FINAL

SUPPLEMENTAL REPORT on THE REFLECTIVE EFFECTS OF A NOISE BARRIER CONSTRUCTED ADJACENT TO I 94 IN THE VICINITY OF UPPER SPUNK LAKE NEAR AVON MINNESOTA

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Purpose:

This supplemental report addresses the results of a third sampling of noise levels and traffic, at two residential sites, intended to clarify and, if necessary, correct the evaluated effects of a barrier reflection based on two earlier, a before and after, samplings. The sampled sites are, as previously noted, two residences adjacent to Upper Spunk Lake, on the west side of I-94, near Avon Minnesota. Potential noise level changes, due to noise reflections off the introduced noise barrier across the highway, on the east side of I 94, are evaluated statistically. Two test sites were selected for the collection of noise level samples. These sites are two residences, one at 17365 Upper Spunk Lake Road and another at 17427 Upper Spunk Lake Road. Simultaneous with the measurement of noise levels at the two sites, classified traffic counts were made, along with the collection of samples of vehicle speeds.

Baseline Results:

The following results are based on a comparison of sampled noise levels collected in 2017 (before noise wall construction), 2018 (the first, after noise wall construction, sampling) and 2019 (a second, after noise wall construction, sampling). Traffic volumes and speeds were collected simultaneously with the noise level measurements during all three samplings (2017, 2018, and 2019). The noise level measurements were done at two residences on the west side of I-94. In the following, these residences are referred to as #22 (17365 Upper Spunk Lake Road) and #21 (17427 Upper Spunk Lake Road) respectively. As the traffic volumes and speeds in 2019 were comparable to the same values as those collected in 2018, we combined all the after barrier data for analysis.

The results of the analysis of the sampled levels and traffic are as follows:

- Based on noise levels collected in 2017, 2018 and 2019, corrected for variations in traffic only, there was an increase in the after L10 noise level by an average of 3.3 ± 0.75 dBA at a 95% confidence level at residence #21.

- Based on noise levels collected in 2017, 2018 and 2019, corrected for variations in traffic only, there was an increase in the after L10 noise level by an average of 3.6 ± 0.75 dBA at a 95% confidence level at residence #22.

- Based on noise levels collected in 2017, 2018 and 2019, corrected for variations in traffic and site shielding effects, residence #21 showed an increase in the L10 noise level, due to the barrier reflection, by an average of 0.3 ± 1 dBA at a 95% confidence level.

- Based on noise levels collected in 2017, 2018 and 2019, corrected for variations in traffic and site shielding effects, at residence #22 showed an increase in the L10 noise level, due to the barrier reflection, by an average of 1.2 ± 1 dBA at a 95% confidence level.

Conclusions:

It's important to remember that this report addresses the L10 noise descriptor only. The results are based on the before barrier samplings in 2017 along with a 3 dBA shielding correction (based on foliage; See the Discussion that follows) for the predictions based on the traffic sampled in 2017, and a combination of the 2018 and 2019 after barrier measurements and sampled traffic noise level predictions. Following are the estimates for the effects of the noise barrier on traffic noise levels at the two measured sites.

- Based on noise levels collected in 2017, 2018 and 2019, corrected for variations in traffic and site shielding effects, at residence #21 (17427 Upper Spunk Lake Road) there was an increase in the after L10 noise level by an average of 0.3 ± 1 dBA at a 95% confidence level.

- Based on noise levels collected in 2017, 2018 and 2019, corrected for variations in traffic and site shielding effects, at residence #22 (17365 Upper Spunk Lake Road) there was an increase in the after L10 noise level by an average of 1.2 ± 1 dBA at a 95% confidence level

The increase at site #21 was statistically insignificant and could be considered to be 0 dBA. The increase at site #22 was statistically significant, averaging 1.2 dBA. This increase is close to the increase expected based on modeling the reflection component due to an image source of traffic (assumes total reflection).

Lastly we want to address the physical meaning and reality of the changes in noise level we found. At site #21 the difference in noise level is unperceivable, it being essentially zero. At site

#22 the difference in noise level averages 1.2 dBA. In order to address this noise level difference we will cite an FHWA Table that's slightly modified from its published form. See Table 3 below.

