ACOUSTIC IMPACT OF THE GREEN CORRIDOR ACTION GROUP'S URBAN DESIGN USING ACOUSTIC MAPPING

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ABSTRACT

The Green Corridor is a not-for-profit organization which has proposed a green landscape concept along the roadway leading to the Ambassador Bridge, the major international crossing between Canada and the USA. In addition to improving the aesthetics of this mostly concrete and industrialized transportation route, the Green Corridor group had the added goal of wanting to improve the soundscape of the nearby neighbourhoods with innovated landscape designs. The high levels of traffic noise within the area are the result from this roadway being one of the busiest land trade corridors in the world. This study analyzed the changes proposed by the Green Corridor action group from an acoustic engineering perspective. The study first measured and modeled existing environmental noise conditions which included the implementation of a reverse engineering exercise to ensure an accurate acoustic map. This was followed by a second model to predict the expected noise levels with the implementation of the Green Corridor design proposals. As a result, this study was able to identify some areas where the proposed Green Corridor changes, if implemented, would be effective in reducing the local environmental noise levels. Other areas were identified where the proposed designs would have no positive acoustic benefit and would require additional abatement if the affected residential area were to meet provincial noise guidelines. A discussion of the benefits of good acoustic design, as well as improved noise legislation is also included. Finally, this study explored the possible physical and psychological health effects to residents living in those areas exposed to severe noise levels.

RESUME

"Green Corridor" est une association à but non lucratif qui propose un concept d'espace vert le long de la route qui mène au pond Ambassador, le principal pond international rejoignant le Canada et les Etats-Unis. En plus de vouloir améliorer l'esthétisme de cette route industrielle principalement faite de béton, le groupe « green corridor » souhaite améliorer le paysage sonore du voisinage avec leurs innovants aménagements paysagés. Le haut niveau sonore du trafic routier du quartier vient du fait que cette route est l'un des plus importants couloirs terrestres du commerce dans le monde. Cette étude analyse d'un point de vue acoustique les changements proposés par les actions du groupe « green corridor ». Dans un premier temps l'étude quantifie et modélise les conditions sonores existantes, incluant la mise en œuvre d'un exercice de retro-ingénierie pour assurer une carte acoustique précise. Dans un second temps l'étude est une prédiction des niveaux sonores suite à la mise place du projet de Green Corridor. L'analyse des résultats montrent qu'à certains endroits, le projet de Green Corridor serait efficace pour réduire le niveau sonore mais qu'à d'autres l'impact serait inexistant. Il faudrait alors mettre en œuvre d'autres mesures pour pouvoir arriver à atteindre les objectifs fixés par la province. Une discussion est jointe sur les bénéfices d'une bonne conception acoustique et sur l'amélioration de la législation. Pour finir, l'étude parle des possibles effets sur la santé physique et mentale des résidents des quartiers exposés à de hauts niveaux sonores.

1. INTRODUCTION

The issue of urban design is a complex one given that the tranquility and appeal of an area is determined by a subjective audience and that many factors come into play in whether or not an urban design will succeed. It has been shown that the quality of an urban area is a function of noise levels and visible natural features [1]. This study explored a proposed urban design for improvement from an acoustic perspective. While the overall success of a project is determined by many and sometimes very complex factors, noise is one that can be predicted and explored.

The work presented here was undertaken as an undergraduate studnet engineering design project given the name, "Windsor Environmental Noise Mapping Initiative (WENMI)". The group's goal was to create an environmental noise map of the present conditions of an area one kilometre in width and five kilometres in length.

This area is centered on Huron Church Road which is a major roadway accessing the Ambassador Bridge crossing between Windsor Canada, and Detroit, USA. Included in the study area are; the EC Row expressway, a railway line as well as well defined residential, commercial, and industrial areas.

The results obtained by the WENMI project were used to evaluate and compare the present acoustical conditions of the study area to a predicted model which includes the proposed environmental concept design developed by the Green Corridor Group (GC). The GC is a not-for-profit organization which has a focus on an environmentally favourable redevelopment of the area considered to be the gateway to Canada. This area is also the northern portion of the WENMI study area. Additional mandates of the GC group are aesthetics, artistic interpretation and education, and awareness of environmental issues. Their design concepts include the construction of berms and addition of vegetation with the purpose to improve air quality, mitigate noise and increase the beautification of the area. An additional goal of the concepts was also to specifically engage the public in considering the quality of the environment around them.

Further, the Green Corridors's design was not made with engineering acoustic principles in mind. As such, a fundamental goal of the WENMI study was to emphasize the importance of an engineering approach to noise abatement in consideration of an urban design. In doing so, it was also thought these outcomes would provide valuable information to the GC group and allow them to improve on the present artistic focused design.

