

Proposed minimum siting distances for Livingston County Wind Farms

Schomer and Associates, Inc.

**LBGA
EXHIBIT
6**

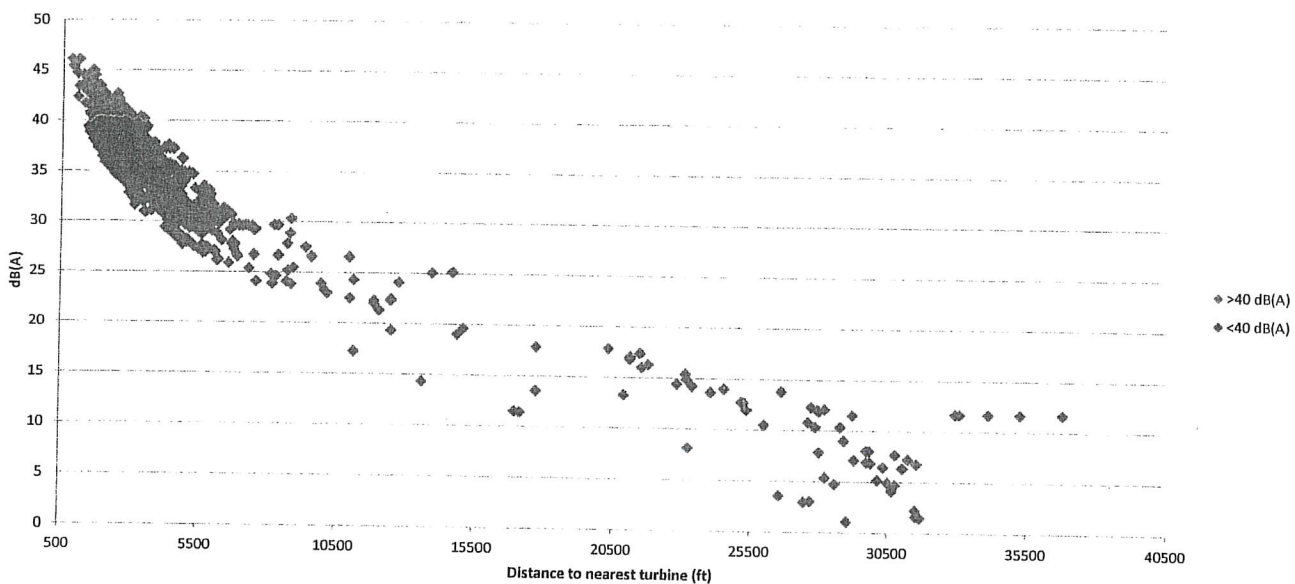
Health Canada Study

- 6 papers in the Journal of the Acoustical Society of America special Issue on Wind Turbine effects:
 - **Wind turbine sound power measurements**
 - **Wind turbine sound pressure level calculations at dwellings**
 - **Exposure to wind turbine noise: Perceptual responses and reported health effects**
 - **Personal and situational variables associated with wind turbine noise annoyance**
 - **Self-reported and measured stress related responses associated with exposure to wind turbine noise**
 - **Estimating annoyance to calculated wind turbine shadow flicker is improved when variables associated with wind turbine noise exposure are considered**
- 3 Papers in other journals
 - "Self-reported and Objectively Measured Health Indicators among a Sample of Canadians Living within the Vicinity of Industrial Wind Turbines: Social Survey and Sound Level Modelling Methodology." in *Noise News International*
 - "An assessment of quality of life using the WHOQOL-BREF among participants living in the vicinity of wind turbines." in *Environmental Research*
 - "Effects of Wind Turbine Noise on Self-Reported and Objective" in *Sleep*

