A Value-Pricing Toll Plan for the MTA

Saving Drivers Time While Generating Revenue

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Executive Summary

Key Finding

A "value-pricing" toll plan for the MTA bridges and tunnels that raises peak-period one-way tolls to $5.00 while maintaining the current $3.50 toll for all other trips would generate increased revenues roughly equal to those expected from the MTA's current flat-rate plan to raise all tolls to $4.00. The revenue increase would be approximately $100 million a year in either case. However, the value-pricing toll plan would also shave 1-2 minutes from the typical peak-period round-trip, a time saving worth as much as $36 million annually when aggregated over the millions of such trips made each year by commuters, truckers and other drivers. In contrast, the MTA toll plan would cut at most a quarter-minute from the average peak round-trip, and the associated time savings are likely to sum to no more than $7 million annually.

Report Summary

This report considers ways to modify the tolls charged on the MTA bridges and tunnels to increase revenue generation and ease chronic travel delays due to traffic congestion on or near the MTA crossings. It was commissioned by the Tri-State Transportation Campaign (TSTC), a non-profit advocacy group based in New York City promoting local and regional transportation policies that enhance community, mobility and sustainability.

The MTA is proposing a 50-cent increase, to $4.00, in the basic toll of $3.50 it now charges in each direction on its major crossings such as the Triborough, Whitestone and Throgs Neck Bridges and the Queens Midtown and Brooklyn-Battery Tunnels. (Tolls on other MTA crossings would rise proportionately under the MTA proposal.) **We estimate that the MTA proposal would increase total annual toll revenues from its crossings by a range of $109-$122 million**, with the precise amount depending on the extent to which the higher toll induce drivers to forego some trips.

We also considered five toll scenarios in which "peak" (rush-hour) travel would be tolled at a higher rate than travel at other times. Any of these scenarios would depart from the MTA's traditional flat-rate pricing and align the authority with other regional agencies such as the Port Authority and the New Jersey Turnpike Authority that in recent years have switched to "value pricing."

Toll levels in the five TSTC scenarios range from $3.00 to $4.00 for off-peak travel, and $4.00 to $6.00 on-peak. One scenario, which maintains the current $3.50 toll for off-peak travel but charges $5.00 for peak periods, appears particularly attractive for three reasons: (i) it would bring in roughly the same new revenue as the MTA proposal, and thus should satisfy the authority's fiscal criteria; (ii) all of the new revenue would derive from peak-period traffic, thus meeting the social criterion of "internalizing" traffic congestion costs;

and (iii) it would probably generate substantial time savings for motorists, partially offsetting the out-of-pocket costs of drivers who will bear the increased toll.

Table 1 compares the two proposals — the MTA's flat 50-cent increase, and the Tri-State Transportation Campaign's $3.50/$5.00 off-peak/on-peak scenario:

Table 1: MTA Toll Proposal vs. Most-Comparable TSTC Proposal

	MTA Proposal	TSTC Proposal
Toll Structure (each one-way trip)	$4.00 all trips	$3.50 off-peak, $5.00 peak
Annual Toll Revenue	$1049 - $1063 million	$1035 - $1054 million
Increase Over Current Revenue	$109 - $122 million	$95 - $113 million
Percent Increase in Revenue	11.6% - 13.0%	10.1% - 12.0%
Percent Reduction in Peak Traffic	0.4% - 1.4%	4.1% - 11.8%
Time Saved per Peak Round Trip	4 – 17 seconds	49 – 142 seconds
Vehicle-Hours Saved (per year)	100,000 – 300,000	530,000 – 1,430,000
Value of Time Saved (per year)	$2 - $7 million	$13 - $36 million

Tolls shown are for MTA "major crossings" except Verrazano-Narrows Bridge, which would be double amounts shown westbound and free eastbound. Tolls at "minor crossing" (Henry Hudson, Gil Hodges and Cross-Bay Bridges) would be half levels shown. Revenue increases are from MTA 2000 revenue of $941 million. Peak hours are 6-10 a.m. inbound and 3-8 p.m. outbound on weekdays; weekend hours to be determined. Vehicle-hours saved are valued at $20/hr off-peak, $25/hr peak. Ranges for revenues and time savings reflect plausible variations in drivers' "price sensitivities" — the extent to which higher tolls and/or time-based toll differentials induce motorists to forego or reschedule some trips.

Table 1 indicates that the MTA and TSTC toll proposals are roughly revenue-equivalent; their total toll revenues agree to within 1%. However, they differ greatly in their likely effect on peak traffic. **Whereas the MTA flat-rate toll proposal would eliminate only around 1% of the traffic stream during peak hours, the TSTC value-pricing proposal would reduce peak traffic by at least 4% and perhaps as much as 12%.** This difference is largely due to the fact that value pricing creates a monetary incentive to switch trip times away from the peak, while an across-the-board, "flat" increase in tolls does not. The price sensitivity of trip time is considerably greater than the price sensitivity of the decision to make the trip in the first place.

We estimate that the thinning of peak traffic resulting from the TSTC proposal will shave 1-2 minutes from the average round-trip peak commute.[1] (Endnotes are on last page.) The total savings accumulated across all drivers' peak trips, day in and day out, would be considerable. These aggregate savings in motorists' time translate to an estimated value to drivers between $13 and $36 million a year. In contrast, the MTA flat-rate proposal would probably save just $2 to $7 million in drivers' time, all from tolling other drivers off the road entirely rather than by switching any trips to less-congested times.

In fact, each of the five TSTC value-pricing proposals far surpasses the MTA flat-rate toll hike in travel time savings, as Table 2 shows.

