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Reduction in City Background Noise Due to Relocation of Artery Traffic into Underground Tunnels

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1. INTRODUCTION

The Central Artery/Tunnel (CA/T) Project in Boston, Massachusetts (see Figure 1), is the largest and most technically challenging highway and urban reconstruction project in American history. Otherwise known as the Big Dig, the project's scope includes extending the Massachusetts Turnpike (I-90) through a new tunnel under Boston Harbor to Logan Airport, replacing old bridges and ramps over the Charles River with a new cable-stayed bridge, relocating the Central Artery (I-93) traffic into new tunnels under downtown Boston, and removing the old elevated Artery to reunify city neighborhoods. At a total estimated cost of \$14.6 billion, the project promises many traffic and socio-economic benefits for the residents and business owners in Boston as well as for the entire New England region.

As the CA/T Project nears completion, many of the highly anticipated benefits of the project are finally coming to fruition. One interesting example is that the background noise in the city has been noticeably reduced since the I-93 Artery traffic was relocated underground. But how much quieter has it gotten, and what are the implications to the CA/T Project's construction noise policies which are based on relative noise criteria? Might the remaining construction noise not be masked as well by the quieter background condition, and if so, will the residents and business owners start complaining more about noise from the remaining construction work?

This paper summarizes the subjective reaction that Bostonians had to the surprisingly quieter conditions that resulted when the old elevated I-93 Artery traffic was relocated underground. Quantitative evidence is provided comparing many years-worth of community noise measurements collected in the Downtown and North End sections of the project. The results show that background L90 noise levels in areas of the city close to the highway project reduced by over 4 dBA during the daytime, and by over 6 dBA during the evening and nighttime, due to the relocation of I-93 Artery traffic underground.

This paper will also summarize the considerations and policy decisions made by CA/T Project officials with respect to potentially changing the contractors' construction noise control specifications to accommodate the quieter background noise condition, as well as the project's strategy for responding to potential additional construction noise complaints from the public.

2. PROJECT STATUS

The CA/T Project has been under construction since the early-1990s. Even though the CA/T Project has an excellent construction mitigation program^{1,2}, the residents and business owners of Boston certainly have endured various long-term impacts in their quality of life. Throughout the entire process, project managers and elected officials kept promoting to the public the anticipated benefits and improvements in the quality of life that the project would ultimately deliver.

As of Spring 2004, many of the highly anticipated benefits of the project are finally being realized. East and west bound traffic is now flowing smoothly to and from Logan International Airport by way of the I-90 Turnpike extension and Ted Williams Tunnel under Boston Harbor. North and south bound traffic is also flowing much better now that the recently completed I-93 tunnels under downtown Boston are open for use. Surface construction activity still continues in selected locations, but it is vastly reduced from the amount of construction that was occurring all through the late-1990s and early-2000s. The most intensive work at this time involves the demolition of the old elevated Artery through downtown Boston.

There will still be some surface street restoration work to perform, but in general, all of the major highway components of the project have been completed and delivered by this time. Once demolition of the old elevated Artery can be completed, the much-anticipated parks and open “green” spaces will be constructed. The CA/T Project is expected to be fully completed by mid-2005.

3. SUBJECTIVE REACTIONS

With the relocation of the last of the I-93 Artery traffic into the new underground tunnels on 12/20/03, Bostonians immediately noticed how much quieter it was in the Downtown and North End sections of the project. Many anecdotal stories resulted about how pleasantly surprised people were with the new quieter background noise condition. Local TV and radio stations covering the progress of the project also noted the change in noise level. The Boston Globe ran a story on 1/7/04 (see Figure 2) in which one North End resident is quoted as saying, “It’s like after-the-nuclear-holocaust quiet,” while other residents use terms like “awesome” and “amazing” to describe the newly-improved quieter background noise conditions.

Because it is always helpful for a public works project to be able to demonstrate the tangible benefits that the project brings to the community, CA/T Project officials were also interested in how much quieter the city had gotten. To answer these and other questions, this study was done to determine through actual noise measurements just how much quieter the city background noise had gotten due to the relocation of the city’s dominant source of noise (I-93 Artery traffic) into new underground tunnels.

4. BACKGROUND NOISE STUDY

With the advent of the Initial I-93 Southbound Opening (ISBO) on 12/20/03 and the final relocation of all I-93 Artery traffic underground into the new tunnels, many Bostonians and CA/T Project staff alike noticed how much quieter the Downtown and North End areas of the project had gotten. While this quieter background noise condition was much appreciated by the public, it raised several questions within the project, namely:

- How much quieter is it in the city now that all the I-93 Artery traffic has been relocated underground?
- What implications does a quieter background have on the Project’s Construction Noise Specification³ in which the relative noise criteria limits are based on baseline L10 noise levels plus 5 dBA?
- Will the quieter background conditions lead to additional noise complaints from members of the public who previously might not have heard the construction due to masking from I-93 Artery traffic noise, and if so how does the project respond to these complaints?

