CITYEXPRESS
COST/BENEFIT ANALYSIS

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Rural Transit Planning Study - Phase II
CityExpress:
Cost/Benefit Analysis

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1. Introduction

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The "CityExpress Service Expansion" report, published in December 1999 by the Southwest Region Planning Commission (SWRPC) with the assistance of Home Healthcare, Hospice and Community Services (HCS) and the New Hampshire Department of Transportation (NHDOT), recommended increasing public transportation in Keene from a single route, operating between 9 a.m. and 4 p.m. weekdays, to a five-route system with expanded hours and service seven days a week. That report identified segments of the City's population, workforce, and visitors where there was believed to exist un-met demand for public transportation and designed routes to meet that need. During 2000 and 2001, HCS increased service to three routes, operating from 6:30 a.m. to 7 p.m., six days a week. Ridership in that time period increased 62%. The expansion was funded by the NHDOT, HCS, the City of Keene and Keene State College.

This "CityExpress Cost/Benefit Analysis" report is a second phase of the ongoing Southwest Region rural transit planning project - whose overarching goal is to provide informational support for policy discussions about the role, operation, and level of transit service in Keene and the Southwest Region. Subsequent phases of this planning project will need to go beyond the funding and operation of a transit system to explore how the service integrates with and supports the full spectrum of community development goals.

Overview:

An effective transportation system for any city is one that provides: 1) maximum levels of mobility and access for everyone, 2) facilitates the efficient movement of people and goods into, out of, and throughout the city, and 3) combines automobile, public transportation, bicycle, and pedestrian transportation in a seamless network of roads, sidewalks, and paths. The notion of a *balanced* system is critical. Focusing on any one element of the system too heavily will inevitably isolate certain segments of the population and lead to unnecessary, and often unintended, monetary and social costs. Unfortunately, the predominant trend since the end of World War II has been away from the balanced transportation system approach and has focused primarily on the convenient, but relatively inefficient, personal automobile.

> *"Effective transit service throughout the City is essential to the success of the vision proposed here."*
>
> *Draft Master Plan - Alternative Transportation Chapter*, City of Keene, as of Fall 2001.

It is evident that decisions affecting the transportation system can have significant impacts on the local and regional economy, the environment, and quality of life. But how significant are these impacts? What are the variables at play in the decision making process and how do they function with respect to dollars spent on infrastructure? What decisions regarding Keene's transportation system can be made so that these benefits are maximized?

Study Focus:

This report develops a set of distinct, quantifiable variables that fluctuate with changing levels of transit, automobile, bicycle, and pedestrian travel. These variables include economic factors such as avoided public expenditures and preservation of public and private infrastructure investment, environmental factors such as air and water quality, and social factors such as safety, and personal mobility. To determine the impacts

> *"Public transportation and pedestrian and bicycle access will be elevated as a design criteria for the City's transportation infrastructure and land use, so as not to rely solely on the [automobile] for movement throughout the City."*
>
> *Draft Master Plan - Alternative Transportation Chapter*, City of Keene, as of Fall 2001.

of increased transit service, the values of these factors are quantified and calculated in terms of a cost or benefit for varying transit system sizes.

The benefit of increased transit service results primarily from the transfer of auto trips to bus trips - and the subsequent removal of personal automobiles from the road. This decrease in automobile travel can lead to improvements in air and water quality, traffic congestion relief, and a decreased burden on road and parking infrastructure. Transit service also significantly increases personal mobility for those unable to own or operate an automobile. The benefits from increased transit service do come with a cost - namely, the cost to purchase, maintain, and manage the transit fleet. This report evaluates the extent to which the benefits of increasing transit service in the City of Keene outweigh the costs of providing the service and of aligning policies to support transit service in the City.

Outcomes:
This report addresses each variable presented above to determine its behavior as the transit fleet increases from the current 3-route system up to a near-term goal of 5-routes, and beyond to a hypothetical 10-route system. The variables are quantified in terms of dollars per year and the ratio of benefit-to-cost is determined for various system sizes. As the conclusions of this report will demonstrate, in terms of cost to benefit, every $1.00 spent on transit service in the City of Keene has the potential to generate over $2.00 in economic, social, and environmental benefit. It is important to note here that this greater than 2-for-1 return means that an investment in transit will provide not only increased mobility and a more balanced transportation system, but will also lead to significant economic, environmental, and social benefits over and above the investment needed to provide the service.

Potential Benefits from Increased Transit Service in Keene

(Application of unit costs from transportation planning literature to a 5-route system in Keene)

- **Safety** - Given the same number of miles traveled, travel by bus has been shown to be nearly 40 times safer than auto travel and can potentially lead to savings of over **$12,000** a year in emergency response, insurance, and medical expenditures.

- **Improved Air & Water Quality** - Increased transit ridership levels will result in improved air and water quality and can lead to over **$14,000** annually in social health benefits.

- **Reduced Roadway and Infrastructure Investments** - By reducing the number of automobiles on the road, costly roadway expansion and parking enhancement projects can be delayed or avoided and can potentially lead to savings of over **$60,000** in average annual infrastructure expenditures.

- **Lower Personal Transportation Costs** - Riding transit regularly is much less expensive than owning and operating a personal vehicle and can lead to nearly **$67,000** in annual benefits, or, almost **$500** per person per year switching from driving to riding the bus.

Since this report is focused on the costs and benefits associated with increased transit service in the City of Keene, the variables will be explored in the context of a changing transit system. Throughout this

analysis the reader should bear in mind that a transit system also relies on the development and maintenance of an integrated bicycling and walking network, coordinated land use planning, and the support of City officials, merchants, and residents to be effective.

Report Layout:
This report begins with an overview of recent CityExpress trends and indicators which serve as a base for subsequent policy analysis and cost/benefit discussions. The trend and indicator summary is followed by an overview of current City policies found in the Master Plan, Site Plan and Subdivision Regulations, Zoning Ordinance, and Community Goals that relate to transportation and growth in Keene. Following this policy analysis is the final section which explores the costs and benefits associated with increased transit service in Keene.

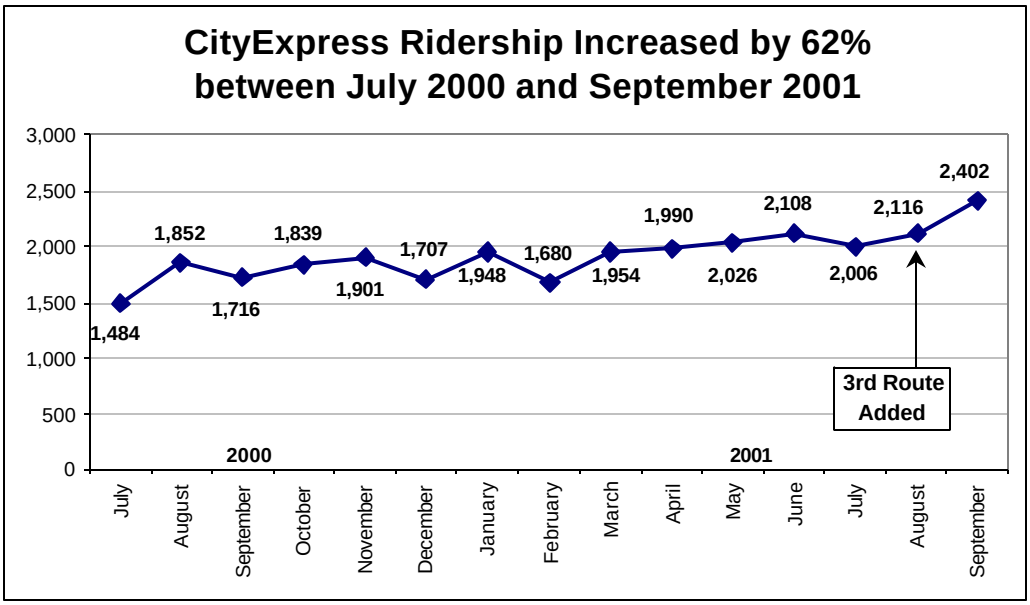
2.

Chapter 1: Introduction | Chapter 2: Trends & Indicators | Chapter 3: Policy Analysis | Chapter 4: Cost / Benefit Analysis | Chapter 5: Conclusions

Review and Comparison of Current Trends and Indicators

This chapter presents an overview of current CityExpress ridership and operating trends. Absolute ridership numbers over the last 15 months are presented along with related benchmarks to establish trends in CityExpress service over the last year and a half. Additionally, CityExpress fiscal and performance benchmarks are compared with the six other rural New Hampshire transit providers to see how the CityExpress service characteristics relate to those from comparable transit services.

