TYPICAL HOURLY TRAFFIC DISTRIBUTION FOR NOISE MODELLING

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1. INTRODUCTION

A prominent feature of the environmental noise in our western world is the sound of vehicles travelling on our roads. Noise from vehicles is estimated using models that incorporate many factors, including traffic volume. However, the ability to characterize the variation in noise level is limited by the temporal resolution of the traffic volume that is available. This study provides input to evaluating the variation of noise level over the course of a day by examining variation in the number of vehicles.

Noise levels are usually represented on the basis of hourly, day/night, or 24-hour time periods. 24-hour time periods usually require no more than the Average Annual Daily Traffic (AADT) volume for a road segment. When breaking the evaluation period into daytime hours and night-time hours or further resolving it to a one hour time period, it becomes necessary to have information about how the traffic is distributed.

Traffic volumes distributed over one hour time periods are not always available for the specific road segments that are being modelled. Since traffic data is used primarily for transportation planning, the traffic volumes are frequently counted only during the morning peak and afternoon peak hours, or during an eight hour daytime period. Data for the evening and night-time periods is therefore missing.

The problem of determining how low the traffic volumes and sound levels fall during evening and night-time periods is particularly real in jurisdictions such as Ontario, where the lowest sound levels are used in determining the applicable limits for permitting of industrial noise. When the data is not available on an hourly basis for a desired road, a comparable road in the vicinity is often used as a proxy. This study addresses the situation where a suitable proxy is not available, by developing a typical hourly distribution.

2. DATA SET

2.1 Data Sources

The typical hourly traffic distribution presented in this study is empirically derived. Data was requested from the provincial and local levels of government across Ontario. Care was taken to represent the widest possible variety of roads by soliciting data from cities, towns, and municipalities in all regions of the province. Each was requested to send data sets reflecting the diversity of road types within the jurisdiction. Rural, collector, arterial, and controlled access roads are all represented.

Each of the data sets was accumulated using automated counters. A large number of the data sets included multiple days of counting. A few of the counts included complete breakdowns by vehicle type and size. However, the amount of this type of data was not sufficient to warrant further examination.

Traffic counting for the data sets obtained was conducted from March through November, with the majority occurring between April and October. One of the counts included hourly averages for each month of the year.

In general, the traffic distributions follow a common pattern. Between 6 am and 8 am there is a rapid rise in volume. The volume is drops somewhat, but rises through the late afternoon. After peaking at the end of the afternoon, it drops off into the evening and night-time hours. The lowest volume occurs between the hours of 2 am and 4 am.

2.2 Data Selection

Most of the data sets that were received were suitable for this analysis. Data sets that were significantly influenced by local features, had low traffic volumes, or were only part of a road segment are excluded in the analysis. Local features such as a dominant industry with shift changes or a nearby school, showed the ability to bias the hourly distribution on a road segment. While this is normal for certain road segments, this is clearly not universal. Data sets with low total volumes were also poorly behaved. They included hours where no vehicles were recorded, and showed comparatively large impacts for small changes in traffic volumes. Upon reviewing the distribution of traffic in the uni-directional data sets, it was apparent that they could not be considered together with the bi-directional data sets. These data sets were typically missing the rapid morning rise in traffic, or the large volumes of the late afternoon and early evening traffic. These data sets would skew the results away from normal conditions, and were therefore not included.

After removing the unsuitable data sets, just over 100 data sets remained for analysis. The distribution of AADT's is shown in Figure 1.

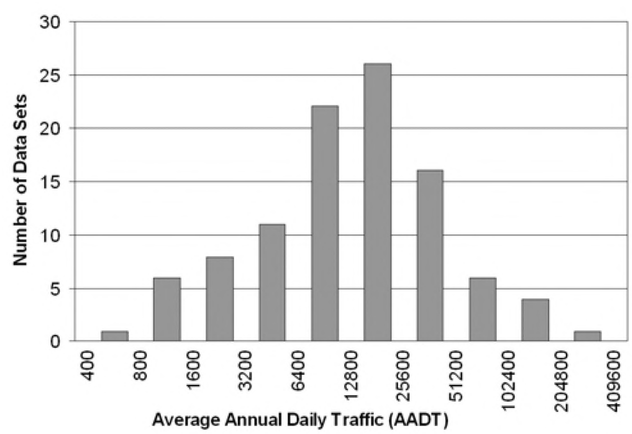

Figure 1. Distribution of AADTs in Data Set

3. ANALYSIS AND RESULTS

3.1 Hourly Traffic Volume

The accumulated suitable data sets were analyzed using the percentage of the AADT occurring in each hour of the day. A single data set was used for each road segment.

Where a number of days were counted for a segment, an average was calculated over the measurement period. The typical distribution was calculated as the mean of each hour over the data set, as shown in Figure 2. The range of values and standard deviation are shown in Table 1.