In the three months since ISBO opened, the answers to these three related questions have been studied, measured, and discussed within the project. In general, the answer is that *the project should take as much credit as possible for creating a quieter background noise condition in the Downtown and North End sections of the city, and in doing so has forever improved the quality of life for Bostonians.* More specifically, the answers to the three questions above are as follows:

A. How much quieter is it in the city now?

As part of the CA/T Project’s construction noise control program⁴, long-term noise data has been collected at hundreds of noise sensitive receptor locations throughout the project’s history. As such, noise data collected at key locations in the Downtown and North End areas could be analyzed and compared to quantify the reduction in background noise levels over the course of many years. For this purpose, four time periods were selected for evaluation, as follows:

- Baseline or pre-construction years ranging from 1990 to 1997.
- The peak construction years of the project ranging from 1997 to 2002.
- The interim period after 3/29/03 and before 12/20/03 when just the northbound I-93 Artery traffic had been relocated into the new underground tunnel (i.e. Post-INBO).
- And finally, the end-state condition after 12/20/03 when the remaining I-93 Artery southbound traffic had been relocated into the new underground tunnel (i.e. Post-ISBO).

Unfortunately the amount of baseline (1990-1997) noise data was fairly limited, but whatever data was available was used in this study. A vast amount of noise data was available from the peak-construction years (1997-2002). An adequate amount of noise data was available from the brief Post-INBO interim period lasting less than a year during 2003, and new Post-ISBO noise data was collected over the winter months in 2004 expressly for the purposes of this study.

The community noise monitors that were used throughout most of the CA/T Project's history were Larson Davis Model 720 Noise Monitors which comply with ANSI S1.4 Standards for Type 2 accuracy. In accordance with CA/T Construction Noise Control Specification³ 721.560, the noise monitors were programmed to measure outdoor community noise levels in 20-minute intervals using an RMS "slow" time constant with the results expressed in A-weighted decibels (dBA). The primary noise metrics of interest for construction contractor compliance with Noise Spec criteria limits were the Lmax and L10 metrics, however the LD720 noise monitors were also used to measure and digitally store many other noise metrics as well such as Leq, SEL, L1, L50 and L90 levels. From the Leq data, 24-hour noise metrics such as Leq(24h) and Ldn were computed as well.

Eight noise monitoring locations were selected for this study based on the expectation that these locations would benefit the most from the relocation of I-93 Artery traffic into new underground tunnels. As shown in Figure 1, the eight noise monitoring locations were all in the Downtown and North End areas of the project where long-term (i.e. weekly) noise level data had been collected intermittently over many years. The eight noise monitoring locations used in this study were as follows:

Site No.	CA/T Receptor Site No.	Receptor Address	Land-Use
1	N-230	Rowes Wharf, 50-70 Atlantic Avenue	Residential/Commercial
2	N-231	Harbor Towers, 65 East India Row	Residential
3	N-238	Mercantile Mall, 111 Atlantic Avenue	Residential/Commercial
4	N-239	Fulton/Cross Apartments, 47 Fulton Street	Residential
5	N-910	Salem & Cross streets, 57-59 Salem Street	Residential
6	N-248	Stillman Place Apartments, 2 Stillman Place	Residential
7	N-291	Bramon Dow Building, 95 North Washington Street	Residential/Commercial
8	N-298	Causeway Condos, 239 Causeway Street	Residential

The results of the long-term noise data comparison indicated that background noise levels in the Downtown and North End areas of the city have indeed reduced due firstly to relocating I-93 northbound traffic underground (INBO) on 3/29/03, and secondly by relocating I-93 southbound traffic underground (ISBO) on 12/20/03. The noise reduction results for all eight receptors can be seen in tabular form in Figure 3 and in graphical form in Figures 4a, 4b, and 4c for daytime, evening, and nighttime periods respectively.

Attempts were made to select measurement data for averaging purposes in this study that was not overly influenced by construction noise. While there was no attempt to account for varying weather conditions, efforts were made to use data from the same general times of year, namely the winter months, in order to avoid seasonal variations.

The noise data shown in Figure 3 shows several noise metrics and percentile quantities. The Leq metric represents the energy-averaged equivalent noise level, but the Leq can be overly influenced by particularly loud events so it is not wholly indicative of the steady background noise that would be produced by traffic flowing on the old elevated I-93 Artery. The Ldn is a 24-hour average noise level in which a penalty of 10 dBA is added to the nighttime hours of 10 PM to 7 AM in order to account for peoples' greater sensitivity to noise during those nighttime hours. The Ldn can, however, also be overly influenced by short-term loud noise events. For example, the overall reductions in Ldn and Leq(24h) levels as shown in Figure 3 are only 0.7 dBA and 0.8 dBA respectively, which would be almost imperceptible to most people.

The L10 metric is a statistical percentile indicating the noise level occurring during 10% of the measurement period. The L10 is often associated with sporadic and intrusive noise conditions, and as such, the L10 has been used in the CA/T Noise Spec³ to evaluate and limit construction noise. The L10 level can be associated with some traffic noise affects such as truck passby noise, but the L10 is not a good indicator of steady background noise.

The important noise metric to consider in this case is the L90 noise level. The L90 represents the noise level that is present during 90% of the measurement period, and it is the metric typically used to describe the constant background noise condition. The L90 noise level is not overly influenced by short event noise sources such as construction activities, so comparing the L90 levels over the past several years gives a good indication of the changes in the steady, traffic-dominated, background noise condition. *As shown in Figure 3, the conclusion of this study is that background noise conditions in the Downtown and North End sections of Boston have reduced by over 4 dBA L90 during the daytime and by over 6 dBA L90 during the evening and nighttime due to the relocation of I-93 Artery traffic into underground tunnels.* Such a reduction is significant and fully consistent with peoples' subjective description of a "noticeable" reduction in noise level.

