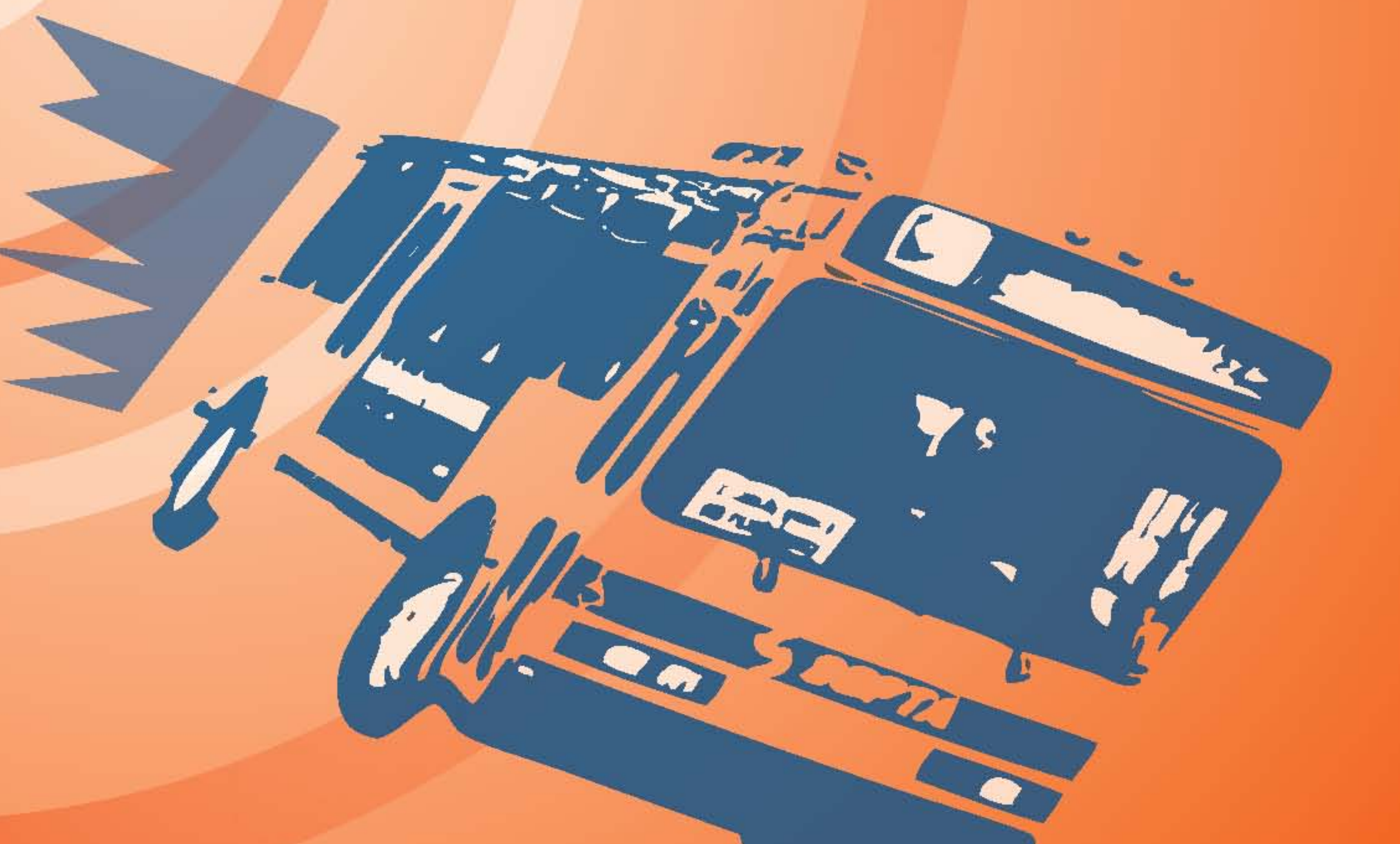
DELAWARE VALLEY
REGIONAL PLANNING
COMMISSION

2008

Speeding Up SEPTA

FINDING WAYS to MOVE PASSENGERS FASTER



Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty, and intercity agency that provides continuing, comprehensive, and coordinated planning to shape a vision for the future growth of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties, as well as the City of Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. DVRPC provides technical assistance and services; conducts high priority studies that respond to the requests and demands of member state and local governments; fosters cooperation among various constituents to forge a consensus on diverse regional issues; determines and meets the needs of the private sector; and practices public outreach efforts to promote two-way communication and public awareness of regional issues and the Commission.

The DVRPC logo is adapted from the official seal of the Commission and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River flowing through it. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey. The logo combines these elements to depict the areas served by DVRPC.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for this report's findings and conclusions, which may not represent the official views of policies of the funding agencies.

TABLE OF CONTENTS

LIST OF CHARTS

LIST OF TABLES

MAPS & FIGURES

EXECUTIVE SUMMARY

The final report of the Pennsylvania Transportation Funding and Reform Commission identified two key opportunities for SEPTA to enhance efficiency: to “reduce costs by improving average system speed” and to streamline and simplify its fare structure. The purpose of this report is to explore the first opportunity through an examination of issues related to the improvement of SEPTA system speed.

Section 1 of this report includes a table that consolidates and summarizes speed-related recommendations from prior studies, with those prior studies being further detailed in Appendix A. Sections 2 through 4 of this report include the results of three breakout analyses on Transit First in Philadelphia (Section 2), techniques to enhance the efficiency of suburban bus service, focusing on Transit Signal Priority (TSP) techniques (Section 3), and the SEPTA Regional Rail network (Section 4). The results and recommendations from these three sections are summarized below.

Transit First in the City of Philadelphia

Comprehensive Transit First improvements have been made to three SEPTA city routes: Bus Route 52 and trolley Routes 10 and 15. Based on schedule data and industry literature, this report reviewed the effectiveness of these improvements on running times:

> Route 10
>
> The improvements in surface running times associated with stop consolidation (just over 1 minute, or roughly 2%) and TSP (roughly 2.8 minutes, or 5.5%) were in line with industry standards. Further stop consolidation should be pursued.
>
> Route 15
>
> An effective before/after scheduled time comparison is prevented by the mode change from bus to streetcar. However, field observations indicate that efficiencies would be enhanced for Route 15 with a greater level of right-of-way protection.
>
> Route 52
>
> A before/after running time comparison for Route 52 is complicated by the route’s trip variations, along with other changes that occurred in the same timeframe as the Transit First investments. However, a comparison of running times in the route’s core Girard Avenue to Baltimore Avenue segment finds improvements of just less than 5 percent, which lags an industry standard expectation of roughly 11 percent for that segment. Field observations suggested that far-side bus zones were too short, limiting bus acceleration while finding windows to reenter traffic and contributing to delay.

In cooperation with SEPTA and the Philadelphia City Streets Department, DVRPC plans microsimulation analyses of some or all of Routes 10, 15, and 52 in order to explore low- or zero-capital techniques to extract additional benefits from the investments already made, particularly with regard to TSP signal timings. Several general recommendations for future Transit First efforts have also been made. These are summarized below by chief acting stakeholder(s).

City of Philadelphia
Transit First should be included in the city's forthcoming Comprehensive Plan.

SEPTA and City of Philadelphia
Jointly explore the possibility of integrating SEPTA's vehicle location data with the city's expanding coordinated traffic signal network, with the aim of widespread TSP throughout the city. Such a project would require a high-level policy decision by both SEPTA and the city, of the sort that the Transit Improvement Committee was originally tasked to enable. Notably, the capital investment required would be relatively minimal - almost all of the required equipment is already in place or being installed as part of other projects.

SEPTA

- Consider Federal Transit Administration (FTA) Very Small Starts funding for future Transit First route-level investments. If Very Small Starts funding is sought, projects would need to have additional design elements to differentiate them from regular surface transit (such as special branding and unique stations/stops).

- For future Transit First investments, improvement target thresholds (i.e., "10% improvement in end-to-end running times") should be identified upfront and projects kept alive until such goals are met.

- Transit First should be kept alive as an ongoing program at a smaller scale. Particularly slow routes could be identified each year as part of the Annual Service Plan process, and "low-hanging fruit" strategies to enhance speeds for those routes could be identified and tested each fiscal year. An ongoing Transit First program such as this would have greater weight with a dedicated line item in SEPTA's capital and/or operating budgets.

Transit Improvement Committee

- Continue efforts to improve traffic enforcement, which impacts transit operations, as well as staff-level coordination. More aggressive and innovative enforcement measures (e.g., bus lane enforcement cameras on buses, designated midday delivery windows) should be explored.

- Include the Center City District as a partner in the Transit Improvement Committee.

- Restore the past practice of having one "annual report" meeting with the mayor to highlight progress, discuss impediments, and set high-level goals for the following year.

Enhancing the Effectiveness of Suburban Bus Service

Generally speaking, investments to enhance suburban bus service speed and quality should be targeted to locations where local land development patterns and planning decisions enable effective connections with the transit service. In order for speed improvements to be realized, there should also be a mechanism in place at a project's outset for running time savings to be internalized into schedules.

The criteria below comprise a checklist to identify candidate suburban corridors for Transit Signal Priority (TSP) projects (and related investments):

1. High levels of base ridership
   FTA's Very Small Starts threshold of 3,000 weekday riders is a reasonable (though not absolute) target threshold.

2. High base-level bus service frequencies
   A minimum threshold of four buses or 100 passengers per peak directional hour.

3. High transit potential and/or transit dependence
   As a general rule, TSP corridors should be anchored by one or more places with a MEDIUM-HIGH or HIGH Transit Score and should traverse or connect multiple geographies with scores of MEDIUM or better.

4. Roadway congestion levels that are not debilitating
   Most intersections should have peak hour volume to capacity (v/c) ratios of less than 0.9.

5. Multilane corridor roadway configurations
   The corridor should have multilane roadways, or two-lane roadways with widening or channelization at intersections.

6. Minimal pedestrian conflicts
   The subject corridor should have no more than 400 conflicting pedestrians per hour at most intersections.

7. Ability to piggyback with police/fire/emergency preemption investments
   This can be viewed as something of a bonus criterion because it helps in building coalitions in support of a proposed TSP investment.

Regional Rail System Speed

Efficiency and speed in SEPTA's Regional Rail network is impaired chiefly by two factors: track sharing and control issues (Amtrak, NJ Transit) and network infrastructure constraints. In an integrated network such as SEPTA's, where individual trains operate through Center City on multiple routes, weak links or constraint points can have cascading effects throughout the network. SEPTA is engaged in a program of investment specifically targeting bottlenecks, but is further challenged by the desirable problem of spiking ridership and demand for service. Several general and specific policy courses are recommended:

- Adjust service standards to require wider station spacings in suburban and rural areas for any prospective new service.

- Continue the policy of installing high-level platforms wherever possible in order to minimize train dwell times through level boarding. Benefits can be maximized by employing Silverliner V cars, and future cars of similar configuration, along routes with greater numbers of high-level platforms.

- Continue the ongoing and successful program of addressing infrastructure bottlenecks through equipment modernization along all lines. Where bottlenecks are removed and/or track segment speed ratings are increased, a framework should be in place where these improvements can immediately be internalized by schedules wherever possible. In the long run, assuming continued broad ridership growth, remaining single-tracked segments along the R2 Warminster, R5 Doylestown, R6 Cynwyd, and R8 Fox Chase lines should be considering for double tracking (on the basis of cost versus operational benefit).

- In the context of a new focus on customer service, SEPTA should be careful to balance the desire for a positive passenger/staff interaction with the cumulative impacts of a relaxed style on end-to-end service speeds.

- SEPTA should consider requiring each conductor and assistant conductor to operate a door at every station, and to direct boarding and exiting passengers to specific doors. A simple “enter at the front of the car, exit at the rear” rule could be effective if properly communicated to riders and enforced by conductors.

INTRODUCTION

The final report of the Pennsylvania Transportation Funding and Reform Commission identified two key opportunities for SEPTA to enhance efficiency: to "reduce costs by improving average system speed" and to streamline and simplify its fare structure. The purpose of this report is to explore the first opportunity through an examination of issues related to the improvement of SEPTA system speed.

In this report, speed refers to the operating speed of transit vehicles (i.e., the end-to-end running times of bus routes or rail lines). As a measure or indicator of service effectiveness, operating speed has two key and interrelated benefits. First, faster service makes transit more competitive to other modes, attracting discretionary riders. Second, higher speeds make it less expensive to operate each mile of service (because the same service frequencies can be achieved with fewer vehicles). This cost savings can be invested in higher levels of service or other amenities, which can further attract new ridership.

It bears noting here that many changes that would increase system speed occur at the expense of other desirable goals. For example, eliminating bus stops will increase the average amount of time a rider spends walking to and from his or her origin and destination stops. This will negatively impact door-to-door trip times for some riders, possibly diminishing the speed-related benefits of stop elimination from the rider's standpoint. Similarly, eliminating stations can enhance the average speed of a commuter rail line, but at the expense of local economic development and potential for transit-oriented development (TOD) that could have accrued in the eliminated station areas. These examples illustrate the complexity of issues surrounding system speed, as well as the myriad stakeholders and interests that can combine to defeat or compromise any speed-enhancement project.

Cost Savings

As a general rule of thumb, cost savings achieved through speed improvements become significant when the end-to-end route or line running time can be reduced by an amount greater than one headway, resulting in the same headways being achieved with one fewer vehicle. The magnitude of potential savings becomes apparent when it is considered that SEPTA's annual fully allocated operating cost per peak vehicle is $142,900 for City Transit Division buses (equivalent peak vehicle costs for suburban bus routes are somewhat lower), $279,200 for Subway-Surface trolleys, and $442,500 for Broad Street Subway and Market-Frankford Line trains. These figures from SEPTA's FY 2007 Annual Service Plan include labor, maintenance, and overhead costs. This "save a bus" principle can be illustrated through the following example.

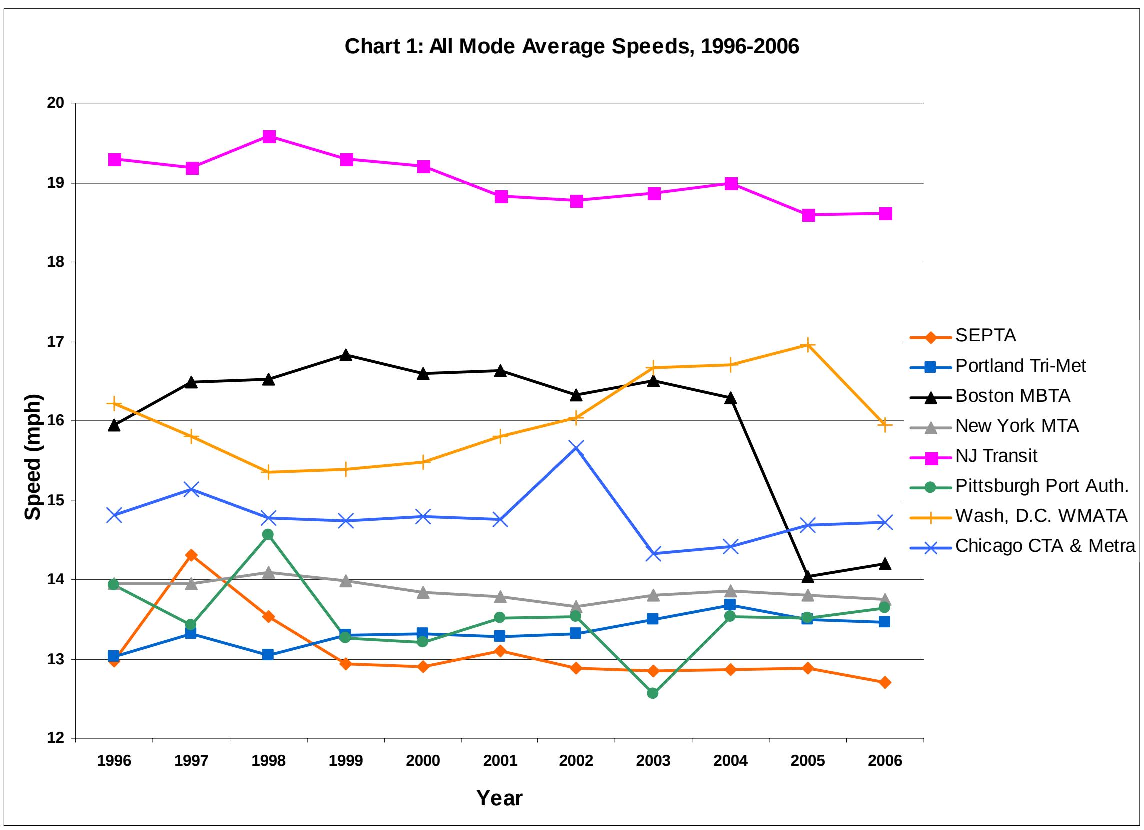
Assume a hypothetical corridor exactly 10 miles long. If buses have an average speed of 10 mph through this corridor (one trip per hour per bus) and have 10-minute peak headways, six vehicles would be required to serve this route during the peak period. If speeds could be increased to 12 mph on average, each bus could make 1.2 trips per hour through the corridor. If headways were kept at 10 minutes (or 6 buses per hour), the number of peak vehicles required would be only five (six buses per hour divided by 1.2 trips/hour/bus).

The Pennsylvania Transportation Funding and Reform Commission estimated that a one-mph speed increase for the City Transit Division's bus service would yield roughly $13 million in annual savings.

Comparison to Peer Agencies

One key measure of operating speed is average system speed across all modes, as measured through a ratio of system revenue miles to revenue hours. By referring to revenue hours and miles (as opposed to non-revenue service), this measurement reflects speeds as perceived by passengers.

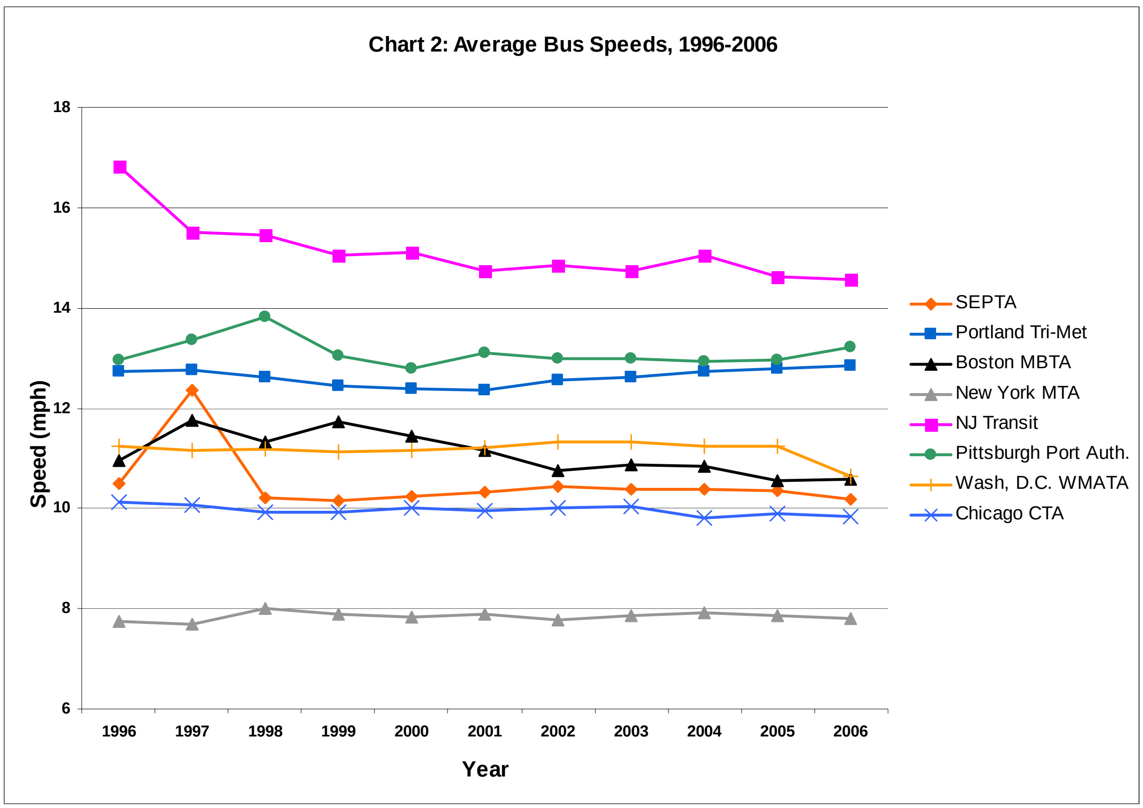
Chart 1 illustrates SEPTA's average system speed for the 11 years from 1996 to 2006, as well as those of a number of selected peer agencies for purposes of comparison. Peer agencies in this chart, and in other charts in this section, were selected to enable a variety of comparisons. SEPTA's peers among older cities (Boston, New York, Pittsburgh, Washington, DC, and Chicago) reflect systems with similar climates, similar development patterns, and somewhat similar multimodal networks. Chicago's system is often cited as a particularly close peer to SEPTA, so the chart shown below reflects combined data for CTA and Metra Commuter Rail, which combine to approximate SEPTA's multimodal nature. New Jersey Transit is included in this peer comparison, being the other multimodal network in the DVRPC region. Finally, Portland Tri-Met is included, as many of its practices are often cited as models of best practices for the industry.



Source: FTA National Transit Database, 2008.

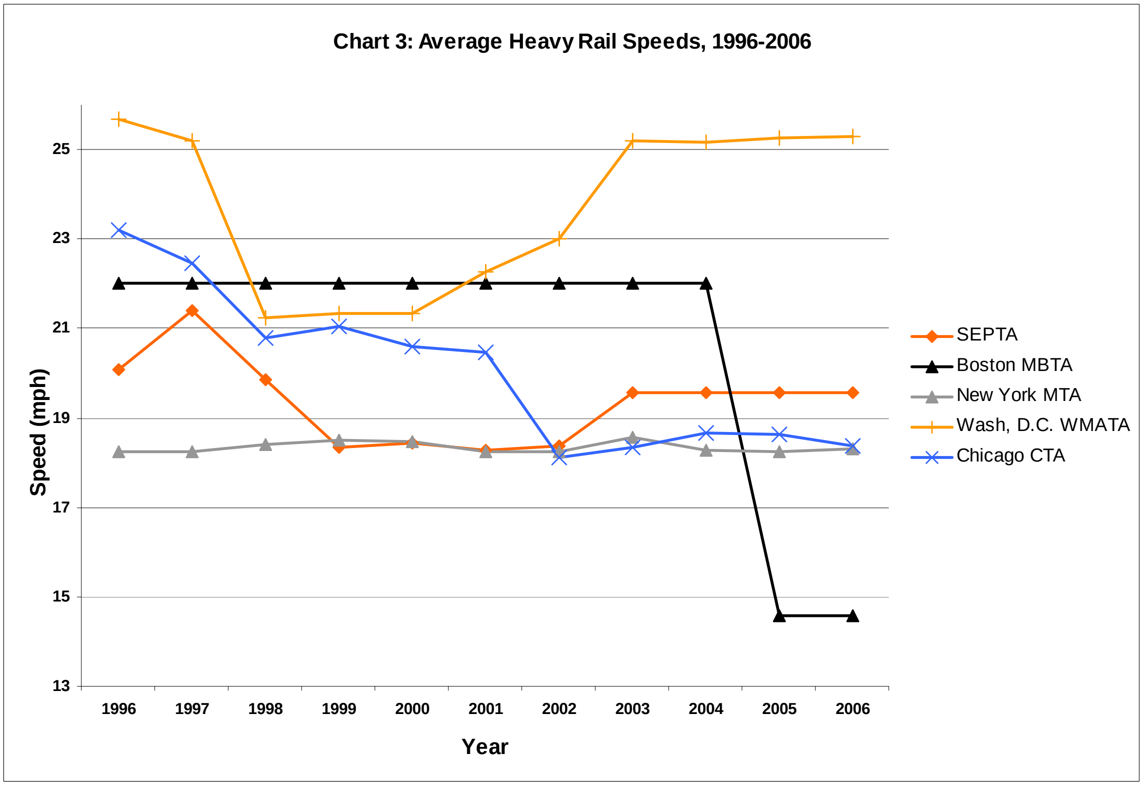
The characteristics of each agency's network are unique, making apples-to-apples comparisons between agencies' speeds difficult. New Jersey Transit's high average speeds, for example, reflect its more suburban and long-distance, commuter-oriented service patterns. Still, a comparison between each agency's speed trends over time is instructive. Among the peer agencies identified here, only Tri-Met showed a notable improvement in systemwide speeds between 1996 and 2006. Several systems showed slight declines, or were largely unchanged, as was the case for SEPTA. It can be said that SEPTA's preventing significant declines in speed represents something of a victory, particularly given the recent climate of annual funding shortfalls. Still, it is a negative characteristic for SEPTA to have the lowest system speed among these peer agencies, and it indicates that there is room for improvement.

