BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

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Richard A. Davey
MassDOT Secretary and CEO
and MPO Chairman

Karl H. Quackenbush
Executive Director, MPO Staff

MEMORANDUM

DATE December 1, 2011

TO Boston Region Metropolitan Planning Organization

FROM Karl H. Quackenbush
CTPS Executive Director

RE Work Program for: MBTA Transit Delay Study

ACTION REQUIRED

Review and approval

PROPOSED MOTION

That the Boston Region Metropolitan Planning Organization, upon the recommendation of the Massachusetts Department of Transportation, vote to approve the work program for the MBTA Transit Delay Study in the form of the draft dated December 1, 2011.

PROJECT IDENTIFICATION

Unified Planning Work Program Classification

Technical Support/Operations Analysis

CTPS Project Number

11382

Client

Massachusetts Department of Transportation
Project Supervisor: Matt Ciborowski

CTPS Project Supervisors

Principal: Elizabeth Moore
Manager: Robert Guptill

Funding

MassDOT §5303 Contract #70174

IMPACT ON MPO WORK

The MPO staff has sufficient resources to complete this work in a capable and timely manner. By undertaking this work, the MPO staff will neither delay the completion nor reduce the quality of other work in the UPWP.

BACKGROUND

Delay and reliability are commonly encountered but difficult-to-address problems for the transportation industry. For the highway network, congestion is regularly cited as costing billions in wasted time, increasing air pollution, and reducing quality of life. In addition, delays to industry supply chains increase the costs of doing business. Transit travel characteristics, such as wait time and travel time, are also regularly affected by delays, disrupting timed transfers between routes and prohibiting people from arriving at their destinations at the expected time. As with other forms of transportation, delays and poor reliability on transit result in an opportunity cost of riders' wasted time, an increase in the stress placed on riders who depend on reliable service, greater pollution as transit vehicles consume more energy, and a detrimental effect on the economy as worker access to jobs is limited.

For transit trips, delay can be measured as the difference between the scheduled and the actual trip time. Presumably, transit trip schedules account for instances of "predictable" delay such as congestion on the roadway or greater transit vehicle boarding times during the peak commute times. These delays occur on a regular basis and at a consistent time on certain days of the week. Schedules therefore account for this "predictable" delay by adjusting the corresponding trip and cycle (running time plus recovery time) times. However, all transit routes that do not have their own designated right-of-way regularly encounter "unpredictable" delay due to factors outside a transit agency's control—such as double-parked cars or delivery vans, roadway accidents, and inclement weather—and even due to factors presumably under the agency's control—such as vehicle breakdowns and reassignments and operator absence or insufficient staffing. Even transit routes with dedicated rights-of-way can face "unpredictable" delays due to vehicle malfunction, medical emergencies, or safety concerns; while the occasional occurrence of these causes of delay is inevitable, their times of occurrence are not predictable.

A transit system is an interconnected network in which a delay incurred by passengers on any one part of the system will reverberate throughout much of the entire network via many individual trips. A better understanding of how this process occurs can assist in identifying the parts of the system (locations and routes) and times of day where delays have the greatest negative impacts on the system as a whole, as measured by the number of individual trips affected. This can help transit planners to better target resources to either reduce the likelihood of delays on certain routes or improve the response to delays on other routes when they occur.

OBJECTIVES

The objectives of this study are: to develop a Transit Delay Model for use in this analysis and ongoing use by MBTA Service Planning; to identify the delays and reliability issues, in terms of their location, route, and time of day, that have the greatest overall impact on the transit system's riders in terms of number of passenger trips affected and total passenger-delay times; to quantify the magnitudes of those delays; to analyze different types of delay and trace their impacts on passenger trips throughout the MBTA system; and to analyze the potential for expressing transit vehicles in order to mitigate the impacts of delays.

WORK DESCRIPTION

Task 1 Develop Travel-Time Model for Existing Trips

The first task will be to create a spreadsheet-based model that will be used to calculate the travel times of all scheduled MBTA trips for all passengers on an average weekday. This spreadsheet will be used to model not only the travel times of trips on individual routes, but also the time for transfers between routes. Inputs from several different data sources will be used for this model:

- The most recent weekday MBTA transit schedules for all bus, rapid transit, commuter rail, and commuter boat trips.
- The most recent average weekday MBTA route- and stop-level ridership information for all bus, rapid transit, commuter rail, and commuter boat trips, broken down by time period.
- Transfer matrices for all modal transfer combinations, broken down by scheduled time period.

In the model, the scheduled trip departure, midpoint, and destination times for all routes will be used to estimate the in-vehicle trip travel time between specific stops anywhere in the MBTA system, on single routes and on different routes between which a transfer is possible (determined from the transfer matrices developed as part of the Automated-Fare-Collection [AFC] Transfer Study). Stop-level ridership information (from the Automated-Person-Counter [APC] system and on-board passenger counts[1]) will be used to estimate the percentage of passenger trips on each route that originate from and are destined for each stop. These percentages will then be applied to the most recent route-level ridership information (from the AFC system) for each route. The schedule information, specifically the scheduled headways for each time period, will also be used

[1] The APC database is currently unavailable for analysis and may not be available when this study is conducted. If it is indeed unavailable, CTPS on-board passenger-count data will be used to construct the model and could be replaced with APC data by the MBTA when the database becomes available.

to estimate the average waiting time for every route and the average transfer time for all possible transfers. The resulting model will therefore estimate the number of average weekday passenger trips for each scheduled time period between each possible stop origin and stop destination with a maximum of one transfer as well as the associated in-vehicle, waiting, and transfer times.