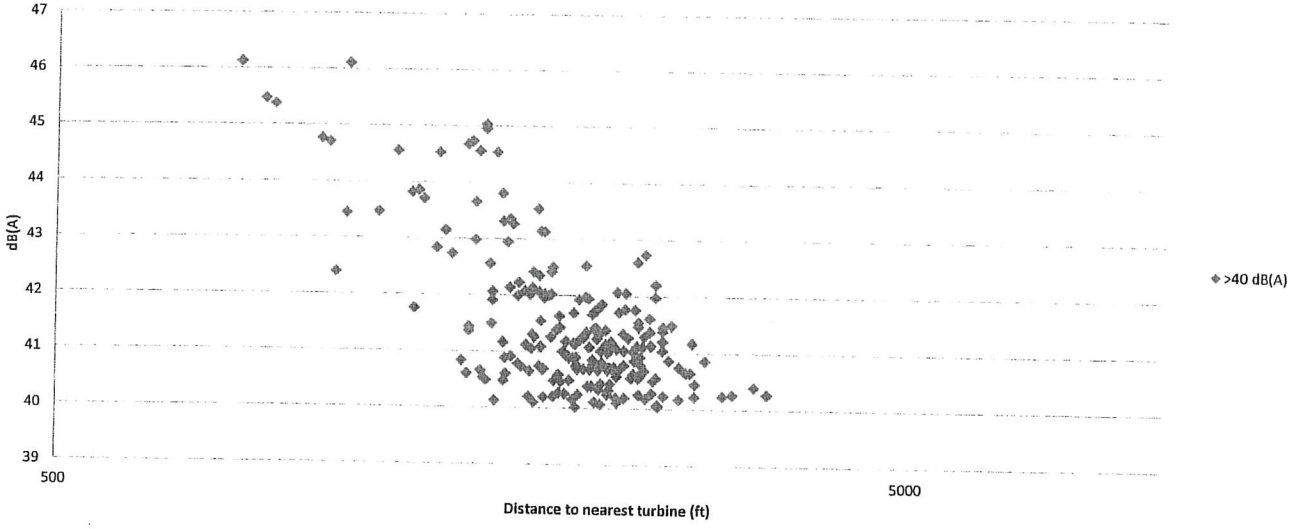
Health Canada Study

- More than 20 on the expert committee with 5 coming from the international community; about 10 Ph.Ds and 4 M.Ds
- About 20 researchers named on the papers
- Comprehensive and thorough with extensive credentials for all involved parties

Distribution of Health Canada Data, 1238 houses



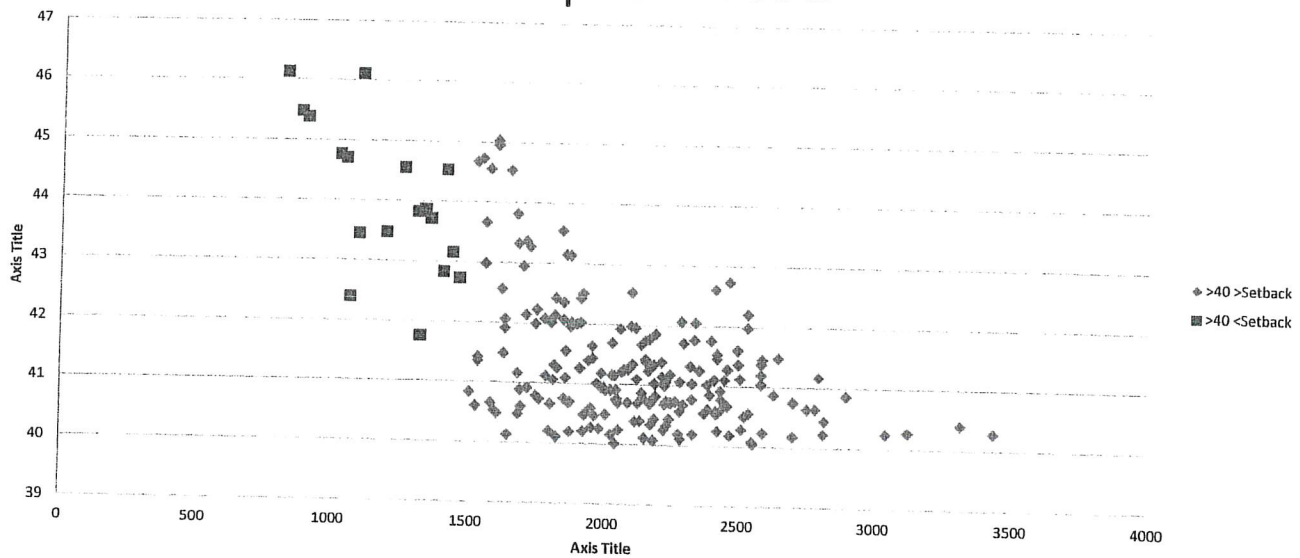
Only data above 40 dB(A) shown, 220 houses No Setback



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)		220									
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