To emphasize the significance of a 4 to 6 dBA reduction in background noise level, it should be kept in mind that these results represent reductions in the steady background L90 noise levels when comparing past-to-present daytime-to-daytime, evening-to-evening, and nighttime-to-nighttime periods. In other words, thousands of Bostonians will benefit by a reduction of 4 to 6 dBA throughout every moment of their daily lives. These results should not be confused with the variations in noise level throughout a typical 24-hour period in the city which, by coincidence, also happens to be about 5 dBA when comparing daytime-to-nighttime average noise levels. The reason why the background noise did not reduce further with the removal of I-93 Artery traffic is because this portion of the city is still dominated by surface street traffic on two- and three-lane streets, local commercial traffic, aircraft overflights, building HVAC systems, and pedestrian activities.

B. Are there any implications for the CA/T Noise Spec?

There should be no contractual implications now that the background noise conditions have been reduced in the Downtown and North End sections of the project because all the potentially affected construction contracts have already been advertised, bid, and awarded, and their respective receptor lot-line noise limits have all been established.

The CA/T Construction Noise Control Specification³ 721.560 (Noise Spec) contains receptor lot-line noise criteria limits which are based on a relative noise increase allowance for the contractor. In general, contractors can produce up to 5 dBA more noise than existed prior to commencing work (i.e. Baseline L10 + 5 dBA). The L10 noise metric was selected for use because it most closely represents unwanted intrusive noise conditions associated with construction activities.

Baseline noise levels were established through measurements, either by the contractors or by project staff, before the construction contracts began work in the field. However, as various follow-on contracts started work in the same areas as previous contracts, it was determined that additional collection of new baseline noise data would not be possible due to the influence of ongoing construction noise. Therefore, the baseline noise levels which had been established for prior contracts were used again for all follow-on contracts in the same areas.

The CA/T Project's construction noise criteria limits have worked very well in practice. Generally, people do not complain about excessive construction noise until the noise levels start to exceed their respective baseline L10 + 5 dBA limits⁴.

The CA/T Environmental Panel discussed the potential implications for the Noise Spec during their meeting on 1/16/04. The panel agreed that the project should NOT consider changing any of the previously established lot-line noise limits contained in the Noise Spec for the following reasons:

- It would be extremely difficult and time consuming to re-measure background noise levels at the dozens of receptors located in the Downtown and North End areas of the project.
- Contractors would likely be entitled to expensive and confusing "change orders" if the project were to try to impose more restrictive noise limits at this time based on the quieter background noise conditions.
- On a more practical point, the noisiest demolition work will likely be completed by the time any change orders could be processed (Summer 2004).

C. Will there be more noise complaints now, and if so how does the project respond?

Bostonians, presumably like all human beings, respond more to changes in noise level rather than the absolute level of noise to which they are exposed. It is expected that people will grow accustomed to their new quieter background noise condition within a few weeks or so. Similarly, their focus on any newly audible construction noise should diminish within a few weeks as well.

In the three months since the last of the I-93 Artery traffic was moved underground (ISBO) there have been about 42 noise complaints called in from abutting residents and business owners, however only 17 complaints have come from people in the Downtown and North End sections of the project. While this complaint rate is greater than the project's typical rate, it is not a dramatically greater number of complaints and may not necessarily be a result of the quieter background noise conditions. During this same time period, demolition activities have intensified dramatically in some of the project's contract areas. Obviously, the noise emission levels generated by demolition work can be substantially louder than the noise levels generated by other construction activities.

A better indicator to see if the "rate" at which noise complaints received by the project might be affected by a lower background noise level is to examine the number of noise complaints verses the amount of work being done in the field. A noise complaint index, as such, has been computed for this purpose which normalizes the number of monthly noise complaints received from the Downtown and North End areas of the project by the number of million dollars invoiced to the project by the contractors working in those same areas.

As shown in Figure 5, the number of noise complaints received by the project, when put in perspective with the amount of work being done in the field, has not increased significantly in the timeframe since the last of the I-93 Artery traffic was moved underground (ISBO). The noise complaint index did increase immediately after INBO, likely due to the start of more intense demolition work, but subsided shortly thereafter and has remained fairly consistent with the index range prior to relocating the traffic. In the three months since ISBO opened, the project has received on average about four noise complaints for every \$10 million-worth of work in the field from people in the Downtown and North End areas of the project.

The CA/T Environmental Panel, a panel comprised of CA/T Project, City of Boston, State Environmental, and FHWA representatives, also discussed this particular question during their meeting on 1/16/04. The panel is tasked with evaluating all environmental-related issues confronting the project and developing environmental policies for the project to adopt and implement. The panel members provide expertise to the project in matters concerning construction, scheduling, cost, legal, environmental, and community liaison affairs. In this case, the panel agreed that in dealing with any potential additional noise complaints attributable to the quieter background noise condition, the project should do the following:

- Take credit for the quieter background noise conditions as an improvement in the "quality of life" for city residents.
- Reassure the public that CA/T contractors will not be making any "more noise" than they were allowed to produce prior to relocating the traffic underground into the new tunnels.
- Continue to ensure that contractors fully obey their respective Noise Spec³ limits and equipment restrictions (e.g. backup alarms).
- Remind residents that acoustical window treatments are still available for qualifying residences through the Off-Site Noise Policy and the C30A1 contract⁵.
- Continue to be open-minded to good suggestions from the public regarding quieter options to "work smart" when it comes to potentially quieter construction methods or techniques.