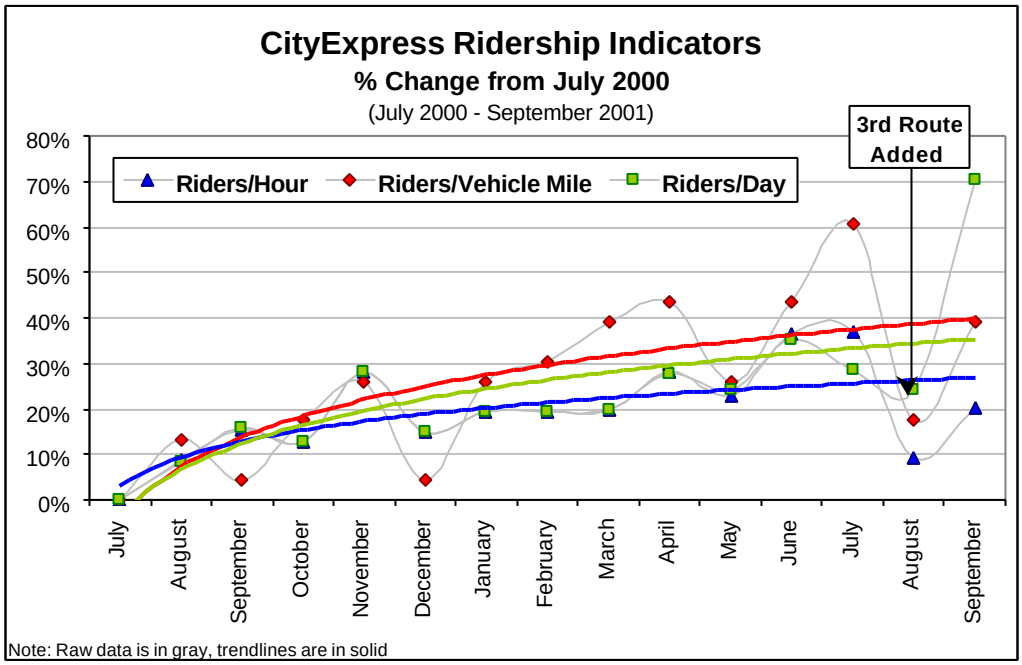
Ridership Trends:
Over the last 15 months, CityExpress service and ridership have witnessed increases. In terms of monthly ridership, the CityExpress has experienced over a 900 person per month increase *(a 62 % increase)* since July 2000. This increased ridership can be attributed to an increased service area (with a third route added in August of 2001 serving Keene State College) and to improved routing and longer service hours.



Source: Home Healthcare, Hospice and Community Services (HCS), 2001

Another way to examine ridership rates is to look at *normalized* trends in passenger trips. By normalizing the ridership figures, one is dividing the total number of trips per month by a factor relating to the amount of service provided (in this case, hours of service, vehicle miles of service, and days of service provided). The resulting value in each case is a ridership rate that does not vary with the amount of service provided. For example, a particular transit system provides 100 hours of service per month and has 100 riders per month. At some point it decides to double its service to 200 hours per month and ridership increases to 200 riders. In absolute terms, ridership can be said to have doubled - from 100 to 200 riders per month. However, by normalizing the ridership by the hours of service, the resulting rate would stay at 1 (i.e. 100 riders/100 hours = 200 riders/200 riders = 1). There are two main benefits of looking at these normalized rates. The first is that it allows one to see how ridership has increased or decreased regardless of changes in the level of transit service. The second benefit behind normalizing is that it makes it possible to compare rates with other transit providers.

The chart below shows trends in these normalized ridership rates (trips/hour, trips/mile, trips/day) in the 15-month period from July 2000 to September 2001. The trend lines show a gradual increase for all three indicators over a July 2000 base figure. This is a positive trend demonstrating that transit ridership is increasing both in absolute terms and in relation to increasing service levels.



Source: Home Healthcare, Hospice and Community Services (HCS), 2001

Performance Benchmark Comparison:

Another important factor in understanding the operational characteristics of the CityExpress system is to see how it compares with other similar transit systems. For the purpose of this report, we have compared five key operating indicators for the CityExpress with those from the six other rural transit providers in New Hampshire. The results of this comparison are shown in the table below and demonstrate that the CityExpress indicators are all relatively close to the average of the other systems. The CityExpress cost per mile and cost per trip indicators are slightly above the calculated average, while the cost per hour, trips per mile and trips per hour indicators are all slightly below the average of the six providers.

Comparing CityExpress Operating Figures with Other Rural NH Transit Providers

	City Express	Advance Transit	Greater Laconia Transit Agency	Tri-County CAP	COAST[1]	Community Transportation Services	Concord Area Transit	*Average: Non-CityExpress*
Area Served	Keene	Hanover/ Lebanon[2]	Lakes Region	Berlin/ Coos Co.	Seacoast Region	Claremont/ Newport	Concord	--
Cost/ Vehicle Mile	$2.41	$2.53	$0.62	$1.55	$2.02	$3.36	$3.50	***$2.26***
Cost/Service Hour	$26.15	$37.38	$12.79	$25.19	$42.96	$42.56	$43.52	***$34.07***
Cost/Passenger Trip	$8.22	$2.87	$2.84	$10.94	$13.70	$11.34	$5.59	***$7.88***
Passenger Trips/Mile	0.28	0.88	0.22	0.14	0.15	0.30	0.63	***0.39***
Passenger Trips/Hour	3.15	13.04	4.50	2.30	3.13	3.75	7.78	***5.75***

Source: NHDOT Monthly Productivity Reports for Fiscal Year 2001

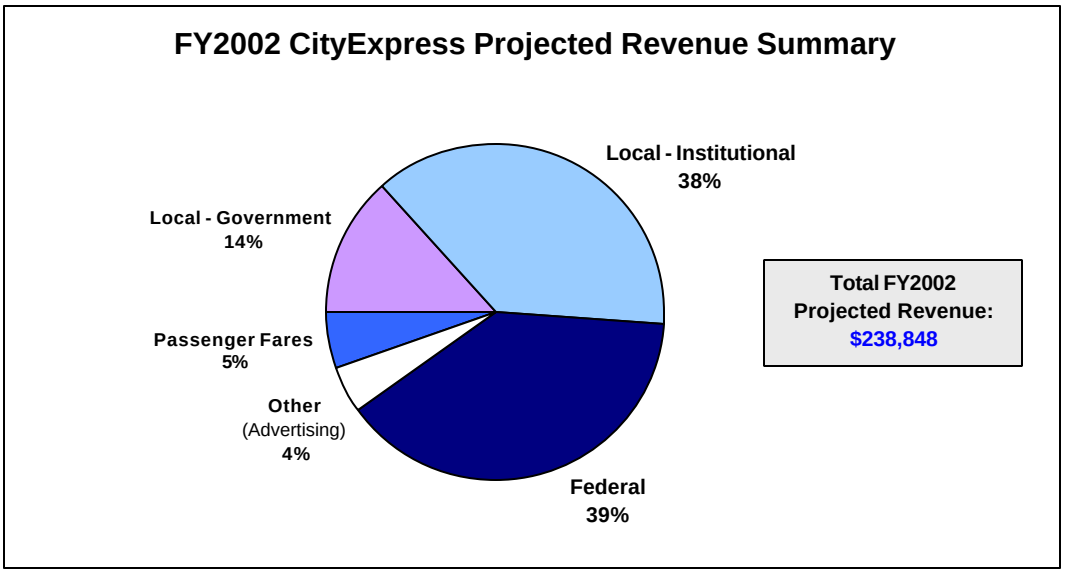
[1] Includes total for both rural and small urban portions (i.e. Sections 5307 and 5311) of COAST service.
[2] Also serves portions of Windsor County, Vermont

Revenue Sources:
The table and chart below show a breakdown of projected Fiscal Year 2002 revenue by source for the CityExpress. The funding sources are categorized as either passenger fares, local, federal, or other. Revenue generated locally is separated further into a *government* category and an *institutional* category. The *government* category captures all funding provided by the City of Keene while the *institutional* category captures funding provided by Keene State College and the Cheshire Health Foundation. The revenue generated locally (from governmental and institutional sources combined) accounts for over half (51%) of the projected FY2002 revenue. Federal funds passed through NHDOT account for nearly 39% of the revenue. Passenger fares and advertising revenue make up the remainder of the CityExpress funding contributing 5% and 4%, respectively.

