scenarios
- Estimated return on investment associated with charging a fare

Fare Collection Considerations

Charging a fare—or not charging a fare—encompasses a wide range of costs and benefits for CHT. By not charging a fare, CHT loses revenue. With ridership close to seven million passengers annually, the potential for fare revenue may be significant. In addition, CHT as an agency is subjected to some negative perceptions that users of the service are not "paying its way."

The costs of operating fare free, however, are balanced by benefits. These benefits include not only increased ridership, but also easier administrative and operational systems. Operating fare free is less complex because it simplifies accounting systems and reduces the need for secure storage of cash. CHT also does not need to manage and distribute fare media. As part of transitioning to a fare system, CHT would need to invest in capital equipment (fareboxes) and hire administrative staff to administer and manage the fare collection system. There are also operating costs associated with charging a fare because passengers boarding the bus and stopping to pay their fare will slow routes.

Fare Policies

Fare collection would also require that CHT develop and implement a fare policy to address financial matters (fare levels and revenue), customer relations, and cost control (administrative/ management issues). An additional fare policy issue for CHT is consideration of the regional transit network and developing a fare system that is consistent with existing regional practices, including transfers, fare technology, and the GoPass regional fare card.

[1] Includes representatives from the Town of Chapel Hill, the Town of Carrboro, and the University of North Carolina-Chapel Hill.

Social equity and environmental justice are also important considerations in establishing and setting transit fares. Transit agencies typically work hard to offer equitable fares because they recognize that riders may have a hard time paying their fares.

Fare Implementation Costs

Capital Cost

Implementing a fare requires capital investment because the vast majority of CHT's vehicles do not have fareboxes and where fareboxes exist, they are outdated. For purposes of this analysis, it is assumed that fareboxes would need to be purchased for all CHT vehicles. There are also a series of other capital equipment needs associated with fare collection systems. In total, the estimated capital investment necessary to purchase and install a fare collection system is estimated to be between $1.8 million and $2.8 million.

Operating Cost

In addition to capital investments, implementing a fare would also have ongoing operating costs associated with administering the fare system. These costs include developing and distributing fare media (tickets and passes), managing reduced fare programs, and customer service questions. Ongoing operating costs for fare implementation are estimated at roughly $530,000 annually. About half of the costs are associated with increased staff, maintenance of the fareboxes, and purchasing fare media. The other half reflect contributions to a capital reserve fund so new equipment can be purchased at the end of its useful life.

Additionally, introducing fare payments to a transit system inevitably will create boarding delays. These delays are related to passengers paying their fares as well as asking questions and talking to the driver. For a single stop, these small delays may seem insignificant. However, over the course of a full route, they can aggregate and create noticeable issues with on-time performance and schedule adherence. Annual operational impacts associated with slower boarding times are estimated to cost approximately $390,000.

Revenue

Ridership and revenue assumptions are based on three fare scenarios developed as part of this analysis.[2] Figure ES-1 shows gross and net revenue projections for the low, medium, and high fare scenarios. Gross revenue projections do not include the cost of collecting fares, capital investments, or additional operating costs[3].

When accounting for annual operating costs, fare revenue set at the high ($1.25) level would generate a net positive return of just over $100,000 annually, or less than 1% of CHT's annual operating budget. The middle and low fare levels are estimated to result in a net revenue loss for CHT.

[2] The low-end fare reflects a "charge something" fare to address potential concerns about riders not paying their way, or could be seen as an introductory fare to get passengers accustomed to a fare structure. The high-end fare represents a level used in a number of peer systems, while also acknowledging CHT passengers' ability to pay. These fares are in line with fares charged for local service by other transit services in the Triangle Region (see also Appendix A).

[3] Potential implementation of a low-income fare would result in less incoming revenue than the amounts cited here.

Figure ES-1 Revenue Estimates

Fare Revenue Alternatives	Low	Medium	High
Fixed Route Fare Structure *(Three fare scenarios)*	*$0.50*	*$1.00*	*$1.25*
Fixed Route Passenger Revenue	$467,572	$870,222	$990,365
EZ Rider Fare Structure *(Three fare scenarios)*	*$1.00*	*$1.25*	*$1.50*
EZ Rider Passenger Revenue	$11,594	$21,708	$34,007
Estimated Gross Fare Revenue (Fixed Route + EZ Rider)	*$479,177*	*$891,930*	*$1,024,372*
Estimated Annual Operating Costs	$922,905	$922,905	$922,905
Estimated Annual Net Revenue Gain (Loss)	($443,728)	($30,726)	$102,014

Notes:

1. Assumed 50% of the full fare would be collected because of discounted fares, pre-paid passes, etc. This percentage is within the industry norm for a small-sized system like CHT.

Ridership Loss

Consumption of transit, like other goods and services, reacts to cost. Significant research over time has examined the sensitivity of transit ridership to fare increases. In transit, the standard measurement of sensitivity to fare changes means that for every 10% increase in fares, ridership will decrease by three percent.

Additionally, research has shown that in central business districts (CBDs), a higher average loss in ridership can be anticipated due to fare increases, since in a CBD short walking trips and transit trips are relatively interchangeable. The higher CBD elasticity value is applicable to CHT, as walking is an option for a number of trips, especially those to/from the University of North Carolina-Chapel Hill (UNC-Chapel Hill).

When analyzing a potential fare for the CHT system, an estimated ridership loss of 28% to 39% is anticipated.[4] Ridership losses are estimated to be less for dial-a-ride (EZ Rider) services because many of these passengers are seniors and/or persons with disabilities who rely heavily on these services. Estimated ridership loss is shown in Figure ES-2.

Figure ES-2 Ridership Estimates

	Low	Medium	High
Estimated Fixed Route Ridership			
CBD % Loss due to Fare	(28%)	(33%)	(39%)
Estimated Ridership Loss in CBD	(294,577)	(359,915)	(414,448)
Estimated EZ Ride Ridership			
% Loss due to Fare	(20%)	(26%)	(30%)
Estimated Ridership Loss	(12,205)	(15,233)	(17,899)

[4] Ridership loss estimates are based on Transit Cooperative Research Program (TCRP) research and peer agency experience.

Return on Investment

A relatively straightforward way to understand the impact of the investment in terms of benefits produced is the return on investment (ROI), which compares the capital and operating cost (investment) against the total benefits over a ten-year period. For purposes of this analysis, it was assumed CHT would be able to pay for all capital investments associated with the fare collection equipment without borrowing money. It was also assumed that operating costs would increase at a rate of 2% per year, while revenues would remain flat for the first five years; in year five, fare revenue would increase by 5% and then remain constant until the end of the 10-year period.[5]

The ten-year analysis suggests that implementing fares will not generate positive benefits for CHT even if fares are set at the high level (see Figure ES-3).

Figure ES-3 Return on Investment for Ten-Year Period

	Low Capital Investment	High Capital Investment
Low Fares	(59%)	(61%)
Medium Fares	(23%)	(28%)
High Fares	(12%)	(18%)

Source: Nelson\Nygaard Consulting Associates

Federal and State Revenue Loss

Federal funds account for roughly $1.9 million (about 12%) of CHT's revenues annually. The majority of these funds are administered through the Federal Transit Administration (FTA) Section 5307 program, which distributes resources based on formula set by law. This formula is designed to allocate resources based on factors such as population, population density, and the number of low-income individuals as well as bus revenue vehicle miles and bus passenger miles.

Likewise, the State of North Carolina provides funding for public transportation services. The State Maintenance Assistance Program (SMAP), the largest of these programs, provides operating costs for urban, small urban, and regional transit systems. Allocations are based on a formula that reflects ridership. In 2013, CHT received $2.7 million (about 17%) from the state.

There is the possibility, therefore, that if ridership on CHT declines, CHT could receive less federal and state funding. For purposes of this analysis, our team tested the impact of a small decline in FTA and state funding assistance (roughly 2.5%) and estimated the ROI for charging fares. The analysis suggests if a decline in federal and state funds is included, fares remain unprofitable at all fare levels (see Figure ES-4).

Figure ES-4 Return on Investment for Ten-Year Period with Loss of Federal and State Funds

	Low Capital Investment	High Capital Investment
Low Fares	(62%)	(64%)
Medium Fares	(30%)	(34%)
High Fares	(31%)	(35%)

Source: Nelson\Nygaard Consulting Associates

[5] Transit industry experience nationally suggests it is difficult for transit agencies to raise fares on an annual basis. Instead fares are raised periodically, roughly every five years.

1 OVERVIEW

Chapel Hill Transit (CHT) transitioned from charging fares to operating fare free in 2002. Shortly after this change, ridership began to increase and ultimately grew from approximately 3.5 million to nearly 7 million between 2002 and 2012. CHT partially credits this growth to its decision to operate fare free.