Table 2: Tri-State Transportation Campaign Value-Pricing Proposals

	TSTC 1	TSTC 2	TSTC 3	TSTC 4	TSTC 5
Off-peak / On-peak rates	$3.00 / $4.50	$3.50 / $4.50	**$3.50 / $5.00**	$4.00 / $5.00	$4.00 / $6.00
Revenue Gain ($ millions/yr)	$12-$18 less	$66 - $76	**$95 - $113**	$173 - $199	$226 - $271
Revenue % Increase	1% - 2% less	7% - 8%	**10% - 12%**	18% - 21%	24% - 29%
% Reduction in Peak Traffic	4% - 12%	3% - 8%	**4% - 12%**	3% - 9%	5% - 16%
Time Saved per Peak Rnd Trip	51 – 140 sec	32 – 95 sec	**49 – 142 sec**	34 – 104 sec	63 – 192 sec
Vehicle-hrs Saved per yr (000)	500-1300	400-1000	**500-1400**	400-1200	700-2000
Value of Saved Time (millions)	$13 - $33	$9 - $25	**$13 - $36**	$11 - $30	$18 - $49

TSTC 3 proposal shown in bold is Tri-State proposal shown in Table 1. See that table for further explanations, as well as results for MTA toll proposal. Revenue Gain and Time Saved are relative to current tolls, not MTA proposal. Note that hours saved are in thousands and value of saved time is an annual figure.

Each of the TSTC proposals in Table 2 yields significant travel-time savings, suggesting that value pricing could come close to being a "win-win" strategy for MTA tolls: the MTA gets additional revenues, while peak travelers get quicker commutes in return for shouldering the higher tolls. As noted, a particularly intriguing proposal is TSTC 3, which would raise peak tolls to $5.00 while keeping off-peak tolls unchanged at $3.50. TSTC 3 nearly matches the MTA proposal dollar-for-dollar in revenues while giving drivers time savings roughly equaling a quarter of their higher out-of-pocket toll expenditures. Accordingly, we concentrate on TSTC 3. (See final section for a brief discussion of TSTC 5.)

MTA Bridges and Tunnels — Overview

New York State chartered the Metropolitan Transportation Authority in 1968 to own and operate (i) the toll bridges and tunnels of the Triborough Bridge & Tunnel Authority, (ii) the subway and bus lines of the New York City Transit Authority, and (iii) the commuter rail lines Metro-North Commuter Railroad and the Long Island Rail Road.

The MTA's 9 crossings — 7 bridges and 2 tunnels — lie entirely within New York City, whereas the bridges and tunnels owned and operated by the Port Authority of NY and NJ span the Hudson River and link New York City with New Jersey. The MTA facilities were constructed over a 30-year period from the 1930s to the 1960s. All charged tolls from the outset and continue to do so.

The crossings may be grouped logically as follows (the Triborough Bridge is listed twice, once for each toll plaza):

Major Crossings into Manhattan
Triborough Bridge (Manhattan plaza)
Queens-Midtown Tunnel
Brooklyn-Battery Tunnel

Major Crossings between Queens and the Bronx
Triborough Bridge (Bronx plaza)
Bronx-Whitestone Bridge
Throgs Neck Bridge

Minor Crossing into Manhattan (from the Bronx)
Henry Hudson Bridge[2]

Minor Crossings between Queens mainland and Rockaway peninsula
Marine Parkway (Gil Hodges) Bridge
Cross Bay Veterans Memorial Bridge

Major Crossing between Brooklyn and Staten Island
Verrazano-Narrows Bridge

In 2000 — the last year not marked by 9/11 and the attendant economic and traffic disruptions — toll-paying motor vehicles made 296 million (one-way) trips on these crossings, paying $941 million in toll revenues, according to MTA figures. The average toll per trip (before rounding) was $3.17.

The early toll rates on these facilities appear quaint from today's perspective. From their inception through the 1960s, the MTA crossings charged motorists just 25 cents to use the Triborough Bridge or Queens Midtown Tunnel, 35 cents for the Brooklyn-Battery Tunnel, and a mere dime for the Henry Hudson Bridge. Since 1972, however, the MTA has raised tolls numerous times, not only to keep up with inflation but as part of a deliberate policy to cross-subsidize the agency's mass transit operations.

The most recent increase, which took effect in March 1996, set the toll rate for autos (cars and light trucks) at $3.50 each way on major crossings, and half that amount, or $1.75, on minor crossings. In a marked exception to this pattern, the Verrazano-Narrows Bridge charges a $7.00 toll in the westbound direction but omits the toll eastbound. In addition, residents of Staten Island and the Rockaways may register to obtain discounted toll rates for the Verrazano-Narrows, Marine Parkway and Cross Bay Bridges, respectively. Large trucks pay more on all crossings, according to the number of axles.

In "real" terms (adjusted for inflation), the $3.50 base toll rate has fallen by 13-14% since it went into effect seven years ago. In fact the increase to $4.00 proposed by the MTA would not quite equal the general rise in price levels between 1996 and 2003.[3] In percentage terms, this 14% toll increase is slightly less than the proposed 17% increase in the base transit fare from $1.50 to $1.75 in the MTA's low scenario, and less than half as great as the 33% increase to $2.00 in the agency's high-fare case.

East River bridges

Tolling the City's four "free" East River bridges — the Brooklyn, Manhattan, Williamsburg and Queensboro — is currently receiving serious consideration.[4] The patchwork of free city-owned bridges and tolled MTA crossings has for decades encouraged drivers to "divert" to the free bridges to evade the tolls. Institution of East River bridge tolls would eliminate such gaming and thus increase usage of and revenue from the MTA crossings, although the precise effect is difficult to predict. Certainly the higher the toll rate on the MTA facilities, the greater the need to toll the city bridges to avoid cramming even more vehicle-miles onto the city's crowded highways.

Toll Rates and Traffic Volumes

Background

Traffic volumes, and, hence, highway congestion, are influenced by toll levels. To be sure, many factors enter into an individual motorist's decision to drive; these include the expected convenience, travel time and comfort level of driving compared to the alternatives, as well as the importance of the trip in the first place. But price is a factor too — not necessarily for every driver or every trip, at least at current toll levels, but certainly for some trips by some drivers. And as noted above, the timing of a trip can be expected to be more price-sensitive than whether the trip is taken at all; therefore, value pricing can be expected to "time-shift" more trips than a flat increase would eliminate.