2. DEVELOPMENT OF THE MODEL

Two acoustic propagation models were developed for the study; the first representing the present acoustic conditions and a second to predict the impact that the GC urban design would have on the area. Both were created using a commercial environmental noise calculation and mapping software package by Brüel & Kjær called Lima 7812. This software is primarily used throughout the European Union (EU) and was developed to fulfill the EU's directives and guidelines applicable to environmental noise computation. While the software is capable of predicting noise traffic noise using many standards, the traffic noise levels for this study were calculated using the British ministry of transport standard, *"Calculation of Road Traffic Noise"* (CRTN). This standard was selected since it meets all requirements of the EU Environmental Noise Directive and is somewhat similar to the Ontario Ministry of Environment calculation standard, *"Ontario Road Noise Analysis Method for Environment and Transportation"* (ORNAMENT). The Dutch RMR/SRM II and the ISO9613-2 standards were used for the rail and industrial noise calculations respectively. These standards are the generally representative approaches used in the EU for railway and industrial environmental noise modeling.

2.1 Noise Model of Present Conditions

The noise model representing the current conditions was created by first importing Geographic Information Systems (GIS) data into the noise mapping software. This data included most topographical details including roadways, however, the quality of the building footprint details was found to be out of date and lacking in sufficient detail. As such, a more laborious task was used to input each building into the model manually. To do this, a satellite image was first imported and calibrated to correlate to the size and orientation of the GIS roadway data. Major building heights were determined using field surveying techniques for each individual structure. For the many residential dwellings within the area, the heights were all assumed to have heights of 4.5 meters. From this, each building footprint was then digitized manually into the model.

Upon completion of the model topography and geographical details, the noise emission levels of the roadways were calculated using average annual daily traffic (AADT) count data provided by the City of Windsor. Such a prediction is only as good as the quality of traffic data inputted into the model. Given that the traffic data used was averaged over a 24 hour period, assumptions were required for the day and night time splits. To correct for this, actual noise measurements were made along the study area and used to calibrate, or reverse engineer the model, using the field measurement data. For this, 24 hour measurements of 20 minute equivalent noise levels (Leq) measurements were conducted at several representative locations. The locations, shown in Figure 1, were selected based on their proximity to the more significant noise sources which also have the most impact on the sensitive receptor areas. Once complete, the noise data was inputted into the software which has a reverse engineering algorithm used to calibrate the theoretical prediction. This process was iterated several times in order to improve the agreement between the CRTN results and the actual noise data. However, once complete, very little of the original noise model was altered in the final noise map, thus confirming the accuracy of the initial CRTN based model

Figure 1: Field Measurement Locations used for Reverse Engineering Calibration of the Noise Mapping Model

2.2 Noise Model of Green Corridor Concept

An acoustic map representing the Green Corridor urban concept was based initially on the model created for the current conditions but with modifications representing the specific details for the GC vision. These details included the creation of earthen berms along the Huron Church Road as well as the removal of some residential homes in order to create a buffer zone between the remaining houses and the transportation route. Other features included low density plantings of deciduous trees and the addition of low profile landscaped hills and swales. All of which were included in the updated noise prediction model. Some of these features are shown in Figure 2.

Figure 2: Artist's Concept showing many of the Proposed Green Corridor Features

3. PRESENTATION OF NOISE MAPS

A detailed look at the predicted impact of the proposed Green Corridor plan is discussed through presentation of the resulting acoustic maps. The noise contour maps provide an excellent visual representation of the noise impact that each of the respective scenarios would create on the study area. Presented first is an overview of the entire study area followed by a more detailed look at specific geographic sections which incorporate the most significant proposed changes by the Green Corridor plan.

3.1 Overall Model

Shown in Figures 3 and 4 are the noise contour models for the daytime conditions without and with the details of the GC plan respectively. It is shown that for the day time predictions, the noise levels in the near vicinity of the major roadways is reduce by at least 5 dB as a result of the earthen berms along the west side of Huron Church Road leading to the Ambassador Bridge. Given that these figures show the "big picture" of the predicted comparisons, a more detailed analysis which focuses on specific target areas on abatement concepts will be discussed further in this section.

The downside associated with visual noise mapping is that while informative, analysis of results is also somewhat subjective. For a more objective approach, a statistical analysis comparing the overall geographical area affected, for deviations of 5 dB, of the two scenarios without and with the GC plan is given in Tables 1 and 2. From these, it is evident that the implementation of the GC concept does improve the noise levels within the study area. For both the day and night time, implementation of the GC concept results in the most significant decrease in percent area affected by high noise levels within the 60 to 65dBA range. At the same time, the sound level range where the GC plan has a positive increase in percent affected area is in the more desirable 45 to 50dBA range. This statistically reinforces the fact that the proposed GC improvements caused the greatest area increase with lower sound levels at the bottom end of the noise level spectrum.