Charts 2 through 5 reflect mode-specific average speeds for bus, heavy rail, commuter rail, and light rail among the same set of peer agencies (although agencies are left out of a given chart when they do not include the mode in question). It bears noting that National Transit Database data, and consequently these charts, do not differentiate between sub-types of each mode, such as between urban, suburban, and long-distance commuter bus service.



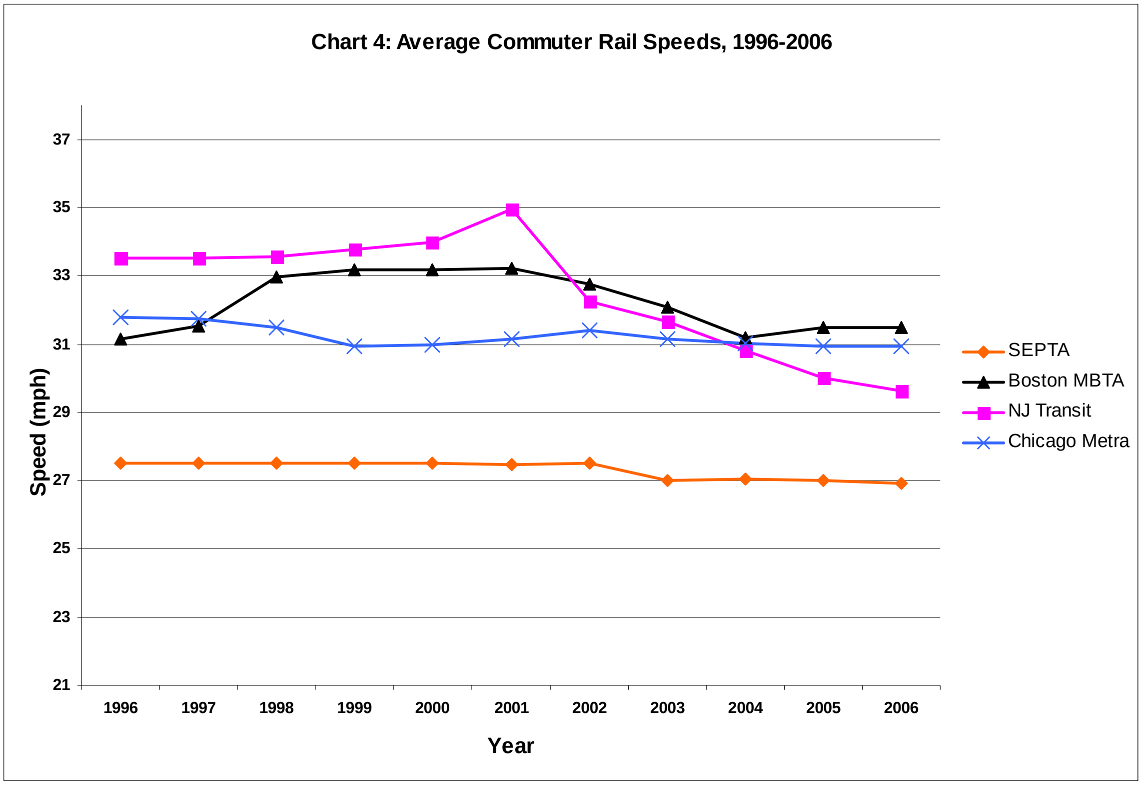
Source: FTA National Transit Database, 2008.

As Chart 2 shows, SEPTA's average system bus speed is middling in comparison to that of its peer agencies, and has been so for the 11 years identified. NJ Transit's average speed is again buoyed by its largely suburban service pattern, whereas MTA's low speed reflects its exclusively urban service pattern. Notably, SEPTA's average speed showed a slight uptick over much of the last decade, followed by a slight decline in 2006 (the most recent reporting year).



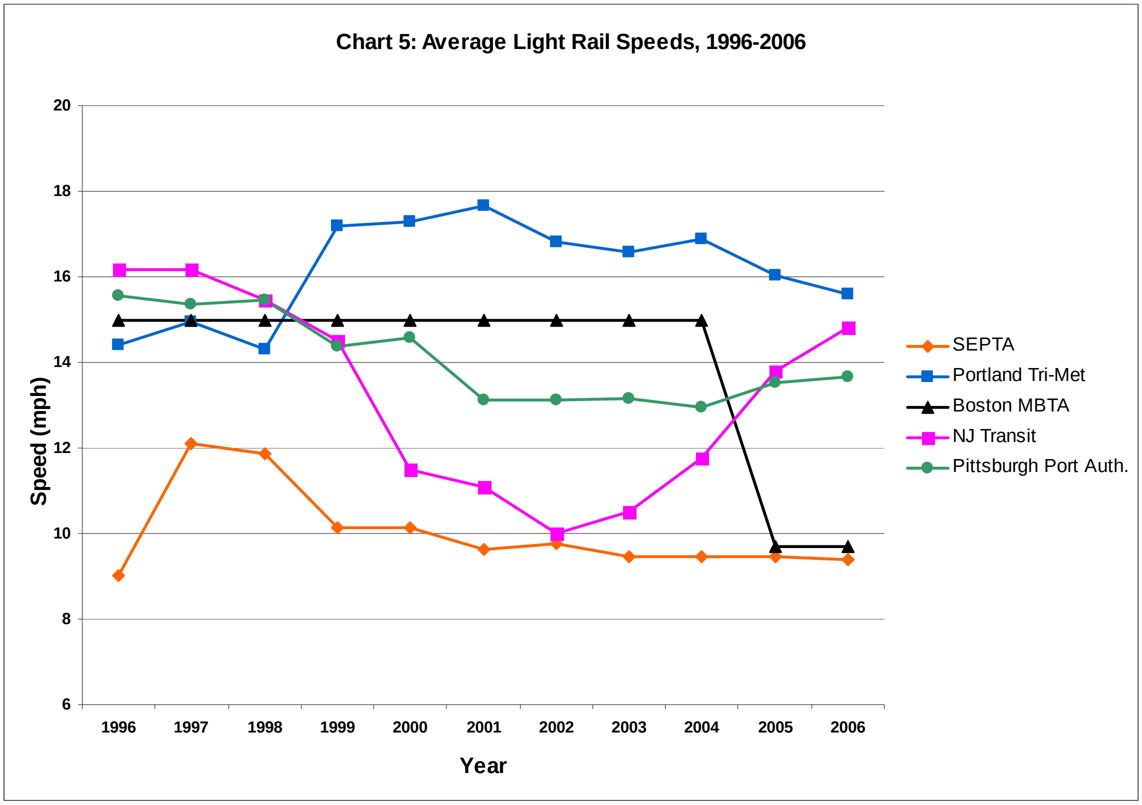
Source: FTA National Transit Database, 2008.

SEPTA's average heavy rail speed, which includes the Market-Frankford Elevated, the Broad Street Subway, and the Route 100 Norristown High Speed Line, shows fairly significant variation across the subject decade in comparison to other mode speeds. New limited stop Route 100 service (begun in late 2004) has positively impacted average speeds over the last several years. On average, SEPTA heavy rail service has performed at a higher speed than New York's MTA and, in recent years, Chicago's CTA.



Source: FTA National Transit Database, 2008.

SEPTA's relatively slow regional or commuter rail speeds, which largely reflect its unusually close station spacing and meandering alignments, are often cited as a service weakness in comparison to peer agencies. Chart 4 reflects these relatively slow speeds and also indicates that Regional Rail speeds have remained largely consistent in recent years.



Source: FTA National Transit Database, 2008.

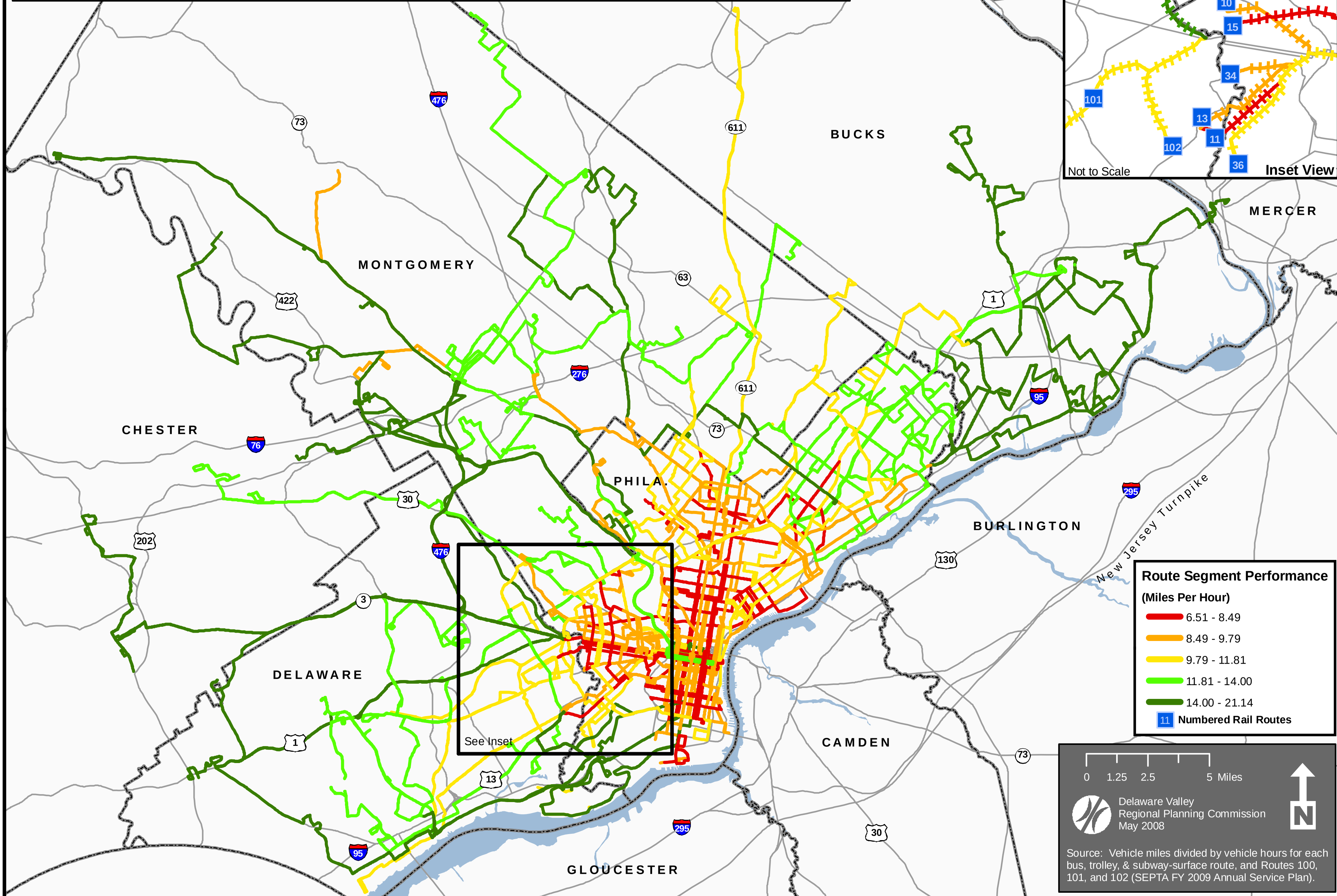
Finally, Chart 5 compares average speeds for light rail service, which in SEPTA's case includes suburban service (Routes 101 and 102) and the city's "green line" subway-surface routes, as well as the Route 15 Girard Avenue trolley as of the 2006 reporting year. In this case, SEPTA's speeds have gradually declined in recent years and remain lower than its selected peer agencies. This reflects SEPTA's every-block stop spacing for urban streetcars/trolleys, which is atypical for modern light rail routes (and most peer agency routes), which commonly have dedicated rights of way and wider stop/station spacing. Transit First efforts in Philadelphia (see Section 2 of this report) have included the consideration of stop consolidation as a way to improve trolley speeds. Similarly, average speeds could be improved along Routes 101 and 102 if closely spaced stations with light patronage were consolidated.

Summary

Charts 2 through 5 present a consistent picture with Chart 1 and with the findings of the Pennsylvania Transportation Funding and Reform Commission. On the whole, SEPTA's average revenue service speeds, be they mode specific or systemwide, generally lag those of its peer agencies. This circumstance is explored in detail in the following sections. For reference, Map 1 summarizes the average vehicle speeds for each of SEPTA's numbered bus, trackless trolley, and rail routes. As would be expected, most of SEPTA's slower routes are concentrated in and around Philadelphia, where signalized intersections and stops are more frequent.

MAP 1: Average Vehicle Speeds for SEPTA Numbered Routes

Includes Dwell Time and Non-Revenue Operating Time



DVRPC PROJECT APPROACH

The goals of this report are first to consolidate and summarize speed-related recommendations from prior studies which may remain viable, and second (given that an exhaustive evaluation of every topic would be prohibitive) to pursue a series of specific analyses of selected topics and modes, as identified with the assistance of the Technical Advisory Committee. The intent is that this report will become a compendium on service speed-related topics, summarizing and evaluating strategies employed to date and highlighting potentially fruitful strategies that can reasonably be attempted in the future.

SECTION 1:
Evaluation and Summary of Previous Report Recommendations

This section summarizes the recommendations from as many prior studies as were available. It includes some summary information, such as whether these recommendations were acted upon, whether they would be relatively costly, and whether they would be short- or long-term strategies. Details on prior studies are presented in Appendix A.

SECTION 2:
Transit First in the City of Philadelphia

Transit First remains SEPTA's broadest effort to date to improve efficiencies by increasing system speed, and it is notable as well for its involvement with a broad coalition of stakeholder agencies. This section summarizes the history of Transit First efforts in Philadelphia (supplemented with additional detail in Appendix B), evaluates the effectiveness of improvements that have been implemented to date, and recommends specific strategies to keep Transit First alive and enhance its effectiveness in the future.

SECTION 3:
Enhancing the Performance of Suburban Bus Service

Even more than with city service, suburban bus service is challenged by development patterns that are designed to accommodate the automobile. This section addresses topics pertaining to increasing suburban bus speeds and focuses on SEPTA Route 104 (West Chester Pike) as a case study. This route was recently evaluated for a potential implementation of Transit Signal Priority (TSP).

SECTION 4:
Regional Rail System Speed

SEPTA's Regional Rail service is often cited for its unusual slowness relative to peer agencies. This section discusses the reasons for this characterization and summarizes the strategies that SEPTA has recently employed to address Regional Rail speed, as well as those planned for the short and long term.

SECTION 1:
EVALUATION AND SUMMARY OF PREVIOUS REPORT RECOMMENDATIONS

The purpose of this section is to consolidate system speed-related recommendations for all relevant reports, both internal and external to SEPTA. The challenges to and opportunities for implementation have been evaluated for each recommendation and are summarized in Appendix A. The relative impact of each recommended improvement on operating speeds has also been estimated in a basic way, drawn from a review of the findings of each original report. In estimating impacts, each recommendation is categorized as LOW, MEDIUM, or HIGH. These categories, while simplistic, permit some sense of general effectiveness despite the vast disparity among improvement types and costs.

Table 1 summarizes all of the recommended strategies that have not yet been implemented, the reports and dates in which they were originally suggested, their estimated impact grades, and an indication of whether they should be considered short-term or longer-term strategies. Table 2 identifies recommendations that were implemented and notes whether the anticipated benefits were achieved as a result of implementation. Please note that specific Transit First strategies within the City of Philadelphia are not included in this section (*for improvements suggested under the Transit First umbrella, please see Section 2 and Appendix B of this report*).

Table 1: Summary of not-yet-implemented report recommendations on service speed

Mode(s)	Location(s)	Strategy/Improvement	Source report	Source date	Estimated speed impact	Short/ long term?
Bus	Philadelphia	Switch to every-other-block stop spacing	Managing Success in Center City	February 2008	HIGH	Short
Bus	Philadelphia	Remove select left-(north) lane bulbouts along Chestnut Street	Managing Success in Center City	February 2008	MEDIUM	Long
Bus	Philadelphia	Clearly delineated and enforced bus lanes in Center City	Managing Success in Center City	February 2008	HIGH	Long
Bus	Philadelphia	Transit Signal Priority (TSP) along Chestnut & Walnut Streets	Managing Success in Center City	February 2008	HIGH	Short
Bus & trolley	Philadelphia	More limited-stop service	Transit Stop Management Study	June 2004	HIGH	Short
Bus	Philadelphia	Increased number of bus bulbs for in-line stopping	Transit Stop Management Study	June 2004	LOW	Short
Bus & trolley	Philadelphia	Citywide transit prioritization strategy	Transit Stop Management Study	June 2004	HIGH	Long
All modes	Philadelphia	Fare simplification	Transit Stop Management Study	June 2004	MEDIUM	Long
Regional Rail	Philadelphia	Closure of Angora Station on the R3 Media/Elwyn Line	Regional Rail Stations Closures Study	November 2003	MEDIUM	Short
Regional Rail	Delaware County	SEPTA should aggressively move to contruct high level platforms along the R3 line	Regional Rail Improvement Study: R3 Media/ Elwyn Line	August 2002	MEDIUM	Long

Mode(s)	Location(s)	Strategy/Improvement	Source report	Source date	Estimated speed impact	Short/ long term?
Regional Rail	Delaware County	Emphasize crew efficiency and "hustle"	Regional Rail Improvement Study: R3 Media/ Elwyn Line	August 2002	LOW	Short
Regional Rail	Delaware County	Adjust Elwyn interlocking signal to permit greater approach speeds	Regional Rail Improvement Study: R3 Media/ Elwyn Line	August 2002	LOW	Short
Regional Rail	Delaware County	Eliminate revenue train crew drop-offs and pickups at Powelton Avenue Yard	Regional Rail Improvement Study: R3 Media/ Elwyn Line	August 2002	LOW	Short
Regional Rail	Bucks and Montgomery counties	Eliminate all grade crossing speed restrictions along R5 line	Regional Rail Improvement Study: R5 Lansdale/ Doylestown Line	January 2002	HIGH	Long
Regional Rail	Bucks and Montgomery counties	Upgrades between Glenside and Doylestown to permit 60-mph max. speeds	Regional Rail Improvement Study: R5 Lansdale/ Doylestown Line	January 2002	HIGH	Short
Regional Rail	Systemwide	SEPTA should continue to purchase Electric Multiple Unit (EMU) cars rather than locomotive-hauled push-pull stock	Regional Rail Improvement Study: R5 Lansdale/ Doylestown Line	January 2002	MEDIUM	Long
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Change the locations of passenger loading assistant staff ("loaders") to busiest locations	Recommendations for Improvement of Green Lines Subway Operations	June 1990	MEDIUM	Short
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Remove rule requiring stops at every switch	Recommendations for Improvement of Green Lines Subway Operations	June 1990	MEDIUM	Short
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Switch to articulated vehicles at next procurement	Recommendations for Improvement of Green Lines Subway Operations	June 1990	MEDIUM	Long
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Enhance intra-organizational communication and management, including the assignment of an overall system manager	Recommendations for Improvement of Green Lines Subway Operations	June 1990	LOW	Short
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Add prepaid fare collection gates at 19th and 22nd Street Stations	Recommendations for Improvement of Green Lines Subway Operations	June 1990	MEDIUM	Short
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Adjust tunnel speed management and speed restrictions	Recommendations for Improvement of Green Lines Subway Operations	June 1990	MEDIUM	Short

Mode(s)	Location(s)	Strategy/Improvement	Source report	Source date	Estimated speed impact	Short/ long term?
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Construct storage track/siding at City Hall	Recommendations for Improvement of Green Lines Subway Operations	June 1990	MEDIUM	Long
Suburban bus	Suburban counties	Operate express bus service in HOV lanes, connecting suburban employment centers	Improving Mobility in Southeastern Pennsylvania – A Public Transportation Solution	October 1989	HIGH	Long

Source: DVRPC 2008

Table 2: Summary of report recommendations that were acted upon

Mode(s)	Location(s)	Strategy/Improvement	Source report	Source date	Were anticipated benefits achieved?
Regional Rail	Philadelphia; Delaware County	Closure of Lamokin Street and Wissinoming Regional Rail stations	Regional Rail Stations Closures Study	November 2003	Yes (generally; impacts not specifically evaluated)
Regional Rail	Delaware County	Operate 1-2 additional outer zone express trains during peak periods	Regional Rail Improvement Study: R3 Media/ Elwyn Line	August 2002	Yes (generally; impacts not specifically evaluated)
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Mark multiple stop locations at each station platform	Recommendations for Improvement of Green Lines Subway Operations	June 1990	Yes (generally; impacts not specifically evaluated)
Green line subway-surface trolleys	Central Philadelphia subway-surface tunnel	Comprehensively reevaluate and reconfigure tunnel signal system	Recommendations for Improvement of Green Lines Subway Operations	June 1990	No (partial implementation only – CBTC signal modernization emphasized safety rather than speed improvement)
Bus, trolley	Philadelphia	Comprehensive implementation of Transit First improvement strategies	Improving Mobility in Southeastern Pennsylvania – A Public Transportation Solution	October 1989	Yes (partial implementation only – see Section 2 of this report)
Regional Rail	Entire region	Widespread installation of high-level platforms	Improving Mobility in Southeastern Pennsylvania – A Public Transportation Solution	October 1989	Yes (partial implementation only); ongoing

Source: DVRPC 2008

For more detail on each of the above recommendations, please see Appendix A. Reports in Appendix A are presented in the same order (reverse chronological) as in the above tables.

SECTION 2:
TRANSIT FIRST IN THE CITY OF PHILADELPHIA

The Transit First policy package represents SEPTA's most significant coordinated effort to enhance efficiency through improving system speed. As previously noted, Transit First was cited as the centerpiece city strategy in the October 1989 report *Improving Mobility in Southeastern Pennsylvania – A Public Transportation Solution.* Its history since 1989 has included both successes and shortcomings; a summary of that history in this section is instructive for both future Transit First initiatives and other strategies that would require coordination among multiple stakeholders.

This section includes:

1. A brief history of Transit First efforts in Philadelphia, supplemented by summaries of the recommendations of prior studies, which can be found in Appendix B.
2. Best case industry standards for the operational improvements that should be expected from the types of changes proposed under Transit First.
3. Evaluations of the effectiveness of SEPTA's three Transit First route implementations (Routes 10, 15, and 52).
4. Recommendations for future directions of the Transit First initiative.

History of Transit First

Inception/purpose

The August 1989 report *Transit First Priority Routes*, jointly published by the City of Philadelphia and SEPTA, described the Transit First concept as follows:

> "Transit First is a cooperative venture between the City of Philadelphia and the Southeastern Pennsylvania Transportation Authority. The purpose of the Transit First program is to improve the quality of life in the city by providing ease of movement for transit patrons and secondarily for general traffic … The benefits of a Transit First program are considerable. First, transit times will be significantly improved. This alone has the potential of reducing transit operating costs, or, alternatively, allowing transit service levels to increase through the more efficient utilization of labor and equipment … All in all, the key elements of a Transit First program are already established in law; application and simple common sense, courtesy and more rigorous enforcement are almost all that is necessary."