5. CONCLUSION

The near completion of the Central Artery/Tunnel Project in Boston brings with it many benefits to the surrounding communities that go far beyond the project's main purpose of improving traffic flow. One such benefit, as determined through the comparison of many years-worth of community noise measurement data, is that the background noise in the Downtown and North End portions of the project has been reduced by over 4 dBA L90 during the daytime, and by over 6 dBA L90 during the evening and nighttime, now that the previously dominant noise source, I-93 Artery traffic, has been relocated into new underground tunnels. Bostonians immediately noticed and appreciated the reduced background noise condition, and the project should take due credit for improving the quality of life for city residents who have endured over a decade of Big Dig construction.

Fortunately for C/A/T Project officials, any concerns that the new quieter background noise might lead to additional noise complaints from the public, or lead to the need to change the relative noise criteria limits contained in the Project's Noise Spec, have proven to be unwarranted. The rate at which noise complaints are received by the project has remained largely unaffected by the reduction in city background noise, and neither the public nor the construction contractors have called for changing the previously established construction noise criteria limits.

6. REFERENCES

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2. *ARTBA 2003 Globe Award Competition Special Recognition*, American Road & Transportation Builders Association, (ARTBA, Washington DC, 2003).
3. *Construction Noise Control Specification 721.560*, Central Artery/Tunnel Project, (Massachusetts Turnpike Authority, Boston, MA, 2002).
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5. M. Fistel and E. Thalheimer, "Window sound proofing for construction noise at the Central Artery/Tunnel Project", *Proc. INTER-NOISE 99*, edited by Joseph Cuschieri, Stewart Glegg, and Yan Yong, Vol. 1, pp. 31-36, (Noise Control Foundation, Poughkeepsie, NY, 1999).



Figure 1. CA/T Project Map and Noise Receptor Locations

Boston Globe 1/7/04

Silence surprises in North End

By Donovan Slack
GLOBE CORRESPONDENT

Rush hour in the North End: There's something not quite right, or at least not the norm for a weekday afternoon. It is quiet. The bass line throb that for generations thundered overhead and rattled through the earth from the Central Artery's steel girders is gone, leaving a kind of peace that many in this cacophonous corner of the city had all but forgotten.

"It's weird," said Ryan McCarthy, who works as a comedian at the Improv Asylum comedy club on Hanover Street, just yards from the elevated artery. "It's not just quiet. It's like after-the-nuclear-holocaust quiet."

It's been three weeks since the last traffic was diverted from the 45-year-old elevated highway into the new Interstate 93 southbound tunnel. For many

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GLOBE STAFF PHOTO/DAVID KAMBERMAN

Mickey Rizzo, owner of Ristorante Marsala on Salem Street, finds the neighborhood so quiet that he can hear outdoor music for the first time.

With Central Artery traffic gone, neighbors come to terms with silence

NORTH END
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who live and work near the "other green monster," the sudden stillness has brought a blissful relief, expressed in terms like "awesome" and "amazing." But it has also caused a certain disorientation as neighbors try to come to terms with fresh air and comparative silence.

"The houses literally used to shake," said Councilor Paul Scoppicchio of the North End, whose constituents often complained about noise and dust from the elevated highway and years of Big Dig construction. "You keep expecting the cars to come, but it's no more. It's kind of surreal right now. It almost feels like a 'Twilight Zone' episode."

More than 90,000 vehicles used to rattle past Conrad Loehlein's apartment window at Mermaid Wharf every day. And that was only northbound. Now he is looking forward to warm

weather, when at last he'll be able to open his windows to invite in spring breezes without the dust and noise. But he has also found himself unexpectedly nostalgic for ambulance sirens, the roar of delivery trucks, and piercing honks of agitated drivers that used to sound less than 100 feet from where he stops.

"You live in the city, you live with urban noise," Loehlein said, looking up at the vacant highway yesterday afternoon. "I love by the city, die by the city."

For some businesses in the shadow of the artery, the rerouting of traffic has at least temporarily cost them customers. In the small meat and fish markets lining Blackstone Street near Haymarket, many a customer strolled by for almost an hour yesterday afternoon. The street used to boast four lanes full of potential customers in bumper-to-bumper traffic, trying to get off the artery and to enter the Callahan Tunnel. Drivers



GLOBE STAFF PHOTO/DAVID KAMBERMAN

A measure of quiet has come to Christopher Columbus Park in the North End, now that traffic has been diverted from the Central Artery into the Interstate 93 southbound tunnel.

often pulled over and ran into one of the shops to pick up lunch or dinner. "But now..." His voice trailed off as he motioned toward the empty street and the green steel girders

on the other side.