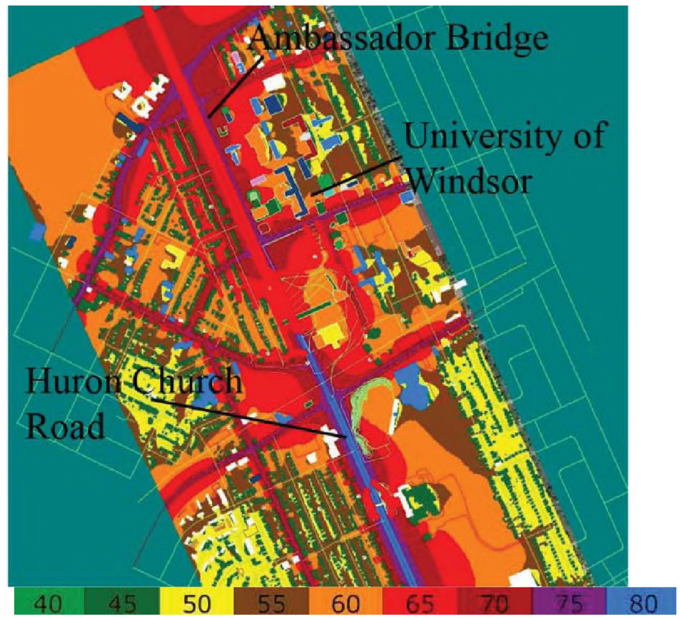

Figure 3: Noise Contour Map of the Study Area showing Present Daytime Noise (dBA) Conditions

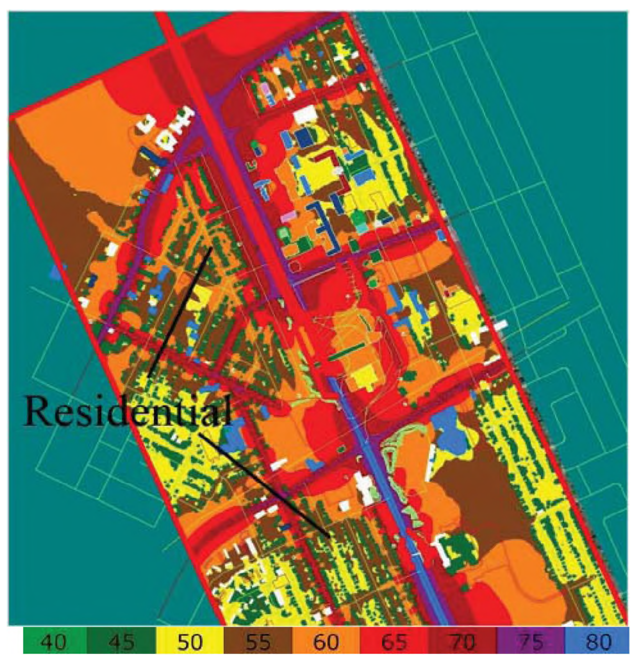

Figure 4: Noise Contour Map of the study area showing Predicted Green Corridor Daytime Noise (dBA) Conditions

Table 1 Daytime Percent Area Affected by Propsed Green Corridor Changes

dBA Range	Current Percent Area	GC Percent Area	Percent Area Change
40.1-45	2.01	2.71	0.7
45.1-50	13.95	14.37	0.42
50.1-55	22.75	22.73	-0.02
55.1-60	20.36	19.99	-0.37
60.1-65	14.66	14.2	-0.46
65.1-70	13.84	13.72	-0.12
70.1-75	8.53	8.43	-0.1
75.1-80	2.48	2.47	-0.01
80.1-85	1.31	1.25	-0.06

Table 2 Night time Percent Area Affected by Propsed Green Corridor Changes

dBA Range	Current Percent Area	GC Percent Area	Percent Area Change
40.1-45	1.26	1.35	0.09
45.1-50	14.65	15.57	0.92
50.1-55	28.21	28.03	-0.18
55.1-60	21.06	21.08	-0.02
60.1-65	15.47	14.99	-0.48
65.1-70	11.71	11.62	-0.09
70.1-75	4.8	4.65	-0.15
75.1-80	2.48	2.36	-0.12
80.1-85	0.28	0.25	-0.03

3.2 South East Sector (Area 1)

The south section of the study area on the east side of Huron Church Road is non residential but still of importance due to its usage. This area is the location of both a large high school and the University of Windsor's Human Kinetics and sports facilities. For this area, the green corridor plan is to make significant changes to the existing berms by breaking them up into several interlocking rolling hills with natural tall grasses as opposed to a single berm. A new berm is also proposed along the north end of the high school. The idea is to provide a more pleasing and natural looking landscape as opposed to a manicured grass covered noise earth berm.