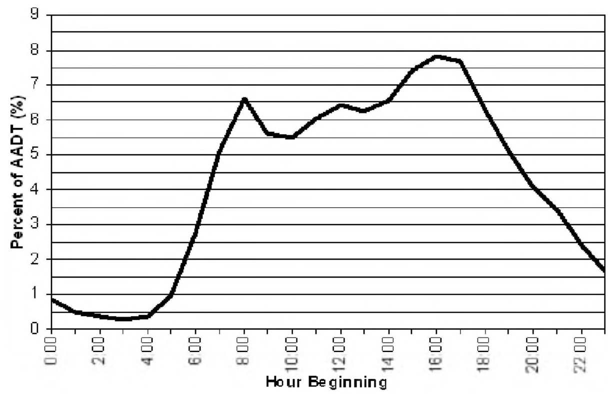

Figure 2: Typical Hourly Traffic Distribution in Percent AADT

Table 1. Range of Values and Standard Deviation for the Supporting Data Set (in Percent)

Hour Beginning	Typical	Maximum	Minimum	Standard Deviation
0:00	**0.87**	1.88	0.18	0.44
1:00	**0.49**	1.21	0.09	0.27
2:00	**0.36**	0.86	0.07	0.21
3:00	**0.30**	0.76	0.05	0.17
4:00	**0.36**	0.87	0.07	0.21
5:00	**0.95**	2.68	0.37	0.54
6:00	**2.75**	5.18	1.19	1.43
7:00	**5.05**	8.59	2.13	2.30
8:00	**6.55**	11.08	3.30	2.81
9:00	**5.62**	7.70	3.96	2.24
10:00	**5.50**	7.73	3.81	2.21
11:00	**6.04**	9.76	4.19	2.48
12:00	**6.48**	9.78	4.45	2.65
13:00	**6.26**	9.75	4.24	2.56
14:00	**6.60**	9.62	4.44	2.63
15:00	**7.41**	10.40	5.51	2.91
16:00	**7.82**	10.34	5.83	3.06
17:00	**7.65**	9.30	5.58	3.01
18:00	**6.27**	8.72	4.42	2.50
19:00	**5.12**	7.44	3.52	2.06
20:00	**4.09**	6.30	2.18	1.69
21:00	**3.41**	5.21	1.30	1.44
22:00	**2.41**	4.09	0.78	1.08
23:00	**1.67**	3.79	0.46	0.86

The significance of the statistical data becomes apparent when the hourly distribution is translated into sound levels. For illustration purposes an L_{eq}(24 hour) of 60 dBA was used for comparison with the L_{eq}(1 hour) sound levels as shown in Table 2. The respective increase or decrease due one standard deviation increase or decrease in traffic volume is also presented.

Table 2. Hourly Sound Levels and Variation Based on an L_{eq}(24hr) of 60 dBA.

Hour Beginning	Sound Level (dBA)	+1 std. dev.	-1 std. dev.
0:00	53	+2	-3
1:00	51	+2	-3
2:00	49	+2	-4
3:00	49	+2	-4
4:00	49	+2	-4
5:00	54	+2	-4
6:00	58	+2	-3
7:00	61	+2	-3
8:00	62	+2	-2
9:00	61	+1	-2
10:00	61	+1	-2
11:00	62	+1	-2
12:00	62	+1	-2
13:00	62	+1	-2
14:00	62	+1	-2
15:00	62	+1	-2
16:00	63	+1	-2
17:00	63	+1	-2
18:00	62	+1	-2
19:00	61	+1	-2
20:00	60	+1	-2
21:00	59	+2	-2
22:00	58	+2	-3
23:00	56	+2	-3

3.2 Day/Night Split

The amount of traffic occurring in each part of the 16/8 and 15/9 hour splits was calculated for each distribution. Table 3 presents the average and range of these values.

Table 3. Day/Night Split Ratios

	16:8 hr	15:9 hr
Mean	92:8	90:10
Maximum Range	97:3	96:4
Minimum Range	87:13	83:17

4. DISCUSSION

To understand the value of this typical traffic distribution, it is necessary to know its limitations. The first indication of limitations is derived from the input data. Low volume roads, unidirectional roads, or those with significant local influences are not covered in this typical hourly traffic distribution.

Regulatory parameters put a practical lower limit on the AADT values where this distribution can be applied. Conditions, including AADT, that are sufficient to generate L_{eq}(24 hour) values of 57 dBA and 52 dBA would be needed to raise the lowest hourly sound levels above the minimum limit values of 45 dBA and 40 dBA respectively. More significantly, the models that use this data also provide limitations. For example, the algorithms currently used in Ontario set a minimum limit of 40 vehicles per hour. An AADT of over 13,000 would be necessary to satisfy this criterion during the early morning hours.

This study proposes a typical hourly traffic distribution together with some indication of its range of variability. It provides a method of estimating minimum hourly sound levels when actual data is missing or incomplete and good proxy data is not available.