Product of Task 1

Summaries of scheduled stop-to-stop passenger trips and associated trip times

Task 2 Conduct Literature Review

A literature review will be performed in order to ensure that this study makes use of the best possible understanding of how delays on one transit vehicle affect the on-time performance of other transit vehicles. For example, bunching is a phenomenon regularly encountered by transit vehicles when one vehicle experiences delay, and increased passenger loads after the delay cause the vehicle to fall further behind schedule as it completes its run, while the following vehicle, due to decreased passenger loads, runs ahead of schedule, so that the two vehicles end up running closer and closer to each other, forming a "bunch." Another instance in which a delay on one transit vehicle can affect another vehicle's on-time performance is when large numbers of transferring passengers from the first vehicle delay the second vehicle's departure because of a greater boarding time.

Product of Task 2

Literature review of transit vehicle bunching theory and other phenomena that can cause transit delay

Task 3 Assess Delays

A function will be developed that incorporates into the model created in Task 1 the ability to "delay" any individual transit vehicle trip or a series of trips and assess the impact on vehicle trip times and passenger trip times (in-vehicle, waiting, and transfer times). This Transit Delay Model will be used to determine the locations, times of day, and routes where delays impact, in the system as a whole, the largest number of passenger trips and cause the greatest increases in total delayed time. Different types of theoretical delays (one-time or recurring, and those that are and are not under the control of the MBTA) will also be modeled in order to trace their impacts.

Product of Task 3

Summary of the modeled impacts of different types of delays

Task 4 Analyze the Impacts of Express Trips

CTPS will investigate the potential of a delay-management strategy regularly used by the MBTA and other transit properties. Since delays typically cause the headways between transit vehicles to vary from the schedule, leading to bunching, a common solution is to express a delayed vehicle in order to re-establish the scheduled headway. In this task, the routes where the MBTA most commonly expresses transit vehicles will be identified, and the Transit Delay Model will be used to analyze the potential for express trips to reduce delayed trips and times on these routes.

Product of Task 4

Assessment of the impacts of express trips on delays, on various routes

Task 5 Document Results

A technical memorandum will be compiled that summarizes the results of the previous tasks. The Transit Delay Model will be supplied to the MBTA, along with an explanatory user's manual; the MBTA may use it to make further assessments of different delay-mitigation strategies. The model will permit the imputation of updated schedule and ridership data such that the MBTA can continually use the model to identify and assess the areas of the system where delays cause the greatest impacts as well as to evaluate strategies for addressing delays.

Products of Task 5

- Final technical memorandum
- Transit Delay Model and accompanying user's manual

ESTIMATED SCHEDULE

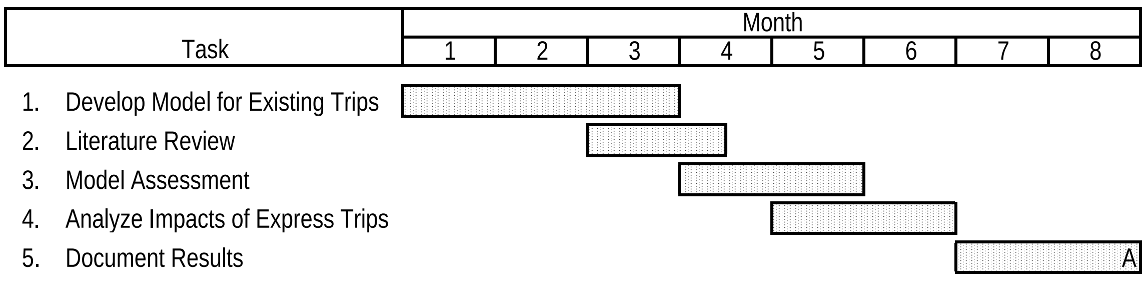
It is estimated that this project will be completed eight months after the notice to proceed is received. The proposed schedule, by task, is shown in Exhibit 1.

ESTIMATED COST

The total cost of this project is estimated to be $59,990. This includes the cost of 24.5 person-weeks of staff time and overhead at the rate of 94.57 percent. A detailed breakdown of estimated costs is presented in Exhibit 2.

KQ/RG/rg

Exhibit 1
ESTIMATED SCHEDULE
Transit Delay Study



Products/Milestones

A: Technical memorandum, Transit-Delay Model, and user's manual

Exhibit 2
ESTIMATED COST
Transit Delay Study

Direct Salary and Overhead	$59,990

Task	Person-Weeks				Direct	Overhead	Total
	M-1	P-4	P-3	Total	Salary	(@ 94.57%)	Cost
1. Develop Model for Existing Trips	1.0	4.5	3.5	9.0	$10,745	$10,161	$20,906
2. Literature Review	0.0	1.0	1.0	2.0	$2,248	$2,126	$4,374
3. Model Assessment	1.0	2.5	1.0	4.5	$5,737	$5,426	$11,163
4. Analyze Impacts of Express Trips	1.0	2.0	1.0	4.0	$5,124	$4,846	$9,970
5. Document Results	2.0	3.0	0.0	5.0	$6,978	$6,599	$13,577
Total	5.0	13.0	6.5	24.5	$30,832	$29,158	$59,990

Other Direct Costs	$0

TOTAL COST	$59,990

Funding

MassDOT §5303 Contract #70174