Practically speaking, the Transit First program includes:

- *Targeted capital improvements* (such as the traffic signal hardware necessary for transit vehicle signal priority treatments)
- *Changes in operating strategies* (such as a shift from every-block bus stops to every-second-block)
- *Better traffic law enforcement* where transit vehicle operations are impaired (such as where double-parked vehicles block transit routes)

This variety of strategies requires cooperation among a number of stakeholders, including SEPTA, the Philadelphia Streets Department, the Philadelphia Police

Department, the Philadelphia City Planning Commission, and the Philadelphia Parking Authority, and requires passenger and city political buy-in in order to be given a chance to succeed. This level of coordination requires a visible and vocal project champion.

Before proceeding with a summary of the history of Transit First in the city, it is important to note that this is a history of more than 20 years. Many of the recommendations made in various reports since have been made obsolete by conversions of streetcar routes to bus service, for example, or by shifts in priority. What began as an effort to modernize streetcar service became an effort pertaining to a different set of priority routes, becoming yet another set of routes for implementation to date.

Now-obsolete recommendations are included here and in the report summaries in Appendix B, however, as they shed light on policy priorities over time (and the reasons for shifts in policy) that remain pertinent to the discussion of future improvements. Table 3 summarizes the changes in proposed and actual Transit First routes since 1989. Routes proposed and implemented are also depicted on Map 2.

Table 3: Routes recommended for Transit First-type improvements

Peer Group Report (Jan. 1989)	Transit Improvement Committee Priority Routes (Aug. 1989)	Routes with improvements implemented, or that remain topical for implementation
Bus Route 6	Bus Route 9	Trolley Route 10 (implemented 2003)
Trolley Route 15	Trolley Route 10	Trolley Route 15 (implemented 2003)
Trolley Route 23	Bus Route 48	Bus Route 23 (restoration of streetcar service desired)
Trolley Route 56	Bus Route 52	Bus Route 52 (implemented 2005)
	Trolley Route 56	Bus Route 56 (restoration of streetcar service desired)

Source: Vuchic et al, 1989; SEPTA and City of Philadelphia, 1989

Peer Group Report

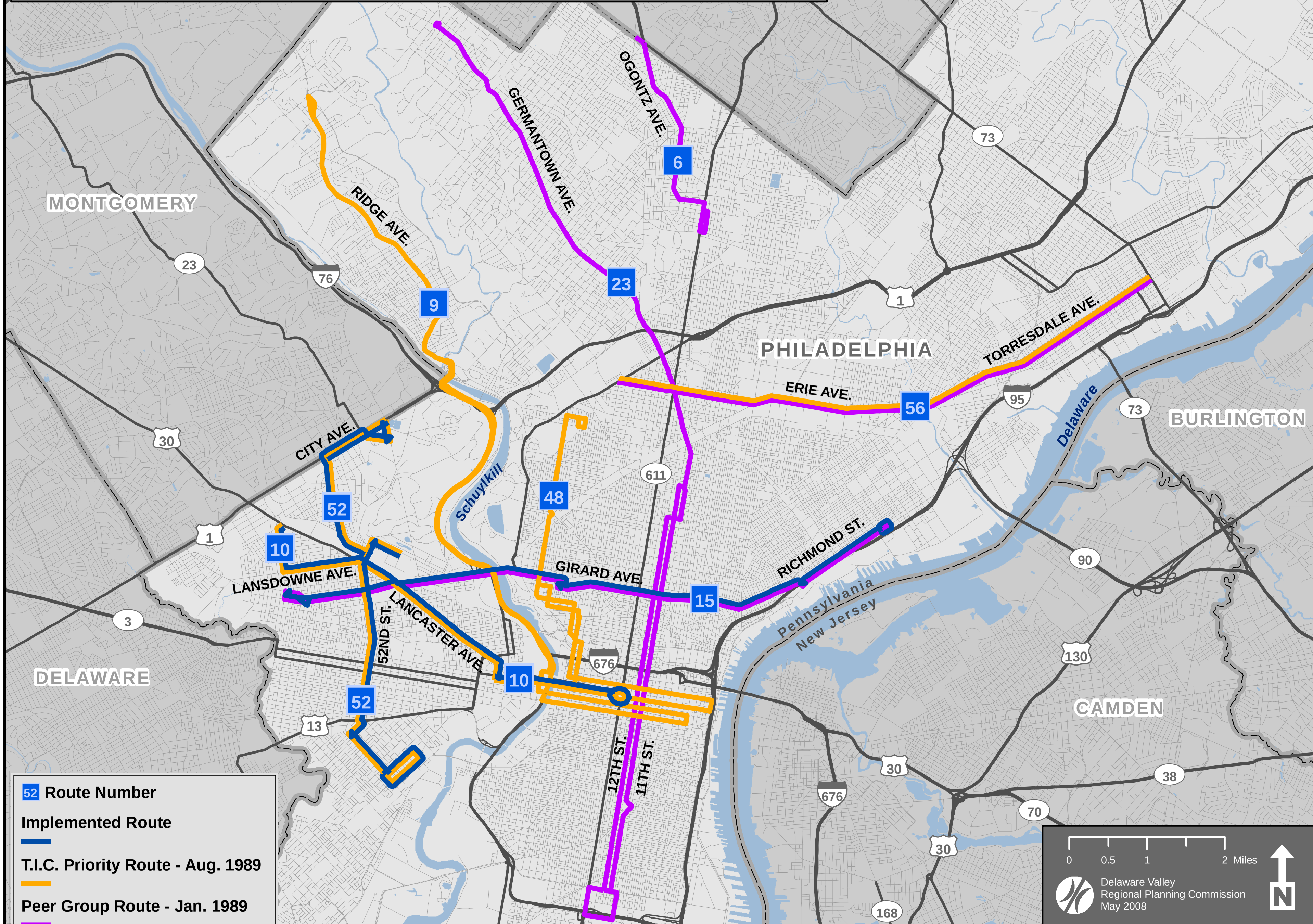
Transit First in Philadelphia has its roots in the January 1989 *Peer Group Review of the Surface Streetcar Lines in North Philadelphia.* This report reflected the results of an analysis by Vukan Vuchic of the University of Pennsylvania, Robert Landgraf of Cleveland, Ohio, and Tom Parkinson of Vancouver, British Columbia, on policy directions for the city's streetcar/trolley routes. Details of the report's findings are described in Appendix B.

Mayor Goode issued an executive order in 1989 (Executive Order 6-89) to pursue Transit First through the establishment of the Transit Improvement Committee, with the mission to devise and implement a coordinated Transit First policy, as recommended by the Peer Group Report. The committee would be comprised of staff from the City Office of Transportation, the City Managing Director's office, the Streets Department, the Police Department, the Philadelphia City Planning Commission, City Council, SEPTA, the Parking Authority, and PennDOT.

Initial Transit Improvement Committee efforts

Breaking from the recommendations of the Peer Study Group, the committee immediately shifted focus from the North Philadelphia trolley routes and selected a set of initial priority study routes that were mixed among bus, subway-surface trolley, and North Philadelphia trolley.

MAP 2: Transit First Routes in the City of Philadelphia



Source: DVRPC, SEPTA 2008.

Several priority corridors were identified in the August 1989 report *Transit First Priority Routes*, which comprised a pilot program of two trolley routes and three bus routes. These routes, and the strategies originally suggested for them in that report, were:

Bus Route 48 (Tioga to Penn's Landing, through Brewerytown, Fairmount, and Center City)

- This route was suggested by the SEPTA Citizen Advisory Committee.
- Improvements suggested for study or implementation included:
  - Increased stop distance (less frequent stops).
  - An investigation of potential signal priority treatments.
  - An exploration of ways to resolve corner clearance issues.
  - Increased use of bumpouts at stop locations.
  - A potential reduction in signalization and stop signs along the route.
  - A potential diamond (bus) lane on Arch Street.

Bus Route 52 (Bala Station to Woodland along 52nd Street, including MFL access at Market Street)

- Improvements suggested for study or implementation included:
  - Increased stop distance (less frequent stops).
  - An investigation of potential signal priority treatments.
  - Increased use of bumpouts at stop locations.
  - A potential reduction in stop signs along the route.

Subway-Surface Trolley Route 10 (Overbrook to Center City via Lancaster Ave.)

- Improvements suggested for study or implementation included:
  - Increased stop distance (less frequent stops).
  - Widespread implementation of preferential signalization.
  - Installation of bumpouts on Lancaster and Lansdowne avenues.
  - Improved reliability through parking enforcement and traffic management.

Trolley Route 56 (Tacony to Nicetown via Torresdale Ave. and Erie Ave.)

NOTE: This route was replaced with bus service in 1992, although a long-term restoration of trolley service is promised.

- Improvements suggested for study or implementation included:
  - Increased stop distance (less frequent stops).
  - Pursue reserved/restricted rights of way.
  - An investigation of potential signal priority treatments.
  - Install bumpouts and shelters along Torresdale Avenue.
  - Improved reliability through parking enforcement and traffic management.

Bus Route 9 (Andorra and Roxborough to Center City via Ridge Ave. and the Schuylkill Expressway)

- Improvements suggested for study or implementation included:
  - Increased stop distance (less frequent stops).
  - An investigation of potential signal priority treatments.
  - Install bumpouts along selected portions of Ridge Avenue.

There were several common problems identified for all five case study routes, namely:

- An excessive number of stops with slow operating speeds as a result.
- Difficulty curbing for loading/unloading passengers.
- Problems for rail routes relating to parking enforcement/double parking.

Drawing on this 'kickoff' report, as well as the mayor's executive order, the Transit Improvement Committee pursued a more detailed evaluation of several of these priority corridors. The findings of these evaluations are described in Appendix B.

Promotion and public engagement

Following the identification of specific improvements for initial priority routes, the challenge shifted toward implementation. As previously noted, Transit First improvements are only fully effective as a package. A shift from every-block to every-other-block stop spacing, for example, is less effective without coordination with intersection signals (which, in the worst timing case, could have the vehicle stopping at every block anyway). Transit Signal Priority (TSP), in turn, is generally less effective with near-side intersection stops, as the time taken between detection and intersection clearance is less predictable.

Given the variety of improvements and a multitude of involved stakeholders, it was particularly important to earn public support. If public objections were to sway any of the stakeholders on the Transit Improvement Committee, and thus compromise the improvement strategies, any strategies that *were* implemented would be less effective as a whole, and consequently less able to crystalize support for the widespread, citywide Transit First program initially envisioned.

Because of this, SEPTA and other members of the Transit Improvement Committee engaged in active community outreach in support of the proposed pilot Transit First projects. Informational materials distributed at a June 1993 community meeting regarding the Route 48 Transit First improvements, for example, presented in detail the intended benefits for SEPTA, the greater Philadelphia community, riders, and specific rider subgroups. The general message was that the proposed improvements would enable SEPTA to provide the same level of service at a lower cost, or a greater level of service at the same cost. In either case, the required number of fare or tax increases over the near and long term would be lower in comparison to the status quo. Concerns about stop reductions were addressed: "While it might take another minute or two to walk to the bus stop, depending upon which stop you now use, this will be more than offset by improved service: trip time on the bus will be cut by 3 to 4 minutes on average, fewer delays will occur, and service in general will be more regular and reliable." Additionally, ancillary benefits were promoted, such as the creation of new legal on-street parking stalls where stops were removed, and a reduced frequency of passenger jostling within the vehicle as a result of fewer stops.

Despite these promotion efforts, however, Transit First was not implemented along Route 48 in any comprehensive way due to community opposition that could not be swayed.

Transit First Implementation Corridors To Date

Beginning in 2003, significant Transit First projects were completed along Subway-Surface Trolley Route 10, Trolley Route 15 (in association with that route's rail restoration), and Bus Route 52. These projects were funded in large part using federal Congestion Management and Air Quality (CMAQ) dollars. The following section details the improvements made under those projects and examines the projects' effectiveness from a speed improvement standpoint.

<u>Transit Signal Priority (TSP) for Routes 10, 15, and 52</u>

As implemented, each of the three Transit First corridors uses a generally identical TSP strategy (note that the strategy implemented for Route 10 does not directly follow those modeled in the 1996 Urban Engineers study for that route, which is summarized in Appendix B). The TSP system for each of the three routes is optical – an optical emitter on vehicles triggers an optical receiver at the traffic signal from a distance of 50 to 250 feet, resulting in a 10-second green phase extension for that signal. This benefits SEPTA vehicles in two ways. First, if the SEPTA vehicle needs to stop at that signal for passenger boarding/alighting, the green extension allows general traffic to clear the intersection. This prevents circumstances where transit vehicles have to stop twice at one signal (once behind a traffic queue and once for passengers to board). Second, in cases of far-side stops, or where the SEPTA vehicle does not have to stop, the extended green generally allows the SEPTA vehicle to clear the intersection during the same signal sequence.

Each of the three routes has the same 10-second phase extension, which was chosen based partly on pedestrian phase timings, and partly for purposes of simplicity and consistency between each of the three corridors, which were all implemented in the same timeframe. TSP along these corridors is simple rather than conditional – green phase extensions are not dependent on a vehicle's status in comparison to its schedule (for details on other types of TSP, see Section 3 of this report). A few locations, largely along Route 10's Lansdowne Avenue portion, have 'early green' TSP functionality as well. Specific details for each route are described and evaluated below.

<u>Best case industry standards for improvement effectiveness</u>

When evaluating the effectiveness of Philadelphia's Transit First efforts to date, it is helpful to know the effectiveness of similar improvements in other places for purposes of comparison. It bears reinforcing that Transit First-type improvements, often implemented elsewhere as in-street Bus Rapid Transit (BRT) investments, are unique on a case-by-case basis, and include a variety of interrelated improvements in corridors with unique land development, traffic, and political circumstances, which combine to make "apples to apples" comparisons challenging. In many cases, the combined performance gains resulting from a multifaceted improvement strategy are known or published, but the relative impacts of specific component improvements are not available.

In order to estimate industry standard (or best case) order-of-magnitude time savings or other performance gains for Transit First improvements in Philadelphia, it is important to isolate the impacts of these discrete improvements in a modular way (i.e., *per stop* or *per mile*) so that their combined anticipated impacts in a specific Transit First scenario can be estimated. Accordingly, published information on the impacts of individual improvements is summarized below and grouped as follows:

- Stop consolidation/elimination
- Stop movement from near side to far side
- Transit Signal Priority (TSP)

The experiences of other transit systems with the effectiveness of these improvements are referenced below. Note that while many of these industry examples relate to BRT projects, the impacts of these three improvement types are fairly mode neutral, particularly in mixed-traffic operations. Accordingly, they can be applied to both trolley and bus Transit First projects, as applicable.

Stop consolidation/elimination

Generally speaking, transit agencies have pursued stop consolidation strategies along with signal prioritization as part of broader in-street BRT or Transit First strategies. Several sources have isolated the impacts of stop consolidation, however. As referenced in the FTA report *Characteristics of Bus Rapid Transit for Decision-Making* (August 2004) (the “CBRT”), the Los Angeles Metropolitan Transportation Authority (MTA) and the City of Los Angeles Department of Transportation conducted an extensive review of the first phase of the widely recognized Metro Rapid lines (*Final Report: Los Angeles Metro Rapid Demonstration Program*, March 2002).

Phase I of the Metro Rapid program included:

- Stop consolidation;
- Signal prioritization;
- A shift to headway-based scheduling;
- Level boarding (aka low-floor vehicles); and
- Significant branding of the service.

With the exceptions of headway-based scheduling and service branding, each of these improvements is analogous to those proposed under many of SEPTA’s Transit First priority corridors and implemented for Route 52. According to MTA staff, headway-based scheduling had particular significance in Los Angeles, since local buses there often run ahead of timetable-based schedules, resulting in operators slowing speeds in order to stay on time. Under headway-based scheduling, buses begin their trips at headway intervals and then run as rapidly as possible for the duration.

Prior to the implementation of Rapid Bus improvements, local bus routes through the subject corridors (Wilshire and Ventura boulevards) had 20 percent of their running time devoted to waiting at traffic signals and 25 percent devoted to passenger boarding delays at stops. In other words, 45 percent of bus revenue service time was spent with the bus stopped or delayed. The MTA and LA DOT post-test review found that the Rapid Bus components of the program (including each of the above-referenced improvements except signal prioritization, and chief among them stop consolidation and headway-based scheduling) yielded:

- A reduction in bus stop delay of nine minutes for the Ventura Boulevard corridor. This is 16 percent of base running time and 64 percent of base bus stop delay.
- A reduction in bus stop delay of 16 minutes for the Wilshire/Whittier Boulevard corridor. This is 21 percent of base running time and 84 percent of base bus stop delay.

These are significant time savings and, according to MTA staff, they were due in roughly equal measure to stop consolidation and headway-based scheduling. For reference, according to MTA staff, Metro Rapid has an average stop spacing of 0.7 miles, while local stops are spaced at an average of 0.2 miles. Thus, the proportional reductions in stop delay (above) generally correspond to the proportional reductions in the number of stops – a 71.4 percent reduction in the number of stops led to a roughly 74 percent reduction (on average) in stop delay.

For the purposes of the present report, the relationship between stop elimination and running time savings observed in Los Angeles will be used to estimate the anticipated travel time savings of stop reduction. In this case, a 71.4 percent reduction in the number of stops (along with other Rapid Bus improvements) was associated with an 18.5 percent reduction in running time, for an elasticity of 0.259 (i.e., a 1% reduction in the number of stops was associated with a 0.259% decrease in running time). Using the estimate by MTA staff that stop consolidation was responsible for 50 percent of this time benefit (with headway-based scheduling and low-floor boarding accounting for the other 50%), we are left with an estimated elasticity of 0.13 for stop consolidation alone, which will be used in our analysis for purposes of estimation. This refers to the ratio of the percentage of stops removed to the percentage of running time saved, and it assumes for purposes of estimation that these factors have a generally linear relationship.

Stop movement from near side to far side

A 2006 technical evaluation of bus stop delay based on bus acceleration profiles and other characteristics[1] found that relative to non-intersection stops, far-side intersection stop placement reduces delay slightly, whereas near-side placement increases delay, often considerably. Specifically, the impacts of stop location on delay were as follows:

Table 4: Impacts of stop location on delay

	Near side (bus overtaking not permitted)	**Near side (bus overtaking permitted)**	**Far side**
Net delay (seconds per bus)	8.9	10.8	-0.4

Source: Furth and SanClemente, 2006

The total calculated improvement between the delay impacts of a far-side stop (-0.4) and a near-side stop with overtaking (10.8) is 11.2 seconds per bus, per stop.

[1] Peter G. Furth and Joseph L. SanClemente, “Near Side, Far Side, Uphill, Downhill – Impact of Bus Stop Location on Bus Delay,” *Transportation Research Record: Journal of the Transportation Research Board*, No. 1971 pp. 66-73, 2006.

Transit Signal Priority (TSP)

As referenced above, the Los Angeles MTA and LA DOT's review of Metro Rapid's demonstration phase estimated the running time impacts of its Transit Priority System, as compared to the other components of the Metro Rapid improvement package.

In support of bus movement, the Metro Rapid signal prioritization program enables an early green signal, an extended green signal, a "free hold" green signal outside coordinated signal timings, or a green transit phase call for queue-jumping or priority left turns. These treatments are only used to maintain schedules, however. If a bus is ahead of its scheduled headway, no TSP treatments are activated (this strategy is known as conditional prioritization). The post-test review estimated the TSP impact as follows:

- A reduction in signal delay of four minutes for the Ventura Boulevard corridor. This is 7 percent of base running time and 36 percent of base signal delay.
- A reduction in signal delay of five minutes for the Wilshire/Whittier Boulevard corridor. This is 7 percent of base running time and 33 percent of base signal delay.

These levels of improvement are consistent with a general industry rule of thumb that reductions in running time of 5 to 10 percent as a result of TSP can be expected, and with the improvements reported by other agencies per FTA's CBRT report. According to that report, TSP treatments reduced base route running times by 6.4 percent (or 31 seconds per intersection) in Portland, and base signal delay was reduced by 32 to 50 percent in Toronto.

It bears noting that the reported results of TSP techniques and strategies can vary significantly, and that some are more comprehensive than the extended green strategy employed in SEPTA's three Transit First implementations to date (for additional detail on TSP strategies, see Section 3 of this report). Additionally, the CBRT reinforces the myriad local factors, including policy choices, which will impact the effectiveness of signal priority treatments. For example, the report notes that while signal prioritization in Phoenix reduced bus stop delay by 16 percent, end-to-end running times were not significantly improved because buses "dragged" to maintain conservative schedules.

For the purposes of an order-of-magnitude estimate of anticipated impacts in the present report, however, a 6.8 percent improvement in base running time resulting from the implementation of a generic TSP scheme will be used. This reflects the average of Los Angeles' two demonstration corridors (7% each), along with Portland's 6.4 percent.

Transit Cooperative Research Program (TCRP) Report 118 (*Bus Rapid Transit Practitioner's Guide*) cites a rule of thumb that TSP treatments save five seconds of running time per intersection, based on experiences in Los Angeles and Oakland. This provides a second means of estimating anticipated benefits.

Effectiveness of Transit First Implementations To Date

To date, Transit First strategies have been implemented along Routes 10, 15, and 52. The effectiveness of these investments is estimated in this section using the rough effectiveness measures calculated based on the industry experience described above.

Route 10

By 1999, some capital work in support of Transit First had been completed, including:

- Painted trolley clearance lines over the length of Lancaster and Lansdowne avenues;
- Bumpout areas to facilitate boarding at select stop locations;
- Extensive regulatory and informational signage;
- Seven new passenger shelters;
- Stop consolidations and relocations – specifically, 15 stops were originally discontinued (out of 52 combined for both directions), with four being since restored due to constituent lobbying;
- Revised traffic signal timing at two locations, including a dedicated phase for trolleys;
- New flashing trolley-activated warning lights on 63rd Street;
- New cutback loop at 52nd Street; and
- 2,600 feet of new tangent track.

Between March 2002 and April 2003, work was completed on Transit First signalization improvements along Route 10, at a total cost of $1.4 million. This project included the replacement of traffic signal control mechanisms along each of the 26 intersections along Route 10, as well as the installation of signal preemption technology in the Route 10 vehicles.

Among the three SEPTA Transit First implementations to date, Route 10 had the greatest number of stop eliminations. Of its 52 bidirectional stops over 26 intersections, 11 (or 21.1%) were permanently discontinued. Based on the relationship between stops reduced and operational changes observed in Los Angeles (above – elasticity of 0.13), along with the 6.8 percent estimated reduction in running time resulting from signal prioritization (or 5 second per intersection), the estimated benefits that should have occurred for Route 10 running time are as follows (these are based on an average surface running time calculated from the Fall 1996 schedule, prior to improvements, of 48.98 minutes):

- *Stop reduction/consolidation:* A roughly 2.74 percent reduction in end-to-end running time, for 1.3 minutes saved.
- *Signal prioritization:* A roughly 6.8 percent reduction in end-to-end running time, for 3.33 minutes saved (alternatively, 5 seconds for each of 26 intersections, for 2.2 minutes saved). Averaging these estimates yields an estimated benefit of 2.8 minutes saved[2].