For the noise map representing the current conditions, shown in Figure 5, much of the stadium playing field shows a noise level ranging between 55-65dBA for the daytime period. Similarly, the high school just south of the stadium has noise levels within the range of 55-70dBA during day. For the night time (not presented), the noise levels were similar to the day time levels, due mostly to the high night time truck traffic volumes which can be as high as 1000 heavy trucks per hour.

Figure 6 illustrates a realized drop in sound levels for this region with implementation of the modifications around the stadium and added barriers near the high school as specified by the Green Corridor action plan. These changes show a drop in both daytime and night time levels on the sports field from 55-65 dBA to the 55-60dBA range. Given that the new berms are not along the entire length between Huron Church Road and the high school, the realized noise attenuation here is less with a 5dBA drop on the north side of the school while the rest of the building remains unchanged.

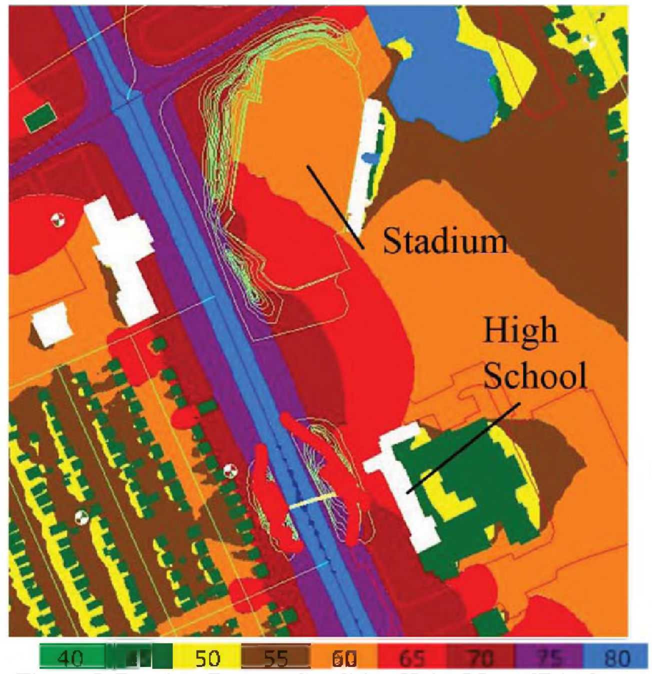

Figure 5: Daytime Present Condition Noise Map (dBA) for South East Sector around U of W Stadium and High School

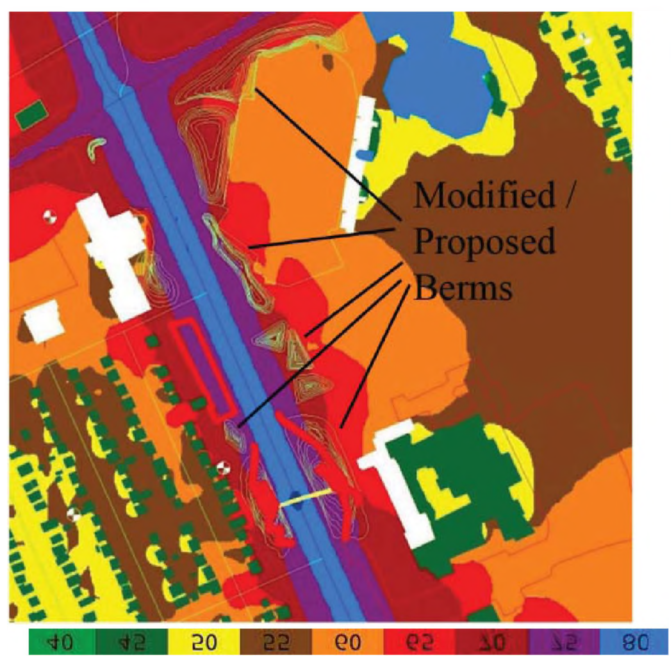

Figure 6: Daytime Green Corridor Noise Map (dBA) for South East Sector around U of W Stadium and High School

3.3 North West Sector (Area 2)

For the north west sector of the study area, a dense concentration of residential houses are located on the west side of the Ambassador Bridge and the roadway leading up to the bridge and Canadian Customs inspection booths. Immediately to the east side of the bridge are student residential housing buildings which are part of the University of Windsor campus. Along this area, the Ambassador Bridge is essentially an elevated roadway approximately five stories tall over top of the residential backyards and approximately 45 meters from the student housing building windows. The bridge has an average daily traffic count of 32,000 vehicles but can see peak volumes as high as 52,000 vehicles per day. This traffic accounts for 40% of the daily trade between the U.S.A and Canada for which a very large percentage is comprised of heavy trucks [5]. To make matters worse, depending on the direction of travel these trucks are either accelerating up or braking down the steep slope of the suspended bridge. Both of these actions produce excessive noise, particularly when the trucks use their engine brakes as they approach the Customs booths.