FY2002 CityExpress Projected Revenue Summary

Source		Funding	% of Total
Passenger Fares		$13,000	5.4%
Local - Government	City of Keene	$32,348	13.5%
Local - Institutional	Keene State College	$75,000	31.4%
	Cheshire Health Foundation	$15,000	6.3%
Federal		$93,000	38.9%
Other - Advertising		$10,500	4.4%

Source: Home Healthcare, Hospice and Community Services (HCS), 2001



Source: Home Healthcare, Hospice and Community Services (HCS), 2001

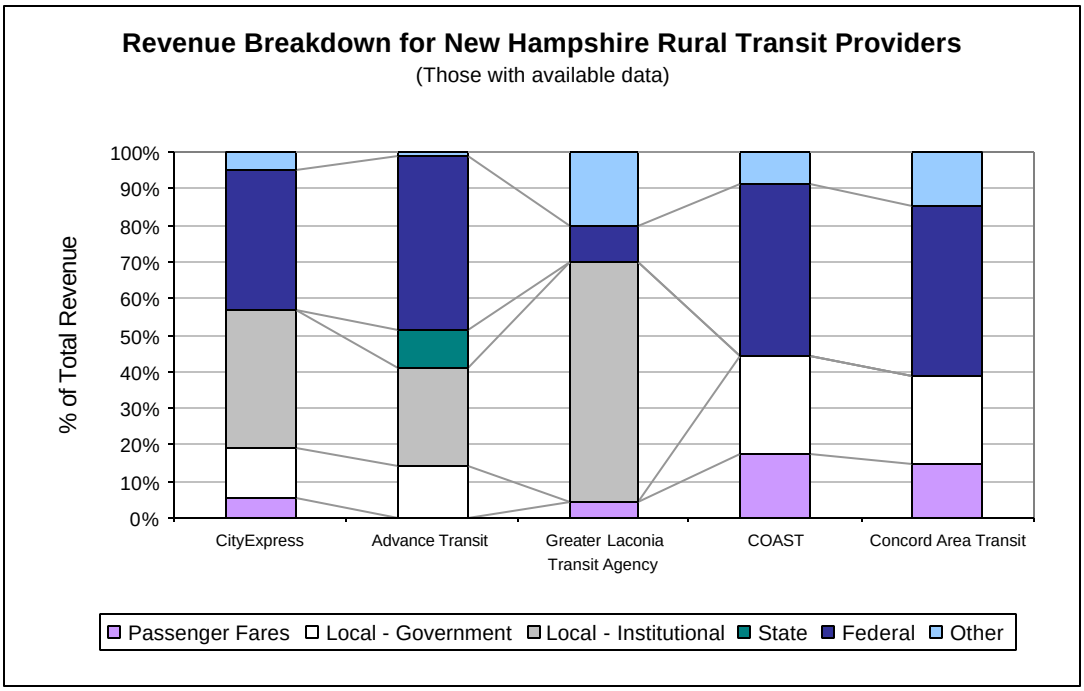
We then compared the revenue breakdown for the CityExpress with the other rural New Hampshire transit providers. For the New Hampshire transit providers with data available, it was found that there was a wide range in the breakdown of their revenue sources. Despite this relatively large variability, the CityExpress revenue breakdown was found to fall close to the average of the other providers surveyed.

Comparing CityExpress Revenue Breakdowns with Other Transit Providers

(Percentage of Operating Funds by Source - For Those Agencies With Available Data)

	City Express	Advance Transit	Greater Laconia Transit Agency	COAST[3]	Concord Area Transit	*Average: Non-CityExpress*
Area Served	Keene	Hanover/ Lebanon[4]	Lakes Region	Seacoast Region	Concord	
Passenger Fares	5%	0%	4%	17%	15%	**9%**
Local - Government	14%	14%	0%	27%	23.5%[5]	**16%**
Local - Institutional (Colleges, Hospitals, etc.)	38%[6]	27%	66%	0%	0%	**23%**
State[7]	--	10%	--	--	--	**2%**
Federal	39%	48%	10%	47%	47%	**38%**
Other (Advertising, charter services, etc.)	4%	1%	20%[8]	9%	14.5%[9]	**11%**

Source: Home Healthcare, Hospice and Community Services (HCS), 11/01
Each operator provided details for their service.



Source: Home Healthcare, Hospice and Community Services (HCS), 11/01
Each operator provided details for their service.

[3] Includes total for both rural and small urban portions (i.e. Sections 5307 and 5311) of COAST service.
[4] Also serves portions of Windsor County, Vermont
[5] Local - Government: 21% City of Concord, 2.5% County
[6] Local - Institutional sources: $75,000 Keene State College, $15,000 Cheshire Health Foundation
[7] New Hampshire transit providers do not receive State funds for operations or capital purchases. *Advance Transit* does receive State funds from the State of Vermont as the service area extends into Windsor County, VT.
[8] Other sources - 20% Advertising and charter service
[9] Other sources - Advertising: 2.5%, Contractual Services: 1.5%, Transit Agency: 10%

3.
Policy Analysis

Before embarking on a detailed analysis of the costs and benefits associated with increased transit service in the City of Keene, we thought it would prove beneficial to present a review of the policies currently shaping decisions in Keene. More specifically, this examination focuses on those policies that directly impact, or in some way influence, transportation in and around the City. The idea behind this examination is to show: 1) whether current City policies are generally supportive or unsupportive of transit, 2) whether any internal conflicts exist between the policy statements, and 3) how increased transit service would impact the polices or address any internal conflicts.

Although sections from the Alternative Transportation chapter of the *Draft Keene Master Plan Update* were cited in this report's introduction and provide a glimpse into current policy dialogue in the City, we have decided to reference only the planning documents listed below that have received formal City endorsement.

POLICY ANALYSIS METHODOLOGY

To determine the current policies guiding Keene's decision-makers the following current City plans were reviewed:

- City of Keene Master Plan[10]
- City of Keene Zoning Ordinance[11]
- City of Keene Planning Board Site Plan and Subdivision Regulations[12]
- City of Keene Community Goals[13]

During the review of these plans, key policy statements that related to transportation in and around Keene were noted. These policy statements were then grouped into the ten categories listed below.

Policy Statement Categories Found in Keene Plan Review:

1. Promote Development Within the Bypass
2. Pursue Multimodal Transportation Options (i.e. bus, bike, pedestrian) as a way to Increase Mobility and Reduce Congestion
3. Promote Rational, Economical, and Environmentally Sound Land Use Decisions
4. Preserve and Protect Natural Resources
5. Maintain a Regional Focus
6. Promote and Maintain Community Economic Viability
7. Preserve Existing/Traditional Neighborhoods
8. Maintain and Expand Safety, Capacity, and Convenience of Major City Roads
9. Additional Parking Provisions are Necessary for the Downtown to Maintain Vitality
10. Ensure No Net Loss of Housing

Each of these policy groupings was examined individually to see: 1) what the future conditions would be under this policy statement, 2) which (if any) other policy statements conflict with it, 3) how increased transit service applies to the policy, and 4) whether the policy is generally supportive or potentially unsupportive of transit service in Keene.

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[10] Based primarily on the *Keene Master Plan Executive Summaries*, prepared by the Keene Planning Board, June 1995.
[11] *City of Keene Zoning Ordinance*, September 3, 1994.
[12] *Planning Board Site Plan and Subdivision Regulations*, adopted September 26, 1994, revised August 23, 1999.
[13] *City of Keene Community Goals*, prepared by the Community Goals Committee, November 1995.

ANALYSIS OF POLICY STATEMENT GROUPINGS

Policy #1 - Promote Development Within the Bypass:

Policy References: This policy was referenced in the transportation, land use, downtown, and economic development chapters of the Master Plan, the Keene Zoning Ordinance, and the Community Goals.

Future Conditions and Relation to Transit: This policy would tend to encourage increased densities of commercial and residential uses within the bypass and is generally a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policies #7, 8, and 9. A potential conflict exists with policy #7 *(preserve existing/traditional neighborhoods)* since the increased development within the bypass may result in the loss of some existing traditional neighborhoods. A potential conflict exists with policy #8 *(maintain and expand safety, capacity, convenience of major city roads)* as expanded roads are not especially conducive to development within the bypass. A potential conflict exists with policy #9 *(additional parking provisions necessary to maintain downtown vitality)* as the land needed for increased parking facilities will also be needed for increased growth within the bypass.

Impacts of Increasing Transit Service: A fully-functioning transit service can provide better and more convenient access into and around the growing central areas - thus reducing the need for wider roads and more parking spaces within the bypass.

Policy #2 - Pursue Multimodal Transportation Options (i.e. bus, bicycle, pedestrian) as a means to Increase Mobility and Reduce Congestion:

Policy References: This policy was referenced in the Community Goals report.