In other words, a combined benefit of roughly 4.1 minutes saved (or 7.1 to 9.5%) should have occurred based on the experiences of other cities. In order to know whether these benefits were actually achieved, we performed an evaluation of the changes in scheduled running times between the September schedules for 1996, 2000, and 2007 (SEPTA's most recent schedule). Ideally, actual running times would be compared, as well as on time performance (OTP), but this data is only reliably available more recently,

[2] For comparison, end-to-end (round trip) surface running time savings of 4.7 minutes and 3.2 minutes in the AM and PM peaks, respectively, were modeled in 1996 by Urban Engineers for a "simple" TSP implementation – See Appendix B.

following SEPTA's fleet-wide installation of Automatic Vehicle Locator (AVL) infrastructure. If we assume a consistent relationship between scheduled running time and actual running time for the years examined, a comparison of scheduled running time is nevertheless instructive and is presented in Table 5 below.

Table 5: Changes in scheduled running time for Route 10, 1996-2007

	Sept. 1996			Sept. 2000 (Change from 1996)			Sept. 2007 (Cumul. Change from 1996)		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
End-to-End Running Time (63rd/Malvern through Center City and back)	65.63 min.	71	52	66.27 min. (+0.64, +0.98%)	73 (+2, +2.8%)	52 (unch)	63.08 (-2.55, -3.9%)	69 (-2, -2.8%)	51 (-1, -1.9%)
Est. Subway Running Time (36th/Market through Juniper and back)	16.65 min.	20	15	18.39 min. (+1.74, +10.5%)	22 (+2, +10%)	15 (unch)	17.95 (+1.3, +7.8%)	19 (-1, -5%)	15 (unch)
Average Surface Running Time (Diff. between total and subway means)	48.98 min.	-	-	47.88 min. (-1.1, -2.2%)	-	-	45.13 (-3.85, -7.9%)	-	-

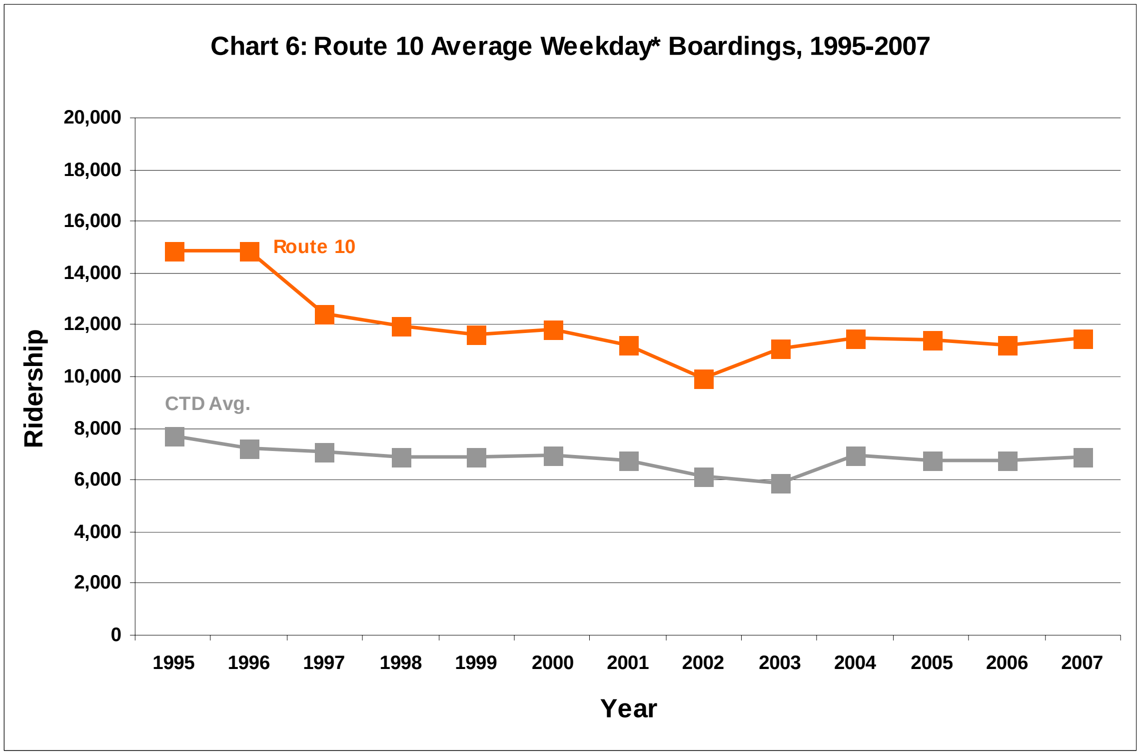
Source: SEPTA, 1996-2007.

In summary, average surface travel times improved by roughly 3.9 minutes (or 7.9%) between 1996 and 2007. Most of this improvement occurred between 2000 and 2007 following TSP implementation, which is consistent with our estimates above. Although the roughly 2.2 percent scheduled time savings between 1996 and 2000 were slightly lower than the 2.74 percent we estimated, they were of the same order of magnitude. They may have been slightly less than estimated because, according to SEPTA staff, many of the stops eliminated were atypically closely spaced or lightly used (many of them were formerly half-block spacings), which would reduce the benefits of their elimination in comparison to higher dwell time locations. Notably, the 2.75 minute average surface running time savings between 2000 and 2007 (most directly attributable to TSP installation) exactly matches our industry estimate for what should have occurred as a result of signal prioritization (2.8 minutes saved).

Additionally, this 2.75 minute mean improvement between 2000 and 2007 is of the same order of magnitude as the 4.7 and 3.2 minute AM and PM peak time savings modeled in 1996 by Urban Engineers for a "simple" TSP implementation without revised signal timings, which most closely approximates what was implemented (we did not isolate scheduled time changes by peak period).

The 7.9 percent overall running time savings calculated is within the 7.1 to 9.5% range we anticipated, indicating that the benefits of Transit First for Route 10 can be considered generally successful by industry standards. It bears reinforcing that not all of these travel time changes or savings can be due to the Transit First improvements, and that broader changes in traffic, ridership, and trip patterns have an impact. Nevertheless, the other industry examples we used to estimate the anticipated benefits for Route 10 would likely be subject to similar "other" factors, lending our analysis accuracy in at least a gross way.

Chart 6 depicts Route 10 weekday boardings from 1995 through 2007, and it indicates that ridership was largely unchanged during the project timeframe (1996 to present). There was no ridership decline that would provide another explanation for the travel time savings (through reduced board/alight times, etc.), but it also does not appear that Route 10 service became sufficiently more attractive, as a result of the Transit First improvements, to attract a boost in ridership.



*Beginning in 2004, daily boardings (a weighted average of weekday and weekend ridership) replaced weekday boardings in SEPTA's annual reporting data. *Source:* SEPTA Route Operating Ratio Reports, 1996-2006; SEPTA, 2008. "CTD Avg" refers to average boards for all City Transit Division (CTD) bus, trackless trolley, and trolley routes.

While we have highlighted running time changes for the surface portions of Route 10 because only these portions would be impacted by Transit First improvements, it is the change in end-to-end time (including tunnel portions) that governs any expected impact on peak vehicles. The cumulative change (1996-2007) for end-to-end time was less than for surface portions (a reduction of 2.55 minutes, on average, or 3.9%), owing to increases in tunnel segment scheduled times. Given peak headways of five minutes, this would not be expected to permit a reduction in peak vehicles, with associated significant benefits for annual route operating expenses. As reported by SEPTA staff, peak vehicles in 2007 are identical to 1996 – 14 vehicles (in 2000, the number of peak vehicles had risen to 18).

Qualitative impressions of improvements

In January 2008, DVRPC staff rode Route 10 end to end in both directions, overlapping the late afternoon peak. Although the operation or intervention of green signal extensions is not apparent to the rider, our general impressions were of an efficient service, without undue stop light delay. There were numerous instances where the vehicle only just made it through an intersection as a light was turning yellow, perhaps indicating a functioning green phase extension. Two details were notable: first, on the westbound ride, there was not a single instance where the vehicle had to stop at a red light solely due to signal timing (in all such red light stops, passengers were boarding or alighting). Second, during the return eastbound trip, the vehicle was delayed by approximately two minutes when the right of way was partially blocked by a tow truck, illustrating a pitfall of trolley or streetcar service in comparison to bus or trackless trolley service.

Recommendations for further improvement

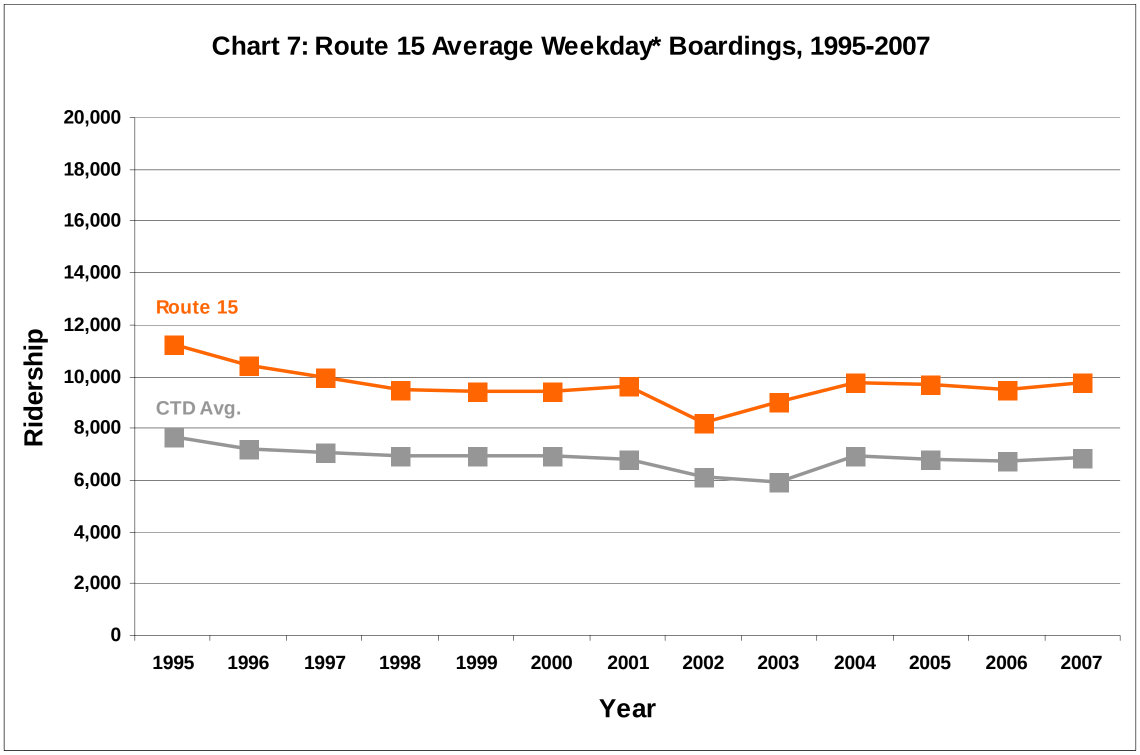
From the above analysis, we estimate that if just over one additional minute could be saved in end-to-end running time, the total time saved through Route 10 Transit First improvements would exceed five minutes, enough to achieve a one vehicle reduction in peak vehicles. Two general strategies could help in achieving this further time savings: further stop consolidation, or more aggressive signal prioritization through the TSP infrastructure already in place.

Based on our evaluation of the time savings that have occurred, as well as our qualitative impressions of the Route 10 ride, the change that would most benefit this route's operating speed is further stop consolidation. Route 10 still has essentially every-block stop spacing for most of its routing, which meets SEPTA's current service standards for established services (500 feet), but falls far short of its 1,000-foot preferred minimum spacing for service in urban areas, as reflected in the service standards for new routes. Further, our analysis indicates that Route 10 has generally achieved industry standard time savings through the signal prioritization already implemented, indicating that additional benefits through more aggressive prioritization may be limited. The benefits achieved through stop consolidation have also generally met expectations, suggesting that further stop removal can be expected to generate time savings at a similar rate.

<u>Route 15</u>

Between January 2002 and February 2003, Transit First improvements were implemented along the Route 15 corridor in conjunction with that route's conversion from bus service to restored trolley service. The portions of this restoration that fell under the Transit First umbrella were enhanced platform areas, TSP (extended green) functionality on board the restored PCC trolley vehicles, and the replacement of 36 signal control boxes with an interconnected system that would accommodate the vehicles' signal priority. The total cost of the Route 15 Transit First project was just over $6 million. Notably, an extended portion of the Route 15 project's core service area (Girard Avenue between 13th and 33rd streets) did not have TSP installed, partly due to concerns about greater impacts on general traffic.

The restoration of trolley service makes a before/after comparison of Route 15 service much more difficult, in that it becomes impossible to isolate the benefits of TSP amid the much more dramatic impacts of the mode switch. By all accounts, the effectiveness of the Route 15 trolley restoration project has been mixed, with predominantly negative short-term transportation impacts (weakened on-time performance, increased customer complaints, often severe disruption of trolley service through right-of-way obstruction), but generally positive nontransportation impacts (historic trolleys are viewed as an economic development boon by neighborhood groups, along with a reduction in noise and pollution). Chart 7 depicts Route 15 weekday ridership between 1995 and 2007, bracketing the project's implementation. Ridership was largely unchanged during this timeframe (after declining around 1992 with the original conversion of the route from trolley to bus).



*Beginning in 2004, daily boardings (a weighted average of weekday and weekend ridership) replaced weekday boardings in SEPTA's annual reporting data. *Source:* SEPTA Route Operating Ratio Reports, 1996-2006; SEPTA, 2008. "CTD Avg" refers to average boards for all City Transit Division (CTD) bus, trackless trolley, and trolley routes.

According to both SEPTA and city staff, the chief impediment to maximizing the benefits of the Route 15 project has been frequent right-of-way interference, due both to incidents (such as accidents) and routine use of the trolley lane by general traffic. Unlike buses or trackless trolleys, trolleys cannot change lanes or detour around accidents, double-parked vehicles, or traffic delays. Accordingly, any disruption to the right of way will result in severe delays, often requiring substitution of bus service until the right of way has been cleared.

Most of Route 15's Girard Avenue portion has a median right of way, with a mix of near-side and far-side stops (with near-side stops being more typical). This right of way is legally restricted to trolleys and left-turning vehicles at certain intersections, but it is not physically protected in any way. Further, field observations make clear that the right of way is widely used not just for left turns (where permitted), but also for through traffic, particularly west of the Schuylkill River. In addition to generating Route 15 delay through simple queue volumes, these illegal traffic flows increase the numerical chances of an accident or other disruption at any given time, constricting the potential benefits of Route 15's improvements for riders and, by extension, weakening its potential for economic development benefits.

From data provided by SEPTA staff, there were 46 separate reported incidents that disrupted Route 15 trolley service from May 2007 through July 2007, as summarized in Table 6.

Table 6: Route 15 incident delays by location and type

Delays by Area			
Zone (From west to East)	**Street**	**Boundaries**	**Delays**
Haddington/West Girard	Girard Ave.	63rd St. to Lancaster Ave.	6
Belmont/Zoo	Girard Ave.	Merion Ave. to 34th St.	5
Fairmount/Francisville	Girard Ave./S. College. Ave.	Poplar Dr. to 15th St.	9
Central	Girard Ave.	Broad St. to Front St.	3
Fishtown	Girard Ave.	Frankford Ave. to I-95 overpass	6
Richmond	Richmond St.	Girard Ave. to Westmoreland St.	17
Delays by Type			
Type	**# Delays**	**# Hours**	
Emergency Personnel	17	8 hours, 46 minutes	
Accident Not Involved	9	4 hours, 42 minutes	
Truck Stuck under Bridge	2	4 hours, 12 minutes	
Accident Involved	6	3 hours, 43 minutes	
Parked too Close to Rail	12	3 hours, 26 minutes	
TOTAL	**46**	**24 hours, 49 minutes (est)**	

Source: SEPTA, 2008.

As this table makes clear, incidents of many types occured throughout Route 15's alignment, and in aggregate generated more than one full day of delay during these three months. The chief delay generator (both in terms of the number of incidents and in terms of aggregate delay time) was emergency personnel activity (fire/police/medical).

Broad Street/Girard Avenue intersection

Although the intersection of Broad Street and Girard Avenue was not the site of any delay-generating incidents during the May to July 2007 period summarized in the above table, SEPTA staff identified it as a particularly challenging location due to traffic movements and heavy transfer volumes between Route 15 trolleys and the Broad Stret Subway, along with several bus routes. This intersection is also atypical among high-volume intersections along Route 15, as all through traffic must use the shared trolley right of way (or otherwise, in the westbound direction, illegally use the right-turn lane as a through lane). This is particularly problematic when disabled passengers board Route 15 trolley vehicles, leading to a 7 to 10 minute delay as the trolley operator activates the manual wheelchair lift, during which time no through traffic movements are legally permitted. Transfers by disabled passengers between the Route C bus (a popular disabled passenger route) and the Route 15 trolley typically occur several times a day. Given these known complexities, DVRPC staff observed trolley, traffic, and passenger movements at this intersection for one afternoon in January 2008.

While we did not observe any disabled passenger boardings, we identified two other issues that lent a generally chaotic feel to movements at and through this intersection:

- Despite a prohibition against left turns out of driveways in the vicinity of this intersection, numerous vehicles were observed making left turns. In addition to the obvious potential for accidents, these vehicles often blocked one lane of traffic flow (or trolley flow) while waiting for safe entry into traffic.
- Several Route 15 passengers were observed crossing traffic lanes and jumping over the fence abutting the passenger island in order to make a trolley, rather than crossing at the designated location.

Eastbound Girard vehicle making illegal left turn into driveway.

Eastbound Girard vehicle making illegal left turn out of driveway.

The Philadelphia City Planning Commission recently completed the *North Broad Transportation and Access Study* (2007), which included several suggestions for improvements to the intersection of Broad and Girard aimed at addressing the through traffic/trolley bottleneck. Specifically, the report suggested:

- Relocating east and/or westbound trolley tracks to the curbs to permit through and turning traffic to pass stopped trolleys on the left. A dedicated trolley signal phase would give trolleys the ability to queue-jump in reentering Girard traffic;
- Removing the current curb extension along the north side of Girard to create enough space to redirect both through and right-turning westbound traffic to the right of the trolley right of way, which would become exclusive in the westbound direction; or
- Maintaining the existing configuration, with a widening of the westbound trolley island (with provision of a canopy) to accommodate high passenger volumes.

Each of these alternatives would appear to be generally neutral in terms of trolley speed impacts, except that redirecting westbound traffic to the right of the trolley right of way would eliminate instances where the trolley must wait behind a westbound queue and then separately dwell at its westbound platform (as illustrated on page 32).

Westbound trolley waits in general traffic queue prior to…

dwelling at westbound platform for high volumes of passenger boards and alights

Again, the intersection of Broad Street and Girard Avenue is among the Route 15 intersections for which the TSP green phase extensions were not implemented. Extended greens would likely ameliorate trolley 'stopping twice' scenarios, as illustrated above, but were deemed to have too negative an impact on Broad Street traffic flows.

Recommendations for further improvement

From staff observations during an end-to-end ride of Route 15 (in both directions), as well as the service disruption incident data summarized above, it appears that the strategy with the greatest potential for improving Route 15 reliability and speed is to achieve greater separation and protection of the Route 15 right of way. The potential to do so is limited where the trolley right of way is shared with turning or through traffic, although strategies to reduce these instances, as suggested above for Broad and Girard, could be fruitful. However, there are numerous segments where the trolley right of way is intended to be exclusive, but is unprotected aside from fairly unobtrusive overhead signage. This leads to a circumstance where no segment is exclusive in reality.

Given the broader mission of Transit First, it is important that the exclusive portions of the Route 15 right of way have their exclusivity protected to a greater extent. This protection could include greater levels of traffic enforcement, but would ideally be self-enforcing, in the form of physical improvements. These could range from, at a minimum, mountable curbs/bumps or stand-up delineators, which would permit safe passage by emergency vehicles, to a more aggressive, permanent separation via an exposed, non-drivable rail bed or non-mountable curbing. In the latter case, such permanent barriers have been used in other cities for beautification and streetscape improvement by installing vegetation in the curbed lane separators.

Median streetcar right of way along Spadina Avenue in Toronto (note the landscaped curbing that protects exclusive portions of the right of way) – photo courtesy IBI Group, Inc.

A model for Route 15 in this regard can be found in Toronto's Spadina streetcar line, which, similar to Route 15's Girard Avenue core, operates along a busy multimodal corridor along a street with fairly generous rights of way. In the case of the Spadina line, the streetcar's right of way was initially unprotected, with restricted general traffic being permitted (i.e., left turns were permitted to use the streetcar right of way, but only during off-peak periods). This resulted in significant levels of driver confusion, manifested by significant numbers of collisions. To achieve greater right-of-way protection, the Toronto Transit Commission (TTC) initially installed low "candlestick" delineators, which were unsuccessful in discouraging motorists. Next, similarly short steel posts were installed, resulting in greater protection of the right of way, but widespread motorist damage due to collision with the posts. Finally, the TTC installed landscaped curbing six inches in height to protect the fully exclusive portions of the trolley right of way.

Each of these strategies should be considered viable for Route 15, with the exception of low steel posts. Where space permits, landscaped curbed dividers could significantly enhance Girard Avenue's streetscape, while also significantly enhancing trolley operations.

Route 52

Between October 2004 and December 2005, work was completed on a Transit First implementation along Route 52. The total cost of this project was $1.2 million, which included:

- TSP along the entire route length (50 intersections) in the form of 10-second green phase extensions;
- Movement of the following 27 stop locations from the near side of the intersection to the far side in order to better capitalize on the green phase extensions:
    - 53rd and Jefferson streets - North and Southbound
    - 52nd and Jefferson streets - North and Southbound
    - 52nd Street and Lancaster Avenue - North and Southbound
    - 52nd and Master streets - North and Southbound
    - 52nd and Thompson streets - North and Southbound
    - 52nd Street and Girard Avenue - Southbound only
    - 52nd Street and Westminster Avenue - North and Southbound
    - 52nd Street and Haverford Avenue - North and Southbound
    - 52nd and Race streets - North and Southbound
    - 52nd and Arch streets - North and Southbound
    - 52nd and Locust streets - North and Southbound
    - 52nd and Spruce streets - North and Southbound
    - 52nd and Pine streets - Northbound only
    - 52nd Street and Cedar Avenue - Northbound only
    - 52nd and Catharine streets - North and Southbound
- Closure of two stop locations, both northbound and southbound (52nd and Parrish streets and 52nd Street and Larchwood Avenue);
- Revisions to lane and stop striping to enhance operations and safety;
- Installation of additional shelters and signage.

The scope of these improvements was developed by SEPTA bus operations staff based on lessons learned from efforts on Routes 10 and 48. Notably, the improvements implemented are significantly different from those originally proposed by the Transit Improvement Committee in 1990. That study did not recommend a switch from near-side to far-side stops, although a specific signal prioritization strategy was not evaluated in detail at that time. Further, the four stops closed (two northbound and two soundbound) fall far short of the 36 originally recommended for closure.

Based on the relationship calculated between stop location at intersections and delay (see above – 11.2 seconds per intersection), the relationship between stops reduced and operational changes observed in Los Angeles (above – elasticity of 0.13), along with the 6.8 percent estimated reduction in running time resulting from signal prioritization (or alternatively 5 seconds per intersection), the estimated benefits for Route 52 running time are as follows (these are based on an average round trip running time calculated from the Fall 2003 schedule, prior to improvements, of 79.97 minutes):

- *Switch to farside stops:* A roughly 6.3 percent reduction in total running time, for a savings of just over 5 minutes (11.2 seconds x 27 stop relocations).

- *Stop reductions:* A roughly 0.52 percent reduction in total running time, for a savings of 0.42 minutes.
- *Signal prioritization:* A roughly 6.8 percent reduction in end-to-end running time, for a savings of roughly 5.44 minutes (alternatively, 5 seconds for each of 50 intersections, for 4.2 minutes saved). Averaging these estimates yields an estimated benefit of 4.8 minutes saved.