The Green Corridor action plan proposes the removal of the houses along the west side of the bridge and thus creating a buffer zone to separate the remaining residential dwellings west of the bridge. This proposed buffer zone is comprised of one row of residential lots approximately 30 meters deep which runs the length of the land based portion of the bridge. Within this buffer zone the Green Corridor group proposes to beautify the area by establishing trees, berms, and settling ponds in an attempt to improve the aesthetics and area quality of life. The resulting noise prediction maps for the present and proposed GC plan are illustrated in Figures 6 and 7 respectively for the day time conditions.

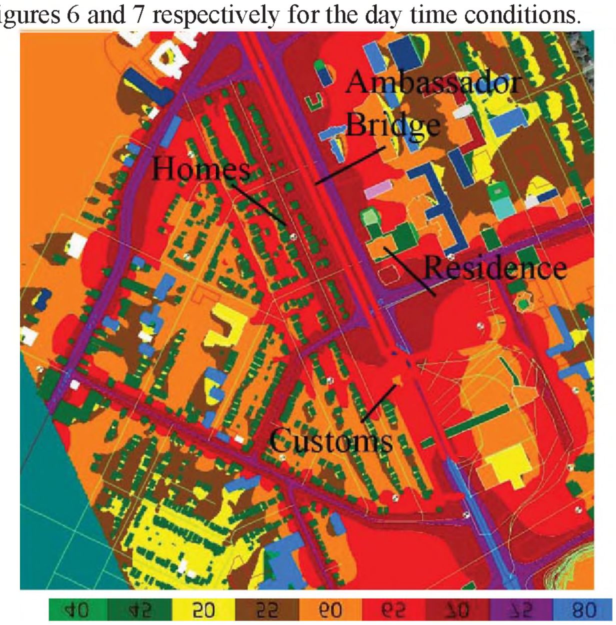

Figure 7: Daytime Present Condition Noise Map (dBA) for North West Sector along the Ambassador Bridge

While aesthetically appealing, inspection of Figures 7 and 8 demonstrates that the green Corridor concept plan does not result in an improvement from an acoustical perspective. According to the guidelines of the plan, the trees are not planted with sufficient density to yield significant attenuation and the settling ponds do not contribute at all to the areas acoustics. The recommended berms also have no appreciable effect given that they are far below the height of the deck of the bridge resulting in an unchanged path length difference between the residential homes and the noise source.

3.4 South West Sector (Area 3)

For this sector, the main receptors include the University of Windsor's Lebel Arts Building as well as a number of residential homes. The residential receptors are orientated with the backyard areas facing Huron Church Road. These homes were built long before the establishment of the present day Ontario Ministry of the Environment (MOE) guidelines for traffic noise were in place. This was also a time when Huron Church Road was only four lanes wide with much fewer vehicles than the divided eight lane roadway it is now. At some locations the houses are approximately 15 meters from the edge of this busy transportation route with no noise abatement.

Inspection of the noise contour map of the present daytime noise conditions given in Figure 9 shows that the noise levels in outdoor living areas of these receptors are in the 65-70 dBA range. This is far in excess of the MOE guidelines for a new residential development. Similarly, it is shown that the University of Windsor's Lebel building is exposed to noise levels within the range of 65-75 dBA during the daytime.

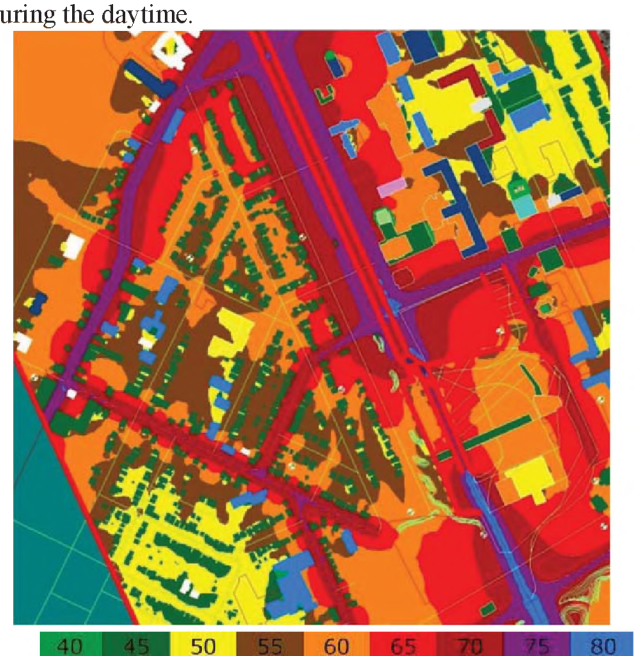

Figure 8: Daytime Green Corridor Noise Map (dBA) for North West Sector along the Ambassador Bridge

The predicted noise results of the Green Corridor concept are given in Figure 10. For here, the GC plan is to abate the traffic noise with low density vegetative plantings between the residential houses and Huron Church Road along with limited placement of berms. While the plantings have resulted in no improvement for the outdoor living areas of the nearest houses, the berms have resulted in minimal effect on the penetration of noise further into the neighbourhood with a 1 to 2 dB decrease in some very small areas resulting in contours dropping to the next lower range. For the Lebel Building, the GC plan is to erect a glass display wall along the length of the building. The predicted result is good protection on the east side of the building creating an area in the 50-60 dBA range along most of this facility which adequately protects it from the effects of the Huron Church traffic noise.