Currently, there are two exceptions to CHT's fare free operations: the Pittsboro Express (PX)—which is jointly operated with the Chatham Transit Network and provides service between the Town of Chapel Hill and Pittsboro; and the Tar Heel Express, which provides transit service to/from football and men's basketball games on the UNC-Chapel Hill campus. The PX and the Tar Heel Express cost $3 for a one-way trip. Tar Heel Express fares are collected off-board, with a contractor handling the sale and collection of fares. In addition, the majority of riders on the PX pay their fares with a monthly pass. As a result, CHT's system is not equipped or experienced with fare collection.

Despite its success operating fare free, financial constraints have led CHT and the CHT Partners[6] to re-evaluate the potential benefits and costs associated with re-instituting fares. As part of the Strategic and Financial Sustainability Plan, the Nelson\Nygaard team explored the likely benefits and costs associated with instituting fares as one potential method for raising revenues. The analysis includes:

- Policy implications associated with charging a fare
- Estimated capital and operating costs and benefits
- Expected ridership and revenue impacts raised by different fare scenarios
- Estimated return on investment associated with charging a fare

The cost-benefit analysis relied on several critical assumptions for estimating capital and operating costs, as well as projecting ridership. The assumptions are referenced throughout this report and are summarized in Chapter 3 for reference.

[6] Includes representatives from the Town of Chapel Hill, the Town of Carrboro, and the University of North Carolina-Chapel Hill.

2 IMPLEMENTING A FARE STRUCTURE: BENEFITS AND CHALLENGES

Charging a fare—or not charging a fare—encompasses a wide range of costs and benefits for CHT. The costs largely include revenue losses, plus a public perception held by some that users of the service are not "paying its way." The costs of operating fare free are balanced by benefits, which include not only increased ridership, but also administrative, operational, and customer service benefits. Not charging a fare simplifies much of CHT's administration, including back-end accounting, secure storage of funds, or distribution of fare media.

Eliminating fares also helps system operations because it reduces the amount of time buses wait at stops (i.e., vehicle dwell time[7]) because passengers board the bus more slowly as they stop and pay their fare. The lack of fares also avoids disputes between operators and passengers regarding properly paid fares. Finally, operating fare free is consistent with the high-level goals of the Town of Chapel Hill—to support a sustainable environment and vibrant local economy as well as technical policies associated with limiting the expansion of existing roadway capacity and limiting parking growth on the UNC-Chapel Hill campus.

Benefits of Implementing a Fare

In the current fiscally-constrained environment, transit agencies around the U.S. are looking for any and all opportunities to increase their operating revenue by securing new funding sources and increasing or introducing transit fares. Indeed, the need for additional revenue is a key factor behind CHT's decision to reevaluate its decision to operate fare free. Some of the key benefits of introducing a fare include:

- Increasing revenue to help close a funding gap, including potentially supporting capital purchases
- Reducing reliance on federal and state funding
- Supporting the perception that the public helps pay for public services (addressing the question: why should transit riders get a "free ride"?)
- Addressing potential problems with individuals who may ride the bus seeking shelter or for other non-transportation reasons

Costs of Implementing a Fare

While offering potential for increased revenue, instituting a fare would require capital investments, create new or expanded responsibilities for staff, and increase operating costs for CHT. Implementing a fare structure requires significant planning activity and policy

[7] More formally, this refers to the amount of time that a bus will "dwell" at a stop to load and unload passengers.

considerations by staff, the Town of Chapel Hill, and the CHT Partners, as well as capital investments and increased staff responsibilities. Some of the significant challenges CHT would face if a fare were introduced are:

- **Investment in fare collection hardware and office/accounting infrastructure**
  - Installing fareboxes on the majority of the vehicle fleet (approximately 115 fixed-route and demand response vehicles)
  - Developing secure space for accounting, auditing, and fare reconciliation
  - Installing a vault for secure money storage
- **Increase in staff responsibilities**
  - Accounting, auditing, and fare reconciliation
  - Additional marketing and customer service responsibilities to convey and educate passengers and drivers about the fare structure and policies
  - Point of sale administration and staffing for selling passes at CHT and distributing passes to retail locations and ticket vending machines (TVMs)
  - New and increased responsibilities for drivers in operating the farebox and conducting fare enforcement
  - Resources needed to conduct public outreach around introduction of fares and future increases in fares
  - Additional responsibility for maintenance/administrative staff to "empty" fareboxes and count fares

Implementing a fare also creates operational costs and challenges, such as:

- **Increased dwell times** (additional boarding time at bus stops) and operational delays associated with collecting a fare.
- **Development of fare validation and enforcement policies**. The collection of fares requires operators to oversee fare validation and enforce policies, and can result in altercations with passengers and inconsistent execution of agency policies.
- **Consideration of Title VI impacts**. CHT must ensure that fare implementation would not disproportionately affect low-income and minority passengers.
- **Training operators and supervisors.** CHT must train drivers, supervisors and dispatchers about fare collection policies, procedures and passenger interactions.
- **Potential conflicts between operators and passengers**. Although some assaults occur without reason, many assaults do have one or more contributing factors. According to a study by the Transit Cooperative Research Program (TCRP), fare enforcement was reported by 67% of respondents as the most common contributing factor in driver assaults.[8]
- **Customer complaints** would likely increase as a result of fare policy implementation.

Each of these issues is explored in this technical memo.

[8] TCRP Synthesis 93: Practices to Protect Bus Operators from Passenger Assault

3 ANALYSIS PROCESS, APPROACH, AND KEY ASSUMPTIONS

This analysis was designed to be understandable and replicable. However, it relies on a series of assumptions regarding behavioral changes anticipated from passengers if CHT were to implement a fare, as well as the costs of different capital and administrative systems.

Resources and Sources

Transit Cooperative Research Program (TCRP) research on fare policy as well as fare collection technical and operational issues were important resources for this study. TCRP is a national professional research organization that works cooperatively with the Federal Transit Administration (FTA); the National Academies, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization. The TCRP serves as one of the principal means by which the transit industry develops innovative solutions on a wide variety of topics through transit research in fields such as planning, service configuration, equipment, facilities, fares, operations, human resources, maintenance, policy, and administrative practices.

In particular, the study team relied on TCRP Report 94: Fare Policies, Structures, and Technologies [9] to identify several elements associated with fare collection and corresponding cost factors such as capital equipment needs and ongoing costs to print and distribute passes, handle cash, and perform other administrative tasks. The TCRP research is based on transit industry standards drawn from a cross section of large and small transit agencies. These factors were used in estimating initial capital costs and ongoing administrative expenses. The TCRP report was updated in 2003, so in many cases assumptions were supplemented with peer review research, the consulting team's professional experience with fare studies conducted across the country, and consultation with a major manufacturer of farebox equipment and facilities.

The final step in the process was collaboration with CHT staff to ensure that the approach reflects CHT's operating environment and that the ridership and revenue analysis is tailored to Chapel Hill's unique atmosphere and high student ridership. Projected administrative costs for new responsibilities were calibrated to CHT's pay structure.

CHT Existing Funding

In combination with federal and state funds, CHT's operating revenues are provided by partner contracts with the Town of Carrboro and UNC-Chapel Hill as well as funding contributions from the Town of Chapel Hill. In the short-term, additional revenues are expected to be available to CHT through the Orange County sales tax and vehicle registration fees. These revenues were not

[9] TCRP 94 – Fare Policies, Structures, and Technologies: Updated 2003.

included in this analysis because the funding mechanisms are still being developed and are not expected to structurally change this analysis.

One of the unique characteristics of CHT is the funding arrangement with its partners and the Town of Chapel Hill—combined, the three entities contribute roughly 60% of CHT's operating and capital resources. As discussed, UNC-Chapel Hill provides roughly 38% of CHT revenues[10], which are paid for through multiple sources of non-appropriated revenue for transit services. The Student Transit Fee pays for access to and around campus for students and largely reflects a "pre-paid" transit fee for students, faculty, and staff at UNC-Chapel Hill. The Town of Chapel Hill contributes roughly 17% of CHT's operating revenues, and the contract with the Town of Carrboro provides approximately 6%.[11] Contributions made by the individual towns are not directly tied to any rider groups or associated with pre-paid fares.

Key Assumptions

In developing this report, the consultant team relied on several key assumptions for estimating capital and operating costs and projecting ridership. The assumptions are referenced throughout this report when the topics are discussed; however they are highlighted below for easy reference.

Capital Investments

- Capital costs are presented as low-end and high-end unit costs consistent with TCRP unit costs and refined based on consultation with major manufacturers.
- Ten percent of initial costs are added for spare parts and to ensure high end equipment is fully functional at all times.
- One hundred percent of capital costs are funded by CHT. It is possible that federal funds could potentially cover up to 80% of the capital costs, but given the existing demand for capital funds, it is assumed CHT would use all local revenues to implement a fare collection system. Ongoing operating costs include a capital reserve replenishment line item based on capital life-cycle periods.