In other words, a combined benefit of roughly 12.1 percent to 13.6 percent, or 10.2 minutes, can be expected based on the experiences of other cities. In order to know whether these estimated benefits were actually achieved, we performed an evaluation of the changes in scheduled running times between the September schedules for 2003 and 2007 (SEPTA's most recent schedule). Ideally, actual running times would be compared, as well as on time performance (OTP), but this data is only reliably available more recently, following SEPTA's fleet-wide installation of AVL/GPS infrastructure. If we assume a consistent relationship between scheduled running time and actual running time for the years examined, a comparison of scheduled running time is nevertheless instructive.

A before/after comparison for Route 52 is complicated by several factors. First, just less than 20 percent of Route 52 trips complete a "Parkside Loop" round trip rather than a full routing. Second, due to actions by St. Joseph's University, SEPTA lost its former Route 52 northern layover location, requiring certain northbound trips to loop to 54th Street and Belmont Avenue before returning for southbound runs. This route segment, added between 2003 and 2007, adds roughly 10 minutes to affected trips. Accordingly, in order to permit as full an evaluation of Route 52's improvements as can be managed, Table 7 compares travel times for full end-to-end routings, Parkside Loop routings, and the portions of all routings that occur between Girard and Baltimore avenues. This is the core Route 52 routing, shared by all service variations, which therefore permits apples-to-apples comparisons.

Table 7: Changes in scheduled running time for Route 52, 2003-2007

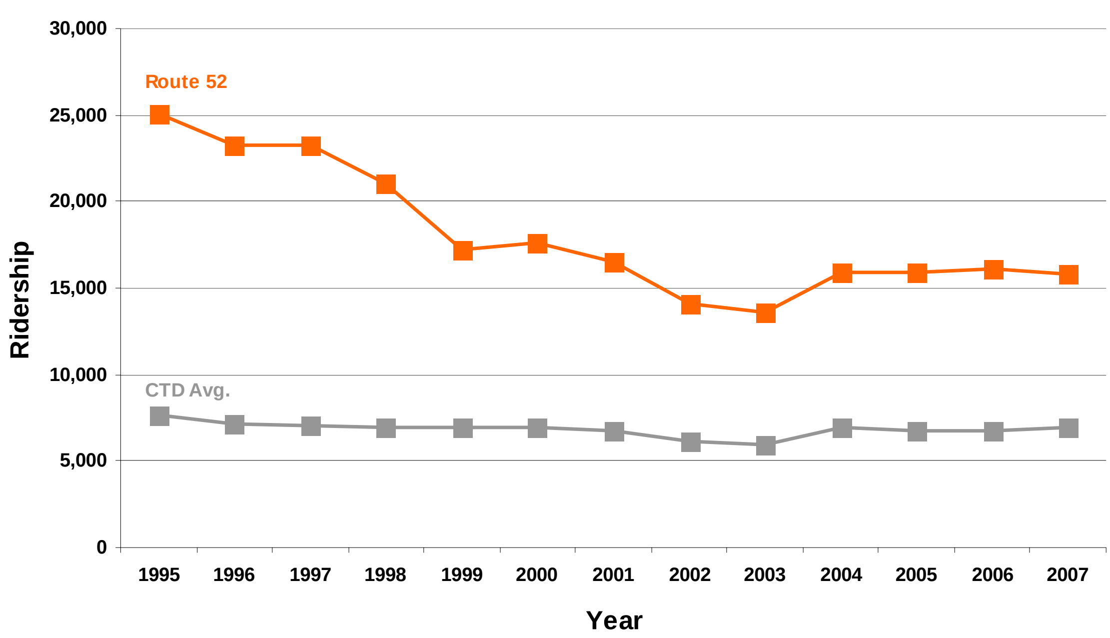
	Sept. 2003			Sept. 2007 (% Change)		
	Mean	Max	Min	Mean	Max	Min
End-to-End Running Time (54th/City Line to 54th/Woodland and back)	79.97	89	57	78.12 (-2.3%)	91 (+2.2%)	55 (-3.5%)
Parkside Loop Running Time (Parkside Ave./Loop to 54th/Woodland and back)	55.37	63	44	51.87 (-6.3%)	68 (+ 7.9%	34 (-22.7%)
Combined Northbound & Southbound Running Times for Girard to Baltimore Avenue segment	25.26	27	19	24.08 (-4.7%)	26 (-3.7%)	18 (-5.3%)

Source: SEPTA, 2003-2007.

Due to the complications described above, it is difficult to cobble together a data set from current Route 52 schedules that enables a pure apples-to-apples comparison with 2003 data. Comparing running times within the Girard to Baltimore avenues segment does permit comparisons, as this segment was shared by all route variations in both 2003 and

2007. Although running times for this segment improved by 4.7 percent, most of Route 52's near-side to far-side stop relocations occurred within this core segment (17 of 27), as did all four of the stop closures. Accounting for the roughly 2 percent of end-to-end running time savings estimated for the 10 relocations outside the Girard to Baltimore segment, we would have expected a roughly 10.1 to 11.6 percent improvement in running times for the Girard to Baltimore Avenue segment (of the 12.1 to 13.6% total end-to-end improvements that were estimated). Accordingly, the 4.7 percent time reduction observed falls significantly short of this estimate. However, it is worth noting that this level of improvement contributed to SEPTA's ability to reduce Route 52 peak vehicles between 2003 and 2007, from 23 to 22. Chart 8 depicts Route 52 weekday ridership between 1995 and 2007.

Chart 8: Route 52 Average Weekday* Boardings, 1995-2007



*Beginning in 2004, daily boardings (a weighted average of weekday and weekend ridership) replaced weekday boardings in SEPTA's annual reporting data. *Source:* SEPTA Route Operating Ratio Reports, 1996-2006; SEPTA, 2008. "CTD Avg" refers to average boards for all City Transit Division (CTD) bus, trackless trolley, and trolley routes.

Notably, ridership increased significantly between 2003 and 2007, the before/after years selected for our running time comparison. Annual average weekday boards were 13,617 in 2003 and 15,852 in 2007 (a gain of 16.4%). This increase, as well as stability in ridership between 2004 and 2007, is particularly striking in the context of the steady declines in ridership between 1995 and 2003. This may reflect the Transit First improvements' contributing to a more attractive service.

Qualitative impressions of improvements

In January 2008, DVRPC staff rode Route 52 end to end in both directions, including late afternoon peak times. Although our general impressions were of an efficient service without undue delay, one particular element of the post-Transit First configuration stood out as a delay generator, particularly during peak times. At far-side stop locations, buses curb in a bus zone not much longer than the bus, with on-street parking immediately in front of the bus zone. Where the last on-street parking stall is occupied (which was observed to be the case in nearly every instance), this short bus-zone length requires the operator to turn sharply (and consequently slowly) left in order to reenter traffic. This contributes to delay, particularly where the bus also must wait for an opening in order to reenter the travel lane. In such instances, this prevents the benefits of a far-side stop from being realized, as dwell time waiting for a green phase is simply replaced with dwell time waiting for a reentry window. This configuration likely contributes to the above-referenced lag between expected and achieved time savings for Route 52.

Recommendations for further improvement

From our quantitative and qualitative evaluation of Route 52, we estimate that there are significant untapped benefits from the Transit First investments made. The chief design impediment identified, the requirement that buses curb in relatively confined bus zones and reenter traffic, was observed to aggravate delay, particularly for new far-side stops. We recommend that far-side bus zones be extended through the removal of additional on-street parking stalls in order to permit bus acceleration and ease reentry.

State of the Practice on City/Transit Agency Cooperation: New York City

Recent and ongoing efforts in New York City's five boroughs by the New York Department of Transportation (DOT) and Metropolitan Transportation Authority (MTA) to improve surface transit (bus) speeds are somewhat similar to Philadelphia's Transit First efforts, and they include several unique solutions that may warrant consideration here.

The bus-speed improvement package in New York has three principal components:

- *Bus Priority:* Bus priority treatments in New York have a history of more than 15 years, in the form generally of a combination of limited stop service (stopping only at major intersections, typically every 8 blocks) and various types of bus-lane priority treatments. As in Philadelphia, the effectiveness of bus lanes in New York has been impaired by lane-enforcement issues (specifically, illegal parking, delivery parking, and parking by official vehicles).

- *Hot Spots:* Specific road segments and intersections where buses routinely experience delay have been identified as part of New York's recent PlaNYC long-range plan for the city. Improvements to address these hot spots generally fall on the city DOT rather than MTA and might include changes in traffic patterns, signal timings, and/or street alignments.

- *Select Bus Service (SBS):* Bus Rapid Transit will initially be implemented along five New York bus corridors, starting with Route Bx12 in Northern Manhattan and along Fordham Road in the Bronx. The SBS program will include three basic improvements (in addition to higher frequencies and levels of service):

    - Further stop consolidation in comparison to limited stop service. SBS routes will also be served by local buses;
    - TSP (red truncation and green extension);
    - Painted (red) bus lanes, with enhanced enforcement efforts;

- Branded buses – initially repainted standard articulated buses, with unique procurements for vehicles with higher door flows planned over the long term; and
- Fare prepayment/multi-door boarding – Fare prepayment for SBS routes will be handled in a unique and fairly low capital way. Fareboxes will be installed at normal bus shelters (rather than more expensive pseudo-stations, as have been employed in places like Los Angeles), allowing riders to pay via MetroCard, cash, and eventually via credit card. Proof-of-payment slips are printed, similar to those used by NJ TRANSIT's RiverLINE in the DVRPC region. This prepayment system will allow SBS riders to board and alight via front and rear doors, significantly reducing dwell times at high-volume station locations.

In contrast to Philadelphia's Transit First efforts, New York's SBS program has specific target thresholds for running time improvements: 10 percent for Phase I improvements (detailed above), and an additional 10 percent for Phase II improvements (which are planned to include more capital-intensive strategies, such as physically separated rights of way). These thresholds may help to keep improvement efforts topical and active on an ongoing basis.

In conjunction with the three-tiered bus-speed improvement approach, New York DOT and MTA are also engaged in a series of enforcement efforts aimed at greater protection of transit rights of way:

- Buses are being incorporated into TrafficStat, the city's software framework for targeting locations for police enforcement;
- Bus lane enforcement is being formalized as a dedicated program within the Police Department;
- State enabling legislation is being pursued to install enforcement cameras on buses (as has been successfully implemented in London); and
- Innovative approaches for managing delivery vehicles are being pursued. As part of Fordham Avenue's SBS project, coordinated delivery windows are being scheduled for midday periods along problem segments of the corridor (10 am to 12 pm along the southern frontage, and 12 pm to 2 pm along the northern frontage).

Specific enforcement strategies such as these should be examined in Philadelphia under the Transit Improvement Committee.

Recommendations for Future Transit First Efforts

The outcomes to date of Transit First planning and investment in the City of Philadelphia fall short of the lofty goals from which the program draws its roots. Instead of a citywide network of corridors in which people movement (in the form of transit vehicles) has clear priority over automobiles, the city has three Transit First routes that demonstrate mixed success. During the last two decades, the success of the Transit First program was mitigated first by difficulties in maintaining an active partership by all necessary implementation partners in the face of public opposition, and second by a series of transit budgetary crises that prioritized survival over investment.

Given a variety of recent positive developments, however, including a burgeoning interest in effective and coordinated planning in the city, growth in SEPTA ridership, a new SEPTA General Manager, and the appointment of a Deputy Mayor for Transportation and Utilities under Mayor Nutter's administration, with the promise of a better relationship with SEPTA, the future potential of Transit First initiatives is significant. The generally positive outcomes from investments in Routes 10, 15, and 52 demonstrate that TSP techniques being applied nationally can also work in Philadelphia, while also providing lessons that can further improve service efficiency for those routes and inform decisions for investments. In addition to the specific recommendations for Routes 10, 15, and 52 detailed above, below are several general recommendations for the Transit First program as a whole, grouped by the stakeholder(s) that would need to take a leadership role for each.

<u>City of Philadelphia</u>

- In order to reinforce the cooperative nature of Transit First policies, we recommend that enforcement and investment priorities related to Transit First be included in the city's forthcoming Comprehensive Plan. A model in this regard can be found in the City of San Francisco's recently adopted municipal plan, which included a section on that city's Transit First program, as well as the 'hot spots' initiatives defined under New York's PlaNYC.

<u>DVRPC/SEPTA/City of Philadelphia</u>

- Opportunity may exist to better capitalize on the TSP system already installed along Routes 10, 15, and 52. As a follow-up to this project and in cooperation with SEPTA and the Philadelphia Streets Department, DVRPC plans microsimulation analyses of these routes in order to identify tweaks that might result in further performance gains.

<u>SEPTA and City of Philadelphia</u>

- To an ever-increasing extent, traffic signals in the City of Philadelphia are linked to a central network. Now that all SEPTA vehicles are equipped with Global Positioning System (GPS) transponders and coordinated through SEPTA's central control room, the possibility exists for the two networks to be linked. This would enable TSP to be implemented throughout the city's coordinated traffic control network (which will eventually cover the entire city) along all SEPTA routes, should policymakers desire it. SEPTA's schedule data could also be linked to such a framework, enabling conditional TSP strategies where vehicles would be granted green phase extensions only when they are behind schedule, for example. In this way, maximum flexibility would be afforded for networkwide conditional or active priority treatments that can be monitored and adjusted by a central controller. Such a project would require a high-level policy decision by both SEPTA and the city, of the sort that the Transit Improvement Committee was originally tasked to enable. Notably, the capital investment required would be relatively minimal – almost all of the required equipment is already in place or being installed as part of other projects.

SEPTA

- As referenced in DVRPC's 2007 *Small Starts Feasibility* report, a new Very Small Starts federal funding category was created under SAFETEA-LU, which provides roughly 50 percent of capital funding for Bus Rapid Transit (BRT) or streetcar projects that include many of the elements proposed and implemented for Transit First projects in Philadelphia, such as TSP, where current weekday corridor ridership exceeds 3,000. We recommend this funding avenue be explored for future Transit First project corridors. If Very Small Starts funding were sought, projects would need to have additional design elements to differentiate them from regular surface transit (such as special branding and unique stations/stops).

- For future Transit First efforts, specific target thresholds for speed improvements should be identified upfront. Projects should be evaluated after implementation to know whether these targets are met, and kept active (with further improvements being made and strategies tweaked) if they have not been.

- To supplement large-scale route or corridor-level projects, such as the Routes 10, 15, and 52 projects, Transit First should be kept alive as an ongoing program at a smaller scale. For example, particularly slow routes could be identified each year as part of the Annual Service Plan process (perhaps the city routes with the lowest average revenue miles per revenue hour) and "low hanging fruit" strategies to enhance speeds for those routes could be identified and tested each fiscal year. An ongoing Transit First program such as this would have greater weight with a dedicated line item in SEPTA's capital and/or operating budgets. This would be one way for SEPTA to demonstrate commitment in responding to the Transportation Funding and Reform Commission's speed improvement recommendation.

Transit Improvement Committee

- Many of the recommendations concerning policy and enforcement from the 1989 Peer Group Report (from which Transit First in Philadelphia derives) remain topical, as illustrated by the delay-generating incidents that have impacted Route 15 trolley service in particular. While these issues are not at all unique to Philadelphia, the Transit Improvement Committee should maintain efforts to improve them at a staff level and above. Innovative options such as those pursued in New York (including enabling legislation for enforcement cameras on buses, along with designated midday delivery windows) should be considered.

- To the greatest extent practical, SEPTA and the city should partner with other relevant policymaking agencies in support of Transit First initiatives. The Center City District has had a growing role in Center City Transportation Planning, as well as a growing cooperation with SEPTA. We recommend that the CCD be made a partner in the Transit Improvement Committee to aid in guiding future efforts.

- Where it was initially formed as a gathering of high-level city and SEPTA policymakers to implement Transit First, the Transit Improvement Committee remains as a staff-level gathering that facilitates communication and coordination between agencies. While this is sensible, as many of the enforcement issues that impede transit efficiencies can be resolved at a staff level, we believe that the future potential for Transit First initiatives requires a renewed prominence. To that end, we recommend the Committee, in cooperation with the city's Deputy Mayor for Transportation and Utilities, restore the past practice of having one "annual report" meeting with the mayor to highlight progress, discuss impediments, and set high-level goals for the following year.

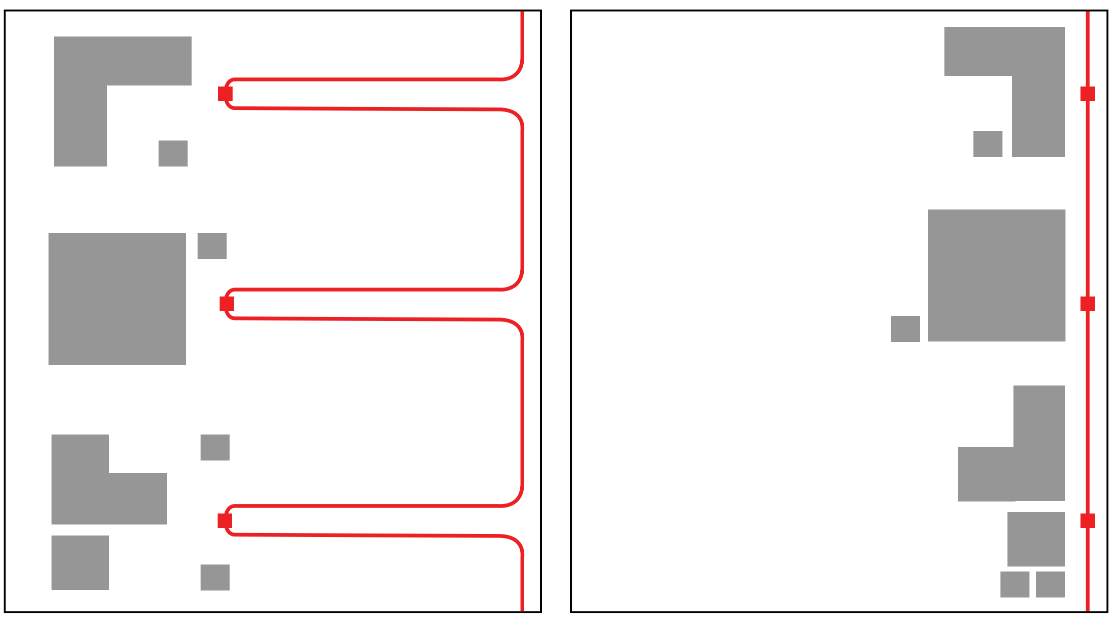
SECTION 3:
ENHANCING THE PERFORMANCE OF SUBURBAN BUS SERVICE

Bus service in automobile-oriented suburban areas has unique challenges that are not limited to service speed or efficiency. These challenges have been well established through industry experience, and they include:

- Development and trip densities that often do not support fixed-route service patterns;
- Poor passenger infrastructure, such as the absence of bus shelters and sidewalks accomodating access to buses along arterial roadways, as well as connecting sidewalks to collector or local roadways;
- New commercial developments that often require buses to make time-consuming route deviations in order to be served;
- Buses are subject to the same road congestion as automobiles, with less of a political constituency for transit-focused improvements than in urban areas.

Figure 1 illustrates the impact of automobile-oriented suburban site plans on suburban bus routings, where buses are forced to divert through parking lots in order to serve development safely.

Figure 1: Impacts of site design on suburban bus service



Transit & pedestrian-hostile: The bus route (red line) diverts across a large parking area in order to stop (red boxes) close to commercial development. In this example, the routing is 4x as long as on the right.

Transit & pedestrian-friendly: The same footprint of commercial development is located close to the street with parking in the rear. Bus stops (red boxes) are in-line, and the bus has to cover much less distance.

Each of these challenges is surmountable, but together they result in a circumstance where truly effective bus service is difficult to provide. This is reflected in the higher typical cost recovery performance of SEPTA city bus routes in comparison to suburban routes. The average operating ratio for City Transit Division routes in SEPTA's 2007

Annual Service Plan was 45 percent, as compared to 32 percent for Suburban Transit Division routes.

Most efforts in other regions with the aim of improving bus service, and improving bus speed specifically, have occurred through Bus Rapid Transit (BRT) projects. BRT projects generally seek to emulate the passenger benefits of rail service, including:

- Widely-spaced stations, including bus shelters of significance, with park-and-ride and/or well connected walk-up/bike-up access;
- Short, regular headways, particularly in comparison to the often-infrequent nature of typical suburban bus service;
- A dedicated right of way for the BRT service is often required where roadway congestion is a significant problem.

Short of full BRT projects, targeted efforts to improve regular suburban bus service can be effective, but avenues of improvement are more limited than for urban service. In contrast to urban routes, for example, suburban routes typically have wide stop spacings, meaning that stop delays and dwell times are a smaller component of overall route delay, which limits the potential benefits from stop consolidation.

In addition to the strategies noted for BRT projects above, other specific strategies that are often employed as stand-alone improvements or as part of an improvement package are[3]:

Transit agency strategies:

- Off-board fare collection;
- Use of low-floor buses and/or raised platforms for level boarding;

Transit agency cooperation with local jurisdictions and state DOTs:

- Updated signal timing plans;
- Passive transit signal priority (retiming signal progressions in a way that is consistent with transit flows);
- Parking removal or restriction;
- Turning prohibitions for general traffic with exemptions for transit;
- Queue jumping lanes, which allow buses to bypass congestion at intersections;
- Bus bulbs (to permit in-lane bus stopping);
- Shared bus/HOV lanes, dedicated bus lanes, or legal shoulder operations;
- Transit Signal Priority (TSP) treatments, analogous to those used in Philadelphia's Transit First routes;
- Relocation of near-side stops to far-side locations in order to minimize intersection delays, regardless of whether TSP treatments are implemented.

State-level policy:

- Yield-to-bus legislation.

Transit Signal Priority (TSP) strategies are often perceived to be less disruptive to general traffic than other capital options and are less maintenance-cost intensive.

[3] *Transit Signal Priority (TSP): A Planning and Implementation Handbook* (ITS America, May 2005).

Further, TSP strategies can be appropriate for a broad number and variety of corridors/contexts, and they have been pursued at a regional scale elsewhere in the United States. As TSP strategies are often a preferred option, with locally-demonstrated success in the form of Philadelphia's Transit First routes, they are the focus of this report section.

Summary of TSP Strategies and Options

TSP strategies can take a number of forms, ranging from passive to centrally controlled. ITS America's 2005 *Transit Signal Priority Handbook* summarizes various options for TSP implementation strategies:

> *Passive Priority:*
> Passive TSP strategies are those that do not require the hardware or software investment of active or adaptive priority treatments. Generally speaking, passive strategies may be appropriate where operating and traffic characteristics are consistent and well established, and would include (for example) revising a corridor's signal timings to account for operational characteristics like average transit vehicle dwell times.
>
> *Active Priority:*
> Active TSP strategies are those typically referred to under the TSP name, and they refer to signal benefits given to individual transit vehicles based on detection and operations. These may include green phase extensions, early green phases (or red phase truncations), and transit actuated phases (unique phases such as exclusive left turns or queue jumps that are only activated when a transit vehicle is detected).
>
> *Conditional Priority:*
> When the appropriate infrastructure is in place, active TSP strategies can be made conditional to account for transit schedules or other characteristics. For example, a signal might only grant a green phase extension if the transit vehicle is behind schedule.
>
> *Integration with Automatic Vehicle Location (AVL) System and Broader ITS Architecture:*
> When transit vehicles are equipped with Global Positioning System (GPS) equipment and traffic signals are connected and coordinated through a central network, maximum flexibility is afforded for networkwide conditional or active priority treatments that can be monitored and adjusted by a central controller.

The handbook also notes that in order to maximize TSP benefits, stops at intersections should be located on the far side of the intersection wherever practical. Within the context of a TSP system, far-side stops mitigate any conflicts with right-turning traffic and simplify the calculation of appropriate green-extension timings by removing dwell times from the equation.