On the other side of the artery, the same quiet prevailed, but Salem Street shopowners were more optimistic. Mickey Rizzo bought Ristorante Marsala eight months ago with hopes of doing bang-up business once the artery comes down. He stood outside at sunset yesterday and noticed that "O, Come All Ye Faithful" was playing through an outdoor speaker. "Before you couldn't even hear that," he said, a note of incredulity in his voice. "It's amazing."

Across the street, Danny DiMare said the elevated artery was such a fixture in the minds of motorists that drivers were known to call North End shops to get traffic reports. DiMare, whose family has owned Dairy Fresh Candles since 1957, cited a recent incident when a salesman on the South Shore called to ask a customer in the candy shop to look and see whether 1-93 was backed up. "What are you talking about?"

Dinoze recalled the customer replying, "We can't see the traffic anymore. It's undermated."

While it may take some getting used to, a little extra effort to reorient, the newfound freedom from constant artery traffic is not something North Enders want to give up.

"It's the best!" exclaimed Heas Iber, a 22-year North End resident who bicycles everywhere he goes. He took a spin around Christopher Columbus Park yesterday afternoon, breathing in the brisk but notably fresh air. Iber stopped to snap a few pictures of the cityscape now visible from the park, then paused to take it all in some more, as if the view weren't going to be there tomorrow.

"This area has just become wonderful, you know," he said. "And they just keep making it better."

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Figure 2. Boston Globe Newspaper Article from 1/7/04

Filename: Changes in Background Noise.xls																	
Date: 01/19/2004																	
Revised: 02/07/2004																	
Purpose: Evaluate the changes in background noise levels in Downtown and North End areas of Boston due to relocation of traffic underground																	
Noise levels measured with Larson Davis Model 700 and 720 Noise Monitors meeting ANSI S1.4 Standards for Type II accuracy																	
All noise level data measured in A-weighted decibels (dBA) with an RMS "slow" time constant																	
				Daytime	Evening	Nighttime	Daytime	Evening	Nighttime	Daytime	Evening	Nighttime					
				7am-6pm	6pm-10pm	10pm-7am	7am-6pm	6pm-10pm	10pm-7am	7am-6pm	6pm-10pm	10pm-7am					
Site	Address	Ldn	Leq(24h)	Leq, dBA	Leq, dBA	Leq, dBA	L10, dBA	L10, dBA	L10, dBA	L90, dBA	L90, dBA	L90, dBA					
Average Noise Reduction Results:																	
negative (-) number means a noise reduction																	
positive (+) number means a noise increase																	
Baseline, preconstruction		baseline	baseline	baseline	baseline	baseline	baseline	baseline	baseline	baseline	baseline	baseline					
Peak construction, circa 1997-2002		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-1.6	-1.2	-1.5	#DIV/0!	-3.2	-0.7					
Post-INBO, after 3/29/03		-0.7	-0.8	-0.7	-1.0	-0.8	-0.8	-2.0	-2.1	-2.4	-3.2	-2.8					
Post-ISBO, after 12/20/03		-0.1	-0.1	-0.4	-1.1	-0.3	0.0	-0.1	0.4	-1.4	-3.3	-3.3					
Average Overall Reduction:		-0.7	-0.8	-0.9	-2.4	-1.5	-1.0	-2.3	-2.1	-4.2	-6.3	-6.1					
N-230	Rowes Wharf																
Noise Spec 721.560 limit							82.0	82.0	77.0								
Baseline, preconstruction							77.0	77.0	74.0								
Peak construction, circa 1997-2002																	
Post-INBO, after 3/29/03																	
Post-ISBO, after 12/20/03							73.0	69.2	70.7	67.8	68.0	73.7	71.0	70.8	61.5	57.3	55.8
N-231	Harbor Towers																
Noise Spec 721.560 limit							83.0	80.0	74.0								
Baseline, preconstruction							78.0	75.0	71.0								
Peak construction, circa 1997-2002							73.3	69.5	71.9	68.7	66.9	74.0	70.3	68.8	67.1	64.5	62.9
Post-INBO, after 3/29/03							72.4	68.6	71.0	68.1	65.9	73.4	69.9	67.8	64.6	61.7	59.6
Post-ISBO, after 12/20/03							73.4	69.7	71.6	68.2	68.0	74.1	70.4	70.1	62.2	58.0	56.5
N-238	Mercantile Mall																
Noise Spec 721.560 limit							75.0	69.5	69.5								
Baseline, preconstruction							70.0	64.5	64.5								
Peak construction, circa 1997-2002							72.3	69.2	71.8	68.7	66.1	73.7	70.3	67.9	66.9	64.1	61.6
Post-INBO, after 3/29/03							74.5	70.7	73.3	69.1	68.3	75.5	70.3	68.5	62.5	59.0	56.1
Post-ISBO, after 12/20/03							72.9	69.2	70.9	67.5	67.7	73.3	70.4	70.0	62.9	58.9	57.7
N-239	Fulton/Cross Apartments																
Noise Spec 721.560 limit							80.1	75.6	73.3								
Baseline, preconstruction							75.1	70.6	70.3								
Peak construction, circa 1997-2002							69.8	66.0	67.8	66.2	63.7	69.5	67.8	65.7	63.7	62.9	60.0
Post-INBO, after 3/29/03							69.3	65.5	67.4	64.3	63.7	69.2	65.9	64.9	63.5	61.8	61.0
Post-ISBO, after 12/20/03							74.8	71.0	70.4	66.3	65.9	73.3	69.5	68.4	62.5	56.2	52.4
N-910	Salem/Cross Residences																
Noise Spec 721.560 limit							77.9	75.8	74.4								
Baseline, preconstruction							72.9	70.8	71.4								
Peak construction, circa 1997-2002							72.0	68.2	69.8	68.3	66.3	71.4	69.4	68.2	65.4	63.8	61.1
Post-INBO, after 3/29/03							71.7	67.9	71.3	68.4	63.6	73.1	69.7	65.9	65.0	62.3	57.1
Post-ISBO, after 12/20/03							69.2	65.4	68.4	64.7	62.1	70.7	66.8	64.3	61.6	57.4	53.5
N-248	Stillman Place																
Noise Spec 721.560 limit							78.7	76.0	74.6								
Baseline, preconstruction							73.7	71.0	69.6								
Peak construction, circa 1997-2002							72.7	69.0	71.1	68.5	66.6	72.8	70.0	68.9	67.7	65.3	62.0
Post-INBO, after 3/29/03							71.5	67.7	69.8	67.7	65.1	71.8	69.4	67.2	62.1	60.9	57.2
Post-ISBO, after 12/20/03							70.6	66.8	69.5	67.3	63.4	71.3	69.0	65.9	61.4	58.4	53.0
N-291	Bramon Dow Building																
Noise Spec 721.560 limit							82.0	78.3	74.1								
Baseline, preconstruction							77.0	73.3	71.1								
Peak construction, circa 1997-2002							75.5	71.7	74.2	71.6	68.8	76.5	73.7	71.1	68.1	66.4	62.3
Post-INBO, after 3/29/03																	
Post-ISBO, after 12/20/03							70.2	66.5	70.7	63.8	62.5	73.8	67.3	65.0	63.3	57.8	56.7
N-298	Causeway Condos																
Noise Spec 721.560 limit							80.1	81.6	77.2								
Baseline, preconstruction							75.1	76.6	74.2								
Peak construction, circa 1997-2002							75.1	76.6	74.2								
Post-INBO, after 3/29/03							72.2	68.4	69.8	68.3	66.8	71.7	70.1	68.8	66.7	65.4	63.0
Post-ISBO, after 12/20/03							70.3	66.5	68.2	67.2	64.2	69.8	68.6	66.4	65.5	64.6	59.7