Ongoing Operating Costs

- Cost estimates are based on CHT operations of roughly 158,000 annual hours at $92/hour, for a total of $14.5 million.
- The study team evaluated impacts based on three different fare levels or scenarios. The suggested fare levels reflect regional fares, which are summarized in Appendix A.
- Tickets/passes assume a hybrid magnetic stripe (transfers and casual pass purchases—30% of monthly passes) and smart card (U-Pass and regular monthly pass users—70% of monthly passes) system. This assumption is consistent with the regional GOPass.
- Two new full-time employee equivalents (FTEs) would be required: an administrative position and a mechanic at $55,000/year (each).
- Assumes no federal funds are used for purchasing capital equipment. Replenishes capital reserves based on lifespan of equipment.

[10] UNC-Chapel Hill contributions to CHT include funding to support fare free access to the system for UNC-Chapel Hill affiliates. The contributions also include funding for specific CHT services.

[11] Chapel Hill Transit FY 2013 operating budget.

- Boarding delay (dwell time impact) is estimated on a per-boarding basis. Assumptions about the impact on dwell time associated with different fare payment methods assume:
  - An additional 1.5 seconds is needed for each individual boarding a CHT vehicle.
  - Impacts on schedules and on-time performance. Many trips currently exceed cycle time[12], resulting in additional trips needed on select routes.

Ridership and Passenger Revenue Estimates[13]

- Ridership estimates are based on 2012 fixed-route ridership of 7 million and assume a low transfer rate of 3.4%. This assumption reflects data collected on CHT's most recent rider survey.
- Ridership elasticity is based on TCRP Research and peer agency experience.
  - Assumes a downtown environment where walking is viable option for short trips.
  - Assumes fixed-route ridership losses ranging from a low of 28% to a high of 39%.
  - EZ Rider ridership loss is assumed to be less than fixed-route because riders are highly transit dependent. Losses are anticipated to range from a low of 20% to a high of 30%.
- Revenue estimates are based on average fare per rider. This number is lower than the actual fare because of passengers paying discounted fares.
- Ridership and farebox revenues are based on a "snapshot" in time. The analysis does not provide projections over time.

[12] Cycle time is the roundtrip travel time including layover and recovery time. Recovery or wait time allows the bus driver to recover from traffic and passenger boarding delay resulting in being able to leave next bus trip on time and avoid ongoing off-schedule domino effect.

[13] Refer to page 15 for additional details.

4 IMPLEMENTING A FARE: POLICY AND STRATEGY

There are a series of fundamental and interrelated considerations associated with implementing a fare:

1. Fare Policy
2. Fare Strategy and Structure
3. Payment Type and Technology
4. Fare Validation/Collection

Each of these four elements is discussed in greater detail in this section.

Fare Policy

As part of implementing fares, CHT would need to implement a fare policy to address financial matters (revenue), equity, customer relations, simplicity, and cost control (administrative/ management issues). An additional fare policy issue for CHT is consideration of the regional transit network and developing a fare system that is consistent with existing regional practices. Developing and prioritizing fare policy goals are important first steps in establishing a fare structure.

Revenue Objectives and Measurements

One of the main reasons for charging a fare is to generate a revenue stream that will help fund agency operations and investments. As part of instituting a fare, the Town of Chapel Hill and the CHT Partners may want to set policies or expectations for fare revenues. Goals for fare revenue are typically identified in terms of a farebox recovery target[14] or level of subsidy such as (for example):

- Achieve a fixed-route farebox recovery ratio of at least 20%.
- Subsidy per fixed-route passenger should not exceed $2.15[15].

Most—although certainly not all—transit systems have established a target for achieving the percentage of costs to be recovered by passenger fares. Standard transit industry practice is for farebox recovery ratio targets for fixed-route local bus service to range between 15% and 30%. Based on current data and assuming all the revenue provided by UNC-Chapel Hill's local proportional share was counted as pre-paid fare revenue, CHT would already achieve a farebox recovery ratio of 25%, a larger proportion than industry practices.

[14] Farebox Recovery Ratio is calculated by dividing all passenger (farebox) revenue by total operating costs. Farebox recovery evaluates both system efficiency (through operating costs) and productivity (through boardings).

[15] CHT's cost per passenger was $2.12 in 2012.

For paratransit and Americans with Disabilities Act (ADA) services, it is more expensive to produce a trip, and the number of passengers carried per hour is significantly lower compared to fixed-route service. As a result, a lower farebox recovery is expected, typically in the range of 5% to 10%.

CHT may choose to set a farebox recovery target as part of a larger effort to help set fares and balance affordability for passengers versus maximizing revenues. Another valuable measurement is subsidy per passenger, which is calculated by subtracting passenger fares from operating costs and dividing this number by ridership. In addition to these quantitative measurements, CHT may want to consider some basic qualitative measures such as maximizing revenue while minimizing ridership loss.

EZ Rider

One area where equity will be important for Chapel Hill is CHT's paratransit service, EZ Rider. Federal rules limit the amount a fare can be charged to riders on ADA-mandated complementary paratransit service to twice the cash fare that is charged for a comparable fixed-route trip (i.e., if a local adult cash fare is $1, the maximum ADA fare is $2).

EZ Rider service is expensive to provide but highly valued by the older adults and people with disabilities living in Chapel Hill and Carrboro. Charging a fare after many years of offering the service may be a difficult transition for many. For the purposes of this analysis, it is assumes that fares would be implemented on EZ Rider in conjunction with fixed-route services.

Public Involvement

As a sub-recipient of FTA funds for transit service, CHT must comply with Title VI including evaluating any and all fare changes to determine whether those changes will have a discriminatory impact based on race, color, or national origin of the transit riders. Specifically, the transit provider shall engage the public in a decision-making process to develop a major service change policy and fare change policy. FTA guidance requires public engagement when developing service change and disparate impact policies.

Transfer Policies and Regional Considerations

Other key fare strategy considerations are transfers and transfer policy. Many systems are designed so that many riders must transfer between bus routes, which require agencies to address transfers. Transfers are issued at the time of boarding and are intended for passengers who need to change buses to get where they're going without paying a fare every time they board. Surveys show a very small percentage (estimated at 3-4%) of CHT riders transfer between CHT routes as part of their trip. This means that if CHT were to introduce a fare structure, the financial impact of one decision over another will not be significant. However, the decision does have regional implications because some riders may transfer from other services to CHT or from CHT to other services.

Agencies that offer transfers—either free of charge or at a discounted rate—typically allow a set time for their use, often a two-hour period, and allow them to be used in one direction only. In this case, a driver issues the rider a transfer with the time stamped on it, and the rider can get on and off as many buses as necessary within the allotted time period as long as travel is generally in one direction. Other agencies allow transfers to function as a two-hour pass, allowing passengers unlimited travel in any direction. Typically the rider displays the valid transfer as proof of payment.

Transfers have become an increasingly sensitive and controversial issue at many transit agencies because of problems associated with their use. For example, a common complaint is that passengers use transfers improperly, such as with an expired time stamp or on a return trip when that is not allowed. Such improper use causes conflicts between operators and passengers and boarding delays when operators take time to validate transfers. Agencies lament that improper use of transfers contributes to fare evasion and creates on-time performance problems. An increasing trend in the transit industry is to eliminate transfers and offer day passes, which allow passengers unlimited ride privileges in a 24-hour period. Day passes and other types of pre-paid fare instruments are discussed in the following section.

Regional Considerations and Inter-Agency Transfers

CHT is one of seven transit operators in the Research Triangle region in North Carolina (see Appendix A). Of these seven agencies, all but two (CHT and the North Carolina State University Wolfline) charge a fare. While not required, it is likely that if CHT charged a fare, the fare would roughly be consistent with other operators in the region. Generally speaking, transit agencies in the Triangle Region:

- Charge between $1 and $1.25 for local service.
- Vary fares based on distance – fares on longer distance and regional services start at $2.00.
- Vary fares based on service types – transit agencies charge more for premium services, such as regional express and special event services. Regional express routes, for example, cost $2.50 for a one-way cash fare. The cash fare on CHT's Tar Heel Express route is $3 for a one-way trip.
- Offer free fares to adults aged 65+ and children aged 12 or less.
- Accept the regional fare card, GoPass. The GoPass is accepted by four of the transit operators in the region.

The GoPass is the Triangle Region's regional fare card. It can be used on the four transit operators in the area that currently charge a fare: CAT in Raleigh, C-Tran in Cary, DATA in Durham, and regional services operated by Triangle Transit Authority (TTA). The only operator not participating in the GoPass is Orange County Public Transportation. GoPasses can be purchased as a day pass, a five-day pass, or a 31-day pass. UNC-Chapel Hill students, faculty, and staff may receive a free GoPass if they live off campus and ride TTA to get to campus.