Future Conditions and Relation to Transit: This policy would tend to lead to increased transportation alternatives within and into the City and is definitely a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policies #8 and 9. A potential conflict exists with policy #8 *(maintain and expand safety, capacity, convenience of major city roads)* as wider, faster streets are not conducive to transit, bicycle, or pedestrian mobility options. A potential conflict exists with policy #9 *(additional parking provisions necessary to maintain downtown vitality)* as additional downtown parking makes driving more convenient and the use of alternative modes less attractive.

Impacts of Increasing Transit Service: An effective transit service would serve as a multimodal transportation option and would reinforce travel by bicycle or on foot around town.

Policy #3 - Promote Rational, Economical, and Environmentally Sound Land Use Decisions :

Policy References: This policy was referenced in the Land Use chapter of the Master Plan and in the Community Goals report.

Future Conditions and Relation to Transit: This policy would tend to foster sound growth decisions both within and outside the bypass and is generally a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policy #8 *(maintain and expand safety, capacity, convenience of major city roads)* as wider, faster roads are not particularly compatible with rational, environmentally sound land use decisions.

Impacts of Increasing Transit Service: A fully-functioning transit service can reduce the need to expand any existing roads as well as significantly improving regional air and water quality.

Policy #4 - Preserve and Protect Natural Resources:

Policy References: This policy was referenced in the Open Space chapter of the Master Plan, in the Subdivision and Site Plan Review Regulations, and in the Community Goals report

Future Conditions and Relation to Transit: This policy would tend to foster decisions leading to increased protection of natural resources and a sustainable community and can be considered a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policies #9 and 10. A potential conflict exists with policy #9 *(additional parking provisions necessary to maintain downtown vitality)* as the additional parking facilities may utilize valuable downtown natural areas, or harm the downtown natural environment by increasing the amount of impervious surface. A potential conflict exists with policy #10 *(ensure no net loss of housing)* as the potential for additional residential development outside the bypass to replace that lost within the bypass may infringe on significant natural resources.

Impacts of Increasing Transit Service: A fully-functioning transit service can reduce the need to expand any existing roads as well as significantly improving regional air and water quality.

Policy #5 - Maintain Regional Focus :

Policy References: This policy was referenced in the Land Use chapter of the Master Plan and in the Community Goals report.

Future Conditions and Relation to Transit: This policy would tend to foster regionally coordinated growth and decision making and is generally a transit supportive policy.

Potential Policy Conflicts: This policy is not in any apparent conflict with the other identified policies.

Impacts of Increasing Transit Service: A fully-functioning transit service can be extended to efficiently and effectively serve a regional population and employment base.

Policy #6 - Promote and Maintain Community Economic Viability:

Policy References: This policy was referenced in the Community Goals report.

Future Conditions and Relation to Transit: This policy would tend to foster a strong and diverse local economy and a vibrant downtown and is generally a transit supportive policy.

Potential Policy Conflicts: This policy is not in any apparent conflict with the other identified policies.

Impacts of Increasing Transit Service: A fully-functioning transit service can improve consumers' access to retail sites as well as significantly improving employees' access to their workplace.

Policy #7 - Preserve Existing/Traditional Neighborhoods:

Policy References: This policy was referenced in the Housing Plan chapter of the Master Plan.

Future Conditions and Relation to Transit: This policy would tend to protect existing neighborhoods that incorporate traditional design elements including sidewalks, smaller lot sizes, and mixed uses and is thus a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policies #1, 8, and 9. A potential conflict exists with policy #1 *(promote development within the bypass)* as development within the bypass may displace existing neighborhoods. A potential conflict exists with policy #8 *(maintain and expand safety, capacity, convenience of major city roads)* as wider, faster roads are not compatible with traditional residential neighborhoods. A potential conflict exists with policy #9 *(additional parking provisions necessary to maintain downtown vitality)* as the additional parking facilities may displace existing neighborhoods or diminish the neighborhood character.

Impacts of Increasing Transit Service: A fully-functioning transit service can reduce the need to expand existing roads, preserve community character, and improve overall mobility.

Policy #8 - Maintain and Expand Safety, Capacity, Convenience of Major City Roads:

Policy References: This policy was referenced in the Transportation and Downtown Plan chapters of the Master Plan, and in the Subdivision and Site Plan Review Regulations.

Future Conditions and Relation to Transit: This policy would tend to lead to wider, faster roads into town and is generally not a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policies #1, 2, 3, 7, and 9. These conflicts arise as the wider and faster roads needed to maintain and expand safety and capacity are not necessarily compatible with the increased development within the bypass, the multimodal travel options, sound land use decisions, traditional neighborhoods, and additional parking encouraged in the policies outline above.

Impacts of Increasing Transit Service: A fully-functioning transit service has the potential to increase the capacity and safety on existing roads and delay or eliminate the need for costly expansions or new roadway infrastructure.

Policy #9 - Additional Parking Provisions Necessary for the Downtown to Maintain Vitality:

Policy References: This policy was referenced in the Downtown Plan chapter of the Master Plan.

Future Conditions and Relation to Transit: This policy would tend to lead to increased parking infrastructure downtown making driving more of an attractive option, the utilization of valuable downtown land for parking, and significant increases in impermeable surfaces, and is therefore generally not a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policies #1, 2, 4, 7, and 8. These conflicts arise as the additional land needed for expanded parking facilities, and the subsequent loss of developable land or natural areas are in conflict with the increased development within the bypass, the multimodal travel options, protection of natural resources, traditional neighborhoods, and expanded roadways encouraged in the policies outlined above.

Impacts of Increasing Transit Service: A fully-functioning transit service has the potential to delay or eliminate the need for additional or expanded parking facilities by shifting auto trips to bus trips.

Policy #10 - Ensure No Net Loss of Housing:

Policy References: This policy was referenced in the Housing Plan chapter of the Master Plan.

Future Conditions and Relation to Transit: This policy may lead to increased residential densities outside of the bypass to make up for housing units lost to commercial, industrial, or parking infrastructure growth within the bypass. If some degree of density were to be maintained immediately outside of the bypass, this could be considered a transit supportive policy.

Potential Policy Conflicts: Potential conflicts exist with policy #4 *(preserve and protect natural resources)* as the potential for additional residential development outside the bypass to replace that lost within the bypass may infringe on significant natural resources

Summary of Policy Analysis

The intention behind this overview was to provide some general context for existing policy directions in Keene and to shed light on any conflicts that could potentially be resolved (or created) through increased transit service in the City. One of the more significant conclusions reached from this exercise is the fact that the policy statements found in Keene's guiding plans are, for the most part, not in conflict with each other and are generally supportive of increased transit service. It can be shown that many of the internal conflicts, such as the conflict between maintaining neighborhood character and expanding roadway capacity, could be resolved through the implementation of an enhanced transit strategy for the City. A more multimodal, integrated approach to transportation in Keene would help to resolve these conflicts and would guide Keene in the direction envisioned in this report's introduction.

4.

Cost/Benefit Analysis[14]

This section explores the costs and benefits associated with increasing transit service in the City of Keene. This analysis will demonstrate how certain quantitative indicators vary as the size of the CityExpress transit system moves from the current 3-route transit system to a hypothetical 5-route future system. When additional transit service is provided, whether through additional routes, more frequent service, or both, do indicators such as traffic congestion, air pollution and City expenditures go up or down? Which direction is a "good" direction for the indicators to move? How fast does one indicator move in relation to the others? How does one go about quantifying and calculating the benefits associated with something like personal mobility in terms of dollars per day? The analysis presented in this chapter will show how these indicators were quantified, how each varies as the transit system grows, and the overall benefit or cost associated with increasing transit service.

COST/BENEFIT METHODOLOGY

This cost/benefit methodology begins with an overview of the identified benefit and cost indicators used to quantify the impacts of increasing transit service in Keene. For each indicator, a summary of its development and quantification is provided, as well as details describing how the factor varies with increased transit in terms of dollars per year. In conducting this analysis, a number of variables not normally thought of in terms of dollar per day benefits or costs (e.g. air quality and safety) were examined and quantified. All the benefit and cost indicators are then summed to determine the overall benefit achieved from increasing transit service.

Benefits Associated with Increased Transit Service:

The benefits associated with increasing transit service in and around the City of Keene are numerous and include benefits to more than just the user of the public transit system. These benefits will be broken down into the following categories and are discussed in more detail on the following pages:

- Social and environmental benefits;
- Local and regional economic benefits; and
- Transit user benefits

Costs Associated with Increased Transit Service:

The costs associated with increased transit service are for the most part limited to those costs required to operate and maintain a transit system. These costs can be broken down into the capital costs, or those costs required to purchase vehicles and other amenities, and operating costs, or those costs required to pay drivers, maintain vehicles, prepare schedules, and other similar operating measures. Also included in the discussion, but not quantified, is the cost of adjusting normal operating and decision-making procedures to create a planning environment that fosters transit growth in the City. The costs are broken down into the following categories and are discussed in more detail on the following pages:

- Transit operating costs;
- Transit capital costs; and
- Cost associated with changing regular operating procedures

[14] The costs and benefit figures presented in this chapter are based on documented methodologies and planning assumptions and all attempts were made to most accurately reflect current and future conditions in Keene. However, the cost and benefit dollars figures calculated in this chapter may not necessarily reflect actual future costs and benefits.