4. DISCUSSION

Ontario's Ministry of the Environment's (MOE) guidelines for acceptable noise levels for a new development are 55dBA during the daytime and 50 dBA during the night. If these noise guidelines are exceeded, then mitigation is required. This may include a warning clause within a purchase agreement of the home, the installation of air conditioning and upgraded windows or the design and installation of a noise barrier, depending on the degree of exceedance. The only circumstance in which a home may be built having outdoor sound levels over 60dBA with no mitigation is if abatement solutions are not feasible or in conflict with local bylaws. In such a case the house must be sold with a more stringent warning clause.

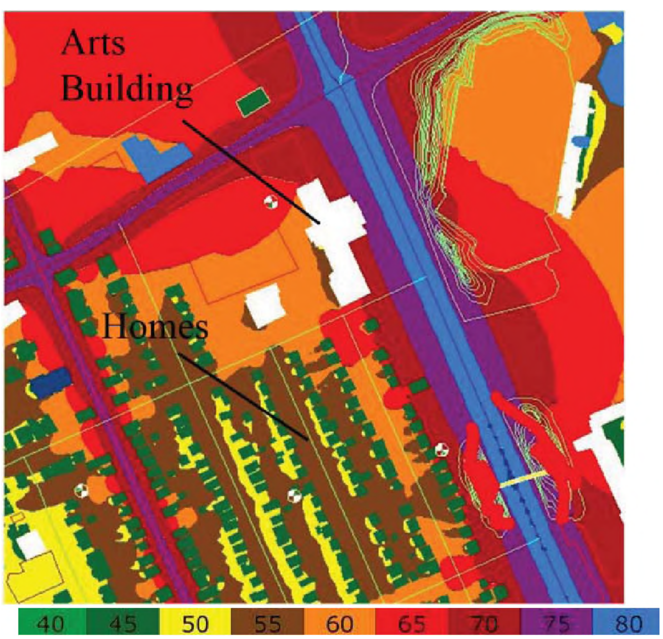

Figure 9: Daytime Present Condition Noise Map (dBA) for South West Sector along Huron Church Road

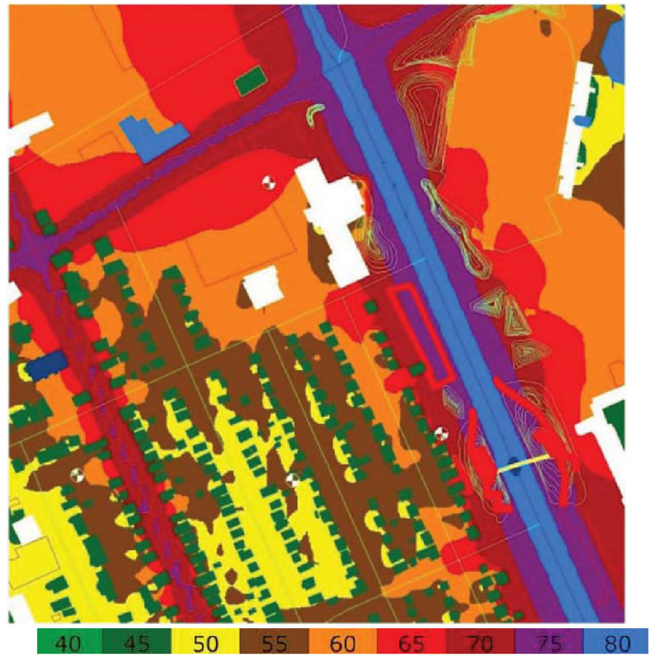

Figure 10: Daytime Green Corridor Noise Map (dBA) for South West Sector along the Huron church Road

From the presentation of the noise contours for the present day conditions, it has been illustrated that many of the homes nearest to Huron Church Road and the Ambassador Bridge are exposed to noise level which far exceed the MOE guidelines. Unfortunately, despite the best intentions of the Green Corridor Urban Action plan the same is true of the predicted noise levels if the plan were to come to fruition. However, the current MOE guidelines for retrofit of noise mitigation for existing residential areas have a number of exclusions, and as such, the residences within this study area are excluded from these guidelines [6]. The following sections are a more in depth look at how the proposed Green Corridor ideas failed to meet their noise attenuation goals as well as suggestions for improvement where possible.