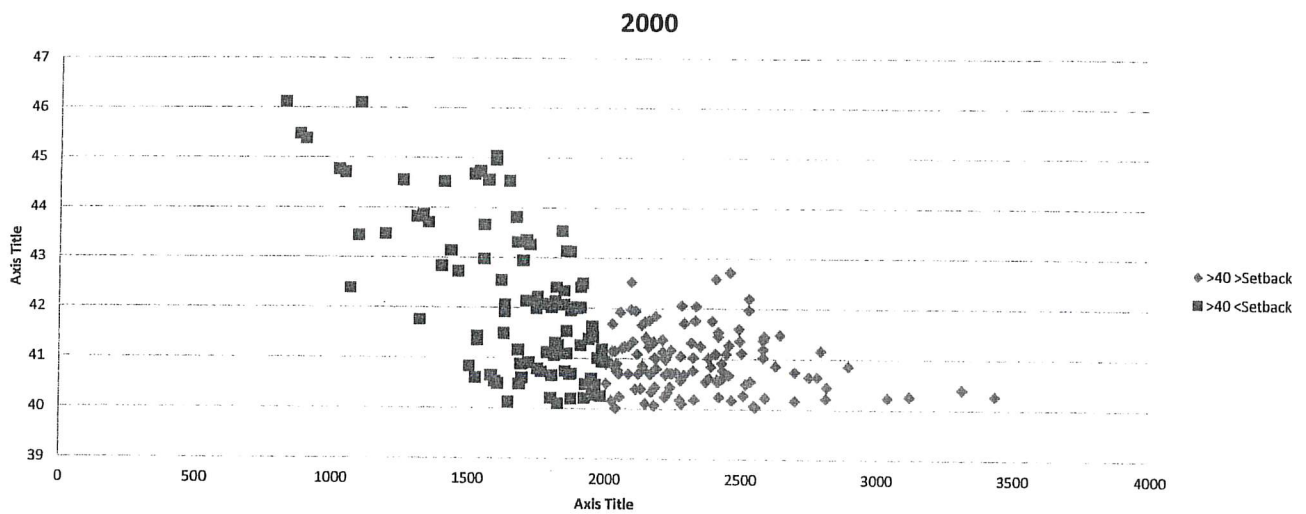
With 1500 ft setback, 202 of 220 remain
18 protected



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)	220		202								
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

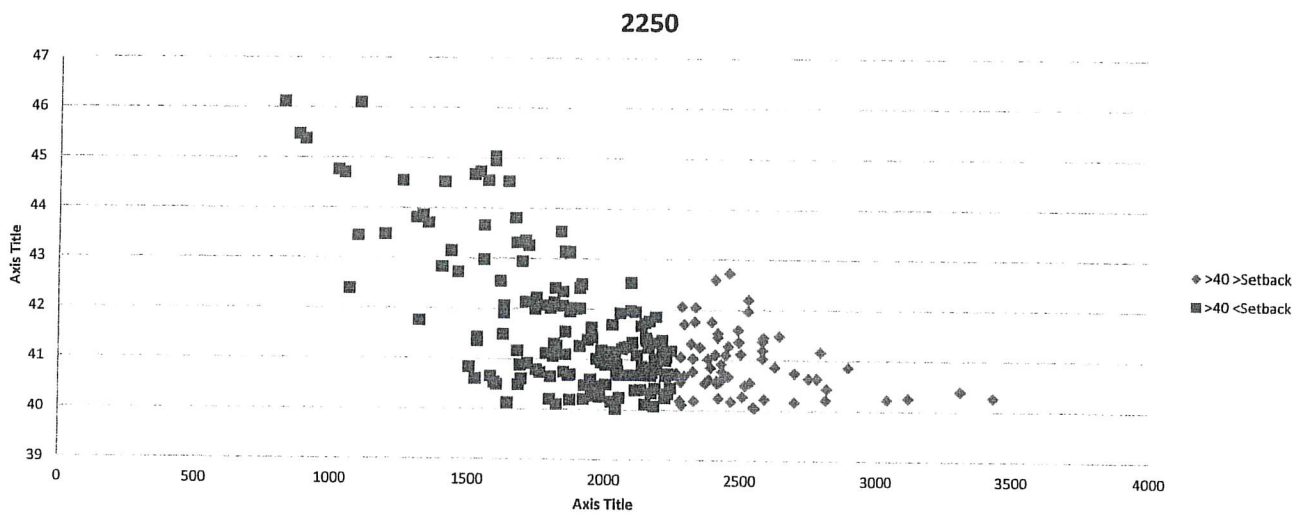
With 2000 ft setback, 124 of 220 remain
96 protected



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)	220	202	124								
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