Case Study on Suburban TSP Potential: SEPTA Route 104

A study conducted by the Transportation Management Association of Chester County (TMACC) on the potential for TSP along the West Chester Pike (PA Route 3) corridor is illustrative of the challenges that are endemic to even the best performing suburban bus routes, as well as the challenges and opportunities associated with TSP strategies in such circumstances.

SEPTA Bus Route 104 connects 69th Street Terminal in Upper Darby, Delaware County, to West Chester Borough in Chester County. Both westbound and eastbound AM peak period headways from and to 69th Street Terminal are roughly 15 minutes. Roughly half of these trips terminate/originate in Newtown Square and half proceed to West Chester (with West Chester trips having roughly 30-minute peak headways). Of all the through trips to West Chester, the shortest westbound trip in or abutting the AM peak period has a 59-minute scheduled run time and the longest is 82 minutes. The eastbound numbers are 63 and 78 minutes, respectively. In many ways, the West Chester Pike corridor represents something of an ideal suburban corridor for TSP strategies: it is a linear bus route and corridor anchored on both ends by significant residential and employment concentrations. Further, its route-level weekday ridership (3,512 as of FY2005) ranks sixth in SEPTA's Suburban Division.

In 2007, DVRPC published a feasibility analysis for a dedicated bus right of way (busway) for much of the Delaware County portion of Route 104 (from 69th Street Terminal to I-476), which generally concluded that passenger volumes and associated frequencies did not justify the provision of a busway. However, less invasive TSP strategies were not evaluated (*Feasibility Analysis of West Chester Pike Busway*, January 2007, DVRPC Publication No. 07001).

The TMACC report (*Transit Advantage: Transit Signal Priority on PA Route 3*, June 2007) includes a detailed evaluation of existing SEPTA Route 104 bus service along the Chester County portion of West Chester Pike, along with a survey of opportunities and challenges to TSP implementation. Many of these characteristics will be shared with other suburban corridors and proposals, and so are summarized below as a resource.

<u>Challenges</u>

Jurisdictional/governmental:

- As SEPTA Route 104 traverses portions of Delaware County and Chester County, as well as a host of municipalities, achieving buy-in from each stakeholder government for a consistent treatment along the entire route length is challenging. Illustrating this challenge, certain police and emergency personnel expressed reluctance about the proposed TSP project, both due to perceived impacts on closed loop signal systems and perceived agency equity issues (not all police vehicles have preemption emitters).
    - To ease stakeholder buy-in, state, multimunicipal, or other funding for TSP projects should be considered as an incentive in order to resolve any inequities for municipalities that lack preemption emitters.

Land use:

- Sidewalks are often absent or poorly connected throughout the corridor, making passengers traverse road shoulders or parking lots in order to access bus stops or shelters. This is exacerbated by numerous circumstances where pedestrian crossing is prohibited at or near bus stop locations. In addition,

some stops at commercial developments and more dense residential developments are located near guardrails that block access and create pedestrian safety issues.
- Most stop locations have no shelters (this is especially problematic during inclement weather).
- With a few exceptions, high-volume trip generating and attracting land uses aside from the route's termini are not easily accessible from West Chester Pike, limiting the utility of enhanced service for those trips.
- Journey-to-work (JTW) connection volumes along the corridor were lower than originally perceived. Localities perceive Route 104 as a predominantly reverse commute engine. This is borne out by CTPP 2000 JTW data. Considering just the route's endpoint anchors, a combined 595 workers traveled from Upper Darby or Philadelphia to West Chester Borough, while only 236 workers made the traditional inbound commute.

Roadway/traffic:

- Local police departments indicated that traffic congestion was a significant problem and that emergency vehicles were impaired by congestion during peak periods despite the presence of preemption. A Level of Service (LOS) analysis conducted by PennDOT for the project determined that a number of study area intersections (in Chester County) had LOS of 'E' or 'F' (in contrast, the aforementioned DVRPC busway study found that intersection LOS for its Delaware County study area were generally good).
- Buses were impeded from merging back into traffic after stopping, forcing drivers to operate on shoulder lanes between stops.
- Roadway and intersection improvement projects are often not coordinated with SEPTA; such coordination could help to mitigate negative transit impacts and preserve future opportunities for service.

<u>Opportunities/benefits</u>

Operational:

- Linear routing and consistent, comparatively high ridership.
- Many corridor traffic signals already have preemption systems installed for emergency vehicles. Only four Chester County corridor intersections would require new or modified equipment in order to enable TSP.
- The only capital costs for a minimal implementation of TSP would be optical emitters on buses.
- Route 104 service has a mix of near-side, far-side, and midblock stops already. This indicates an amenable climate for relocations of near-side stops to far-side stops, which would also not be impeded by existing shelter facilities in most cases.
- The majority of Route 104 passengers are long-distance commuters who would likely be amenable to, and would not be displaced by, a more express-oriented, limited stop operation.

Recommended actions

As a result of its evaluation, the TMACC report recommends implementation of a modest priority scheme in the short term, with five- to ten-second green phase extensions limited to peak periods, along with a coordinated multimunicipal effort to improve pedestrian access to the bus corridor.

While the TMACC report did not estimate the benefits of TSP on Route 104 running times, it is possible to roughly estimate the benefits of a generic TSP strategy using the framework employed for Philadelphia's Transit First routes in this report. Between 69th Street Terminal and the Market Street/Gay Street split at the gateway of West Chester, Route 104 traverses 59 signalized intersections. Using the five-second per intersection rule of thumb on TSP running time savings, this corresponds with a 295-second end-to-end savings, or 4.9 minutes. The worst case AM peak scheduled running times between West Chester Transportation Center and 69th Street Terminal are 76 and 64 minutes (westbound/eastbound). Using the 6.8 percent estimated running time savings also employed in the Transit First section generates an estimated savings of 5.2 and 4.4 minutes, respectively. Based on these calculations, a rough end-to-end savings of five minutes seems reasonable to expect.

This is not nearly enough to save a peak vehicle given 30-minute headways, but it may be a significant time savings from the passenger's standpoint. Additionally, while a round trip time savings of 10 minutes may not significantly reduce operating expenses in the short term, if combined with other strategies (such as targeted stop consolidation), it may result in greater long-term time savings that could be used to improve scheduled service speeds along a portion or the entirety of the West Chester Pike corridor.

The capital costs associated with TSP implementation may be minimal, according to the United States Department of Transportation's ITS Costs Database (on the web at http://www.benefitcost.its.dot.gov): for the most basic TSP functionality, roughly $2,000 per bus for emitters, or $20,000 to $25,000 for Route 104's 10 peak vehicles, plus roughly $2,500 each for the five Chester County corridor intersection approaches (over four intersections) which presently lack signal preemption receivers. The most significant impediments are jurisdictional cooperation and, ideally, a broader corridor-level strategy to better integrate Route 104 service with corridor communities through investments in pedestrian connectivity.

Characteristics of Suburban Corridors Where TSP Would be Most Appropriate

West Chester Pike is certainly not the only regional suburban bus corridor in which TSP and similar strategies might be appropriate. The TSP *Planning and Implementation Handbook* surveyed a number of transit carriers on their means of selection for TSP projects. Based on the results of this survey, as well as the selection method described for the Chicago region in a Regional Transportation Authority report[4], the below criteria comprise a checklist to identify regional suburban TSP projects with the greatest potential for success.

[4] *Final Report: Regional Transit Signal Priority Location Study, Phase I*, Regional Transportation Authority (RTA)/Parsons Transportation Group & EJM Engineering, December 2000.

1. *High levels of base ridership*
   The FTA Small Starts program uses a threshold of 3,000 weekday riders for Very Small Starts applicant BRT corridors. This represents a reasonable (though not absolute) target threshold for TSP and related investments. Section 3 in DVRPC's *Small Starts Feasibility* report (DVRPC Publication No. 07016, June 2007) identifies suburban corridors that meet this ridership threshold.

2. *High base-level bus service frequencies*
   In the Chicago region, a minimum threshold of four buses or 100 passengers per peak directional hour was established.

3. *High transit potential and/or transit dependence*
   DVRPC's Transit Score model[5] may be used to identify areas with high levels of transit supportiveness as related to residential and employment densities. The density of zero-car households is also factored into the Transit Score calculation as a measure of transit dependence. As a general rule, TSP corridors should be anchored by one or more places with a MEDIUM-HIGH or HIGH Transit Score and should traverse or connect multiple geographies with scores of MEDIUM or better.

4. *Roadway congestion levels that are not debilitating*
   In the Chicago region, a "preponderance" of intersections was required to have peak hour volume to capacity (v/c) ratios of less than 0.9.

5. *Multilane corridor roadway configurations*
   In the Chicago region, TSP investments were limited to multilane roadways, or two-lane roadways with widening or channelization at intersections.

6. *Minimal pedestrian conflicts*
   In the Chicago region, the subject corridor was required to have no more than 400 conflicting pedestrians per hour at "most" intersections.

7. *Ability to piggyback with police/fire/emergency preemption investments*
   This can be viewed as something of a bonus criteria, and it helps in building coalitions in support of a proposed TSP investment.

Summary and Recommendations

Generally speaking, investments to enhance suburban bus service speed and quality should be targeted to locations where local land development patterns and planning decisions enable effective connections with the transit service. The criteria above should be viewed as a checklist in identifying corridors with high potential for such investments. In order for speed improvements to be realized, there should also be a mechanism in place at a project's outset for running time savings to be internalized into schedules.

[5] *Transit Score* = 0.41*(population per land acre) + 0.09*(jobs per land acre) + 0.74*(zero-car households per land acre);
Score categories – Low: < 0.6, Marginal: 0.6 – 1.0, Medium: 1.0 – 2.5, Medium-High: 2.51 – 7.5, High: > 7.5;
Source*: Creating a Regional Transit Score Protocol: Full Report*, DVRPC Publication No. 07005, May 2007.

SECTION 4:
REGIONAL RAIL SYSTEM SPEED

SEPTA's Regional Rail service is often cited for its unusual slowness relative to peer agencies. This section discusses the reasons for this characteristic and summarizes the strategies SEPTA has recently employed to address Regional Rail speed, as well as those planned for the short and long term.

As reflected in Table 2 in this report's introductory section, SEPTA's average Regional Rail service speeds, while stable over the last decade, are the slowest among the four peer agencies highlighted. This is consistent with the results of a survey published in the March 2, 2007 edition of the *Urban Transportation Monitor*, which indicated SEPTA's average Regional Rail speeds to be the slowest among 11 responding commuter rail carriers.

It bears noting here that the relationship between operating speed and operating cost is somewhat different for commuter rail than for other transit modes, such as bus or streetcar. Commuter rail generally, SEPTA Regional Rail included, tends to have much lower peak frequencies than those modes. Because of this, it is much more difficult for incremental, marginal changes to add up to time savings significant enough for a peak vehicle to be saved while providing the same levels of service. Absent more draconian operational changes (such as closing a significant portion of stations), Regional Rail speed improvements will have greater benefits for quality of service and passenger satisfaction than for agency cost savings.

Further, the recent Regional Rail ridership gains experienced under the current system have created a passenger capacity constraint on a number of lines, resulting in greater passenger boarding delays and, consequently, longer station dwell times. Changes to improve the speed of service can be expected to make service more attractive for discretionary riders, challenging service speed anew. In short, operational efficiency through scheduled speed improvement is a moving target for SEPTA Regional Rail.

Impediments to Regional Rail operating speeds can generally be grouped into two categories:

Hard Constraints – Network or infrastructure factors, including:

- Station design and spacing.
- Network characteristics (i.e., track configuration, switching).
- Vehicle technology and design.

Soft Constraints – Policy factors, including:

- Crew procedures.
- Scheduling policies.

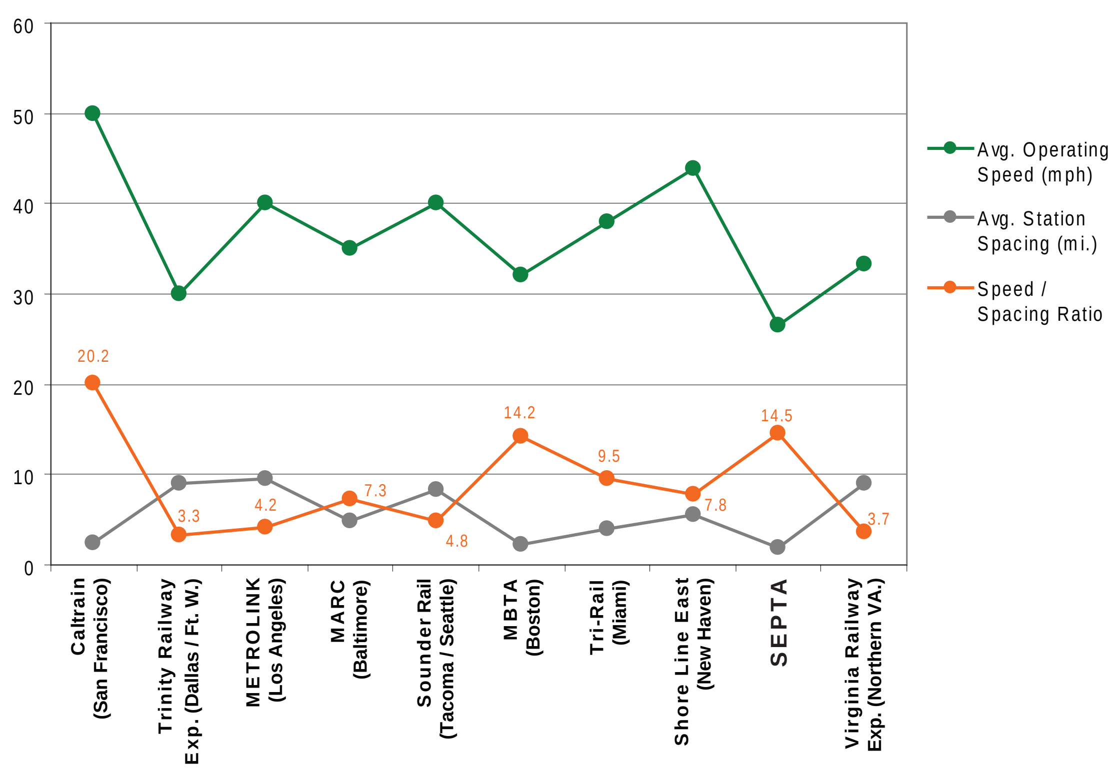
This section frames potential improvement strategies in the context of these constraint groupings.

Hard Constraints

Regional Rail station spacing

As previously noted, the chief reason cited for SEPTA's unusually slow Regional Rail operating speeds is the system's unusually close station spacing. Data from the *Urban Transportation Monitor* survey referenced above is illustrative of the relationship between station spacing and average speed. The green and grey lines in Chart 9 indicate the reported average operating speed (including stops) and average station spacing, respectively, for the 11 responding carriers.

CHART 9: Operating Characteristics of Select Commuter Railroads



As this chart indicates, SEPTA's speed and spacing were the lowest reported. However, the ratio of speeds achieved to station spacing (as illustrated by the orange line) is higher for SEPTA than all but one other carrier (Caltrain in San Francisco, California). In other words, SEPTA's average Regional Rail speeds are on par or better than these peer carriers after accounting for stop spacing. An intuitive solution to improve speeds would be to eliminate certain station stops from service. In this way, time would be saved through trains not having to slow, stop, dwell, and accelerate. Removing stations, however, often requires exchanging economic development and accessibility for speed. Promoting transit-oriented development (TOD), for example, becomes impossible when stations are removed from service. In addition, Environmental Justice (EJ) concerns can affect proposed station closures in disadvantaged areas.

As noted in a prior section, DVRPC conducted an evaluation of potential station closures in 2003 (*Regional Rail Stations Closures Study* – DVRPC pub. 03034). This study evaluated seven stations, which were:

- Lamokin Street Station (R2 Wilmington/Newark)
- Angora Station (R3 Media/Elwyn)
- Wissinoming Station (R7 Trenton)
- Delaware Valley College Station (R5 Lansdale/Doylestown)
- New Britain Station (R5 Lansdale/Doylestown)
- Link Belt Station (R5 Lansdale/Doylestown)
- Fortuna Station (R5 Lansdale/Doylestown)

The study estimated that if all seven stations were closed, passengers would save a cumulative 228.4 daily hours of travel time, and ridership on the affected lines would increase by 2 percent as a result of speedier service (this was the midpoint of the -1 to +3% modeled ridership change). Based on a variety of characteristics, including a pattern of unusually low ridership, the report recommended that three of the original seven stations be closed: Lamokin (R2), Angora (R3), and Wissinoming (R7). Of these, Lamokin and Wissinoming were closed at the end of 2003 (Angora Station remains open despite persistent low ridership – 34 daily boards per SEPTA's 2007 ridership census, where SEPTA Service Standards have a threshold for intervention of 75 daily boards). The anticipated end-to-end running time savings for each affected route following closure was not evaluated, nor was the potential for operating cost savings through fewer train runs. Closing Lamokin and Wissinoming stations was estimated to have saved SEPTA through passengers 162 onboard passenger hours daily, and to have saved SEPTA almost $35,000 in annual operating costs in the form of power and station maintenance. Closing Angora, which had and still has the lowest ridership of any stations in the original study, is estimated to save an additional $11,000 in power and station maintenance costs and 112 daily onboard passenger hours.

SEPTA's most recent Service Standards (2007) call for Regional Rail stations to be spaced no closer than 0.5 miles in urbanized areas, 1.0 mile in suburban areas, and 2.0 miles in rural areas. Generally speaking, then, SEPTA's existing spacing, as atypically close as it may be, conforms to these standards for new station locations (meaning that any new lines or connections could have a similar station pattern). It may be prudent to adjust these service standards to require somewhat wider spacing for new stations or service. Additionally, SEPTA and its partner stakeholder governments should continue targeted efforts to discontinue service at perennially underperforming stations, absent other compelling reasons for service to be continued (such as a planned TOD, for example).

Station facility speed constraints

Beyond the number, spacing, and distribution of stations, station and rail car design factors also have an impact on train dwell times and, as a consequence, on total running times. The chief considerations in this regard are level boarding (i.e., high-level platforms), and car boarding/alighting flows (i.e., more and wider available doorways, along with more efficient door locations).

High-level platforms

As noted previously, the 1989 regional report *Improving Mobility in Southeastern Pennsylvania – A Public Transportation Solution* had as one of its chief recommendations the widespread installation of high-level platforms throughout the SEPTA system. SEPTA presently has a general policy to install high-level platforms as part of every station reconstruction or renovation project where it is possible to do so. According to research presented in Transit Cooperative Research Program (TCRP) Report 13 (*Rail Transit Capacity*, 1996), door flow times per single stream door (no simultaneous boards and alights) with level boarding (i.e., high-level platforms) were roughly half those of step-up boarding (1.75 seconds versus 3.6 seconds), as well as for level alighting versus step-down alighting (roughly 1.9 versus 3.25 seconds). Using similar ratios, the 2002 DVRPC *Regional Rail Improvement Study* for the R5 Lansdale/Doylestown Line (Systra Consulting) estimated the dwell time savings for an inbound express peak trip that would result from converting a number of low-level platform stations to level boarding facilities. The total dwell time savings was estimated to be just over six minutes if all stations were to be converted. Since that report was published, SEPTA has installed (or installation is pending) high-level platforms at six R5 stations: Chalfont, New Britain, Link Belt, Colmar, Fort Washington, North Wales, and Ambler. The 2002 study estimated an average 32-second peak trip dwell time savings for high-level platform installation at each of these stations (savings were not estimated for Link Belt station, which was presumed to be skipped by the express trip that was modeled).

Based on this example from one Regional Rail line, the potential for dwell time savings through the provision of high-level platforms systemwide is significant. However, illustrating the myriad other factors at play, SEPTA's most recent R5 schedules actually reflect increased travel times along this line, owing to higher dwell times associated with spiking ridership (weekday ridership on the R5 Lansdale/Doylestown line increased by 10.5% between 2005 and 2007). Further, the ability to install high-level platforms systemwide is limited where rights of way are shared with freight rail. The greater width of freight cars would require mitigation in the form of "flip up" high-level platforms or freight bypass tracking, at considerable expense.

Car door configuration

SEPTA's existing Regional Rail fleet consists of Silverliner II, III, and IV rail cars, which have an "end vestibule entranceway" (EVE) door configuration. In practical terms most cars have a single passenger stream available (with the conductor opening a door at one end of the car) for both boarding and alighting at most stops, which leads to relatively high dwell times at higher volume stations. Variations of door/entryway configurations that are designed to improve dwell times via a variety of tweaks to this traditional configuration are collectively referred to as short dwell time entranceways (SDEs). These include more and/or wider available doors, quarter-point doors that split passenger flows within the car, and train-line controlled doors (where the engineer or conductor operates multiple doorways electrically).

The design for SEPTA's forthcoming Silverliner V rail cars combines several of these techniques. Three high-level or two low-level passenger streams will be available per car at each stop, operated via train-line control (at least in the first car). These represent the potential for significant dwell time and operational benefits once these cars are distributed through the fleet, which can be maximized if cars are directed to routes with the highest degree of dwell time delay. Research presented in the 2004 Transportation Research Record[6] estimated the overall running time benefits of SDE improvements of roughly the type used in the Silverliner V design to be 5.4 or 3.6 percent (for station spacings of 1.25 miles and 2.5 miles, respectively) for Diesel push-pull trains, and 3.3 or 2.1 percent (again for 1.25 and 2.5 mile station spacings, respectively) for Electric Multi Unit trains of the sort principally used by SEPTA (benefits in the latter case are more difficult to isolate from the research as consistent level boarding was also assumed). Given that these are net running time benefits, we can assume that station-level dwell time benefits would be still greater.

Based on this, SEPTA should pursue a design similar to the Silverliner V for future procurements and should target Silverliner V sets to lines or line pairs with the greatest degree of dwell time delay. Since Silverliner V cars will have three high-level boarding streams and only two low-level streams, benefits would be further maximized along lines with a higher proportion of stations with high-level platforms. The 2002 DVRPC *Regional Rail Improvement Study* for the R3 Media/Elwyn Line (Systra Consulting) recognized the potential combined benefits of high-level platforms and Silverliner V-type rail cars. That report recommended the installation of high level platforms along the R3 line, finding that the combination of such platforms with a new four boarding stream car design (the final Silverliner Vs will have 3 streams) would result in a greater than 3 percent savings in end-to-end running time.

The R5 Lansdale/Doylestown line, with its recent investments in high-level platforms and recent schedule changes due to increasing dwell times, would appear to be a natural candidate for Silverliner V service.

<u>Rail network constraints</u>

The speed of trains between stations is limited not only by vehicle acceleration/deceleration profiles, but also by the characteristics of the network itself. Speed constraints in this regard may take the form of antiquated infrastructure (switches/interlockings, for example) or capacity constraints owing to conflicts with other rail service (freight or passenger). Portions of the SEPTA Regional Rail network are encumbered by each of these constraint categories.

Figure 2 on the following page draws on prior studies, as well as information provided by SEPTA, and graphically illustrates three types of capacity constraints across the entirety of the Regional Rail network: merge points, shared rights of way, and single-tracked segments. Some single-tracked segments are physically single tracked, in some cases single-track operation is forced by station platform configurations, and some segments are single tracked through agreements with other freight and passenger carriers. While this figure is comprehensive at the regional scale, it does not address the mechanics of more localized choke points, such as antiquated switches and/or signals where maximum speeds are constrained. Additionally, it bears reinforcing that service is also constrained by other network characteristics, such as the presence of freight rail traffic (which also impacts the ability to install high-level platforms along certain corridors).