4.1 Buffer Zone Next to Bridge

The proposed buffer zone along the west side of the bridge has resulted in very little effect for noise abatement except at the most southerly and lowest section of the bridge. At this location, any traffic noise propagation from the bridge is low enough in elevation such that the proposed berms will have some positive effect. Another aspect of the creation of the buffer zone is the removal of an arterial road which will result in a reduction of localized traffic noise.

Despite the above positive effects of the proposed buffer zone at the south end of the bridge, the same cannot be said along the remaining and majority of the bridge length. Here, the proposed installation of the berms, low density coniferous trees and the green space created through the removal of derelict residential buildings has little effect on the predicted noise levels. Given that the bridge is an elevated noise source, traffic noise will carry over the buffer zone and above the barrier berms resulting in no positive abatement. However, the removal of houses immediately adjacent to the bridge does remove residents out of the region of highest noise levels within the entire study area. It is also purported that the additional green space will have the effect of improved air and water quality.

Unfortunately, very little can be done to improve the environmental noise levels in this part of the study area. Given the technical and economical difficulties associated with abating a 90 year old suspension bridge with a highly elevated noise source, very little could be done to improve the GC's model.

4.2 Role of Trees in the Green Corridor Model

The stated intention of the Green Corridor's concept to use tree plantings extensively is to improve the aesthetics of the area, to improve the air quality and to abate noise emissions from the nearby Huron church Road and Ambassador Bridge. However, the proposed plantings are mostly low density deciduous trees which offer almost no noise attenuation characteristics. It is normally expected that 30 meters of dense bush will provide approximately 5 dB of noise attenuation. The available green space between source and receiver within the corridor area is 10 meters at the widest. Assuming a linear relationship between attenuation and thickness of planting, the GC's trees could provide no more than 1-1.5 dB attenuation. This may be counteracted by the effect that screening of a noise source often has on the perception of the noise. The work of G. Watts et al. [4] postulates a statistical relationship between the perceived noise level, the actual noise level and the amount of screening of the noise source. The relationship showed that the sensitivity to a noise increased with an increase in the screening of the source, meaning that for the same measured noise level, an observer perceived a higher level when the source was blocked from view. This suggests that the addition of vegetation in the fashion proposed by the GC plan may result in a rise in the perceived noise levels at the residents' homes. On the other hand, some suggest that the addition of trees as a natural feature will generally improve the subjective perception of an urban area.

While most standards completely disregard the attenuation of noise by vegetation belts of insignificant densities, proper plant selection can provide some attenuation. If vegetation is to be included for simple aesthetics, some advantage could be gained by designing the plantings in a dual role. Studies have shown that properly planted, a 6-10 meter wide strip can provide between 2 and 3 dB of attenuation [2, 3]. The most ideal design being a row of high density evergreen shrub plants followed immediately by a row of evergreen trees. This design maximizes density close to the ground while still providing height. If planted with the proper spacing to allow the plants to reach full maturity and density it has been suggested that it is possible to realize attenuations as high as 6 dB [2]. This small change to the GC concept would provide some residents in the immediate area an effective privacy screen and aesthetic improvement combined with a modest acoustic improvement.

4.3 Noise Attenuation Berms

The implementation of earthen berms to block roadway noise is a viable and cost effective solution in order to attenuate noise. Within the Green Corridor plan, berms are proposed along the west side of Huron Church Road from the Ambassador Bridge entrance to the southerly extent of the study area about 1.5 km away. Berm are also proposed within the suggested buffer zone adjacent to the Ambassador Bridge. The placement and heights of the berms were designed with aesthetics in mind and without considering acoustic engineering principles. Because of this the full degree of their effectiveness is unknown. This investigation offered the opportunity to analyze the current berm proposal and determine how effective the berms are in reducing the present noise levels.

The exact slope of the proposed barriers was not specified in the GC plan but a ratio of no more than 3:1 would be the most practical approach. It has been demonstrated that a slope of 1.5:1 or 2:1 can provide an additional 0.5 to 1 dB attenuation [7]. This is though often impractical as a steeper slope is more difficult to maintain and has the potential for soil erosion. To be effective, the berm height must be sufficient to break line between the road and receptor with each additional meter of height providing an additional noise reduction of 1.5 dB [7]. Unfortunately there are sections along Huron Church Road where there is not enough distance between the road and residence to install a berm. Also much of the proposed berm is located on the east side of the road which will protect the university stadium and high school whereas it may have been more appropriate had the model included berms on the other side of Huron church Road so as to protect the housing development. This would most likely provide a measurable improvement in the quality of life for those residing in the houses along this busy roadway.