Higher tolls reduce total trips: To see how higher tolls depress traffic volumes, consider annual crossings on the MTA bridges and tunnels linking the so-called outer boroughs with Manhattan — the Triborough and Henry Hudson Bridges and the Queens-Midtown and Brooklyn-Battery Tunnels. (Historical data are more readily available for these "hub-bound" crossings than for others that skirt Manhattan.) During the period 1970-2000 inclusive, total vehicle volumes increased at an average annual (compounded) rate of 0.7%. However, a striking pattern is revealed when the 31 individual years are split into two groups, depending upon whether the "real" toll level (toll rates adjusted for inflation) rose or fell in that year. *For the 14 years in which the real toll rate increased,*[5] *total traffic volume declined an average of 2% from the prior year; conversely, for the other 17 years in which the real toll rate fell, traffic volume grew an average of 3%.*

Toll differentials encourage time switching more than toll increases deter trips: Consider recent experience with value pricing on the Hudson River crossings. The Port Authority raised peak tolls on these crossings in March 2001, effectively discounting off-peak trips by $1.00 for motorists using EZ-Pass and by $1.00 per axle for large trucks, with $2.50 per axle discounts for big rigs traveling overnight (between midnight and 6 a.m.). According to the Port Authority, *motorists took the bait and reduced morning peak trips by 7% and afternoon peak trips by 4% while increasing trips during off-peak hours,* *particularly the "pre-peak" hours of 5-6 a.m. and 3-4 p.m. Similarly, trips by truckers fell 7% in the morning peak and rose 4% overnight.*[6]

Price-Elasticity

To calculate how different toll rates will affect traffic volumes, we must determine drivers' responsiveness to changes in price. Economists call this the *price-elasticity* of car use, or elasticity for short.

Two kinds of price-elasticity are relevant here: the extent to which *higher prices* lead drivers to *forego* some driving trips entirely — by car-pooling, using transit, cycling, walking, substituting a different destination, or simply staying home; and the potential for *price differentials* (value pricing) to cause some trips to be *rescheduled* (switched) to different times.

In the past, some opponents of value pricing have insisted that car usage is completely inelastic. According to this view, neither higher tolls nor value pricing will change traffic volumes one iota. This position appears untenable in light of the data presented above. On the other hand, empirical evidence suggests that it takes fairly large percentage changes in tolls to reduce driving significantly on New York City highways, including the MTA bridges and tunnels.

Why is this? Informal conversations with New York City car users suggest that they place a high value on the convenience of driving, including the ability to choose and control their own schedule (subject of course to the vagaries of traffic congestion, which can be considerable). Thus, many drivers may not be deterred from driving by higher tolls. Another possibility is that tolls make up only part of the overall out-of-pocket cost of a trip; indeed, parking, when it must be purchased, usually costs far more than bridge or tunnel tolls.

Peak-period trips appear to be even less sensitive to toll rates than off-peak trips, partly because the former are made disproportionately by affluent and/or subsidized drivers. This doesn't mean that peak traffic levels are set in stone; rather, premiums for peak tolls must be fairly sizeable to induce reductions in peak driving.

Elasticity Assumptions

For travel on the MTA bridges and tunnels, we have assumed an elasticity for off-peak travel of 0.10 to 0.20, i.e., the decline in usage is assumed to be 10%-20% as great as the percentage increase in the toll rate. For peak travel, we specify an elasticity of 0.025 to 0.10, i.e., the decline in usage is assumed to be 2.5%-10% as great as the percentage increase in the toll rate. Thus, our assumed peak travel elasticity is 2-4 times *less* than the off-peak elasticity. These elasticities are drawn from the effects of MTA toll hikes on vehicle volumes since 1970, as discussed in the text box further below.

In addition, for each 10% premium in the peak vs. off-peak toll rate, we assume that between 1.25% and 2.5% (i.e., between 1 in 40 and 1 in 80) of trips in the first and last peak hours (which we call the "edge peak") "migrate" to the immediately adjacent off-peak hour. Similarly, for each 10% premium in the peak vs. off-peak toll rate, we assume that between 0.3125% and 1.25% (1 in 80 to 1 in 320) of trips in the "central peak" hours (all peak hours not immediately adjacent to an off-peak hour) migrate to the nearest off-peak hour. These elasticities are primarily based on the effects of the Port Authority value-pricing program on peak-period travel in 2001 (see text box below).

Peak Hours Defined

Peak hours are defined as those in which the traffic volume in either direction is at least 6% of the total daily traffic in that direction. Based on hourly crossing volumes compiled by NYC DOT,[7] four morning and five afternoon hours fit this criterion for weekdays — 6-10 a.m. and 3-8 p.m. Although comparable hourly data were unavailable for weekends, we observe that the Port Authority's value-pricing program classifies 12 noon - 8 p.m. on Saturdays and Sundays as peak hours. MTA hourly volumes should be reviewed to determine which weekend hours should be treated as peak.

MTA and TSTC Toll Proposals — Effects on Vehicle Volumes

MTA Flat-Rate Toll Proposal ($4.00 off-peak / $4.00 on-peak)

Table 3 shows the changes in traffic volumes that would result from the MTA toll proposal, under the assumptions spelled out above.

Table 3: Effect of MTA Proposal on Traffic Volumes (in-bound, morning)

Hour		Tolled Off		Switched Out		Switched In		Net Change	
(a.m.)	Base	Low	High	Low	High	Low	High	Low	High
4-5	5,200	70	150	-	-	-	-	– 70	– 150
5-6	12,700	180	360	-	-	-	-	– 180	– 360
6-7	26,400	90	380	-	-	-	-	– 90	– 380
7-8	31,200	110	450	-	-	-	-	– 110	– 450
8-9	29,500	110	420	-	-	-	-	– 110	– 420
9-10	26,000	90	370	-	-	-	-	– 90	– 370
10-11	21,300	300	610	-	-	-	-	– 300	– 610
11-noon	19,700	280	560	-	-	-	-	– 280	– 560
6-10 tot.	**113,100**	**400**	**1,620**	**-**	**-**	**-**	**-**	**– 400**	**– 1,620**
4-12 tot.	**172,000**	**1,230**	**3,300**	**-**	**-**	**-**	**-**	**– 1,230**	**– 3,300**

Volumes are in vehicles per hour. Base volumes are year-2000 and were calculated by assigning annual MTA crossing volumes according to the 48-hour (24 in-bound and 24 out-bound) weekday "load shape" for all bridges and tunnels into and out of Manhattan — an approximation necessitated by the unavailability of hourly volumes for MTA crossings. Sums may not agree with totals due to rounding. Out-bound afternoon trips are not shown here but follow a similar pattern, except that the peak is defined to cover 5 hours, from 3 to 8 p.m.