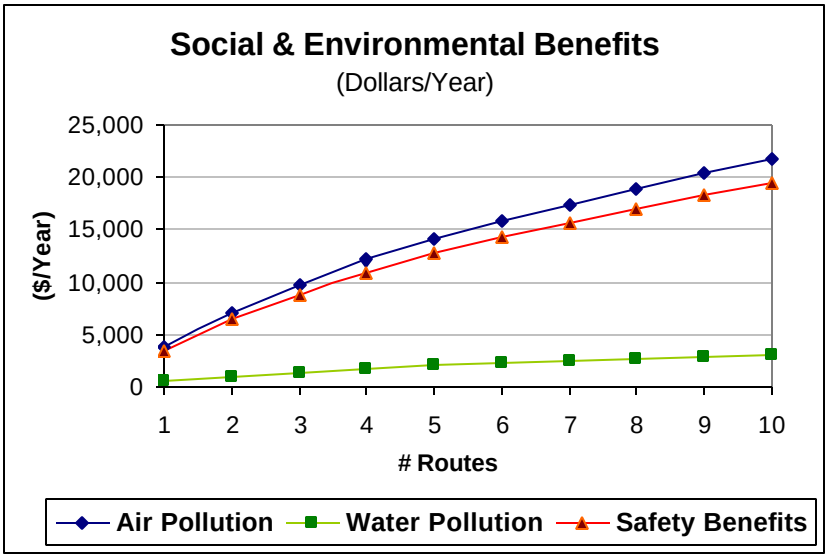
1. Social and Environmental Benefits:

The social and environmental benefits of increasing transit service can be the most noticeable, but are often the most difficult to quantify. For example, how can factors such as decreased noise pollution, greater neighborhood vitality, and social equity (all outcomes of increased transit) be transcribed into terms of *dollars saved per day?* For the purposes of this analysis, we have limited the scope of quantifiable social and environmental benefits to reduced air pollution, reduced water pollution, and increased roadway safety. The table below shows benefits, in terms of dollars per day, associated with increasing transit ridership. Each benefit's methodology is described in detail following the summary table and chart.

Summary of Social and Environmental Benefits

	Ridership	# Auto Trips Reduced	Daily VMT Reduced	Air Pollution	Water Pollution	Safety Benefits	Total Annual Benefits
	One-Way	1.15 persons/ vehicle	5 mi avg. trip length	$0.069/Mile	$0.01/Mile	$0.062/Mile	
# Rts	Trips/Day	Trips/Day	Miles/Day	$/Year	$/Year	$/Year	$/Year
1	50	43	217	$3,780	$548	$3,397	**$7,724**
2	95	83	413	$7,182	$1,041	$6,453	**$14,676**
3	130	113	565	$9,828	$1,424	$8,831	**$20,083**
4	160	139	696	$12,096	$1,753	$10,869	**$24,718**
5	186	162	809	$14,062	$2,038	$12,635	**$28,735**
⬇	⬇	⬇	⬇	⬇	⬇	⬇	⬇
10	287	250	1248	$21,697	$3,145	$19,496	**$44,338**

Note: Factors may exhibit some variability when the number of trips is very small



- Air Pollution: Although a traditional diesel bus typically produces a larger quantity of harmful pollutants than a personal automobile, the opportunity presented by a bus to potentially take as many as forty personal vehicles off the road for a given route provides for significant reductions in overall harmful pollutant production. *(See the "Packing Pavement" demonstration below)* The overall effect on air quality of switching from diesel bus engines to propane, natural gas, or electric powered vehicles presents an opportunity for even greater reductions in harmful pollutant emissions.

"Packing Pavement" Demonstration

Road Filled With 40 Cars

Cars Replaced with 40 People

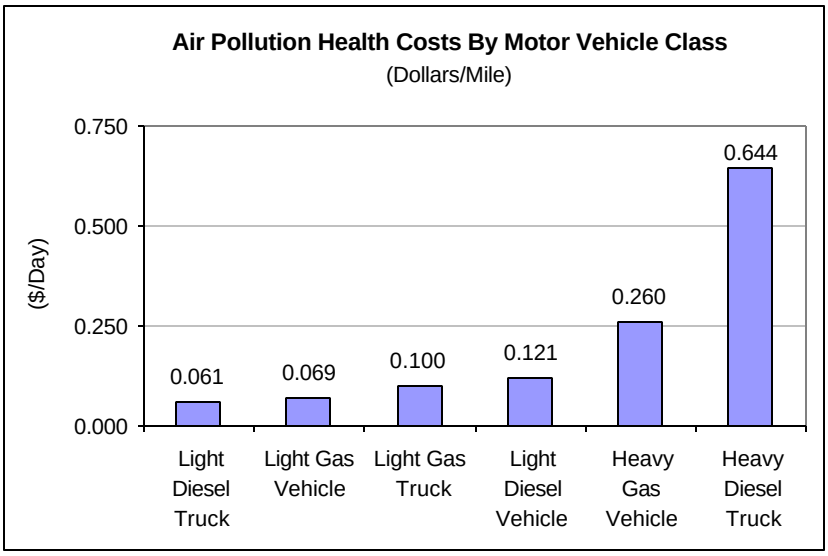
40 People in One Bus

40 People Walking & Biking

SOURCE: Jim Beamguard for the TampaTribune, "Packing Pavement", 7/1/99

Based on research conducted by the American Public Transit Association, one person converting from driving to riding the bus for a year reduces, on average, 130 pounds of harmful emissions - including over 9 pounds of hydrocarbons, over 60 pounds of carbon monoxide, and nearly 5 pounds of nitrogen oxide. A number of studies have been conducted to show typical conversions from pounds per day of emission reductions to reductions in terms of dollars per day, primarily through benefits from improved social health and welfare.[15] When quantifying these impacts in terms of social health costs, reductions from vehicles removed from the road can range from $0.64 per mile for heavy diesel trucks to $0.06 per mile for a light duty diesel truck.[16] For purposes of this analysis, we used an average rate for light-duty gasoline automobiles of $0.069 per mile of travel reduced. *(See table on the following page)*

[15] As referenced in Hovee, Eric D., "Socio-Economic Benefits and Impacts of Transit", June, 1997, page 34.
[16] Litman, Todd, *Defining and Quantifying Public Transit Benefits*, February, 1997.



Source: Donald McCubbin and Mark Delucchi, *Social Cost of the Health Effects of Motor Vehicle Air Pollution*, Institute of Transportation Studies, 1996, Table 11.7-6.

- Water Pollution: Automobiles contribute significantly to the degradation of water quality through oil and gas leaks in parking lots, roads, and gas stations. The large expanse of paved parking areas needed to accommodate automobiles also contributes to increased stormwater management costs, reduced groundwater recharge areas, and the degradation of water quality.

  Research has shown financial impacts on water quality can range from a maximum of $0.2 per mile of auto travel reduced for a major oil spill to $0.01 per mile reduced for minor spills, road salt, and hydrologic impacts.[17] For purposes of this analysis, we used the more conservative rate of $0.01 per mile of auto travel reduced.

- Safety Benefits: Research into the relative safety of transit versus automobiles shows that transit riders are much less prone to accidents than those in cars. In fact, one study concluded that, given the same number of miles traveled, travel by bus is nearly 40 times safer than auto travel.[18] Given this heightened safety of transit use over automobile use, it can be assumed that a quantifiable safety benefit in terms of fatalities, injuries, and property damage will ensue as transit ridership increases.

  For purposes of this report, we utilized an estimate of $0.062 of benefit for each mile shifted from driving to transit. This value was calculated by factoring in insurance costs, property damage, and "human capital", or the calculated value of a person's life.[19] Using determined factors for the relative likelihood and severity of an automobile and transit crash, this per mile estimate of benefit was calculated to be $0.062 per mile.