The Green Corridor's implementation of berms within its plan do provide minimal noise attenuation, but with additional acoustic practices a more refined model could be achieved while maintaining the artistic integrity of the concept. With these concerns addressed an attractive and highly functional design can be coalesced.

4.4 Possible Concerns and Health Effects

The study area chosen was considered important to the community given the number of residential homes and major learning institutions located within the area. As part of this, it is important to consider the impact that noise has on the lives of those living and working in the study area. The EU adopted the Directive on Environmental Noise in 2002 (2002/49/EC) which in part requires that strategic noise contour maps be produced to identify regions which have ambient levels above 55 dBA so as to minimize annoyance and loss to quality of life. Such an exercise is very similar to the efforts and motivation taken in this study. While this investigation of the propose Green Corridor concept did not demonstrate a realized attenuation to levels below 55 dBA, it did show the merit of noise mapping in order to gain a better understanding of how communities are affected by major transportation routes such as Huron Church Road and the Ambassador Bridge.

One of the difficult components of studying noise related health effects is quantifying the resulting perception. The World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” [8]. Unfortunately, most people associate the research of noise exposure with the physical effects of hearing loss without consideration of the other real non-auditory physiological effects which can include a possible increase in cardiovascular disease from elevated blood pressure [9]. “There is some evidence that suggests an increased risk of hypertension and ischaemic heart disease for people living in areas with road or air traffic noise at outdoor equivalent sound levels above 70 dB(A) based on exposure between 6:00 a.m. and 10:00 p.m.” [10]. With respect to this study, the reality is that there are areas of residences in near proximity to Huron Church Road where the noise does reach levels in excess of 70 dBA.

Perhaps the most common health affect which can result from excessive community noise is that of annoyance. A study which looked at noise annoyance in Canada revealed that nearly 8% of Canadians surveyed were either very or extremely bothered, disturbed or annoyed by noise in general for which traffic noise was identified as being the most annoying source [11]. Given the health concerns identified above this is a large percentage of the Canadian population, including a potentially much larger percentage within the study area considered here, which have not only self identified mental effects from community noise exposure but may also eventually suffer from other physiological diseases.

Another type of annoyance considered harmful to a persons well being is sleep disturbance. Sleep is essential to good health and noise has been reported to lessen both the quality and duration of sleep, and thus, quality of life [10]. The World Health Organisation suggests that for good sleeping conditions noise levels should not exceed 30 dBA in the sleeping area or 45 dBA for a single event [12]. As developed countries continue to grow in population, they are becoming more congested and noise levels are continuing to increase, leading to increased sleep disturbance. In a study of how traffic noise can effect sleep of young adults it was found that, “sleep disturbances are clearly related to noise levels, to the number of stimuli, to frequency spectra etc and people are less disturbed by continuous than by intermittent noises” [13]. As a result of these findings it is clear that the health of individuals exposed to excessive environmental noise is significantly reduced in all senses of the definition. This study demonstrated that the majority of the population within the study area are exposed to night-time levels well above this, with and without the proposed GC concepts.

5. CONCLUSIONS

The goal of this study was to measure, model and compare the current noise conditions along the Huron Church Road and the Ambassador Bridge to the predicted soundscape given the theoretical implementation of the Green Corridor’s concept of a better and healthier urban model. While it is not possible to predict the subjective visual effects of the design, this study has used the prediction of acoustic performance metrics to evaluate the outcome of this urban design.

While noise levels were shown to be reduced by the Green Corridor concept at some areas, it was not enough to bring the noise below the target 55 dBA at most receptors. However, it was also shown that the models could be improved with a number of simple changes. Better implementation of vegetative plantings and berm placements would reduce noise levels further along with the aesthetic effect of more greenery in the city. This study’s presentation of the possible negative health effects of excessive noise to the general public living in this area suggests that implementation of these suggestions would help to improve the quality of life for those living, working, and going to school within the study area.

6. REFERENCES

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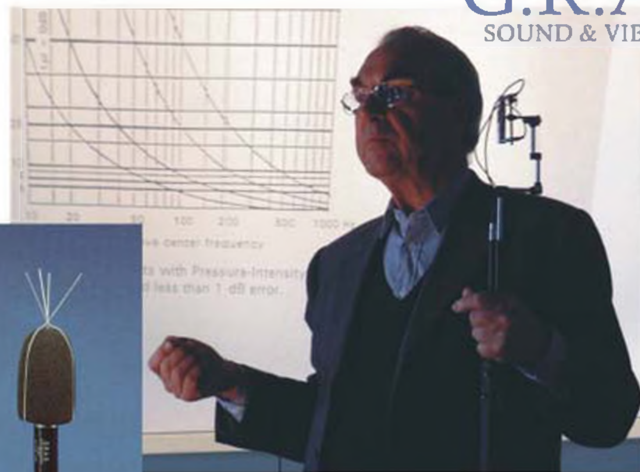

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