In the case of CHT, transfer policies are further complicated by the fact that other transit services (TTA, for example) operate in Chapel Hill and Carrboro. As part of developing a transfer policy, CHT would need to negotiate transfers between systems. The negotiation includes CHT's willingness to accept transfer riders from other systems as well as other system's willingness to accept CHT riders transferring to their services, including participation in regional fare cards such as GoPass.

Most transit agencies in the Triangle Region do not charge for a transfer, although some charge a nominal amount. Currently, only TTA in the Triangle Region charges for transfers, requiring an additional $0.50 for riders transferring between local and express services. GoPass holders, however, are able to transfer free of charge between nearly all of the regional service providers.

Fare Strategy and Structure

Fare strategy refers to the general type of fare collection and payment structure. Possible approaches include flat fares, differential pricing (by distance traveled, time of day, or type of service), market-based or discounted payment options, and transfer pricing. Other options are fares based on a zonal system, peak/off-peak differentials, and express or other special surcharges. Fare structure represents the combination of one or more fare strategies with specific fare levels. CHT has already established a fare for its longest distance trips. Beyond the handful of routes, CHT only operates short distance local trips and short distance express trips. Therefore, a fare structure will likely not be as complex as other transit agencies.

The process of establishing pricing levels is influenced by political and social equity concerns and closely tied to revenue objectives. A common practice for transit agencies is to monitor farebox recovery ratio as an indicator of when and how much to raise fares. For example, if a transit agency has a farebox recovery target of 20% for its fixed-route service and this ratio is declining as costs increase, then it will consider increasing fares. However, such decisions need to be carefully considered because ridership typically drops after a fare increase. A rule of thumb in the transit industry is that for every 10% increase in fares, ridership will decrease by 3%. This "–0.3 elasticity" has proven to be a very accurate estimate of the relationship between overall ridership and fares over the years.

When establishing a fare structure, it is important to consider the types of passengers carried and the types of services offered. Typically, transit agencies have four to five categories:

- Adult (full or base fare)
- Seniors and people with disabilities (federally-mandated discounted fare)
- Students (discounted fare)
- Children (under five years old ride free with paying adult)
- Premium fares (express or limited-stop service)

The base cash fare for local bus service should be at a level that is reasonably affordable for riders and represents a "fair share" of the costs of operating transit services, although in both cases these are value judgments. While there is no one "right" answer, the standard in the industry for a transit agency operating in a relatively compact service area with a fleet size of about 100 buses ranges between a 15% and a 25% farebox recovery ratio systemwide.

Reduced Fares and Title VI Considerations

Social equity and environmental justice are important considerations in establishing and setting transit fares. Transit agencies try to offer equitable fares because they recognize that some passengers who depend on the service for their mobility needs may have a harder time paying for it. Environmental justice considerations also address equitable and fair treatment for all segments of the population.

The FTA requires that fixed-route services that receive FTA operating assistance offer older adults and persons with disabilities a 50% discount from the full fare during off-peak hours. Many transit agencies go beyond the legal requirements and offer a 50% discount throughout the day for cash fares as well as discounted monthly pass or tickets.

Many transit agencies also have a variety of fare instruments and discounted fares to address these social equity/justice concerns. Reduced and discounted fares for young children and

students (elementary and high school), for example, are frequently available, as are discounted monthly passes or ticket books. Many transit agencies also offer free fares for children less than five years of age, provided they are traveling with a fare-paying adult. Regionally, several agencies, including CAT and DATA, offer discounted cash fare for students (aged 17 or less) and youths (aged 12 or less).

Additionally, many transit agencies negotiate special fare pricing or fare mechanisms with human and health service organizations. Human and health service agencies want to ensure their clients can get to programs, services and employment and work with transit agencies to develop appropriate fare media, such as ticket books or tokens. These arrangements are usually negotiated between staff from both agencies. As part of identifying special fare classifications, agencies must also determine how people will qualify or demonstrate eligibility for reduced fares, including the federal half-fare program.

Low-Income Fare Considerations

Chapel Hill and Carrboro have expressed interest in investigating implementation of a low-income fare program if fares were reinstated. A policy decision would need to be made as to whether UNC-Chapel Hill students would qualify for such a program.

Secure Cash Fare Handling

All cash farebox revenue must be securely counted and reconciled. Revenue controls, processing, and handling can be particularly difficult for small to mid-sized agencies because they often do not have large administrative staff to manage these systems. Reconciling fare collections serves as both a preventive and detective control and can deter and identify a potential misappropriation of farebox receipts. CHT would need to ensure the proper administrative and handling controls to securely convey any cash collected for deposit.

Customer Relations Objectives and Measurements

The structure and policy of passenger fares at many transit agencies has evolved over several years, sometimes resulting in a complex fare structure with a myriad of fare instruments that are confusing to both riders and operators alike. An important consideration when establishing a fare structure is to create a system that is relatively simple, easy to understand, and easy to use for both riders and operators alike. This means that if transfers (paper slips issued upon boarding that allow passengers to change from one bus to another without paying additional fare) are offered, the rules governing them should be straightforward.

Similarly, how tickets and passes work should be simple to understand, and it should be easy to pay fares. For many agencies, the challenge arises when they balance the goal of simplicity against other goals addressing customers' ability to pay. A common outcome is various multiple-ride passes with discounts and/or convenience for those who can't afford a full monthly pass.

Payment Type and Technology

Payment type refers to the type of fare payment media (i.e., cash, token, paper ticket, or advanced payment media) and equipment used to collect fares. Agencies are increasingly offering a broad range of payment options that segment the market based on frequency of use and willingness to prepay. Most agencies offer one or more types of multiple-ride pass as well as some form of discounted multi-ride options; the most common types are described below. They include

monthly, weekly, and daily passes as well as special or innovative pass types through partnerships with universities, employers, and other institutions.[16] The passes sold below can be sold as "rolling" or calendar date passes. A rolling pass will become valid upon first use for the specific duration on that pass (e.g., 31 days, seven days, one day). A calendar pass will be valid on a specific date or date range.

In the Triangle region, most of the transit agencies that charge a fare have very similar fare structures, which are consistent with the GoPass. These fare levels include:

- **Day passes** are usually offered as an alternative to transfers and priced between 2.5 and 4 times the base cash fare. They are valid for a 24-hour period or a calendar date and are the only type of pass sold on board vehicles.
- **Weekly passes** provide unlimited rides for seven days or a calendar week. Weekly passes are typically activated when they are first used rather than a set Sunday-through-Saturday schedule. The GoPass is available as a five-day pass; DATA and C-Tran also offer a seven-day pass.
- **Monthly pass** or 31-day rolling passes allow unlimited rides for a given month or for a 31-day period starting on the day it is issued. Pass prices are based on the cash fare and a multiplier[17]. Agencies also offer discounted monthly passes to seniors and people with disabilities.

Fare Collection Technology

Part of CHT's decision regarding technology would also reflect a decision to become part of the regional GoPass. GoPass uses smart card technology to track ridership and assign fares. If CHT were to implement a fare and wanted to participate in the GoPass, it would need—at a minimum—to develop smart card reader technology. If CHT is not interested in participating in the GoPass system, then it would be free to adopt the fare collection technology that it determines to best meet local needs.

Generally speaking, there are two primary types of fare collection technology: smart cards and magnetic strip cards (see Figure 1). There are also different types of smart card systems—open and closed systems. An "open" system is a smart card system that is reliant on existing "third party" cards with built-in RFID (proximity card) capabilities. As an example, if one already has a proximity-enabled debit or credit card or employer ID, these can be used as a "smart" card on transit vehicles. A "closed" system is a more traditional smart card where a transit agency is in control of the fare media, including sales, distribution, reconciliation, and support.

[16] The multiple-ride instruments in this section are usually sold at several points of sale including retail outlets, agency administrative offices, schools, employers, and through TVMs. Day passes are often sold on board buses as is the case at GET (Bakersfield), C-Tran (Vancouver, WA) and Capital Metro Transit (Austin). Passengers deposit cash directly in the farebox, and a pass is produced. Drivers are not required to handle cash when passengers purchase day passes on board vehicles.

[17] The term "multiplier" refers to the number that is multiplied by the cash fare to determine the price of a monthly pass. This can also be considered the "break even" point for a customer purchasing the pass. For example, a multiplier of 30 would mean a monthly pass price of $30 with a base cash fare of $1. A customer would need to ride a system using their monthly pass 30 times within a month before breaking even on their purchase.