Table 3: Decibel Change, Loudness Change, and Acoustic Energy Change (FHWA)

Sound Level Change	**Relative Change in Loudness**	**Acoustic Energy Change Energy (new) – Energy (init)**
0 dBA	Reference	0
±3 dBA	Barely Perceptible Change	100% or 50% of the Energy (init)
±5 dBA	Readily Perceptible Change	216% or 68% of the Energy (init)
±10 dBA	2 times or Half as Loud	900% or 90% of the Energy (init)
±20 dBA	4 times or 1/4 as Loud	9900% or 99% of the Energy (init)
±30 dBA	8 times or 1/8 as Loud	99900% or 99.9% of the Energy (init)

The above Table shows that, for a broadband (many included frequencies) time varying noise level, differences less than 3 dBA are essentially unperceivable by human beings. A difference of 1.2 dBA is unperceivable. An increase of 1.2 dBA would represent an acoustic energy increase of about 32%, 3 times less than a 3 dBA increase would indicate, which is, itself, barely perceivable.

Discussion:

Some history of this reflection study may help to clarify our determination of the values of the effects of the barrier reflection component based on the 2017, 2018 and 2019 samplings. As explained in the original Avon Report, after the 2018 sampling we found

that the traffic corrected differences between the before and after barrier construction noise levels (about +3

dBA) were greater than expected. Our expectations (+1 dBA) for the level increase due to barrier reflections were based on the geometrics and modeled effects of the barrier. The first noticeably unusual aspect of the 2017, 2018 samplings was the disparate traffic mixes we ran into. We felt that the surprising level results might be related to the model's inability to accurately correct for the surprising differences in the traffic mixes found during the traffic samplings. This, as it turns out, was an unfounded concern. The noise model is well able to address differences between traffic noise levels due to different and disparate traffic flow parameters.

As the traffic sampled in 2018 was close to the traffic sampled in 2019 we still had larger than expected differences between before and after noise levels. So it was a case of either the reflection component was larger than we expected or we had missed some effect due to a difference in sound path or measurement site characteristics. We decided to scrutinize the measurement sites for any missed differences that cropped up between 2017, 2018 and 2019.

Based on photos of the sites and recollections of the personnel that worked the sites we determined that the density of deciduous foliage and underbrush seen in July of 2017 was clearly much greater than that seen in September 2018 or May 2019. It appeared highly likely that the foliage shielded the 2017 measurements more than those made in 2018 and 2019. Based on the measurements made and modeling of different foliage shielding scenarios we determined that a shielding effect of 3 dBA could realistically be applied to the 2017 modeled results. A 3 dBA shielding effect wasn't initially anticipated as we don't run into seasonal site changes like this in the urban and suburban areas we usually need to address. So, we needed to normalize out two variable effects, both traffic variations and changes in foliage density in order to accurately estimate the reflection component.

TABULATION
OF
COLLECTED DATA

	AFTER MEASUREMENTS (2019)							
		#21		#22				
Time		17427		17365			S BOUND	
		dBA		dBA			VEH/HR	MPH
10:30 AM	L10	69		65.5		AUTO	684	
	L50	65		62		MT	6	68.4
	Leq	66.3		62.9		HT	198	
10:47 AM	L10	69		64.5		AUTO	534	
	L50	64.5		61		MT	18	67.0
	Leq	65.9		62		HT	186	
1:30 PM	L10	69.5		64		AUTO	666	
	L50	64.5		61		MT	42	70.6
	Leq	66.2		61.6		HT	198	
1:50 PM	L10	69		64		AUTO	726	
	L50	64.5		60.5		MT	54	68.6

	AFTER MEASUREMENTS (2018)							
		#21		#22				
Time		17427		17365			S BOUND	
		dBA		dBA			VEH/HR	MPH
11:17:00	L10	69		65		AUTO	474	
	L50	64		62		MT	12	68.9
	Leq	65.6		62.6		HT	204	
11:37:00	L10	68		64.5		AUTO	498	
	L50	63.5		61.5		MT	30	69.8
	Leq	65.3		62.1		HT	138	
13:07:00	L10	68.5		64.5		AUTO	480	
	L50	63.5		61		MT	48	68.8
	Leq	65.1		62.2		HT	156	
13:25:00	L10	68		64		AUTO	666	
	L50	64		61		MT	6	70.8

	BEFORE MEASUREMENTS (2017)							
		#21		#22				
Time		17427		17365			S BOUND	
		dBA		dBA			VEH/HR	MPH
11:20:00	L10	66		62.5		AUTO	1062	
	L50	62		59		MT	54	70.7
	Leq	62.9		60.5		HT	114	
13:36:00	L10	66.5		61.5		AUTO	1470	
	L50	62.5		59		MT	36	66.7
	Leq	63.8		57.9		HT	168	
13:57:00	L10	66.5		61.5		AUTO	1254	
	L50	61.5		58		MT	66	73.3
	Leq	63.1		59.3		HT	126	

MAP
SHOWING
RECEPTOR LOCATIONS
AND
INPLACE EASTSIDE
NOISE WALL


Stearns
29
28
27
26
25
In-Place Eastside Noise Wall
Upper Spunk Lake Rd
#21
#22