The MTA proposal maintains the authority's traditional flat-rate pricing structure, raising the one-way base rate 14%, from $3.50 to $4.00. Thus, the toll hike offer no incentive for drivers to switch travel times. A small number of trips would be expected to be "tolled off" the roads, however. Of 113,000 peak-direction trips during the 6-10 a.m. morning peak, 400 to 1,620 would disappear. More trips would be eliminated during the off-peak hours of 4-6 a.m. and 10 a.m. – 12 noon, but the congestion-relieving benefit would be far less since bridges, tunnels and highways are less crowded then.

Figure 1: Effect of MTA Proposal on Traffic Volumes (In-bound, morning peak)

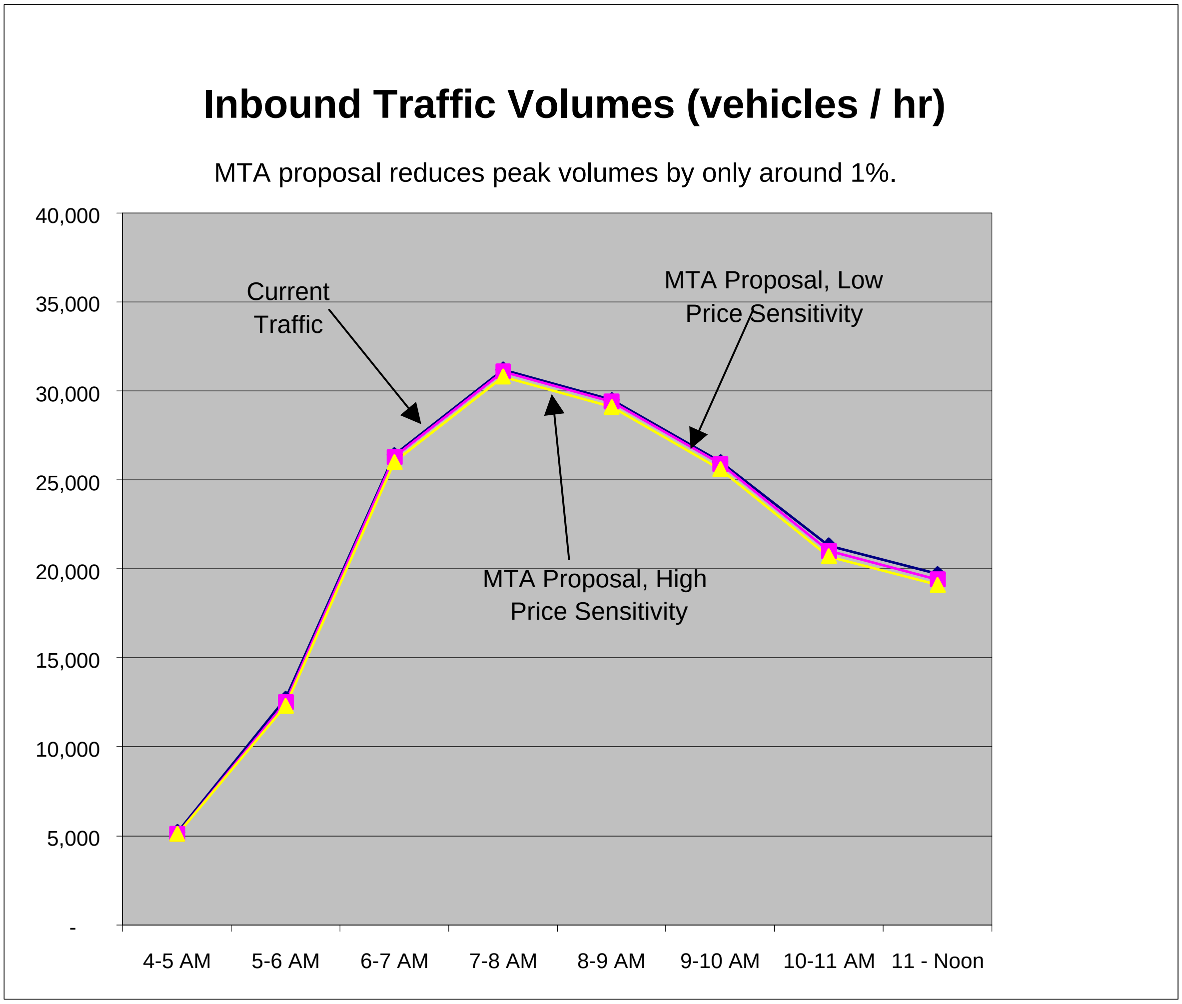

Figure 1 shows that the decline in peak-period traffic expected from the MTA's uniform 14% proposed toll increase is barely perceptible (0.4% - 1.4%). The drop in off-peak volumes is somewhat greater, 1.4% - 2.9%.

Based on year-2000 vehicle volumes, the MTA flat-increase proposal would bring in between $1,049 and $1,063 million a year, an increase of $109 to $122 million from year-2000 revenue of $941 million. In effect, a 14% toll increase (from $3.50 to $4.00

per one-way trip) brings about a 12-13% revenue increase. The difference between the percentages reflects the “tolling off” the roads of a small number of trips.

Tri-State Campaign Variable-Rate Proposal ($3.50 off-peak / $5.00 on-peak)

Table 4 shows the expected changes in traffic levels associated with the “TSTC 3” value-pricing toll proposal, which, as we have noted, is roughly revenue-equivalent with the MTA’s proposed flat-rate hike.