Figure 1 Electronic Fare Collection: Advantages and Disadvantages

	Magnetic Stripe Card	Smart Card (Open System)	Smart Card (Closed System)
Enhanced Data Collection	+	++	++
Safeguards against fare evasion	+	++	++
Enables fare simplification	+	++	++
Provides information for focused marketing	+	++	++
Reduces printing and cash handling	0	+	+
Requires technology upgrades and infrastructure	—	—	—
Improves customer experience and fare security	+	++	++
Costs of distribution network infrastructure[18]	0	+	—
Transit agency experience with this technology	0	0	—

Negative Impact — ←--------- 0 *Neutral*----------→ + *Positive Impact*

Fare Validation/Collection

The type of fare validation refers to the manner in which fares are enforced or inspected. The basic fare validation options are:

- Pay fare upon boarding – passengers pay, purchase fare media or validate fare media when getting on the bus.
- Pay fare at barriers – passengers pay or validate fare at barriers, such as turnstiles, to control access to the transit vehicle.
- Proof of payment (POP) – passengers purchase fare before they get on the vehicle. Enforcement of fare payment is done by random inspection or 100% conductor validated.

Of the four options, only fare purchase or fare instrument validation on board is currently the most relevant for a bus operator like CHT. The other three options are generally appropriate for rail or bus rapid transit systems. However, given CHT is exploring implementation of a bus rapid transit service and a rail light rail system regionally, CHT may want to consider the ability of any fare validation method proposed now to be integrated with new systems in the future.

The latest generation fareboxes are "validating" fareboxes, such as GFI's "Odyssey."[19] They can verify that magnetic stripe or smart card passes and/or transfers are valid. In addition, they can validate cash payments, verifying the amount and authenticity of bills and coins.

[18] Includes required new equipment for participating retailers to sell and recharge smart cards.

[19] GFI is a farebox manufacturer.

5 COSTS ASSOCIATED WITH IMPLEMENTING A FARE

Introduction of a fare structure and fare collection system involves numerous up-front and ongoing costs to establish and maintain fare collection equipment, as well as internal and external processes to print and distribute tickets and passes, collect and reconcile fares, and conduct other customer relations and financial transactions.

This section presents a detailed review of equipment that would be necessary to begin fare collection at CHT and a range of corresponding costs. It also estimates ongoing operating costs that reflect new administrative responsibilities for CHT. These cost estimates are used in tandem with ridership and fare revenue projections to determine the "bottom line," i.e., whether a net income gain or loss would result if CHT were to introduce a fare (see Chapter 8).

The basic facts about CHT that are used as inputs for this analysis are listed in Figure 2 below. The inventory of CHT's fare collection resources shows that roughly two-thirds of the fixed-route vehicles do not have any fare collection equipment installed. The remaining vehicles have fare collection equipment, but in every case, the fareboxes are already more than 10 years old and are unlikely to be compatible with new technology. Therefore, the study team assumed that new fareboxes would be required for all vehicles.

Figure 2 Inputs for Estimating Costs

Annual Fixed Route Ridership (unlinked) [1]	6,715,000
Estimated Transfer Rate [2]	3.4%
Fixed Route Vehicles without Farebox (fleet vehicles purchased since 2002) [3]	67 (68%)
Annual EZ Rider Trips	59,620
EZ Rider (Paratransit) Vehicles without Farebox	19 (100%)

Source: NTD 2013

1. Includes Safe Routes but not Tar Heel Express.
2. A transfer rate of 49% is assumed due to the timed-transfer design of the CHT system coupled with 2012 survey results.
3. CHT's fixed-route fleet has 99 vehicles, 67 of which were purchased after 2002 (the year CHT became fare free). For purposes of this analysis, it is assumed that CHT would need to purchase fareboxes for all 67 vehicles, regardless of the remaining useful life of the vehicle.

FARE LEVELS

To estimate the potential impacts on ridership and the resulting farebox revenues if a fare were introduced, three different fare scenarios were included in this analysis (see Figure 3). The three scenarios are designated "Low," "Medium," and "High," to reflect corresponding fare levels. The low-end fare reflects a "charge something" fare to address potential concerns about riders not paying their way, or could be seen as an introductory fare to get passengers accustomed to a fare structure. The high-end fare represents a level used in a number of peer systems, while also acknowledging CHT passengers' ability to pay. These fares are in line with fares charged for local service by other transit services in the Triangle Region (see also Appendix A).

Figure 3 Three Fare Scenarios Used for Analysis

Service	Base Fare Level		
	Low	Medium	High
Fixed Route	$0.50	$1.00	$1.25
EZ Rider	$1.00	$1.25	$2.00

INITIAL CAPITAL INVESTMENTS

Implementing a fare requires several capital investments (see Figure 4). Most of CHT's vehicles do not have fareboxes. As discussed, although some of CHT's older vehicles have fare collection equipment, the technology is old and would not be compatible with a new system purchased in 2015 or 2016. For purposes of this analysis, it is assumed that fareboxes would need to be purchased for all CHT vehicles. All capital costs are listed separately, including initial marketing and education costs plus a 10% contingency for all capital costs. On the low end, the required capital costs are estimated at $1.9 million, and the high end costs are estimated at just over $2.8 million.

ONGOING OPERATING COSTS

In addition to capital investments, implementing a fare would also have ongoing operating costs associated with administering the fare system (see Figure 5). Implementing fares also includes recurring direct costs such as purchasing fare media (passes, tickets, etc.), plus ongoing marketing activities and administrative tasks. There is some variation in the ongoing operating costs that reflect different fare levels and how many fare media would be needed. Differences between options are minor; ongoing operating costs are estimated at roughly $530,000.

Administration Impacts

There are many administrative responsibilities associated with a fare structure, from printing, selling, and distributing tickets/passes, to procuring fareboxes and other capital investments, to reconciling monthly financial transactions and monitoring and measuring farebox recovery ratios. Systems with a complex fare structure typically devote several full-time staff members to administering fares.

Figure 4 One-Time Capital Investments

Fare Collection Implementation Costs					
One-Time Capital Investments	Qty	Unit Cost Low	Unit Cost High	Total Cost Low	Total Cost High
Fixed Route Fareboxes[1]	99	$12,000	$15,000	$1,188,000	$1,485,000
EZ Rider (Demand-Response) Fareboxes[2]	19	$2,500	$9,000	$47,500	$171,000
Farebox Installation Costs[1]		3%	10%	$37,065	$165,600
Ticket Vending Machines (TVMs)[1]	4	$30,000	$55,000	$120,000	$220,000
Attended Card Encoders[1]	2	$13,000	$19,000	$26,000	$38,000
Data Processing Software and Hardware[1]	1	$35,000	$55,000	$35,000	$55,000
Vault (on wheels)[1]	1	$30,000	$40,000	$30,000	$40,000
Spares Parts (10% of fareboxes and TVMs)[2]				$135,500	$187,600
Money Room and Clean Room Build Out[3]	1	$160	$220	$57,600	$99,000
Contingency Budget (10% of all Capital Costs)[4]				$167,672	$246,120
One-Time Capital Costs [5]				$1,844,387	$2707,320
Initial Marketing and Education				$45,000	$60,000
Total Capital Costs				$1,889,387	$2,767,320

Notes:

Bus probes and garage probes will be needed for data collection from vehicles (these will likely be provided by hardware vendor at no cost as noted from GFI).These are needed for downloading data from fareboxes into data processing computers, typically via infrared emitters/sensors. Attended Card Encoders are devices to program (encode) blank fare media (magnetic stripe or smart cards). They can be used to generate multi-ride passes and/or smart cards from individuals participating in partner program.

1. Farebox, TVM, other hardware and installation costs are based on figures from TCRP Report 94.

2. Cost for spares (additional spare parts and pieces) is factored only for high-use equipment such as fareboxes and TVMs. Ongoing spare parts costs is determined by taking 10% of the initial capital cost of spare parts.

3. Room Build Out costs assumes 360 Sq Ft (small) and 450 Sq Ft (large). Per unit costs reflect per-square-foot costs.

4. Contingency budget has been developed to cover 10% of all above capital costs.

5. Capital costs are FTA eligible; however, this analysis assumes capital costs would be funded by CHT. If federal funds are secured, then it would cover 80% of the cost, reducing CHT's contribution to 20%.