Figure 3. Average Background Noise Level Data Summary

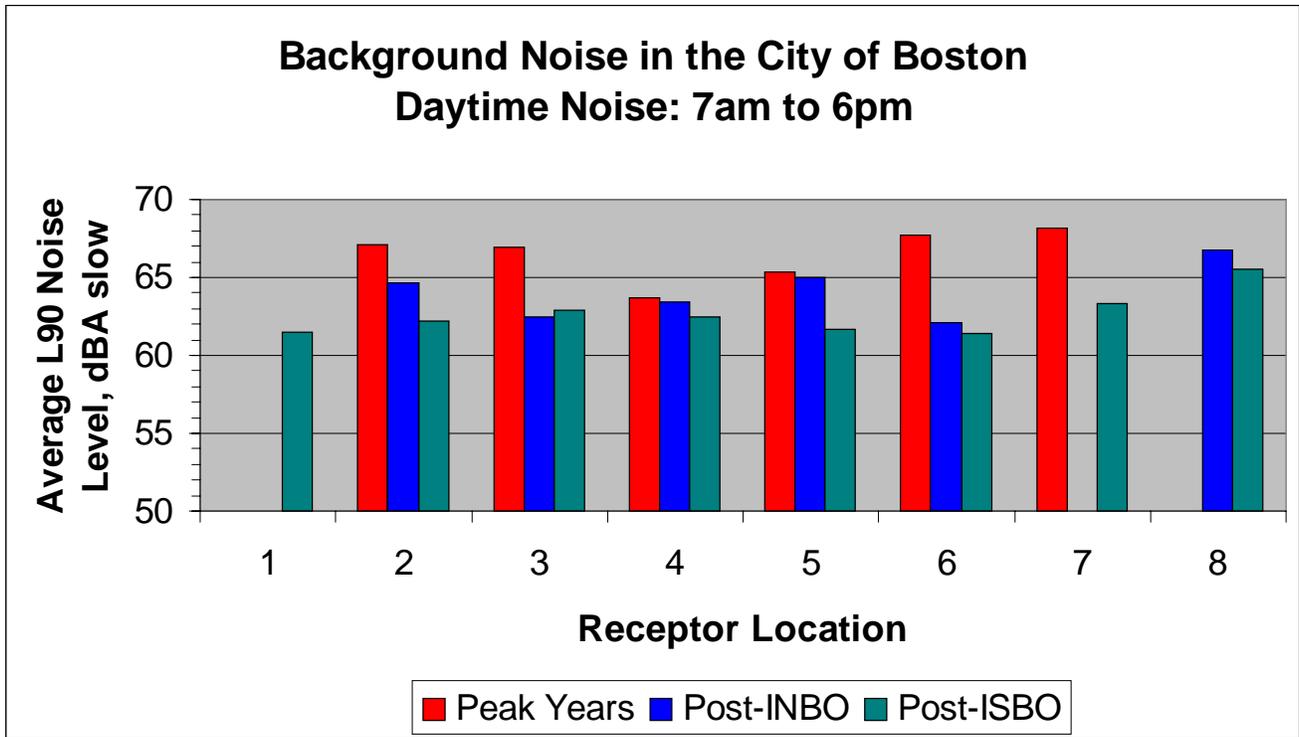


Figure 4a. Average L90 Noise Levels During the Daytime