Table 4: Effect of TSTC Proposal on Traffic Volumes (in-bound, morning)

Hour		Tolled Off		Switched Out		Switched In		Net Change	
(a.m.)	Base	Low	High	Low	High	Low	High	Low	High
4-5	5,200					450	1,110	+ 450	+ 1,110
5-6	12,700					1,350	3,340	+ 1,350	+ 3,340
6-7	26,400	280	1,130	1,410	2,830			– 1,700	– 4,000
7-8	31,200	330	1,340	420	1,670			– 700	– 3,000
8-9	29,500	320	1,260	400	1,580			– 700	– 2,800
9-10	26,000	280	1,110	1,390	2,790			– 1,700	– 3,900
10-11	21,300					1,350	3,340	+ 450	+ 1,110
11-noon	19,700					450	1,110	+ 1,350	+ 3,340
6-10 tot.	**113,100**	**2,850**	**11,400**	**8,500**	**20,900**	**N.A.**	**N.A.**	**– 11,400**	**– 32,300**
4-12 tot.	**172,000**	**2,850**	**11,400**	**8,500**	**20,900**	**8,500**	**20,900**	**– 2,850**	**– 11,400**

See notes to Table 3.

As Table 4 shows, the Tri-State Transportation Campaign proposal would reduce peak-period traffic in two ways: (i) by tolling between 3 and 11 thousand of current peak trips off the road; and (ii) by switching an even greater number of trips — roughly between 9 and 21 thousand — to off-peak hours.

The share of peak trips tolled off the bridges and tunnels in the TSTC proposal, some 1%-4% of current peak trips, is triple that in the MTA proposal for the simple reason that the $1.50 rise in the TSTC peak toll rate is triple the $0.50 rise in the MTA rate. Conversely, the TSTC proposal eliminates no off-peak trips, since the off-peak toll rate remains constant at $3.50.

In fact, it is the re-scheduling (switching) of trips from peak *into* off-peak hours that distinguishes the respective proposals. As we noted earlier, the MTA’s maintenance of its flat-rate toll structure provides no incentive to re-schedule trips. In contrast, the sizeable ($1.50, or 43%) peak vs. off-peak premium in the TSTC proposal would create a strong enough incentive that some drivers would switch some of their trips out of the peak period. Some 5%-11% of the trips in the 6-7 and 9-10 a.m. “edges” of the peak, and 1%-5% of peaks in the 7-9 a.m. heart of the peak, would be expected to move to the 4-6 a.m.

and 10 a.m.- 12 noon periods, with most of these trips “migrating” to the hours closest to the peak: 5-6 a.m. and 10-11 a.m.

All told, under the TSTC proposal 3%-8% of peak trips move to off-peak periods. Combined with the 1%-4% of trips that would be tolled away completely, we could expect to see peak traffic volumes shrink by 4%-12% under the TSTC $3.50/$5.00 toll proposal.

Figure 2: Effect of TSTC Proposal on Traffic Volumes (In-bound, morning peak)

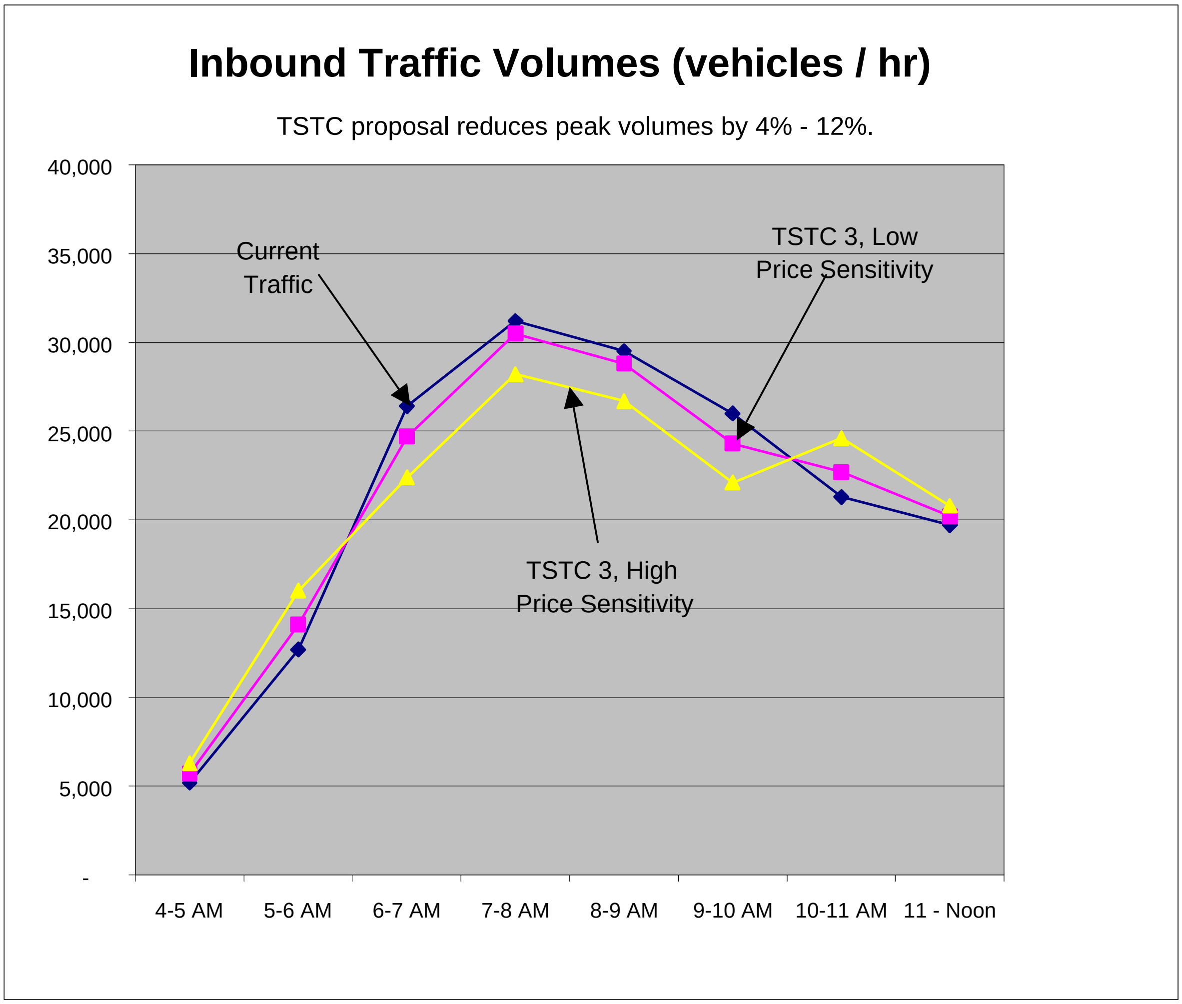

Figure 2 makes clear the potential for value pricing to bring about significant reductions in peak traffic volumes, particularly if there is a substantial differential between peak and off-peak tolls.