Figure 5 Ongoing Costs Associated with Fare Collection

Annual Costs for Fare Media and Personnel Functions	Unit Cost	Low Fare	Medium Fare	High Fare
Procure annual transfer media (paper stock, mag stripe)[1,2,8]	$0.02	$763	$710	$647
Procure annual pass media (plastic stock, mag stripe)[1,2]	$0.03	$26	$24	$22
Procure annual smartcard media[1,2]	$1.45	$2,738	$2,548	$2,320
Cost to purchase and install farebox		$32,315	$32,315	$32,315
Procure annual EZ Rider smartcard media[1,2]	$1.45	$66	$62	$58
Equipment Maintenance Costs[4]	6%	$96,945	$96,945	$96,945
Additional Ongoing Marketing Costs		$5,000	$5,000	$5,000
Annual FTE Employee Costs: includes media distribution and reconciliation, maintenance, revenue handling, and software maintenance[5]	2 FTE	$105,000	$105,000	$105,000
Capital Reserve Replenishment[6]		$288,456	$288,456	$288,456
Annual Ongoing Operating Costs		$531,309	$531,060	$530,763

Notes:
1. Assumes hybrid smart card/mag stripe system.
2. Assumes that pass media is purchased at 50% over required demand for that fare class, based on ridership projections from Figure 7. Costs for media are higher at lower fare levels because ridership is projected to be higher and thus a higher quantity of fare media is necessary.
3. Based on TCRP Report 94, staff costs for various aspects of fare collection is taken as a percentage of overall revenue. The suggested FTE cost of $52,500 is roughly at the midpoint of TCRP's range from that report.
4. Equipment maintenance costs range between 5% and 7% of equipment costs. An average of 6% is used for fareboxes and TVMs.
5. Assumes one new full-time mechanic ($55,000) and one new full-time administrative employee ($50,000). To reflect the customer service CHT riders have come to expect, additional administrative/customer relations staff may be needed.
6. Capital Reserve Replenishment takes the average between low and high FTA-eligible capital costs and annualizes it over the intended lifespan (10 years for farebox related equipment and 30 years for structures).
7. Dwell Time Costs: We assumed four lines would require an additional 15.5 hours total of operating time per day, 255 weekdays/year times $92/hour.
8. Transfer rate is estimated to be 3.4% given 2012 survey results.

While it can be difficult to quantify staff time and expense dedicated to these activities, an increasing concern at many transit agencies is how to reduce the time and effort spent on administering fares. Agencies should quantify the costs to administer the fare collection system and monitor the costs over time. One way to ensure that administrative responsibilities do not become burdensome is to routinely adjust fares so that the cost of fare collection is maintained or declines as a percentage of total fare revenue. Administrative costs typically range between 10% and 15% of total operating costs.

Capital Reserves

Ongoing costs also include assume a capital set aside for fare collection system. Replenishing the capital reserve account is calculated based on annualized costs of capital equipment. The sum of $105,658 shown in Figure 5 scenarios assumes that 100% of capital projects will be covered by CHT. A ten-year life cycle is assumed for all capital equipment (fareboxes, TVMs, etc.), and a 30-year life cycle is assumed for the money room. Additionally, a 6% annual maintenance cost was assumed for fare equipment.

6 PROJECTED REVENUE GENERATION

The purpose of charging a fare to riders is to raise revenues. For example, if each of CHT's seven million riders each paid $1 every time they boarded the bus, the system would collect nearly $7 million annually. However, as discussed, not all riders pay the full cash fare, potentially because they are over the age of 60, have a disability, hold a monthly pass, or are transferring between systems. In addition, experience also shows that when asked to pay a fare, some riders will use a different way to travel, rather than pay the fare. The cumulative effect of these factors means that not every rider pays a fare, not every rider pays the full fare, and some existing riders will stop riding. Revenue projections, therefore, will reflect these circumstances. Previous sections of this memo outlined the costs associated with setting up the fare collection infrastructure and costs to manage the system. This section evaluates the revenue potential.

FARE ELASTICITY

Consumption of transit, like other goods and services, reacts to cost. Significant research over time has examined the sensitivity of transit ridership to fare increases. In economic terms, the change in the product purchase pattern with respect to the change in price is referred to as "elasticity." Ridership elasticity with respect to fare (commonly referred to as "fare elasticity") measures the percentage change in ridership in response to a change in transit fare. In transit, the standard fare elasticity is –0.3. This means that for every 10% increase in fares, ridership will decrease by three percent.

The notion of fare elasticity is not applicable to the case when fares are instituted for a free-fare system, as this represents an infinite increase in fares. But research into fare elasticity for the elimination of fares can be used to predict ridership losses when reversing the situation and adding a new fare.

Based on limited research into fare-less demonstration projects for a number of years, TCRP Report 95, Chapter 129[20], demonstrates the effect of eliminating fares. This implies the percent increase in ridership is equal to elasticity value given the 100% drop in fares. The report found that in central business districts (CBDs), a higher average fare elasticity of -0.52 (+/- 0.13) can be applied, since in a CBD short walking trips and transit trips are more interchangeable than longer trips. For example, in London, trips under one mile in length were found to be almost twice as sensitive to fare changes as longer trips; fare elasticity for trips shorter than a mile ranged from £0.50 to £0.55. The average fare elasticity for a limited number of non-CBD studies averaged -0.32. The higher CBD elasticity value is also applicable to CHT, as walking is an option for a number of trips, especially those to/from UNC-Chapel Hill.

[20] TCRP 94 – Fare Policies, Structure, and Technologies: Updated 2003.

Therefore, the nominal elasticity value of -0.52 suggests that a 52% increase in ridership will result if fares are eliminated in a CBD or other area where transit competes with other modes. Conversely, the addition of a fare under these conditions will result in a (34%)[1] loss in ridership. Figure 6 highlights the range of expected ridership losses given the range of elasticity cited for the free-fare systems. When analyzing a potential fare for the CHT system, the greater loss (39%) is assumed for the high-end fare assumption and the lesser ridership loss (28%) is assumed for the low-end fare assumption.

Figure 6 Elasticity-Based Ridership Losses when Instituting a Fare

Case	Elasticity	Ridership Loss if Free Fare is Eliminated
CBD – high end	-0.65	(39%)
CBD – nominal value	-0.52	(34%)
CBD – low end	-0.39	(28%)
Non-CBD – high end	-0.45	(31%)
Non-CBD – nominal value	-0.32	(24%)
Non-CBD – low end	-0.19	(16%)

Source: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_95c12.pdf 12-32

The elasticity is less for dial-a-ride (EZ Rider) services because many of these passengers are seniors and/or persons with disabilities who rely heavily on these services (these individuals' demand would be considered fare inelastic). The transit industry has generally found that ADA ridership does not decline after a fare increase, primarily because there is enough pent-up demand that any rider who does discontinue using the service is immediately replaced by another rider. As an example, the Metropolitan Transit District (MTD) in Santa Barbara reports that when it doubled its ADA fares (from $1 to $2) and also eliminated multi-ride discounts, there was no measurable impact on ADA ridership. However, it is reasonable to assume that when transitioning from a free-fare system to charging a fare, there would be a small percentage of riders who would seek a different travel options or choose to travel less often. Therefore, a range between 20% and 30% is used when estimating a loss in ridership.

The ridership and revenue assumptions are based on three fare scenarios shown in Figure 7 and Figure 8. The top third of the figure presents current (2010) EZ Rider and fixed-route ridership with an assumed 3.4% transfer rate based on CHT 2012 ridership surveys. The estimated ridership loss under the three fare scenarios is shown for each service. Figure 8 lists the low, medium, and high fares, the percent of the fare collected, and the average fare per rider. For fixed-route service it is assumed that 50% of the full fare would be collected, based on the high percentage of riders that would be paying a reduced fare.

If every rider on CHT paid a $1 fare for every trip taken, the system would collect roughly $6.7 million annually through the farebox. Based on these parameters, CHT would receive between $785,000 and $1.6 million in fare revenues annually, depending on the fare level. These figures do not include the cost of collecting fares, capital investments, or additional operating costs; costs associated with these activities are discussed in detail in other sections of this report.

Figure 7 Ridership Estimates

Current (2013) Ridership	Low	Medium	High
Annual Fixed Route Ridership (Unlinked Trips)			6,715,000
% Pre-Paid Ridership (UNC-Chapel Hill and UNC-Chapel Hill Health Care Students, Faculty, and Staff)			60%
Annual Fixed Route Ridership (Linked Trips) [1]			2,686,000
Adjusted Linked Trips			2,597,679
CHT EZ Rider /Lifeline Service			59,620
Assumed Transfer Rate[2]			3.4%
Estimated Fixed Route Ridership			
Non-CBD % Loss due to Fare[3]	(16%)	(24%)	(31%)
Estimated Ridership Loss in non-CBD	(454,157)	(689,566)	(882,763)
CBD % Loss due to Fare[3]	(28%)	(33%)	(39%)
Estimated Ridership Loss in CBD	(294,577)	(359,915)	(414,448)
Trips that will Charge a Fare	3,147,784	2,847,037	2,599,308
Potential Transfers	107,025	96,799	88,376
Estimated EZ Ride Ridership			
% Loss due to Fare[4]	(20%)	(26%)	(30%)
Estimated Ridership Loss	(12,205)	(15,233)	(17,899)
Ridership with Fare	47,415	44,387	41,721

Notes:

1. A linked trip represents the entire passenger trip from trip origin to trip destination regardless of the number of transfers that may be involved. An unlinked trip represents a single bus boarding whether at the trip origin or at a transfer location.
2. A transfer rate of 49% is assumed due to the timed-transfer design of the CHT system coupled with 2012 survey results.
3. Loss of fixed-route ridership due to fare increases is assumed at all three levels, with losses between 28-39%.
4. Loss of ADA ridership is assumed at all three levels. Since ADA riders are highly transit dependent, they have few travel choices, and the projected loss is lower than the fixed-route ridership loss rate.