[17] Arnold, Chester Jr., "Impervious Surface Coverage", *Journal of the American Planning Association*, Spring, 1996
[18] Donald Camph, "Dollars and Sense: The Economic case for Public Transportation in America", July, 1997
[19] Todd Litman, " Evaluating Public Transit Benefits and Costs", for the Victoria Policy Institute, December 1999

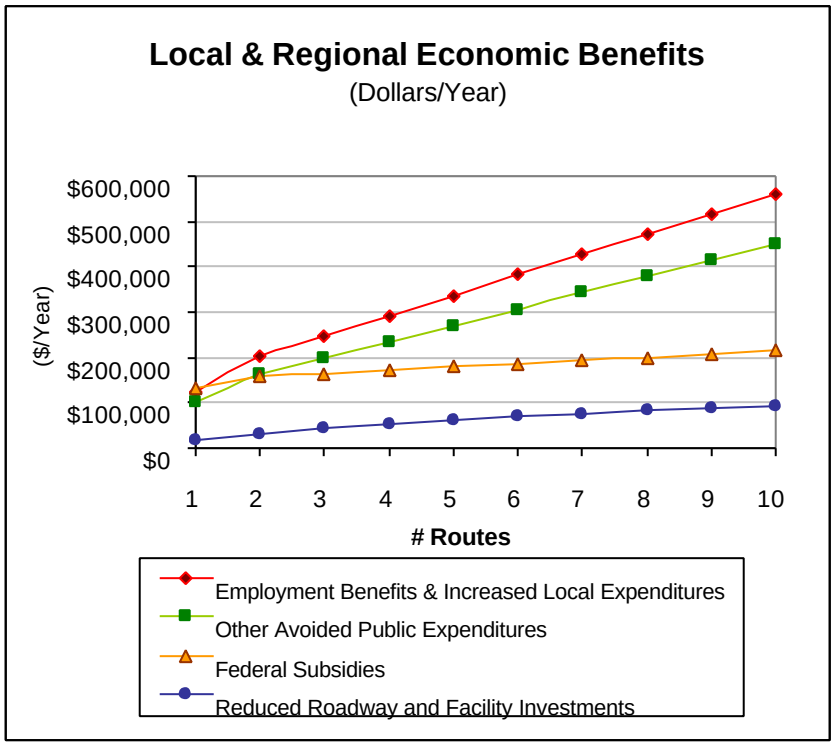
2. Local and Regional Economic Benefits:

The local and regional economic benefits quantify many of the positive impacts of increased transit service that often go unnoticed in day-to-day life. For the purposes of this analysis, we have examined the following quantifiable economic benefits: 1) reduced roadway and facility investments, 2) other avoided public expenditures, 3) employment benefits and increased local expenditures, and 4) Federal subsidies. The table below shows the local and regional benefits, in terms of dollars per day, associated with increasing transit ridership. Each benefit's methodology is described in more detail following the summary table and chart.

Summary of Local and Regional Economic Benefits

# Rts	Ridership One-Way Trips/Day	# Auto Trips Reduced 1.15 persons/ vehicle Trips/Day	Daily VMT Reduced 5 mi avg. trip length Miles/Day	Reduced Roadway and Facility Investments $0.30/mile $/Year	Other Avoided Public Expenditures $1 Investment = $0.60 Benefit $/Year	Employment Benefits & Increased Local Expenditures $1 Investment = $0.75 Benefit $/Year	Federal Subsidies[20] Capital & Operating $/Year	Total Annual Economic Benefits $/Year
1	50	43	217	$16,435	$99,360	$124,200	$132,000	**$371,995**
2	95	83	413	$31,226	$162,000	$202,500	$158,000	**$553,726**
3	130	113	565	$42,730	$198,000	$247,500	$165,000	**$653,230**
4	160	139	696	$52,591	$234,000	$292,500	$172,000	**$751,091**
5	186	162	809	$61,137	$270,000	$337,500	$179,000	**$847,637**
⬇	⬇	⬇	⬇	⬇	⬇	⬇	⬇	⬇
10	287	250	1,248	$94,336	$450,000	$562,500	$214,000	**$1,320,836**

Note: Factors may exhibit some variability when the number of trips is very small



[20] Assumes historical trends in Federal funding for system operations will continue and a continued 80% Federal contribution for capital investments.

- Reduced Roadway and Facility Investments: The decreased dependency on the automobile brought about by increased transit service translates into less congested roadways - roadways, consequently, that are less often in need of costly repairs, resurfacing, expansion, and traffic police. Studies have shown that, on average, roadway facility costs are estimated to average $0.006 per mile for automobile usage and $0.012 per mile for buses.[21] Although on a per vehicle basis buses contribute more to the wear and tear of a roadway, on a per person basis (with buses typically holding up to 40 passengers), transit riders generate significantly less impact on road surfaces. Additionally, as more auto trips are shifted to transit, additional capacity on roads is freed up - thus delaying any potential need for costly roadway expansion.

  Traveling by bus has been shown to be significantly safer per mile than traveling by car. As a result of this increased safety, demands on law enforcement and medical services are significantly decreased as trips shift to transit. The calculated benefits for decreased reliance on traffic law enforcement and emergency response have been estimated to average $0.012 per mile.[22]

  Assuming that each bus removes on average 25 cars from the road (i.e. buses are not always filled to capacity), the net benefit assumed in these calculations for reduced roadway and facility investments is approximately $0.30 per mile.[23]

- Other Avoided Public Expenditures: It has been shown that in four major federal programs - Medicare, Medicaid, Food Stamps, and Unemployment Compensation - each dollar invested in mobility improvements, such as increased transit service, reduces the cost to administer these programs by an average of $0.60. [24] These benefits are the result of the decreased reliance on ambulances to provide for routine hospital care trips, the availability of affordable commuter transportation to help people retain their jobs, and a reliable transportation alternative for home health care visits.

  For the purposes of this report, it was assumed that for every dollar spent on the transit system a $0.60 benefit would be achieved.[25]

- Employment Benefits and Increased Local Expenditures: One of the more significant economic benefits associated with increased transit service is it's positive effect on job creation and local spending. Expenditures on automobile infrastructure (primarily road construction and maintenance) tends to be very capital intensive and is often imported from outside the region. Transit infrastructure and operating expenditures on the other hand tend to be predominantly locally produced and relatively labor intensive.[26] Additionally, the relatively high cost of owning and operating an automobile (and maintaining the infrastructure) in relation to other modes diverts both public and private dollars away from more economically beneficial local expenditures.[27]

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[21] Todd Litman, " Evaluating Public Transit Benefits and Costs", for the Victoria Policy Institute, December 1999
[22] 1993-1994 California Transportation Energy Analysis Report, California Energy Commission (Sacramento), Feb. 1994, p. 29.
[23] 1993-1994 California Transportation Energy Analysis Report, California Energy Commission (Sacramento), Feb. 1994
[24] Hovee, Eric D., "Socio-Economic Benefits and Impacts of Transit", June, 1997
[25] Ibid.
[26] Peter Newman and Jeff Kenworthy, Sustainability and Cities; Overcoming Automobile Dependency, Island Press, 1998; Todd Litman and Felix Laube, Automobile Dependency and Economic Development, VTPI, 1999.
[27] Jeff Kenworthy, Felix Laube, Peter Newman and Paul Barter, *Indicators of Transport Efficiency in 37 Global Cities*, Sustainable Transport Research Group, Murdoch University (Perth), for the World Bank, 1997

The net result of the employment benefits and increased local spending related to increased transit service is significant. Research has shown that benefits associated with increasing transit service range from $0.50 to $2.00 for every dollar spent on the system.[28] For the purposes of this analysis we have assumed a relatively conservative return of $0.75 on every dollar invested in the transportation system.

- Federal Subsidies: Although they are ultimately generated through tax revenues, the Federal operating and capital subsidies can be seen as a benefit to the City as these monies would be spent elsewhere without CityExpress service in Keene. In other words, it is the ability of the CityExpress service to capture and spend these Federal dollars locally on drivers' and managers' salaries, vehicle maintenance, etc. that is seen as a benefit to the area.

  For the purposes of this report, we have made two general assumptions in calculating the benefits from Federal subsidies. The first component is Federal funding support for system operations. We have calculated the percent of Federal support provided for the 2-route and 3-route systems and projected that percentage out to the hypothetical 10-route system. The second component is the Federal funding for purchase of vehicles. We have made the assumption that the Federal funding support for 80% of the cost of a new vehicle will continue into the future. With the assumption made that a new vehicle costs $90,000, the assumed Federal support per bus is calculated at $72,000. The total Federal subsidy benefit then is the total of the funding support for operating and capital investments.