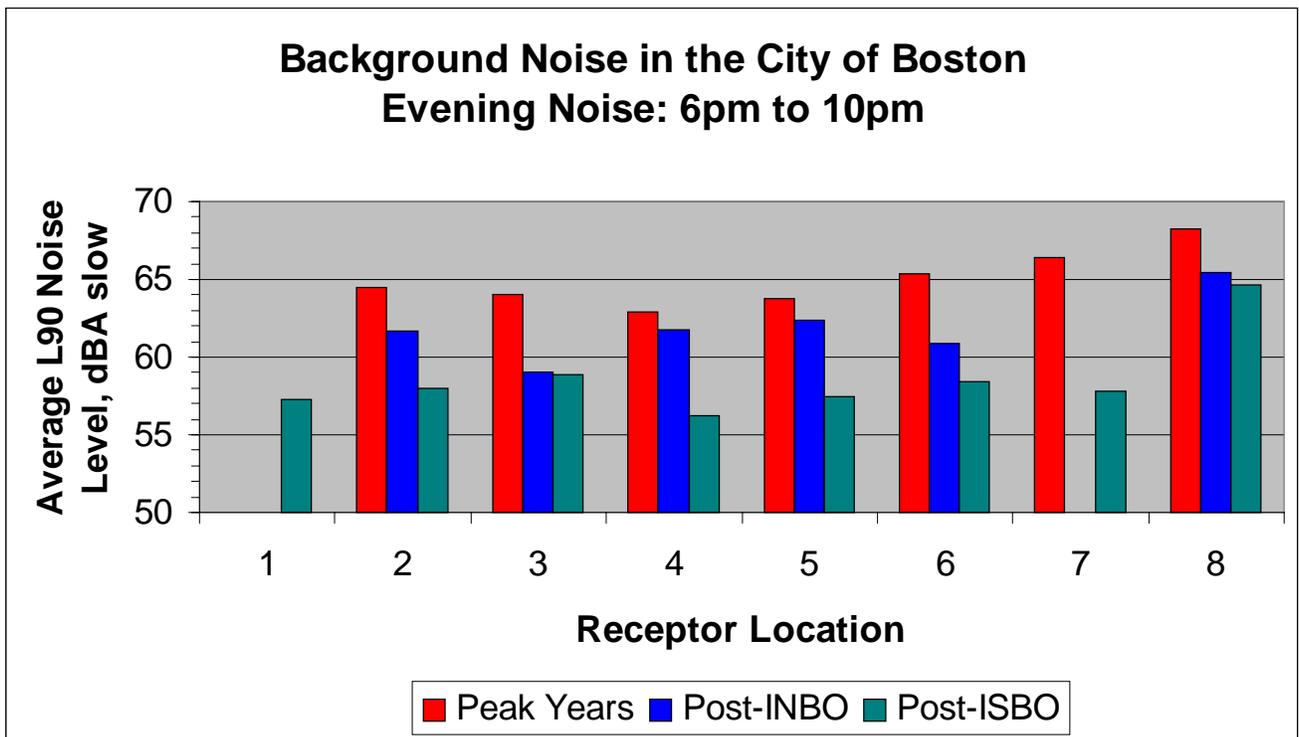


Figure 4b. Average L90 Noise Levels During the Evening

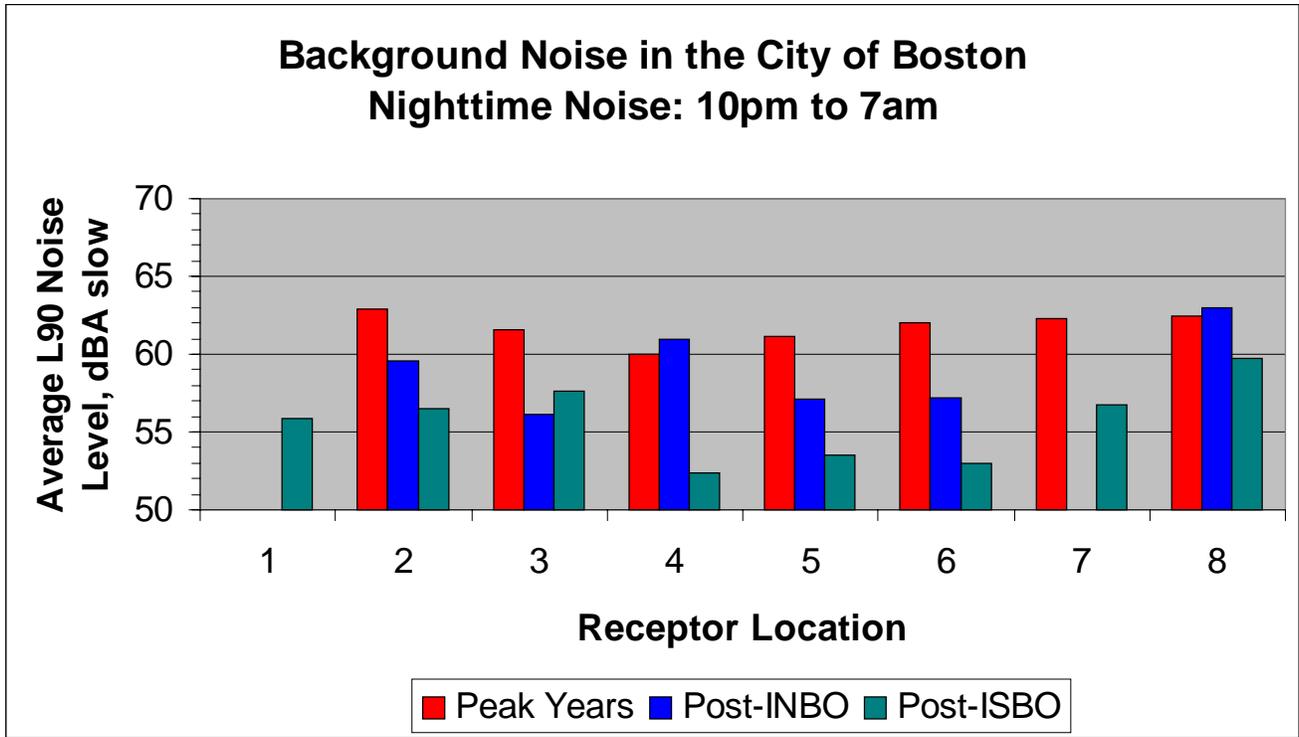