Based on year-2000 vehicle volumes, the TSTC $3.50/$5.00 toll proposal would generate between $1,035 and $1,054 million a year, an increase of $95 to $113 million from year-2000 revenue of $941 million. In effect, a 43% increase in the on-peak toll (from $3.50 to

$5.00 per one-way trip), in conjunction with maintaining the $3.50 toll for off-peak travel, brings about a 10-12% revenue increase.

Empirical Basis for Price-Elasticity Assumptions

Effect of higher prices in "tolling trips off the road"

For all years between 1970 and 2000, inclusive, we calculated the real (inflation-adjusted) year-to-year change in toll rates for the MTA's "hub-bound" crossings (Triborough Bridge, Manhattan plaza; Queens-Midtown Tunnel; Brooklyn-Battery Tunnel; Henry Hudson Bridge, excluding discounts, along with the year-to-year change in volumes for those crossings. From the 14 years in which the real average toll increased, we constructed subsets and calculated the price-elasticity for each as the ratio of the average percentage decline in traffic volume to the average percentage increase in the real toll rate.

- For years after 1980 in which the increase in the real toll rate exceeded 5% (number of years, "N," = 9), the price-elasticity was 0.07.
- For years after 1970 with a double-digit percentage increase in the real toll rate (N = 6), the price-elasticity was 0.15.
- For years after 1975 with a double-digit percentage increase in the real toll rate (N = 5), the price-elasticity was 0.19.
- For years after 1980 with a double-digit percentage increase in the real toll rate (N = 4), the price-elasticity was 0.26.

Based on these ratios, we specified price-elasticities of 0.10 to 0.20 for off-peak travel, and 0.025 to 0.10 for peak travel, which is generally considered less malleable.

To be sure, not all of the disappeared trips were "tolled off the road" by the price increases; some migrated to the free East River bridges. On the other hand, the measured price-elasticity has risen in each successive decade. Considering the concurrent increases in transit ridership, trip diversion to the free bridges may be declining in relative terms.

Effect of value pricing differentials in switching peak trips to off-peak

The value-pricing data most relevant to possible toll differentials on the MTA crossings are from the Port Authority's March 2001 toll rate change on its Hudson River crossings. For passenger vehicles using E-ZPass, the toll rate remained at $4 for off-peak trips, but increased by 25% to $5 for on-peak trips. Cash tolls rose by 50% to $6 across the board. Assuming that 80% of peak drivers use E-ZPass, the average increase in the on-peak toll was 30%.

Port Authority officials reported in June 2001 that selected traffic counts in May 2001 vs. May 2000 showed 7% fewer vehicles during the morning peak and 4% fewer during the afternoon peak, for an average decline of 5½ %. Based on the peak price elasticities specified above, 0.025 to 0.10, the 30% peak toll increase should have tolled between 0.75% and 3.0% of peak trips off the road, or an average of 1.9%. Since 5.5% of trips actually left the peak, another 3.6% would have been switched out, a migration that would be expected with a 14-15% "switching elasticity," in the face of a 25% peak/off-peak price differential for E-ZPass automobiles (there is no differential for cash). Our switching elasticities — roughly 3%-12.5% for the middle of the peak, and 12.5%-25% for the edge of the peak — satisfy this criterion.

MTA and TSTC Toll Proposals — Effects on Travel Times

During peak periods — 6-10 a.m. in-bound and 3-8 p.m. outbound — 27,000 vehicles an hour, on average, use the nine MTA bridges and tunnels in the "rush" direction. For all other times, which are subsumed under the rubric "off-peak," the average is just over half as great, or 14,600 vehicles per hour in each direction.[8] Peak travel is notoriously subject to traffic congestion and its attendant delays; off-peak travel, less so. Accordingly, any shrinkage of the traffic stream yields its biggest time savings to drivers in peak periods.

Time Saving Results: MTA vs. TSTC Proposals

We estimate that the "TSTC 3" toll proposal to charge $5.00 for peak trips while maintaining the $3.50 toll for off-peak trips will eliminate or shift enough peak trips to shorten peak travel times by roughly 1 to 2 minutes (actually, 49-142 seconds) per round-trip. In contrast, the MTA proposal to raise all tolls by 50 cents to $4.00 will, we estimate, shorten peak round-trips by a mere 4 to 17 seconds.

Off-peak round-trips also stand to be shortened by several (2-3) seconds under the MTA proposal, while the TSTC proposal will, it appears, actually *extend* off-peak trips by around the same amount — the result of luring some peak trips into off-peak periods.[9] These effects are minor, however. All told, when the value of drivers' (and passengers') travel time is taken into account, the TSTC value-pricing proposal promises to deliver time savings worth between $13 and $36 million to drivers, by shortening the travel times of those using the MTA crossings, whereas the MTA flat-rate proposal offers aggregate time savings worth just $2 to $7 million.

Methodology for Estimating Time Savings from Toll Proposals

The relationship between traffic volumes and highway speeds is a rich area of study in applied mathematics, one replete with elaborate models and sophisticated algorithms. Unfortunately, the empirical data needed for a formal queuing analysis were not available. Instead, we constructed a simple model to estimate the extent to which reduced traffic volumes will tend to shorten travel times.