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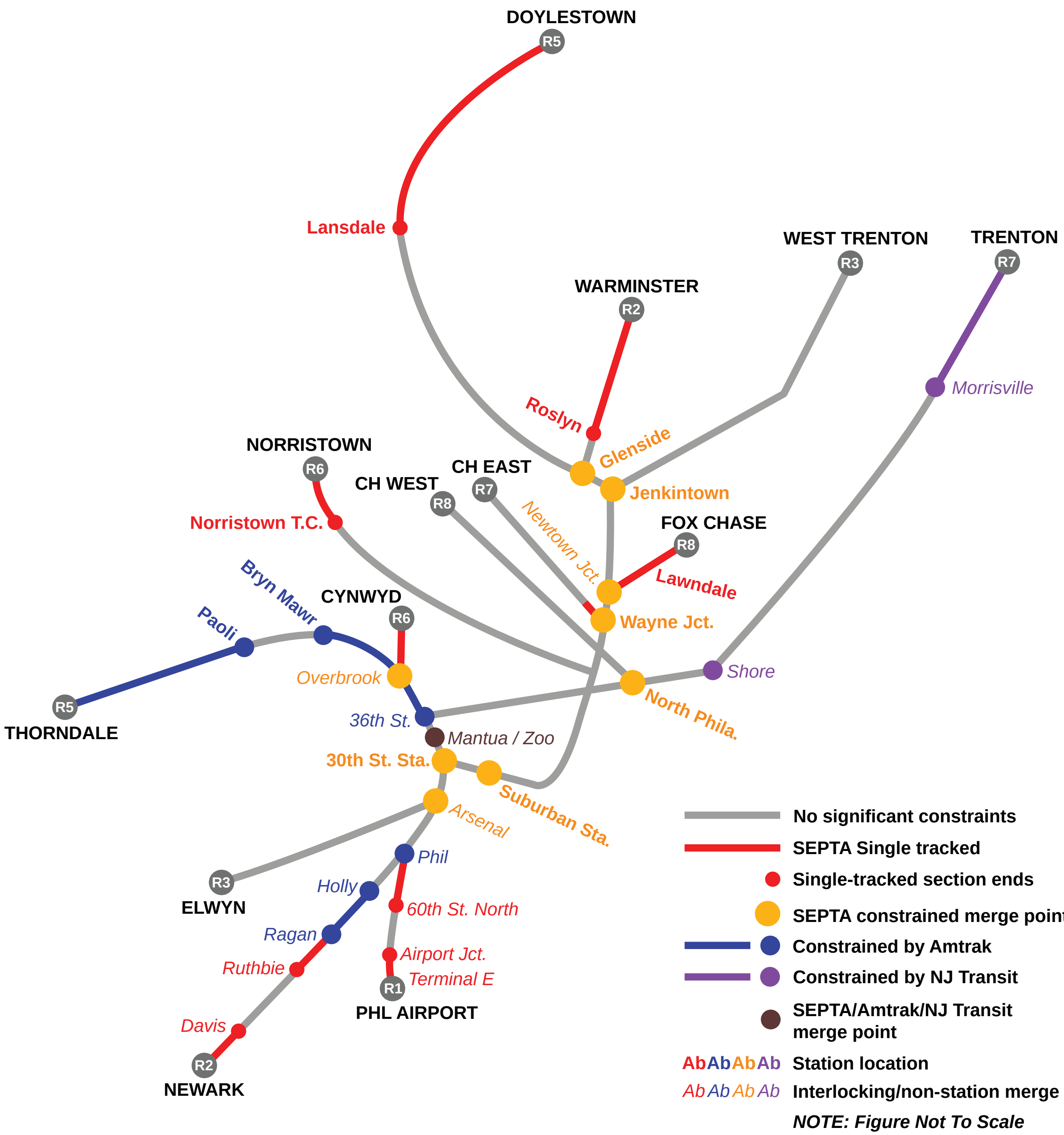
[6] Morlok, Edward K. and Nitzberg, Bradley F. “Speeding Up Commuter Rail Service: Comparative Actual Performance of Different Train and Station Platform Designs.” *Transportation Research Record* vol. 1872, 2004, pp. 37-45.

Figure 2: Significant SEPTA Regional Rail network constraints



Sources: Vuchic, Vukan, and Kukuchi, Shinya, *Short-term Improvements for SEPTA's Regional Rail System*. 1994; SEPTA, 2008.

As Figure 2 indicates, a network as expansive as SEPTA's, portions of which are shared with Amtrak and New Jersey Transit, has a number of constraint points that impair systemwide efforts at enhancing operating speeds. In many cases, entire lines can have their service potential impaired by a single "weak link" or constraint point. In the case of the R7 Trenton line, for example, the impacts of sharing a several-hundred-foot section of track through the Mantua Interlocking with both Amtrak and SEPTA permeate throughout the line, particularly where SEPTA requires space from the same two carriers at Trenton. Scheduling a single trip with clearance at both locations is problematic and limited. SEPTA has recently been working with Amtrak on the development of a new Northeast Corridor (NEC) master plan; significant bottlenecks identified during that work are also reflected in Figure 2.

As summarized in Section 1 and Appendix A (pages A-9 – A-10), DVRPC's 2002 *Regional Rail Improvement Study* for the R5 Lansdale/Doylestown Line includes a number of specific recommendations to address localized line segment constraints on service. In its final recommendations (selected on a cost/benefit basis), the report recommended relocating a host of crossing gates in order to eliminate speed restrictions relating to grade crossings, along with upgrading the entire Glenside-Doylestown segment to a 60-mph maximum speed corridor. The latter strategy was indicated to require a host of localized improvements, including the elimination of an antiquated spring switch siding at CP-Forest and the relocation of train meets to Lansdale and Doylestown.

SEPTA has been engaged in an ongoing effort to address such bottlenecks, with the stated aim of eliminating speed restrictions and consistently operating at rated track speeds. This program is reflected by recent improvements to the Lansdale-Doylestown line. In addition to the high-level platform efforts described above, SEPTA has (or has short-term plans to):

- Improve Dale interlocking (south of Lansdale Station) to permit parallel train movements;
- Eliminate the 5th Street Crossing, which has a 5-mph speed restriction;
- Replace catenary equipment;
- Improve signals between Wayne Junction and Glenside; and
- Install a new passing siding south of Chalfont, replacing Forest siding.

As a result of these improvements and others, operating speeds are expected to improve. The Lansdale-Glenside segment will be upgraded to 70-mph maximum speeds and the Wayne Junction-Glenside segment has been upgraded to 60-mph maximum speeds. Note that because trains need to accelerate and decelerate through curves and around stations, and due to other transient factors such as wet leaves on tracks, actual operating speeds are often lower than maximum rated speeds.

Other improvements recently completed or programmed for short-term completion along other lines include:

- *R2 Warminster*
  Project to replace the signal system along the entire line. Among other improvements, this will include retiring and replacing the spring switch at Roslyn with a high-speed turnout.

- *R3 West Trenton*
  Project to replace overhead catenary along the length of the line, allowing the removal of several speed restrictions (line now operates at 70-mph maximum speeds).

- *R6 Norristown*
  Project to increase track speeds from 50 to 60 mph between the northern limits of 16th Street and Wissahickon and between Conshohocken and Dekalb.

- *R5 Paoli*
  Funded in conjunction with Amtrak, the Keystone Corridor Improvements Program has included the installation of continuous welded rail and concrete ties from Paoli to Overbrook. Additionally, new interlockings will be installed at Overbrook, Bryn Mawr, and Paoli. Finally, SEPTA has recently begun rebuilding "K" Interlocking west of 30th Street Station, an improvement that will benefit multiple Regional Rail lines upon completion.

- *R8 Fox Chase*
  High-level platforms have been installed at Cheltenham Station and are under construction at Olney Station. High-level platforms will be installed at the remainder of the line's stations over the next five years.

- *Signal Modernization*
  Implementation of a networkwide signal modernization plan is ongoing, with completion on all lines planned by 2015. In addition to providing a higher level of safety (through Automatic Train Control and the installation of enhanced pedestrian crossing signals), this program will also help to address bottlenecks by enhancing flexibility through certain signalized interlockings. In addition to the line-specific improvements noted above, this program will also include switch and interlocking modernizations along the R5 Lansdale/Doylestown (partially described above), R2 Warminster, R6 Norristown, R6 Cynwyd, R7 Chestnut Hill East, and R8 Chestnut Hill West lines.

The specific impacts of each of these improvements on line-level speed performance have not been evaluated in detail. Generally speaking, SEPTA's network modernization program has made progress in recent years, with a defined schedule for continued improvement over the next several years.

Soft Constraints

In addition to hardware and infrastructure issues, matters of policy and other "soft" issues can also have a significant impact on speed performance. A 2002 article in the *Philadelphia Daily News*[7] noted that despite improving technology and the closure of a number of stations, "about half" of the Regional Rail lines took longer to reach Center City than equivalent service in the 1940s. In addition to modern jurisdictional issues of track sharing (as summarized in Figure 2), two policy explanations were cited: crew "hustle" and conservative scheduling (with time being padded, particularly in Center City).

[7] Flander, Scott, "Regional Rail Lines Slowing Down With Age," *Philadelphia Daily News*, May 30, 2002.

Crew hustle

Issues of hustle were also cited in DVRPC's 2002 *Regional Rail Improvement Study* for the Media/Elwyn Line, as well as the 1994 report *Short Term Improvements for SEPTA's Regional Rail System*[8]*.* In the 2002 R3 study, crew inefficiency, or "slack," throughout the line (but particularly at Media Station) was cited for dwell times of unnecessary length.

The 1994 *Short Term Improvements* report made two specific recommendations in this regard. First, it was suggested that crews be trained on better crowd management and decisive corrective measures in case of delays, and second, that SEPTA implement rules requiring train crews to open all car doors that they could feasibly handle and supervise. The first recommendation is related to crew explanations cited in the 2002 *Daily News* article concerning interactions with passengers. In that article, crew cited a greater level of customer service, including patience with elderly or disabled passengers, for delays blamed on hustle. This issue remains topical under the policy proposals of new General Manager Joseph Casey, who emphasizes an expanded customer service focus. These two quality of service objectives (staff friendliness/consideration and service efficiency/speed) can be in conflict.

With regard to the second recommendation, SEPTA staff indicates that there are presently enough conductors and assistant conductors on most trains for multiple doors per car to be operated. As such, the 1994 recommendation on new crew rules still stands as a sound one. SEPTA should consider requiring each conductor and assistant conductor to operate a door at every station, and to direct boarding and exiting passengers to specific doors. A simple "enter at the front of the car, exit at the rear" rule could be effective if properly communicated to riders and enforced by conductors.

Scheduling policies

Concerning the issue of padding being built into schedules, particularly in Center City, SEPTA staff indicates that such time is made necessary by constraint points elsewhere in the network, as reflected in Figure 2. Similar to the constraints noted above on either end of the R7 line, any time gained in Center City would be lost in delays owing to single-tracked peripheral line segments and Amtrak or NJ Transit scheduling. Timed train meets throughout the network were specifically cited in this regard – time cut from schedules for Center City segments would need to be added at those schedule points. In short, the constraints cited in Figure 2 result in a limited number of available "windows" for an integrated Regional Rail network, resulting in a built-in degree of delay that can be redirected, but not eliminated.

Summary and Recommendations

Efficiency and speed in SEPTA's Regional Rail network is impaired chiefly by two factors: track sharing and control issues (Amtrak, NJ Transit) and network infrastructure constraints. In an integrated network such as SEPTA's, where individual trains operate through Center City on multiple routes, weak links or constraint points can have cascading effects throughout the network. SEPTA is engaged in a program of investment specifically targeting bottlenecks, but is further challenged by the desirable

[8] Vuchic, Vukan and Kukuchi, Shinya, *Short-term Improvements for SEPTA's Regional Rail System*, 1994.

problem of spiking ridership and demand for service. Several general and specific policy courses are recommended:

- Adjust service standards to require wider station spacings in suburban and rural areas for any prospective new service. The present two-mile minimum spacing in rural areas is closer than the typical spacing of many peer commuter rail operators for any area type. Station closures to permit greater spacing along existing corridors are less practical in the current climate of ridership growth, with a few exceptions (such as Angora Station on the R3 Media/Elwyn line, for which the SEPTA Board has already authorized closure).

- Continue the policy to install high-level platforms wherever possible in order to minimize train dwell times through level boarding. Benefits can be maximized by employing Silverliner V cars and future cars of similar configuration along routes with greater numbers of high-level platforms.

- Continue the ongoing and successful program of addressing infrastructure bottlenecks through equipment modernization along all lines. Where bottlenecks are removed and/or track segment speed ratings are increased, a framework should be in place where these improvements can immediately be internalized by schedules wherever possible. In the long run, assuming continued broad ridership growth, remaining single-tracked segments along the R2 Warminster, R5 Doylestown, R6 Cynwyd, and R8 Fox Chase lines should be considered for double tracking (on the basis of cost versus operational benefit).

- In the context of a new focus on customer service, SEPTA should be careful to balance the desire for a positive passenger/staff interaction with the cumulative impacts of a “gentle” style on end-to-end service speeds. In terms of passenger satisfaction, each of these aspects is significant.

- SEPTA should consider requiring each conductor and assistant conductor to operate a door at every station, and to direct boarding and exiting passengers to specific doors. A simple “enter at the front of the car, exit at the rear” rule could be effective if properly communicated to riders and enforced by conductors.

APPENDIX A:
Details on Prior Report Recommendations from Section 1

Report: ***Managing Success in Center City***
Center City District/Central Philadelphia TMA
Consultant: Kise Straw & Kolodner, Sam Schwartz PLLC
Date: February 2008

Mode(s): City bus

Recommendation:
Revise bus stop spacing to have an every-other-block stop spacing.

Estimated relative impact on travel speed: HIGH

Challenges:
- Passenger habits.
- Political resistence.
- Possible contractual issues with bus shelter management firm.
- Could discourage discretionary ridership by making transit somewhat less convenient.

Opportunities:
- Zero-cost strategy.

Recommendation:
Remove select left-lane bulbouts along Chestnut Street.

Estimated impact on travel speed: HIGH

Challenges:
- Relatively high capital cost.

Opportunities:
- There is presently a three-minute time differential for buses to traverse the same distance along Chestnut and Walnut streets. The Center City District finds bottlenecks exacerbated by the bulbouts to be a significant contributor to this circumstance, indicating high potential benefits for bus flows.

Recommendation:
Pursue more obviously delineated (i.e., colored or textured) bus lanes along Walnut, Chestnut, and Market streets, as well as other corridors.

Estimated relative impact on travel speed: HIGH

Challenges:
- This is a long-term, more invasive strategy – if bus lanes were properly enforced, impacts on other vehicles could be significant.

- Higher installation and maintenance costs for colored and/or textured bus lanes.

Opportunities:

- True right-of-way protection for transit vehicles could significantly improve running times.

Recommendation:
Pursue TSP treatments along Walnut and Chestnut streets.

Estimated relative impact on travel speed: MEDIUM

Challenges:

- Capital costs.
- Benefits are diminished if stop spacing is not increased concurrently.

Opportunities:

- Benefits have been demonstrated along Routes 10 and 52 (see Section 2 of this report).
- As signals are modernized and incorporated into the city's centralized traffic signal network, the opportunity exists to integrate SEPTA's Automatic Vehicle Locator (AVL) data, enabling TSP citywide through software (see Section 2 of this report).

Report: ***Transit Stop Management Study***
City of Philadelphia, Office of Strategic Planning
Consultant: Baker
Date: June 2004

Mode(s): City bus, trolley, and trackless trolley

Recommendation:
Revise stop spacing in a shift from every-block stops to more limited-stop service.

Estimated relative impact on travel speed: HIGH

Challenges:

- Passenger habits.
- Political resistence.
- Possible contractual issues with bus shelter management firm.

Opportunities:

- New city administration may provide new opportunities for political leadership.
- Zero-cost strategy.

Recommendation:
Increase the installation of curb extensions (bus bulbs) to make bus curbing more efficient.

Estimated relative impact on travel speed: LOW

Challenges:

- Potential loss of on-street parking stalls.
- Capital cost of installation.
- Lack of established guidelines for placement priorities.
- Potential impacts on bicycle lanes (where present).
- Can have unintended congestion impacts and result in bottlenecks.

Opportunities:

- Benefits transit riders, transit operators, and pedestrians (in terms of shortening crossing distance); possible to build a broad constituency for support.
- Low capital cost.

Recommendation:
Pursue a comprehensive citywide transit prioritization strategy in the vein of Transit First. Ideally, several low-cost/high-yield elements of such a strategy would be identified based on the experiences of other cities for widespread implementation.

Estimated relative impact on travel speed: HIGH

Challenges:

- Requires substantial planning to identify component elements and most appropriate routes/locations.
- Capital cost could be substantial.
- Political compromises could limit effectiveness.

Opportunities:

- New city administration may provide new opportunities for political leadership.
- A broad, citywide program with financial backing would have the potential to significantly enhance the image of transit generally and SEPTA specifically.
- As signals are modernized and incorporated into the city's centralized traffic signal network, the opportunity exists to integrate SEPTA's Automatic Vehicle Locator (AVL) data, enabling TSP citywide through software (see Section 2 of this report).

Recommendation:
Simplify the fare collection system (this can be expected to reduce dwell times).

Estimated relative impact on travel speed: MEDIUM

Challenges:

- A broad fare modernization to a 'smart card'-type solution has a high capital cost.
- Full modernization should include cross-compatibility with PATCO and NJ TRANSIT services, which could complicate the project.

Opportunities:

- Broad constituency of support for fare modernization.

Report: ***Regional Rail Stations Closures Study (Pub. No. 03034)***
Delaware Valley Regional Planning Commission
Date: November 2003

Mode(s): Regional Rail

This study evaluated opportunities to improve efficiencies by identifying stations that would be candidates for closure. The seven stations evaluated were Lamokin Street Station on the R2 Wilmington/Newark Line, Angora Station on the R3 Media/Elwyn Line, Wissinoming Station on the R7 Trenton Line, and Delaware Valley College Station, New Britain Station, Link Belt Station and Fortuna Station on the R5 Lansdale/Doylestown Line. The study estimated that if all seven stations were closed, passengers would save a net of 228.4 daily hours of travel time and ridership on the affected lines would increase by 2 percent as a result of speedier service (this was the midpoint of the -1 to +3 percent modeled ridership change). The potential for operating cost savings through fewer train runs (as a result of faster running times) was not evaluated.

Recommendation:
Three of the seven stations (Lamokin, Angora, and Wissinoming) were recommended for closure due to low daily ridership. Lamokin and Wissinoming were closed at the end of 2003. Angora remains open, although total boards were only 34 in 2007 (per SEPTA's 2007 Regional Rail Ridership Census). This is well below SEPTA's 75 board service standard, but an increase of 7 boards from the 2005 Census.

Estimated relative impact on travel speed: MEDIUM

Challenges:

- Political considerations at Angora.

Opportunities:

- Closing Lamokin and Wissinoming stations was estimated to have saved SEPTA through passengers 162 onboard passenger hours daily, and to have saved SEPTA almost $35,000 in annual operating costs in the form of power and station maintenance. Closing Angora, which had and still has the lowest ridership of any stations in the original study, is estimated to save an additional $11,000 in power and station maintenance costs and 112 daily onboard passenger hours.

Recommendation:
Two stations, New Britain and Link Belt, were planned for conditional closure, contingent upon viable service alternatives being present. Both stations are still in service. Linkbelt's daily boards increased from 59 in 2005 to 66 in 2007, while New Britain's increased from 34 to 52 over the same span. As alternate transit service remains unavailable in these locations, the continued operation of New Britain and Link Belt Stations is consistent with the recommendations of this study.

Estimated relative impact on travel speed: MEDIUM

Challenges:

- Finding transit service alternatives for displaced passengers, where over 50 percent of the riders at these stations indicate that they would find an alternative to SEPTA if service was discontinued.
- Environmental Justice (EJ) and equity concerns have significant weight in closure considerations.

Opportunities:

- Eliminating service at the two stations was estimated to save 25 hours daily in onboard through passenger time and over $21,000 annually in power and station maintenance costs.

Recommendation:

Monitor Fortuna Station as Job Access/Reverse Commute (JARC) service (provided by Bucks County TMA) is introduced into the area, eventually running a two-directional all-day schedule. The plan would be to eventually close the station if JARC implementation was successful. As of now, no JARC service is present near Fortuna station, and the station remains open (consistent with the recommendations of this study). As of the 2007 Regional Rail Ridership Census, total daily boards were 85, an increase of 25 from the 2005 Census.

Estimated relative impact on travel speed: MEDIUM

Challenges:

- The biggest employers near Fortuna Station are located in Montgomery, not Bucks County. Discussion of implementing this type of service seems to have ceased several years ago, as the two routes mentioned as links to Fortuna were discontinued.

Opportunities:

- Ending service to this station was estimated to result in approximately 25 hours in daily onboard passenger time savings and an annual power and station maintenance cost reduction of roughly $11,000.

Report: ***Regional Rail Improvement Study: R3 Media/Elwyn Line***
Delaware Valley Regional Planning Commission
Consultant: Systra
Date: August 2002

Mode(s): Regional Rail

This study technically evaluated a host of operational change concepts for their impact on travel time in relation to estimated cost (the specific measure was "capital costs per passenger-minute of travel time saved per day").

Recommendation:
Assuming that the SIlverliner V design will have four passenger streams for boarding/alighting at high-level platforms and two streams for low-level platforms, SEPTA should aggressively move to contruct high-level platforms along the R3 line.

Estimated relative impact on travel speed: MEDIUM

Challenges:
- Highest capital cost of all the improvement scenarios that were evaluated (roughly $44 million).

Opportunities:
- Would reduce total daily passenger travel and wait time by more than 3 percent, according to the study.

Recommendation:
Schedules should have a greater emphasis on outer zone express services. Specifically, SEPTA should operate one to two additional outer zone express trains in the morning and evening peak periods (which may require an expansion of Media Yard to minimize dead-heading).

Estimated relative impact on travel speed: MEDIUM

Challenges:
- Relatively low capital cost, although a specific cost was not estimated.
- Additional train runs would increase operating costs.

Opportunities:
- Would reduce total daily passenger travel and wait time by roughly 4.5%, according to the study.

Recommendation:
SEPTA should emphasize crew efficiency and "hustle," specifically at Media Station (the scheduled travel time appears to include roughly two minutes of slack according to study observations, resulting in dwell times that are longer than necessary).

Estimated relative impact on travel speed: LOW

Challenges:

- Existing standards and operating procedures.

Opportunities:

- No significant capital or operating costs.

Recommendation:
Adjust Elwyn interlocking signal to permit greater approach speeds.

Estimated relative impact on travel speed: LOW

Challenges:

- Minor capital cost.

Opportunities:

- Noticeable 'bang for the buck,' although the specific impacts were not modeled.

Recommendation:
SEPTA should eliminate revenue train crew drop-offs and pickups at Powelton Avenue Yard and instead use 30th Street Station, which is only one-quarter mile away.

Estimated relative impact on travel speed: LOW

Challenges:

- Staff habits and preferences.

Opportunities:

- No cost.
- Potential for schedule tightening, although the specific impacts were not modeled.

Report: ***Regional Rail Improvement Study: R5 Lansdale/Doylestown Line***
Delaware Valley Regional Planning Commission
Consultant: Systra
Date: January 2002

Mode(s): Regional Rail

This study technically evaluated a host of operational change concepts for their impact on travel time in relation to estimated cost (the specific measure was "capital costs per passenger-minute of travel time saved per day"). The three recommendations below were selected in part because they would not displace passengers through station closure.

Recommendation:
Eliminate all grade crossing-related speed restrictions on the R5 line.

Estimated relative impact on travel speed: HIGH

Challenges:
- Requires relocation of crossing gates at a host of locations.
- Requires coordination with many municipalities and regulatory agencies; political compromise is likely.