Figure 4c. Average L90 Noise Levels During the Nighttime

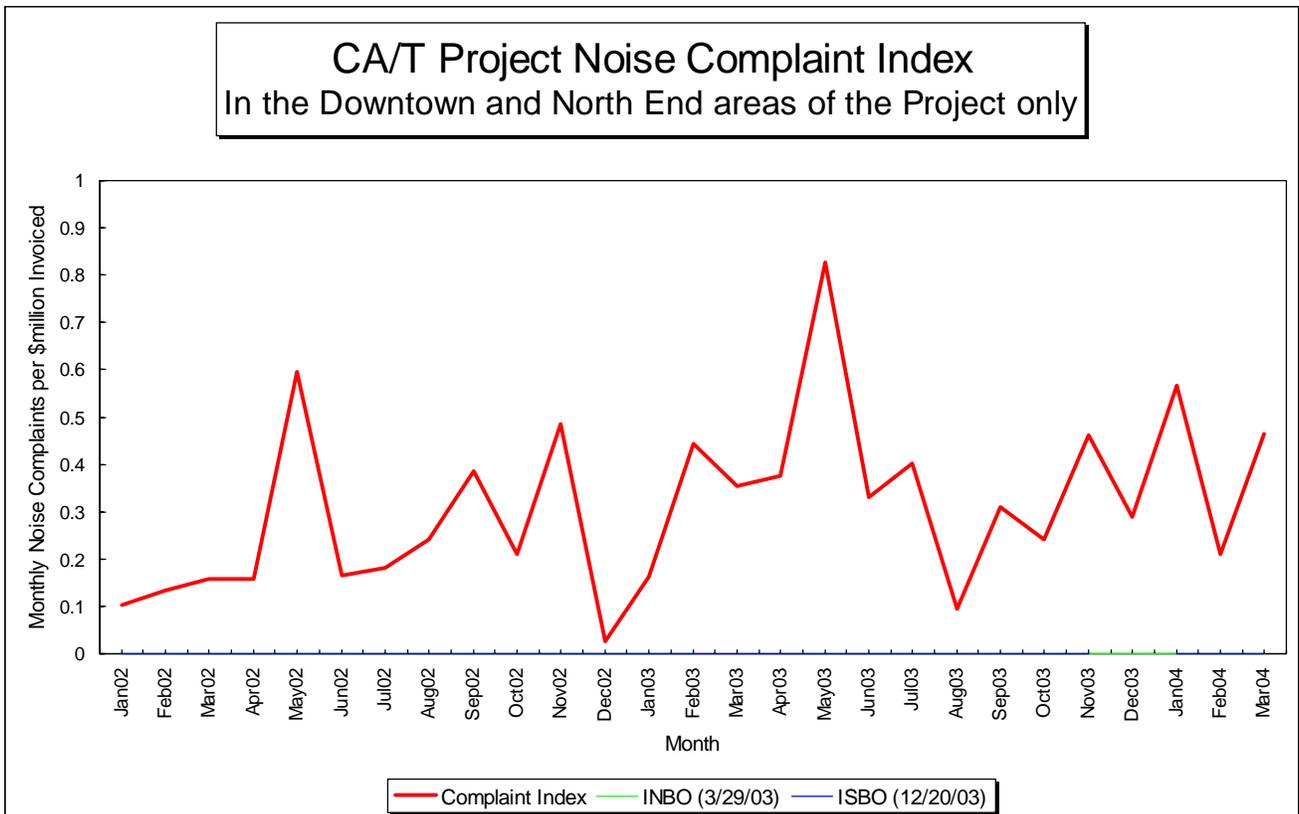


Figure 5. CA/T Project Noise Complaint Index