Our point of departure is the idealized free-flowing highway, on which each vehicle's speed (and thus its travel time) is unaffected by the number of vehicles preceding it. This happy state of affairs is reversed in the maddeningly familiar traffic queue — the bunched-up, barely-moving line of vehicles that materializes at high traffic volumes whenever speed must be reduced — at a toll plaza, for example, or because a highway lane has been "taken out" by a merge or disabled vehicle.

Unlike drivers enjoying free-flowing conditions, participants in a traffic queue care very much about the number of vehicles in front of them. For it is the length of the queue, expressed as the number of vehicles in the line, along with their crawling speed, that determines the delay time experienced by each vehicle, i.e., how long it will take to clear the queue and resume "normal" highway speed.

For this report, we assume that each lane of traffic on an MTA crossing or on the highway or roadway leading into or out of that crossing experiences *two queues* that persist for the duration of the daily peak period. (Where exactly these queues occur is immaterial, though, interestingly enough, observation of MTA toll plazas suggests that the bulk of delay is created "upstream" of actual toll collection points.)

We further assume that: (i) the average time spent by a vehicle in each queue encountered in peak periods is 5 minutes; (ii) each vehicle in the queue occupies 30 feet (including buffering distance from the preceding vehicle); and (iii) the queue inches along at 3 mph before dissipating. These assumptions produce this important result: *each car removed from a traffic queue during peak hours (either by being tolled off the road or switched to off-peak times), shortens the queuing time of the other vehicles remaining in the queue by an aggregate of 5 minutes*.[10]

Now recall that 27,000 vehicles an hour are traveling toward the 9 MTA bridges and tunnels in the peak direction during peak periods. We estimate that approximately 30 highway lanes "feed" these 9 crossings, for an average of 900 vehicles per lane per hour during peak conditions.

What if 1% of the vehicles in a typical peak lane were to disappear? Then each traffic queue would be shortened by 9 vehicles (1% of 900). Since the removal of one vehicle from a traffic queue saves an aggregate of 5 minutes for the vehicles following behind, removing 9 vehicles per lane (by thinning peak traffic by 1%) would save 45 minutes of time for the vehicles in that lane (since 9 x 5 = 45).

From this result it is simple to calculate the aggregate time savings for an entire year's worth of peak traffic due to eliminating 1% of the peak traffic flow. We simply multiply the preceding result (45 minutes saved by all the vehicles in each traffic queue) by 30 lanes, by 9 hours of peak one-directional traffic per day (4 in the morning, 5 in the evening), by 365 days a year, and by the assumed 2 queues per one-way trip. This yields nearly 150,000 aggregate hours saved for each 1% thinning of peak traffic.[11]

The same procedure may be used to calculate annual time savings from reducing off-peak traffic (or, symmetrically, the lengthening of travel times caused by moving some peak traffic into off-peak hours). For this calculation, however, the queues are assumed to last just 1 minute each instead of 5, and each one-way (off-peak) trip is assumed to encounter 1 bottleneck per one-way trip, not 2. The result is that a 1% thinning of all off-peak traffic would be expected to save approximately 35,000 vehicle hours over the course of a year.[12]

Annual time savings from the MTA's toll proposal and all five of the TSTC scenarios are shown in Tables 1 and 2 in the Executive Summary. Time savings per trip for each scenario were calculated by dividing the aggregate time savings by the number of trips per year, after accounting for trips moved to off-peak periods or tolled off the roads.

Value of Time Savings

We have assigned values of $25 and $20 to each vehicle-hour saved (or added) during peak and off-peak travel periods, respectively. These round-number values were arrived at on the basis of the following assumptions and observations: (i) although single-occupant vehicles make up a majority of vehicles using the MTA crossings (or did, prior to the traffic restrictions imposed by New York City after Sept. 11), a number of vehicles carry one or more passengers, and buses and para-transit carry many; (ii) peak travelers tend to place higher values on their time than off-peak travelers, sufficiently so to more than offset the higher average occupancy rate of off-peak vehicles; (iii) for commercial vehicles bearing tradesmen and/or cargo, time is valued more highly than for passenger vehicles.

Conservatisms in the Time-Savings Analysis

This analysis is conservative in several respects. First, it treats delays from traffic congestion as *linear* phenomena, though queuing theory predicts that queuing time increases exponentially as usage approaches saturation. We further ignore the cascading benefits of withdrawing small percentages of traffic from congested roadways; for example, the frequency as well as the length of traffic queues on the MTA crossings and approaches should decline as peak traffic is lightened, but we ignored this effect. As well, we confined our estimates to highways and did not attempt to estimate time savings from reducing traffic on the local and arterial roads that begin and conclude virtually all trips that use an MTA bridge or tunnel.

It is true that our time-savings analysis is essentially a snapshot with a one-year time horizon. So-called "background" increases in car ownership could eventually erode the traffic reductions and time savings from higher tolls. On the other hand, policies to constrain vehicle miles traveled in the city or region, such as increased fuel taxes and/or road pricing measures that charge motorists per mile driven, would help lock in the time savings. So would continuing improvements in public transit that build on the resurgence of subway, bus and commuter-rail service and ridership in recent decades. And, of course, so would periodic increases in the toll rates.

Further Value-Pricing Toll Options

We also examined four other options for increasing peak tolls (see Table 2 in the Executive Summary). One of them, "TSTC 5," would raise the off-peak toll to $4.00 and the peak toll to $6.00, and give the MTA at least double the $100 million revenue gain expected from its flat-rate proposal or the $3.50 / $5.00 TSTC 3 plan. TSTC 5 would also lengthen the time savings from TSTC 3 by about a third, to 1-3 minutes per daily round-trip (63-192 seconds on average, as compared with 49-142 seconds under TSTC 3).

A $6 peak toll is probably too steep to implement in 2003. TSTC 3, which is revenue-neutral with the MTA's flat-rate proposal, will enable the MTA to make the move to value pricing without excessive "sticker shock." But revenue is also important. The City, State and the MTA itself will all be pressed financially for years. Stepping up from TSTC 3 to TSTC 5 would bring in an extra $150 million a year.