Opportunities:
- This strategy has the highest 'bang for the buck' of the nonstation closure strategies evaluated (in terms of "capital costs per passenger-minute of travel time saved per day").

Recommendation:
Upgrade the R5 line between Glenside and Doylestown to permit 60-mph maximum speeds throughout.

Estimated relative impact on travel speed: HIGH

Challenges:
- Estimated capital cost of roughly $4 Million for improvements, including the elimination of the CP-Forest spring-switch siding where trains typically meet, and a relocation of train meets to Lansdale and Doylestown.

Opportunities:
- Similar 'bang for the buck' as the first recommendation (above).

Recommendation:
In future rolling stock procurements, SEPTA should continue to purchase Electric Multiple Unit (EMU) cars rather than locomotive-hauled push-pull stock.

Estimated relative impact on travel speed: MEDIUM

Challenges:
- None.

Opportunities:

- The modeling in this study indicated that a hypothetical switch to push-pull stock for the R5 line resulted in longer trip times and lower corresponding operating speeds.
- This strategy has been pursued by SEPTA, as reflected in the Silverliner V procurement.

Report: ***Recommendations for Improvement of Green Lines Subway Operations***
Professor Vukan R. Vuchic, Ph.D., University of Pennsylvania
Professor Sinya Kikuchi, Ph.D., University of Delaware
Date: June 1990

Mode(s): "Green lines" subway-surface routes

This report evaluated opportunities to improve service speed and efficiency in the subway-surface routes' shared subway tunnel.

Recommendation:
Mark multiple stop locations at each station. Each platform is designed to accommodate at least two vehicles, and most are designed to accommodate three or four. Multiple simultaneous stopped vehicles were previously accommodated at 15th Street Station (westbound), which permitted combined frequencies of up to 120 vehicles per hour (in contrast to the roughly 55 vehicles per hour accommodated as of this report's publication). The specific recommendation was to accommodate two stop locations at each tunnel platform, with the exceptions of 15th Street and Juniper Stations, where there should be four stop locations (both eastbound and westbound).

> NOTE: Since this report's publication, two stop locations have been added to each underground station platform. 15th Street and Juniper stations still have two berths rather than the four berths proposed.
>
> Estimated relative impact on travel speed: HIGH
>
> *Challenges:*
> - Minor costs for platform stop location striping.
> - Minor costs to reactivate and maintain lighted overhead signs at platforms where four stop locations would be provided.
>
> *Opportunities:*
> - Low capital costs.
> - This was estimated to be the single most effective means of increasing line capacity.

Recommendation:
Platform attendants ("loaders") should be in place during the peak hours at the following stations/platforms: 19th Street eastbound, Juniper Street, 15th Street, and 30th Street westbound. The exact duration of loader help will vary from station to station with passenger volumes.

> Estimated relative impact on travel speed: MEDIUM
>
> *Challenges:*
> - Depending on where loader staff would be drawn from, this may require additional staffing, with associated increases in operating costs.
> - The benefits of loader assistance on dwell time and boarding efficiency accrue through management of passenger behavior (enforcing rear-door

boarding at stations with off-board fare collection, for example); this will require an adjustment of passenger habits.

Opportunities:

- Given the high combined vehicle frequencies attained in the tunnel, any opportunity to reduce dwell time at bottleneck stations is key.
- Based on the observations reflected in this report, the presence of loaders was seen to have a significant impact on dwell times, although some loaders were observed to be more effective than others.

Recommendation:

The tunnel signal system should be comprehensively reevaluated and redesigned so that there would be a reduced number of signals and with less conservative timing. Additionally, the forced-stopping feature/failsafe should be enabled.

Estimated relative impact on travel speed: HIGH

Challenges:

- Capital cost of implementation could be significant.
- The tunnel signal control system has already been modernized through the Communication Based Train Control (CBTC) project (completed between 2005 and 2008). While this project enhanced safety, it did not emphasize vehicle speed improvement.

Opportunities:

- Would permit higher speeds, greater passenger comfort (through less start/stop), greater energy efficiency (less waste during braking), reduced wear and tear, and better safety (assuming the enabling of the forced-stopping feature).

Recommendation:

Remove the operating rule requiring every car to stop prior to negotiating any switch. This rule is obsolete and unnecessary, particularly at modern switches such as that in the vicinity of the 40th Street portal.

Estimated relative impact on travel speed: MEDIUM

Challenges:

- Operator adjustment.

Opportunities:

- Would permit higher speeds, greater passenger comfort (through less start/stop), greater energy efficiency (less waste during braking), and reduced wear and tear.

Recommendation:

Introduce articulated vehicles at the next procurement opportunity.

Estimated relative impact on travel speed: MEDIUM

Challenges:
- Higher capital cost than single unit vehicles.
- Potentially significant traffic and other impacts along entirety of route.
- Incompatible with the above recommendation to provide multiple stop locations at each subway station (would require return to single berth platforms if implemented).

Opportunities:
- Would permit greater passenger throughput without requiring additional vehicles, which would contribute to delays.
- Would enhance passenger comfort.
- No impact on labor/operator requirements.
- Natural retirement of Kawasaki fleet provides a unique opportunity for implementation.

Recommendation:
Make adjustments to staff communication and management to enhance operational efficiency. From the top down, the study specifically recommended: a) assigning a single individual as overall manager of the green line unit; b) mandating better communication and active management between supervisors; and c) more detailed run sheets for operators.

Estimated relative impact on travel speed: LOW

Challenges:
- Organizational inertia.

Opportunities:
- Could permit efficiency gains at very low (or zero) cost and better capitalize on the benefits afforded by SEPTA's modern command and control center.

Recommendation:
Space permitting, add prepaid fare collection gates at 19th and 22nd street stations.

Estimated relative impact on travel speed: MEDIUM

Challenges:
- Space constraints.
- Some capital cost.

Opportunities:
- Would reduce dwell times at these stations, enhancing efficiency and reliability.

Recommendation:
Adjust speed management in the tunnel by introducing a general speed limit of 45 to 50 mph, and posting speed limit signs on line segments where lower speeds are required (this would include a shift from point speed control to line speed control and would result in higher average speed).

Estimated relative impact on travel speed: <u>MEDIUM</u>

Challenges:

- None of note.

Opportunities:

- Would permit higher speeds, greater passenger comfort (through less start/stop), greater energy efficiency (less waste during braking), and reduced wear and tear.

Recommendation:
Construct storage track/siding on the south side of City Hall.

Estimated relative impact on travel speed: <u>MEDIUM</u>

Challenges:

- Potentially significant capital costs.

Opportunities:

- Would reduce delays relating to stacking at the Juniper terminus.

Report: ***Improving Mobility in Southeastern Pennsylvania – A Public Transportation Solution***
Elected officials of Bucks, Chester, Delaware, and Montgomery counties, and the City of Philadelphia
Date: October 1989

Mode(s): All modes

This report comprised a “Strategic Mobility Plan” for Southeastern Pennsylvania and recommended financial, operational, and strategic reforms to modernize, in the authors’ view, SEPTA’s policies and its relationship with member counties.

Recommendation:
Comprehensively pursue Transit First strategies in the City of Philadelphia to enhance operating speeds and performance of surface routes.

Estimated relative impact on travel speed: HIGH

Challenges:
- High cost for comprehensive implementation of improvements such as Transit Signal Priority (TSP).
- Interagency policy conflicts.
- Competing interests among stakeholders.
- Lack of a long-term “champion.”

Opportunities:
- Potentially significant operational benefits.
- Lessons learned from Transit First implementations on Route 10, 15, and 52 could benefit future implementations.
- A new city administration provides an opportunity for a new champion.

Recommendation:
Pursue widespread installation of high-level platforms at Regional Rail stations (recommended to begin in Center City and then work outward in order of descending station passenger volume).

Estimated relative impact on travel speed: HIGH

Challenges:
- High capital cost for systemwide implementation.
- Operational conflicts with freight rail carriers.

Opportunities:
- Potentially significant operational benefits.
- SEPTA’s current policy is to install high-level platforms as part of station projects wherever practical.

Recommendation:
Pursue express bus service in High Occupancy Vehicle (HOV) lanes to major suburban employment centers. HOV lanes would be provided along every major transportation

corridor in Southeastern Pennsylvania, based on ridership potential. Where the Regional Rail network intersects with major highway corridors, interchanges including park-and-rides would be provided.

Estimated relative impact on travel speed: HIGH

Challenges:

- HOV lanes may conflict with other stakeholder priorities.
- HOV lanes may be technically unfeasible along certain congested corridors without roadway expansion.
- Integration with the rest of the transit network may be problematic.

Opportunities:

- Potential to capitalize on a broader constituency than transit users and advocating policymakers if HOV/HOT lanes are part of a broader regional investment strategy.
- Relatively low capital costs for HOV lanes and potential for costs to be shared by many parties.

APPENDIX B:
Details on Prior Transit First Reports

Peer Group Review of the Surface Streetcar Lines in North Philadelphia
Vukan Vuchic, Robert Landgraf, Tom Parkinson
January 1989

This report presented a basic policy choice between 'defeatism,' (i.e., the continued conversion of streetcar lines to bus routes in the face of spotty enforcement, poor agency coordination, and inconsistent investment), and a reinforcement of choice streetcar routes through selective modernization, more favorable street design, and enhanced/coordinated enforcement. The report's three key recommendations were:

1. Routes 15, 23, and 56 should be retained as streetcar routes and modernized, and Route 6 should be restored from bus to streetcar service. Kawasaki vehicles should be employed on these routes as new articulated vehicles are acquired for the subway-surface routes.
2. The above-recommended modernization should be conditional on supportive policies and actions by various city bodies, including the Streets Department, the Police Department, the Department of Public Property, the Parking Authority, and the City Planning Commission.
3. A new Transit Improvement Committee should be formed, chaired by the city's Director of Transportation.

As background, the Peer Group Report notes a 1987 memorandum from the City Managing Director advocating greater use of transit-preferential techniques such as signal preemption and dedicated transit lanes. In response, then-SEPTA General Manager Joseph Mack promised to find $200 million in capital dollars for a modernization of the streetcar routes. Yet then, as in various times since, this ambitious and favorable policy climate was not reflected in the on-the-ground actions of the myriad stakeholder agencies, which included ad hoc cuts and decisions, as well as the removal of streetcar-specific branding from SEPTA maps, schedules, and signage.

The Peer Group Report included specific recommendations for a number of streetcar routes, as summarized below.

Route 15
- 1989: Roughly 18,000 weekday riders, 8.1-mph typical operating speed.
- The Peer Group Report estimated that Transit First improvements would improve operating speed to 10.0 mph and reduce peak vehicle requirements from 17 to 13.

Route 23
- 1989: Roughly 30,000 weekday riders, 7.1-mph typical operating speed.
- Among all routes, Route 23 was deemed to suffer the most disruption from a lack of enforcement (and related issues), and so was treated in greater detail in the Peer Group Report. Specific recommendations included:
  - New connecting tracking between the northbound and southbound tracks was recommended in order to permit short turns and delay recoveries.
  - The distance between stops was recommended to be increased.

  - o Better delineation/marking of the streetcar lane was recommended, particularly in the southern single-tracked section.
  - o The possibility of splitting this route into two separate routes, possibly separated at Erie Avenue or at Bainbridge Street, was suggested.
  - o Significantly better enforcement of traffic and parking regulations was recommended (absent this enforcement, it was recommended that the southern portion of the route be converted to bus).
- The Peer Group Report estimated that Transit First improvements would improve operating speed to 8.3-mph and reduce peak vehicle requirements from 33 to 27.

Route 56

- 1989: Roughly 14,000 weekday riders, 8.8-mph typical operating speed.
- The Peer Group Report estimated that Transit First improvements would improve operating speed to 12.0-mph and reduce peak vehicle requirements from 18 to 14.

Route 6

- The Peer Group Report recommended restoration of streetcar service to this route, conditioned on Transit First-style modernization. It was deemed well-suited to streetcar service because of its short route length and high passenger volumes.

Route 53

- This route was not recommended for streetcar service restoration due to its relatively low passenger volumes.

To oversee the implementation of its recommendations for modernization of the streetcar system, the Peer Study Group recommended the formation of a Transit Improvement Committee, chaired by the city's Director of Transportation and consisting of representatives of several SEPTA departments, the City Police Department, the Streets Department, the Department of Public Property, the Parking Authority, the City Planning Commission, and City Council. The report further recommended specific action steps as follows:

Transit Improvement Committee:

- Formulate and implement a coordinated Transit First policy.
- Organize and undertake (through its component stakeholders) planning, design, regulatory, and financing tasks for the recommended streetcar improvements.
- Prepare a contractual agreement between the city and SEPTA to ensure continued joint efforts.
- Establish clear jurisdiction over street and intersection design, preferably assigning said jurisdiction to the city's Office of Transportation.
- Define responsibility for financing, construction, and maintenance of track area paving.
- Prepare amendments to the State Vehicle Code and City Ordinances, including:
  - o A prohibition on passing streetcars on the right as passengers are alighting.

- o Introducing higher penalties for blocking transit vehicles.
- o Introducing signage and regulations to ensure streetcar and bus right of way during turns and ingress/egress at stops.
- Following modernization efforts in North Philadelphia, the Committee should extend its work to the West Philadelphia routes, trackless trolleys, and normal buses.

SEPTA:

- Prepare a set of actions that would lead to improved streetcar operations following city adoption of a Transit First policy.
- Adopt a policy (backed up by capital programming) that emphasizes modernization of the streetcar system as a priority.
- Develop a related infrastructure improvement plan with time commitments.
- Increase organizational expertise in modern streetcar technology and operations.
- Plan to purchase articulated vehicles for the West Philadelphia subway-surface routes so that Kawasakis can be employed in North Philadelphia.
- Consider the possibility of purchasing low-floor LRT vehicles to speed boarding and alighting.
- Reduce the number of stops along streetcar routes and coordinate near-side and far-side stop locations to increase speed and efficiencies.
- Modernized streetcar service should be given a distinct image and marketed as a “semirapid” transit mode.

City Agencies:

- Correct “lethargic, defeatist attitudes” affecting policy, design, and operational changes necessary for modernization.
- Innovate and update practices in traffic planning and regulations as they pertain to transit.
- In cases of parallel streets, create a hierarchy of function such that each street predominantly serves a distinctive purpose (e.g., parking and deliveries, automobile through flow, or transit movement).

Detailed Transit First Priority Corridor Evaluations
Transit Improvement Committee
1990-1991

Following the identification of five priority routes, the Transit Improvement Committee completed individual analyses of each of these routes, which were summarized in five *Summary of Efforts* reports. Three of these are summarized below, along with a more technical follow-up evaluation of Route 10 (the Route 56 report is not summarized here, as that route’s conversion to bus service makes that report’s recommendations largely moot).

Transit First – Summary of Efforts, Route 48 (April 1990)

Following the identification of five priority routes, Bus Route 48 was selected as the intial route for detailed study. In November 1989, members of the newly formed Transit

Improvement Committee rode Route 48 end to end, which generated a host of comments by committee members on opportunities for improvement. Specifically, the committee observed issues with speed, stop frequency, turning movements, and passenger circulation within the vehicle. As the report noted, "while the relative significance of each negative is small, the composite is weighty."

To establish a 'base case,' the route was mapped and catalogued in detail, as well as walked end to end by members of the Transit Improvement Committee's design subcommittee. As a result of their impressions and analyses, the committee recommended a series of specific changes.

Table 8: Changes to Route 48 recommended by the Transit Improvement Committee

	Northbound	Southbound
Total Passenger Stops	67	61
Suggested Elimination of Stops	28	16
New Stops Recommended	1	1
Concrete Bumpouts	11	3
Pavement Treatments	4	3

Source: City of Philadelphia and SEPTA, 1990

Additionally, the committee recommended that as signal hardware is replaced as part of its normal replacement cycle, priority should be given to interconnected signals and inductive loops that would interface with bus transponders.

The report notes than an estimation of the impacts that the proposed route revisions and capital investments would have on travel time is "fraught with uncertainty," and also recognized that certain improvements' effectiveness would be conditional on other improvements. In other words, the Transit First package of strategies would be compromised if it were implemented piecemeal. As a practical measure, the committee found it unlikely that speeds would increase significantly until the signal system was modernized.

Having said that, the report does include a series of specific estimates for expected speed improvements by scenario. It was estimated that the elimination of unwarranted passenger stops could, assuming 10 seconds saved per stop, reduce the round trip time by seven minutes and improve the worst case operating speed by 0.7 mph (from 7.9 to 8.6 mph). As a result, the number of operating vehicles could be reduced by one, for a significant cost savings, or, alternatively, additional service could be supplied at no additional cost.

The committee also estimated that modernization of the traffic signal system with some form of signal prioritization for buses would further reduce the worst case travel time by five minutes and, when combined with the above reduction in passenger stops, increase the worst case operating speed to 9.1 mph, yielding an overall speed improvement of 30 percent (7.9 to 9.1 mph). This would permit one additional vehicle to be removed from service.

Transit First – Summary of Efforts, Route 52 (November 1990)

The study of Route 52 was conducted in the same way as Route 48, with two additions to the evaluation method: surveys of bus operators and a detailed examination of transit accidents. As a result of their impressions and analyses, the committee recommended a series of specific changes.

Table 9: Changes to Route 52 recommended by the Transit Improvement Committee

	Northbound	Southbound
Total Passenger Stops	46	45
Suggested Elimination of Stops	17	19
New Stops Recommended	0	0
Concrete Bumpouts	2	4
Pavement Treatments	11	12

Source: City of Philadelphia and SEPTA, 1990

Additionally, the committee identified five stop locations with "extraordinary" passenger volumes: 52nd and Girard, 52nd and Market, 52nd and Chestnut, 52nd and Baltimore, and 54th and Chester, and recommended that these locations be given special design considerations. The committee also recommended the provision of a system of interconnected signals and preferential signalization.

Impacts of the recommended improvements were estimated in a similar way to Route 48, except that stop elimination was estimated to save 15 seconds per stop rather than 10, and overall speed and time impacts were broken out by travel direction. For northbound travel, assuming stop elimination and the provision of interconnected signals, the then-current worst case speed of 8.2 mph would be improved to 9.8 mph (a 19.8% improvement). For southbound travel, the then-current worst case speed of 8.0 mph would be improved to 9.5 mph (an 18.75% improvement).

Transit First – Summary of Efforts, Route 9 (March 1991)

The study of Route 9 was conducted similarly to the above routes. As a result of their impressions and analyses, the committee recommended a series of specific changes.

Table 10: Changes to Route 9 recommended by the Transit Improvement Committee

	Northbound	Southbound
Total Passenger Stops	70	73
Suggested Elimination of Stops	23	21
New Stops Recommended	0	0
Concrete Bumpouts	0	1
Pavement Treatments	4	3

Source: City of Philadelphia and SEPTA, 1991

In addition to these modifications, the committee recommended that the route's layover location be moved closer to its terminus.

As in the case of Route 52, the impacts of these changes were summarized by travel direction. For both northbound and southbound travel, the worst case speed was estimated to improve from 9 to 10 mph in the route's Center City and expressway portions (an 11% improvement), and from 10 to 12 mph in the route segment between the intersection of Wissahickon Avenue and Cathedral Road and the Wissahickon Transfer Center (a 20% improvement). The committee estimated that the round trip travel time could be reduced by 11 minutes, potentially saving one peak headway.

Route 10 Trolley Transit First Improvements: Evaluation of Signal Coordination and Preemption Strategies on Performance of Transit Operations
Urban Engineers
November 1996

As a followup to the Transit Improvement Committee's *Summary of Efforts* for the Route 10 trolley, Urban Engineers performed a technical evaluation to model the specific impacts of various signalization strategies on Route 10 service. The report notes that "for SEPTA, travel time savings was considered to be significant where the same headway can be provided with fewer trolleys." Various computer simulations were conducted and 'order of magnitude' cost estimates were provided.

This report evaluated eight scenarios. Four signal preemption strategies were tested (note that this report refers to preemptions where such techniques are commonly referred to as prioritizations):

- A simple preemption algorithm, without adjustments for the volumes of cross-street traffic volumes;
- A complex preemption algorithm, with detailed intersection-by-intersection adjustments for cross-street volumes;
- A 'combo' preemption algorithm, with adjustments to the standard simple algorithm at a handful of high-priority cross-street intersections; and
- A scenario with no signal preemption.

Each of these strategies was modeled under existing conditions, and with new timing plans such that the signal timings along Lancaster and Lansdowne avenues would be as follows:

- Lancaster Avenue: 100 seconds in the AM peak, 80 seconds in the PM peak
- Lansdowne Avenue: 65 seconds in both peaks

The study concluded that a new timing plan without preemption would have a significant impact, with greater impact occurring in the AM hours. It was estimated that there would be networkwide (all mode) benefits in speed and delay reduction, including benefits to Route 10 trolleys. When any of the preemption strategies were combined with new signal timing, these benefits were enhanced for the trolleys without significant negative impacts on general traffic.

The report noted that any scenario that reduces round trip travel time by six minutes (equivalent to the route's typical peak headways) enables SEPTA to save a vehicle, and consequently to save costs (an estimated $250,000 annually at the time per vehicle). Any combination of new timing with any of the three preemption algorithm variants was calculated to achieve this. Since this cost savings is stepped (i.e., is achieved only with the savings of a whole vehicle), the simple algorithm was determined to be the most cost effective – its cost was lowest, and its effectiveness (as measured by vehicle reductions) was equal to the other alternatives. The summary cost/benefit table is repeated here.

Table 11: Route 10 comparison of costs and benefits

Simulation Case	Costs	Peak-Hour Round Trip Time Savings		Estimated Annual Benefits*
		AM	PM	
Existing Timing Plan Simple Preemption Algorithm	$640,000	4.7 minutes	3.2 minutes	$0
Existing Timing Plan Complex Preemption Algorithm	$1,215,000	4.8 minutes	3.8 minutes	$0
Existing Timing Plan Combination of Algorithms	$715,000	6.5 minutes	3.1 minutes	$0
Revised Timing Plan No Preemption	$290,000	5.4 minutes	1.6 minutes	$0
Revised Timing Plan Simple Preemption Algorithm	$810,000	8.5 minutes	5.1 minutes	$250,000
Revised Timing Plan Complex Preemption Algorithm	$1,385,000	8.9 minutes	5.1 minutes	$250,000
Revised Timing Plan Combination of Algorithms	$885,000	9.8 minutes	4.8 minutes	$250,000

Source: Urban Engineers, 1996

The report recommended other scenarios for further study, including stop consolidation/relocation and the modification of conservative operating rules regarding stopping and speed reductions (similar to recommendations made in the June 1990 *Recommendations for Improvement of Green Lines Subway Operations*).

TITLE: Speeding Up SEPTA: Finding Ways to Move Passengers Faster

Publication No.: 08066

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Geographic Area Covered: Bucks County, City of Philadelphia, Chester County, Delaware County, Montgomery County

Key Words: SEPTA, Transit First, Transit Signal Priority, Regional Rail, Pennsylvania Transportation Funding and Reform Commission

ABSTRACT: The final report of the Pennsylvania Transportation Funding and Reform Commission identified two key opportunities for SEPTA to enhance efficiency: to "reduce costs by improving average system speed" and to streamline and simplify its fare structure. This report explores the first opportunity through an examination of issues related to the improvement of SEPTA system speed. Section 1 of this report includes a table that consolidates and summarizes speed-related recommendations from prior studies, with those prior studies being further detailed in Appendix A. Sections 2 through 4 of this report include the results of three breakout analyses on Transit First in Philadelphia (Section 2), techniques to enhance the efficiency of suburban bus service, focusing on Transit Signal Priority (TSP) techniques (Section 3), and the SEPTA Regional Rail network (Section 4).

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