[28] Todd Litman, " Evaluating Public Transit Benefits and Costs", for the Victoria Policy Institute, December 1999

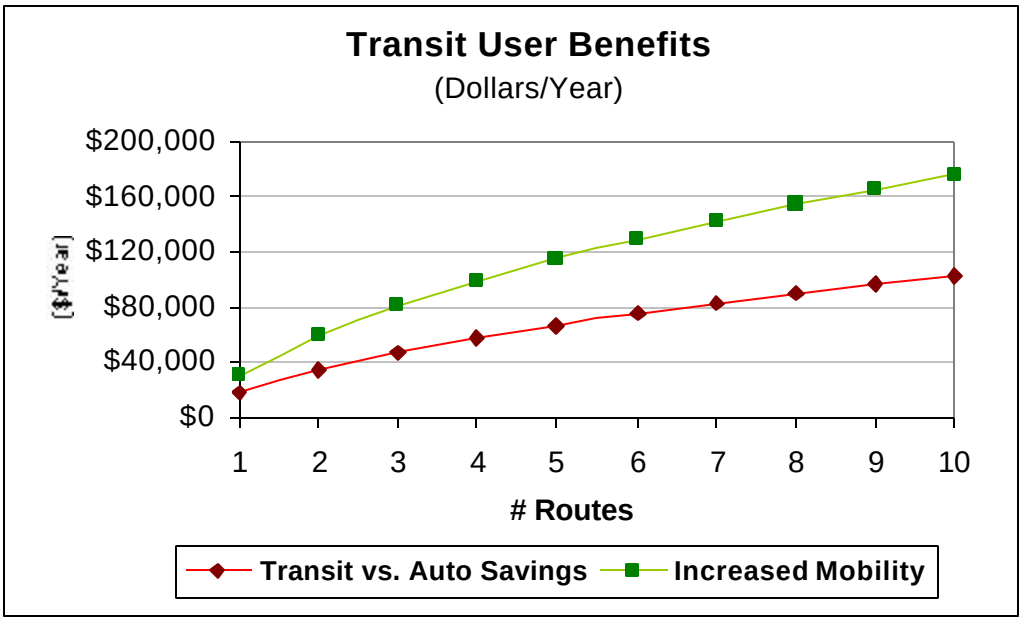
3. Transit User Benefits:

The transit user benefit quantifies both the cost savings of riding the bus over owning and operating a car, and the benefits associated with increased overall mobility and independence. The personal benefit of taking the bus versus taking an automobile is a relatively straightforward calculation. However, the benefit of increased personal mobility resulting from increased transit service is a little more difficult to quantify and is discussed in more detail below.

Summary of Transit User Benefits

	Ridership	# Auto Trips Reduced	Daily VMT Reduced	Transit vs. Auto Savings	Increased Mobility	Total Annual User Benefits
	One-Way	1.15 persons/ vehicle	5 mi avg. trip length	$1.90 savings/trip	$2.45/trip	
# Rts	Trips/Day	Trips/Day	Miles/Day	$/Year	$/Year	$/Year
1	50	43	217	$17,955	$30,870	**$48,825**
2	95	83	413	$34,115	$58,653	**$92,768**
3	130	113	565	$46,683	$80,262	**$126,945**
4	160	139	696	$57,456	$98,784	**$156,240**
5	186	162	809	$66,793	$114,836	**$181,629**
⬇	⬇	⬇	⬇	⬇	⬇	⬇
10	287	250	1248	$103,062	$177,194	**$280,256**

Note: Factors may exhibit some variability when the number of trips is very small



Transit vs. Automobile Savings: The box below shows the calculations and assumptions used to determine the daily savings of riding transit over owning and operating an automobile. These calculations take into account both the obvious costs of driving such as purchasing gasoline and the not so apparent costs such as vehicle wear and tear, regular maintenance, and insurance premiums.

Calculating Transit vs. Automobile Savings

Step 1: Calculate Daily Driving Costs

1. Average trip length of 5 miles (considering the extent of current or potential near-term transit service from the downtown, 5 miles seems a reasonable assumption)

2. Average daily round trip of 10 miles (1 trip each way)

3. Average daily parking cost of $0.50

4. $0.34 per mile to own and operate an automobile [29] (this includes such factors as vehicle maintenance, gasoline, regular vehicle wear, insurance, etc.)

Bringing these assumptions together, we get an estimate of $3.90 per day to operate an automobile:

(10 miles per day) x ($0.34 per mile) = $3.40 + ($0.50 parking) = **$3.90 per day**

Step 2: Calculate Daily Transit Costs

Assuming transit rides remain $1 per trip, the daily cost for a roundtrip (two one-way trips) is **$2.00 per day**

Step 3: Calculate Transit Savings

The total benefit of switching from driving to transit is:

$3.90 - $2.00 = **$1.90 per day net benefit.**

It was assumed that 75% of the new users captured by the increased transit service would be current automobile owners. So, to calculate the total user benefit from increased transit service, the $1.90 per day benefit calculated above is multiplied by 75% of the projected transit ridership.

[29] The 2001 US Tax Law lists the standard mileage rate for the cost of operating a car is 34 ½ cents per mile for all business miles

Mobility: One of the more apparent benefits of increased transit service is the resultant increase in mobility for those either without an automobile, or for those who choose not to drive for one reason or another. The monetary benefit received through increasing one's mobility varies with a number of factors including income, proximity to transit service, and access to an automobile.

To see how important transit service is to the low- and moderate-income population without access to an automobile, consider the following example.

The Importance of Transit to Those Without Cars

A person or family with a $20,000 annual income typically spends about $2,500 per year on transportation.[30] This $2,500 can purchase the following:

- For someone with access to a car, approximately 7,500 miles of auto travel per year,
- For a non-driver without access to transit, only about 1,500 miles of taxi travel, or about six 5-mile trips per week.[31]
- A non-driver with access to transit can purchase a monthly transit pass and still afford 4 taxi trips per week for trips unsuitable for transit.[32]

So, with access and the ability to afford a car, this person can easily purchase over 7,000 miles of transportation a year. If, on the other hand, a car is not accessible and no transit service is available, this person's mobility options are limited significantly.

The quantified benefit from improved mobility is determined by calculating the average consumer surplus (i.e. the net value of transportation to an individual) per transit trip across all income levels and then subtracting the public expenditures required to operate a transit system.[33] The table below shows this breakdown of consumer surplus versus average salary:

Average Salary	Consumer Surplus
Under $11,500	$8.68
Under $20,000	$7.09
Under $24,500	$6.41
Under $31,500	$5.84
Under $34,500	$5.66
All Income Levels	$4.70

Source: David Lewis and Michael O'Conner, *Economic Value of Affordable Mobility,* 1996.

The average public expenditures per one-way trip associated with operating a transit system is assumed to be $2.25. So to determine the benefits from improved mobility, this average public expenditure cost of $2.25 is subtracted from the average consumer surplus value of $4.70 to arrive at a net economic benefit from increased personal mobility of $2.45 per transit trip.[34]

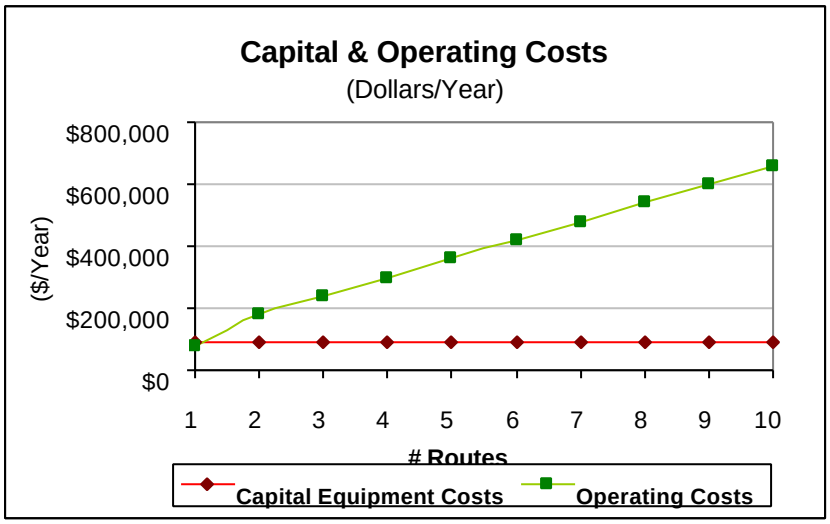
[30] Todd Litman, " Evaluating Public Transit Benefits and Costs", for the Victoria Policy Institute, December 1999
[31] Ibid.
[32] Ibid.
[33] Lewis, David and Michael O'Conner, *Economic Value of Affordable Mobility, 1996.*
[34] Ibid.

Costs Associated with Increased Transit Service:
As one could see in the first half of this chapter, the benefits of increased transit service are numerous and far-reaching -- including benefits to the user, the operator, the local and regional economy, and the environment. The costs associated with increased transit service on the other hand are much more limited. For the purposes of determining total expenditures, transit capital and operating costs were examined and quantified. A slightly more abstract notion of the cost associated with changing the way business is done is discussed below but not quantified.