Figure 8 Revenue Estimates[21]

Fare Revenue Alternatives	Low	Medium	High
Fixed Route			
Fixed Route Fare Structure *(Three fare scenarios)*	*$0.50*	*$1.00*	*$1.25*
Percent collected[1]	50%	50%	50%
Assumed Avg Fare Per Passenger	$0.25	$0.50	$0.63
Fixed Route Passenger Revenue	$467,572	$870,222	$990,365
Dial-a-Ride			
EZ Rider Fare Structure *(Three fare scenarios)*	*$1.00*	*$1.25*	*$1.50*
Percent collected[1]	95%	95%	95%
Assumed Avg Fare Per Passenger	$0.95	$1.19	$1.43
EZ Rider Passenger Revenue	$11,594	$21,708	$34,007
Estimated Total Fare Revenue (Fixed Route + EZ Rider)	*$479,177*	*$891,930*	*$1,024,372*

Notes:

1. Assumed 50% of the full fare would be collected because of discounted fares, pre-paid passes, etc. This percentage is within the industry norm for a small-sized system like CHT.

[21] Potential implementation of a low-income fare would result in less incoming revenue than the amounts cited here.

7 OPERATIONAL IMPACTS

Introducing fare payments to a transit system inevitably will create boarding delays. These delays are related to passengers paying their fares as well as asking questions and talking to the driver. For a single stop, these small delays may seem insignificant. However, over the course of a full route, they can aggregate and create noticeable issues with on-time performance and schedule adherence. This section will briefly outline the potential operations impacts that can be caused by the introduction of fare payment and how it specifically may impact CHT.

Boarding delay caused by fare payment is quantifiable and is often measured on a per-boarding basis. However, the magnitude of the delay can vary depending on the fare payment type. Fare media that require visual inspection only (such as flash passes) are likely to cause the least delay per boarding, whereas an individual paying cash fare (and requiring exact change) may take significantly longer. As one can imagine, fareboxes that require exact change may prompt customers to spend several seconds digging for correct change. Other fare media such as swipe (magnetic stripe) cards or proximity smart cards fall between the above two examples in terms of delay.

National research has considered the delay caused by passengers paying a fare (see Figure 9). Based on CHT's existing free-fare service model and this research, it is assumed that current CHT boardings take approximately 2.5 seconds per passenger. If CHT were to introduce fare payment on its services, it would likely add boarding delay on top of the existing 2.5 seconds.

Figure 9 Boarding Delay by Fare Payment

Situation	Suggested Default Passenger Service Time (Seconds/Passenger)
Pre-Payment (includes no fare)	2.5
Exact change	4.0
Swipe or dip card	4.2
Smart card	3.5

Source: Transit Cooperative Research Program (TCRP 100- Transit Capacity and Quality of Service Manual

Based on TCRP research, the Nelson\Nygaard team assumed that requiring a fare payment on CHT routes would add approximately 1.5 seconds to each boarding (the difference in time between free fares and delay from requiring exact change). It is understood that not all future passengers will have exact change (4.0 total seconds per boarding is a middle ground between those using smart cards, change, and swipe cards).

Impacts on CHT Routes

Based on the CHT Comprehensive Operations Analysis (COA), there are several routes in the CHT network that consistently show on-time performance issues. Our analysis assumes on-time performance issues will be exacerbated with fare collection, such that additional resources may be needed. The analysis only examines routes that currently have on-time performance issues. If a route did not have on-time performance issues, the study team assumed the route could absorb incremental dwell time increases associated with fare collection. Express routes, for example, did not report on-time performance issues and therefore were not included in the dwell time analysis.

Figure 10 shows the individual routes and number of trips currently exceeding "cycle time"[22] based on a count the week of September 12, 2011, excluding the routes that entirely or mostly serve the UNC-Chapel Hill campus (NU, RU and U). "Exceeded Cycle Time" refers to the trip exceeding its scheduled cycle time. For instance, if Route 1 is scheduled for a 30-minute round trip and has a trip that took 31 minutes to complete, it exceeded its cycle time.

The travel time plus recovery time per trip collected as part of the COA was used to inventory the percentage of trips that were experiencing difficulty adhering to their schedule. The ridership on each route was reduced by 34%, the mid-range assumption for ridership loss if fares were implemented. The longer boarding time was then applied to the reduced ridership for each trip (see Figure 10). The "Max Added Dwell Time per Trip" column shows the additional dwell time added to each trip. While this amount may not seem significant in many cases, it pushes trips at their current scheduling limit over the edge. If the additional dwell times increased the travel time by 2% or more and/or 30% of all trips were not on-time, then we assumed additional investment in the route would be required. The additional investment was broadly estimated by adding trips in proportion to the number of delayed trips. In sum, the additional costs incurred by CHT due to operational issues are estimated to be roughly $400,000.

In addition to delays caused by passengers paying fares, operators may see an increased role in helping to explain, educate, and enforce fare policies to CHT customers. Again, on a case-by-case basis, the delay caused by these activities may seem minor, but can quickly accumulate over the course of a route. These types of interactions were not factored into the above estimations given their unpredictable nature, but should be considered, particularly during the initial rollout of fare collection when numerous customers may have questions and concerns about the policy and each time the fare structure is changed.

[22] Route cycle time includes the scheduled route round trip travel time to and from the Transit Center plus recovery time of three to four minutes.

Figure 10 Estimated Dwell Time Analysis

		Existing Conditions		With Fare and Additional Dwell Time					
Route	Daily Trips 1)	Current Trips Exceeding Cycle Time 2)	Adjusted Ridership	Max Added Dwell Time Per Trip (seconds)	Percent Trips Missing Transfers 6)	Recommendation	New Daily Hours Needed	Annual Hours	Annual Cost ($92/hr)
A	20.5	7	818	100	1.2%	Add service	5.3	1348.695	$105,535
CL	6	3	95	39	0.7%	No change			
CM	19.5	7	416	53	1.5%	Add service	2.2	551.9475	$43,190
CW	20	6	485	61	1.2%	No change			
D	30	7	1098	92	1.0%	No change			
F	17.5	3	626	89	1.1%	No change			
G	16.5	4	570	86	0.9%	No change			
HS	7	1	96	34	0.7%	No change			
J	47	8	2559	136	1.8%	Add service	5.6	1438.2	$112,539
N	19	3	344	45	0.9%	No change			
NS	31	8	2008	162	2.8%	Add service	4.2	1067.175	$83,506
S	48	6	783	41	1.0%	No change			
T	20	4	855	107	1.7%	Add service	2.3	598.4	$46,825
V	17	3	464	68	0.5%	No change			
Total	97	28			2%		19.6	5004.4	$391,596

Notes: Current Trips Exceeding Cycle Time means trip has no recovery time and no time for transfers

2014 Ridership data are averages collected from Jan 26-Feb 2, 2011

1) Daily Trips - The number of round trips to/from the Transit Center
2) Current Trips Exceeding Cycle Time - This counts the number of trips that currently exceed their scheduled cycle time.
3) Percent Trips Missing Transfers - If the cycle time was not hit, then transfers were likely missed. This is the percentage for the week of September 12, 2011.
4) Maximum Added Dwell Time per Trip - Using Ridership data collected the week of Jan 26-Feb 2, 2011, the number of passengers per trip for each trip was calculated, as was the dwell time for this trip, using 2.5 seconds/passenger. If a fare is instituted, ridership will drop by an estimated 34% and the dwell time will increase to 4 seconds/passenger. The maximum difference between the existing dwell time and the projected dwell time per trip is reported in this column.
5) Projected Trips Exceeding Cycle Time - This counts the number of trips that are projected to exceed their scheduled cycle time with the additional dwell time caused by a fare.
6) Percent Trips Missing Transfers - If the cycle time was not hit, then transfers were likely missed. This is the projected missed transfer rate.

8 FARE IMPLEMENTATION COST AND REVENUE SUMMARY

This technical memo lays out the costs and benefits associated with implementing a fare. A key goal of the analysis is to determine if the benefits (revenues) associated with implementing a fare outstrip the costs associated with implementing a fare, and if so, by how much and under what circumstances.