One possible scenario is for the MTA to adopt TSTC 3 and commit itself now to adopting TSTC 5 in, say, 18 months. (The NJ Turnpike introduced its value pricing program with just such a two-step toll increase.) A year-and-a-half is near enough to factor into today's budgeting and planning, while giving motorists ample lead time before the $6 peak toll kicks in to switch travel times or find different ways to get to work.

The Tri-State Transportation Campaign is an alliance of public-interest, transit-advocacy, planning and environmental organizations working to reverse deepening automobile dependence and sprawl development in the New York / New Jersey / Connecticut metropolitan region.

The Campaign was formed in 1993 as a response to ever-mounting economic and environmental costs of automobile and truck dependence in the 32-county greater-New York metropolitan area, including air and noise pollution, traffic death and injury, hindrance to mobility, fiscal subsidization of driving, loss of community and neighborhood character, and the destruction of open space by highway-driven sprawl development.

The Campaign marshals the talents of the region's most effective environmental and transportation policy watchdogs to promote center-oriented development, expanded and improved public transit including cycling and walking, and comprehensive road pricing. The Campaign staff of seven are skilled in community and campaign organizing, technical analysis, and media and legal advocacy. The Campaign is governed by a board of directors comprising senior staff from its founding organizations.

Charles Komanoff has been engaged in New York City transportation-reform work since the mid-1980s. He is a founding trustee of the Tri-State Transportation Campaign, the "re-founder" of Transportation Alternatives, a founder of Right Of Way, and author or co-author of *Subsidies for Traffic, The Bicycle Blueprint*, and *Killed By Automobile*. He currently spearheads the Bridge Tolls Advocacy Project, which seeks to re-toll the city's East River bridges. Komanoff gained prominence for deconstructing the economics of nuclear power in the 1970s and '80s as author-researcher (*Power Plant Cost Escalation, Fiscal Fission*) and expert witness for New York City and State and other states and municipalities. His recent energy-policy monographs include *Ending The Oil Age* and *Securing Power Through Energy Conservation and Efficiency in New York*. Komanoff has a B.A. from Harvard in Applied Math and Economics. He lives in lower Manhattan with his wife and two sons.

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Notes

[1] The precise estimate, 49 to 142 seconds saved per peak-period round-trip, is derived further below.

[2] High traffic volumes on the Henry Hudson Bridge — a daily average of 59,600 toll-paying trips during 1991-2000, and 66,300 in 2000 alone — belie its classification as a minor crossing by the MTA. At current volumes, the difference between the present $1.75 toll and the MTA's standard $3.50 rate equates to around $40 million a year in lost revenue.

[3] The basic U.S. inflation index, the Consumer Price Index (CPI) for Urban Wage Earners and Clerical Workers (all cities) stood at 154.1 in 1996 and 175.9 in 2002. Extrapolating at the 2002/2001 increase rate, 1.4%, the 2003 CPI will be 178.3, yielding a 15.7% increase for the seven-year period 1996-2003. Applied to the base toll rate of $3.50, that percentage increase yields $4.05.

[4] See www.bridgetolls.org for a survey of mayoral and other support for tolling the East River bridges.

[5] Although tolls have been increased only nine times during 1970-2000, many of the increases took effect during the year rather than on Jan. 1, thus causing toll increases to straddle consecutive calendar years and creating the statistical appearance of 14 years in which the annual-average toll rate rose.

[6] Port Authority data are based on comparing two "typical" days in May 2001 with similar days 12 months earlier, and were reported in the Tri-State Transportation Campaign *Mobilizing the Region* newsletter, Electronic Edition Number 324, July 2, 2001. Note that these data are untainted by possible diversion to free crossings, since all Hudson River crossings are tolled.

[7] NYC Dept. of Transportation, *2000 Manhattan River Crossings.* In the absence of actual hourly vehicle volumes for the MTA bridges and tunnels, we used Manhattan crossing data (which subsume not only the MTA crossings into Manhattan but the Port Authority and NYC bridges and tunnels as well) as a proxy.

[8] These hours constitute the weekday peak. Some weekend vehicle volumes now rival peak weekday traffic, and it is reasonable to assume that peak pricing on the MTA crossings would encompass some weekend hours, as does the Port Authority's value pricing. Unfortunately, we were unable to obtain hourly 7-day volumes for the MTA crossings. Absent this data, in calculating the revenue and travel-time effects of the different toll scenarios we have mathematically extended the weekday peak/off-peak dichotomy — 4½ hours out of 24— to weekends.

[9] Peak trips that move to off-peak will also be shortened. The time savings were not counted here, however, since the preference of the trip-takers was to travel during the peak, even if the trip itself took longer.

[10] A queue or any other object traveling for 5 minutes (1/12th of an hour) at 3 mph covers 1/4th of a mile, or 1320 feet. 1320 feet divided by 30 feet/vehicle = 44 vehicles. Separately, a 30-foot long "vehicle" traveling at 3 mph, or 4.4 feet/sec, takes 6.8 seconds (30 feet divided by 4.4 feet/sec) to pass a fixed point. These results dictate that each vehicle removed from the head of the queue saves the 44 vehicles behind it an aggregate of 6.8 seconds per vehicle x 44 vehicles, or roughly 300 seconds. Note that this 5-minute aggregate result is coincidental with the assumed 5-minute duration of the queue as perceived by the individual driver.

[11] The calculation for a 1% thinning of peak traffic is: 9 vehicles/hour removed x 5 minutes saved (combined) by all members of the queue per vehicle removed x 30 lanes x 9 hours x 365 days x 2 queues per one-way peak trip, or approximately 148,000 hours per year.

[12] The analogous calculation for a 1% thinning of off-peak traffic is: 5 vehicles/hour removed (5, not 9, since the average off-peak traffic flow being spread over 30 lanes is 14,600) x 1minute saved per vehicle removed x 30 lanes x 39 hours (the sum of 20 off-peak hours in-bound and 19 out-bound) x 365 days x 1 queue per one-way peak trip, or approximately 35,000 hours per year.