Summary of Transit Capital and Operating Costs

	Ridership	# Auto Trips Reduced	Daily VMT Reduced	Capital Equipment Costs	Operating Costs	Total Annual Costs
	One-Way	1.15 persons/ vehicle	5 mi avg. trip length	1 New Bus/Year		
# Rts	Trips/Day	Trips/Day	Miles/Day	$/Year	$/Year	$/Year
1	50	43	217	$90,000	$75,600	**$165,600**
2	95	83	413	$90,000	$180,000	**$270,000**
3	130	113	565	$90,000	$240,000	**$330,000**
4	160	139	696	$90,000	$300,000	**$390,000**
5	186	162	809	$90,000	$360,000	**$450,000**
⬇	⬇	⬇	⬇	⬇	⬇	⬇
10	287	250	1248	$90,000	$660,000	**$750,000**

Note: Factors may exhibit some variability when the number of trips is very small



- Capital Equipment Costs: Transit capital costs include the purchase of vehicles and other transit-related amenities such as shelters and stop locators. The capital cost values shown above for the CityExpress are primarily the cost to purchase an additional vehicle (to increase service to that level). For the purposes of this report, it was assumed that the cost for a new CityExpress bus would average $90,000 per vehicle.

- Transit Operating Costs: Transit operating costs account for the salaries of all bus drivers, mechanics, and management officials as well as the maintenance and upkeep of the vehicles and facilities. The average per vehicle operating cost used for this report was based on calculations made for expanded service in the recent *CityExpress Service Expansion* (1999) report and from

recent trends collected by Home Healthcare, Hospice and Community Services (HCS). This figure was factored out to get a total system-wide operating cost.

- Cost of Doing Business: One of the more intangible, but nonetheless important, costs associated with increased transit service is the cost of changing typical operating procedures. In order to move towards a fully-operational transit system, with both frequent service to residents and businesses, as well as land use and growth patterns that support transit, a significant shift may be required in daily municipal operating procedures. An effort will be required by elected officials, municipal staff, and the public to re-examine both the City's goals and objectives and day-to-day decisions to ensure that they are moving towards the envisioned integrated transportation system.

General Assumptions Made In Calculating Overall Cost/Benefit:
In calculating the various cost and benefit indicators for this report, a number of general assumptions were made. In each instance, the assumptions were factored in such a way as to ensure that they were providing relatively conservative estimates. The following list summarizes these assumptions:

- Number of Transit Vehicles: For the purposes of this report, the calculations ranged from 1 to 10 transit vehicles. The calculated value assumes that all vehicles are on the road at a given time - either on its own route, or providing for more frequent service on an existing route.

- Ridership Projections: The ridership levels for one, two, and three vehicles was taken from the *CityExpress Service Expansion, Rural Transit Planning Study* (1999) and from recent ridership trends collected by HCS. The ridership projections for 4 to 10 vehicles was then calculated assuming a decreasing rate of increase model. That is, as more buses and routes are added, ridership will increase, but not as sharply as it did when only a few buses served the City.

- Number of Auto Trips Reduced: To determine the number of auto trips reduced, the number of people projected to ride the bus (calculated above) was divided by the average vehicle occupancy rate in the SWRPC region of 1.15 persons/vehicle from 1990 Census journey to work dataset.

- Daily Vehicle Miles of Travel (VMT) reduced: An assumption was made that the average auto trip replaced by transit would average 5 miles in length. Thus, the daily VMT reduced would be the total number of one-way trips reduced (calculated above) multiplied by 5 miles.

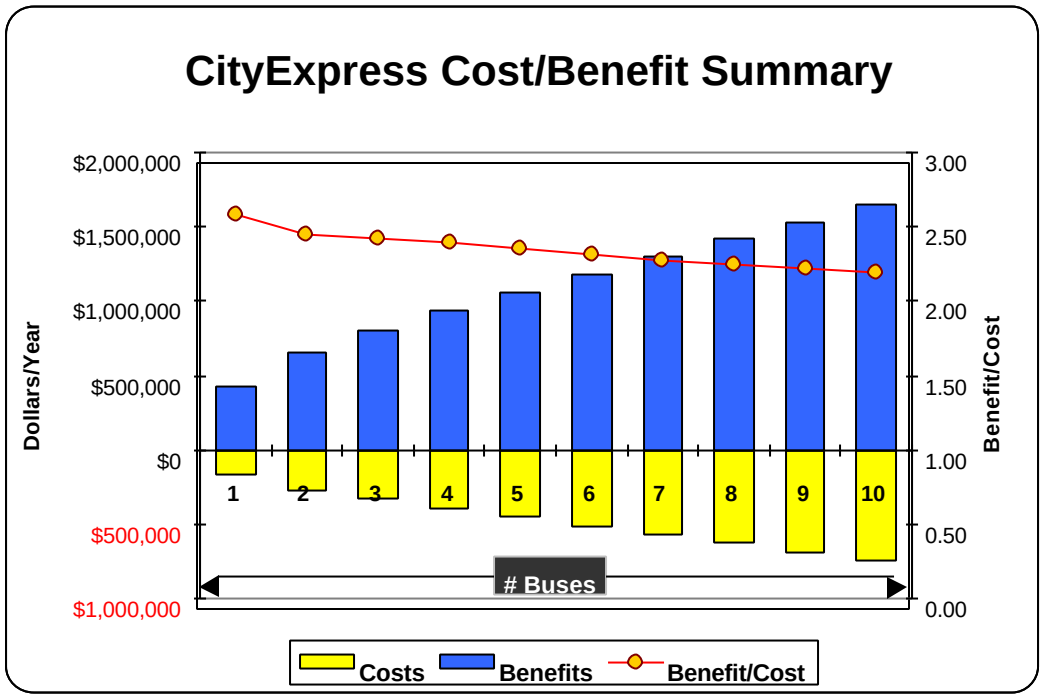
- Daily Vehicle Service Miles: The average daily transit vehicle service miles were based on assumptions made for one, two, and three vehicles in the *CityExpress Service Expansion, Rural Transit Planning Study* (1999) and from recent trends collected by HCS. These rates were then factored out for 4 to 10 vehicles.

- Inflation Adjustments: Although it is recognized that an expanded transit fleet will take some time to develop, the dollar figures used in the calculations have not been adjusted to account for variations over time.

Cost/Benefit Summary:
The table and graphic below show the hypothetical *total* cost and benefit values for various system sizes. The ratio of benefit to cost for service up to a 10-route system can be seen to vary between 2.2 and 2.6. This benefit to cost ratio range means that for every $1 that goes into the transit system, more than $2 will potentially be returned to the City and region in environmental, economic, and social benefits.

Cost and Benefit Summary

# Routes	Costs	Benefits	Difference	Benefit/Cost
1	$165,600	$428,544	$262,944	2.59
2	$270,000	$661,170	$391,170	2.45
3	$330,000	$800,259	$470,259	2.43
4	$390,000	$932,049	$542,049	2.39
5	$450,000	$1,058,001	$608,001	2.35
⬇	⬇	⬇	⬇	⬇
10	$750,000	$1,645,429	$895,429	2.19



One application of the results of this report would be to examine the potential results if two additional routes were added to the existing 3-route system to expand the service area and increase the overall level of service. It has been shown in this report that this increase would cost approximately $180,000 for the purchase of two new buses and approximately $120,000 a year for operations and maintenance. As this report has shown, that $300,000 expenditure can be expected to generate over $700,000 in environmental, social, and economic benefit to the City's residents, workers, and visitors.

5. Conclusions

Chapter 1: Introduction | Chapter 2: Trends & Indicators | Chapter 3: Policy Analysis | Chapter 4: Cost / Benefit Analysis | Chapter 5: Conclusions

The following list of conclusions were reached in the course of this analysis:

- Current CityExpress ridership trends (both total and relative to the amount of service provided) have been increasing steadily over the past several years. In absolute terms, CityExpress ridership has increased by 62% - or 900 riders per day - over the last year and a half. CityExpress service has also increased, with a third route added in August 2001 and downtown trolley service initiated in November 2001.

- In comparison to the other six rural New Hampshire transit providers, the CityExpress performance benchmarks (cost per mile, cost per hour, cost per trip, trips per mile and trips per hour) were close to the Statewide average.

- The policy statements found in Keene's guiding plans are, for the most part, not in conflict with each other and are generally supportive of increased transit service.

- The benefits associated with increased transit service were shown to be extensive and included the following: increased personal mobility, decreased congestion, cleaner air and water, avoided public expenditures, decreased demand for parking, increased property tax revenue, and savings on personal transportation expenditures.

- For a proposed 5-route transit system, the cost to benefit ratio was calculated to be 2.35 which means that the for every dollar spent on transit in the City of Keene, $2.35 may be returned in the form of economic, social and environmental benefits.