The data identifies the following costs:

- One time capital investment of between $1.8 million and $2.8 million to purchase and install fareboxes and other equipment necessary to implement a fare.
- Ongoing operational costs of roughly $530,000 annually. About half of the costs are associated with increased staff, maintenance of the fareboxes and purchasing fare media. The other half reflect contributions to the capital reserve fund so new equipment can be purchased at the end of its useful life.
- Operational impacts that account to costs on the order of $390,000 annually that account for operational delays associated with slower boarding times.

Charging a fare, on the other hand, would generate revenue. Based on a one-way cash fare of between $0.50 and $1.25, CHT could raise between $500,000 and $1.0 million annually (see Figure 11). On an annual basis, including only operating costs, fare revenue set at the high ($1.25) level would generate a net positive return of just over $100,000 annually.

Figure 11 Net Annual Revenue to CHT by Fare Level

Fare Level	Operating Costs	Operating Revenues	Net Gain (Loss)
$0.50	$922,905	$497,177	($443,728)
$1.00	$922,656	$891,930	($30,726)
$1.25	$922,358	$1,024,372	$102,014

Source: Nelson\Nygaard Consulting Associates

Return on Investment

A relatively straightforward way to understand the impact of the investment in terms of benefits produced is the return on investment (ROI), which compares the capital and operating cost (investment) against the total benefits. For purposes of this analysis, it was assumed CHT would be able to pay for all capital investments associated with the fare collection equipment without borrowing money. It was also assumed that operating costs would increase at a rate of 2% per

year, while revenues would remain flat for the first five years; in year five, fare revenue would increase by 5% and then remain constant until the end of the ten-year period[23].

The analysis suggests that implementing fares will not generate positive benefits for CHT even if fares are set at the high level (see Figure 12).

Figure 12 Return on Investment for Ten-Year Period

	Low Capital Investment	High Capital Investment
Low Fares	(59%)	(61%)
Medium Fares	(23%)	(28%)
High Fares	(12%)	(18%)

Source: Nelson\Nygaard Consulting Associates

SCENARIO ANALYSIS

The fare analysis suggests potential for a positive return on investment if fares are charged. However, there are a number of assumptions or potential risks associated with charging a fare. As part of understanding the return on investment, therefore, the study team tested a handful of these scenarios to test the robustness—or risk—of the ROI. The analysis examines, for example, how sensitive the rate of return is to factors that CHT may or may not be able to control.

FTA and State Transit Funding Programs

FTA administers approximately eight programs, roughly half of which are formula programs that provide basic financial support for transit services. Federal funds account for roughly $1.9 million (about 12%) of CHT's revenues annually. The majority of these funds are administered through FTA Section 5307 program, which distributes resources based on formula set by law. This formula is designed to allocate resources based on factors such as population, population density, and the number of low-income individuals as well as bus revenue vehicle miles and bus passenger miles.

Likewise, the State of North Carolina provides funding for public transportation services. The State Maintenance Assistance Program (SMAP), the largest of these programs, provides operating costs for urban, small urban and regional transit systems. Allocations are based on a formula that reflects ridership. In 2013, CHT received $2.7 million (about 17%) from the State of North Carolina.

There is the possibility, therefore, that if ridership on CHT declines, CHT could receive less federal and state funding. For purposes of this analysis, our team tested the impact of a small decline in FTA and state funding assistance (roughly 2.5%) and estimated the ROI for charging fares. The analysis suggests if a decline in federal and state funds is included, fares remain unprofitable at all fare levels (see Figure 13).

[23] Transit industry experience nationally suggests it is difficult for transit agencies to raise fares on an annual basis. Instead fares are raised periodically, roughly every 5 years.

Figure 13 Return on Investment for Ten-Year Period with Potential Loss of Federal and State Funds

	Low Capital Investment	High Capital Investment
Low Fares	(62%)	(64%)
Medium Fares	(30%)	(34%)
High Fares	(31%)	(35%)

Source: Nelson\Nygaard Consulting Associates

Assumption Test: Fare Elasticity

Two assumptions that drive the revenue projections is the portion of riders lost from the system due to the fare and the portion of people who pay the full fare. To understand the sensitivity of revenue projections to these assumptions, the study team reduced the ridership loss by half (to between 14% on the low end and 20% on the high end), and, at the same time, assumed that 75% of the riders paid a full fare. Under this scenario, the potential for revenue from the farebox increases to between $850,000 and $2 million, and the investment in fare collection systems would show a positive rate of return under the both the medium and high fare scenarios (see Figure 14).

Figure 14 Return on Investment for Ten-Year Period: Lower Fare Elasticity and Fare Collection Rate

	Low Capital Investment	High Capital Investment
Low Fares	(27%)	(32%)
Medium Fares	41%	32%
High Fares	70%	60%

Source: Nelson\Nygaard Consulting Associates

The analysis also suggests that even taking into account a loss of federal and state revenue, this scenario also produces a positive rate of return under the both the medium and high fare scenarios (see Figure 15).

Figure 15 Return on Investment for Ten-Year Period: Lower Fare Elasticity and Fare Collection Rate with loss of Federal and State Revenue

	Low Capital Investment	High Capital Investment
Low Fares	(32%)	(36%)
Medium Fares	29%	22%
High Fares	27%	20%

Source: Nelson\Nygaard Consulting Associates

Assumption Test: Portion of Riders who are UNC-Chapel Hill Affiliates

Another key assumption of the fare analysis is that roughly 60% of all CHT riders are formally affiliated with UNC-Chapel Hill as faculty, staff, or students. These riders would pay their fare as part of the pre-paid program administered by UNC-Chapel Hill. The analysis assumes no loss in ridership for these individuals.

The assumption that 60% of riders are UNC-Chapel Hill affiliates is based on survey data that shows roughly 60% of the riders begin or end their trip at UNC-Chapel Hill. It is possible that some riders may get on/off the bus near the UNC-Chapel Hill campus but are not directly affiliated with UNC-Chapel Hill. They may, for example, transfer to other transit routes (TTA), work on Franklin Street, or travel to campus for another purpose.

This assumption is critical to the analysis because if CHT ridership contains a higher portion of non-UNC-Chapel Hill affiliates, a larger number of riders may be influenced by fares. If, for example, only 40% of the CHT riders are affiliated with UNC-Chapel Hill, then the potential cash revenue increases to between $700,000 and $1.5 million. The analysis shows that the medium and high fare scenarios would have a positive ROI in this assumption test (see Figure 16).

Figure 16 Return on Investment for Ten-Year Period with Fewer UNC-Chapel Hill-Affiliated Riders

	Low Capital Investment	High Capital Investment
Low Fares	(39%)	(43%)
Medium Fares	14%	7%
High Fares	30%	22%

Source: Nelson\Nygaard Consulting Associates

APPENDIX A: RESEARCH TRIANGLE PARK TRANSIT AGENCY FARE STRUCTURES

Agency	One-Way Cash Fare	Discount for People +65 and with a Disability	Other Fare Categories	Pass Types
Chapel Hill Transit (CHT)	Free	Free	Pittsboro Express - $3.00 one-way Tar Heel Express - $3.00 one-way	31 Day Pass for Pittsboro Express ($65)
Capital Transit Authority (CAT)	$1.00	$0.50	Children less than 12 – Free Adults aged 65+	CAT Day Pass ($2) CAT 5 Day Pass ($8.50) CAT 31 Day Pass ($36) $25 Stored Value Card ($20)
C-Tran (Cary)	$1.25	$0.60		C-Tran Day Pass ($2) C-Tran Weekly Pass ($12) C-Tran 31 Day Pass ($45)
Durham Area Transit Authority (DATA)	$1.00	$0.50	Children less than 12 – Free Adults aged 65+ - Free Students less than 17 - $0.25	DATA Day Pass ($2) DATA 5 Day Pass ($8.50) DATA 7 Day Pass ($12) DATA 31 Day Pass ($36)
Triangle Transit Authority (TTA)	$2.00	$1.00	Express - $2.50 Transfers (regular to express) - $0.50	Express Day Pass ($5) Express 31-Day Pass ($85) 10-Ride Pass ($16) Discounted Bundles of Day Passes $25 Stored Value Card ($20)
North Carolina State University Wolfline	Free	Free	n/a	n/a
Orange County Public Transportation (OPT)	Fixed Route Service - $2.00 Hillsboro Circulator – Free	$1.00 (persons with disabilities) Free (adults 60+)	OPT Route 420 - $2.00	None

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Agency	One-Way Cash Fare	Discount for People +65 and with a Disability	Other Fare Categories	Pass Types
Regional Pass (GoPass) – unlimited rides on CAT, C-Tran, DATA and TTA				Regional Day Pass ($4) Regional 5-Day Pass ($17) Regional 31 Day Pass ($68)

Source: GoTriangle Webpage (2014)

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