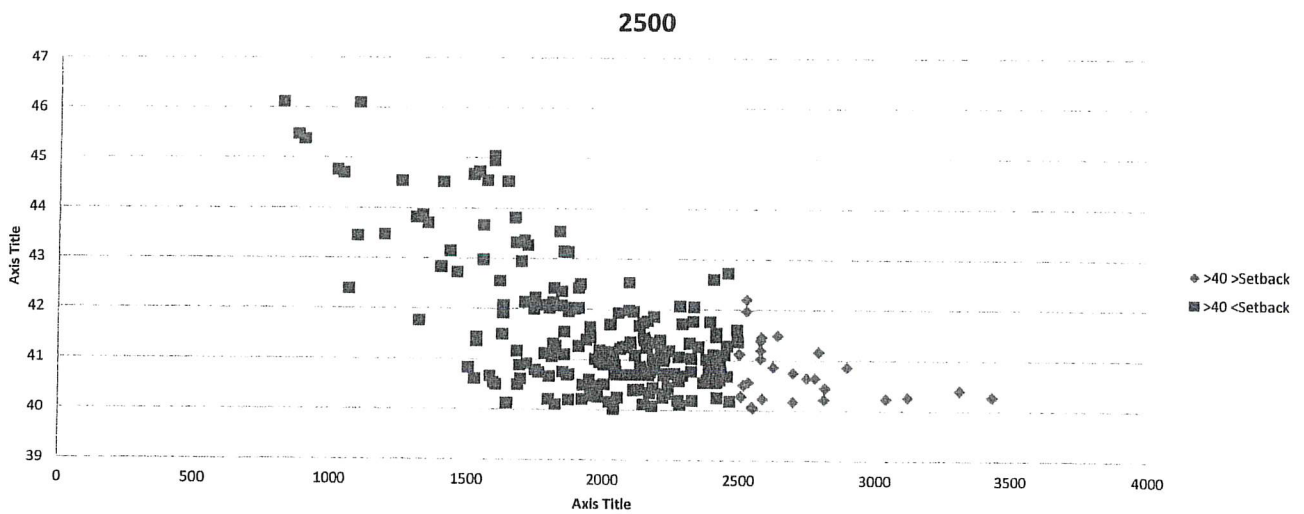
With 2250 ft setback, 66 of 220 remain
154 protected



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)	220	202	124	66							
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

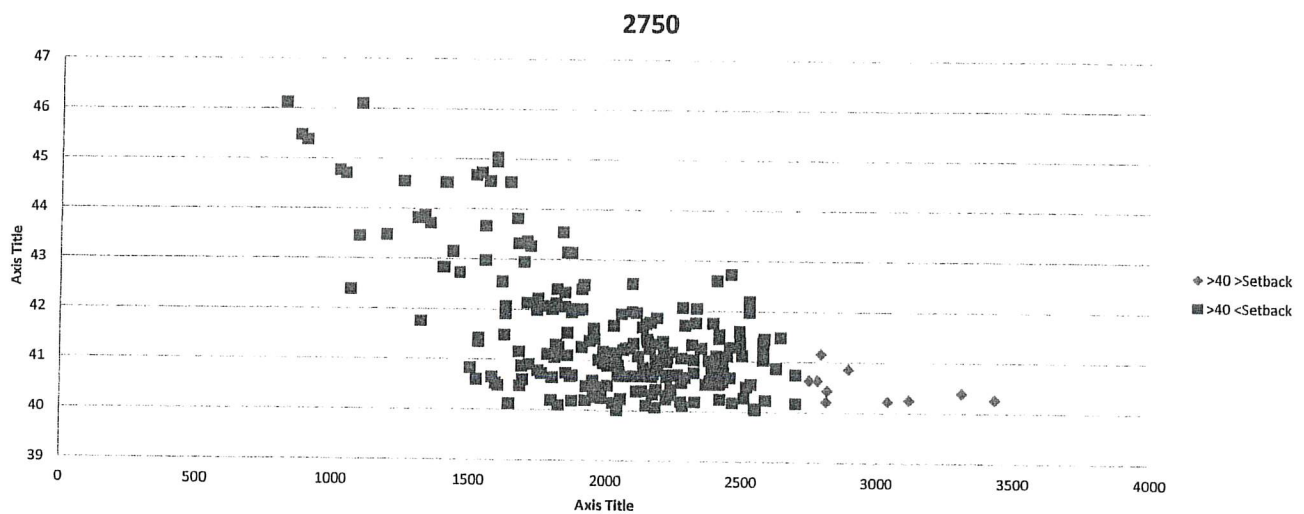
With 2500 ft setback, 27 of 220 remain
193 protected



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)		220	202	124	66	27					
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

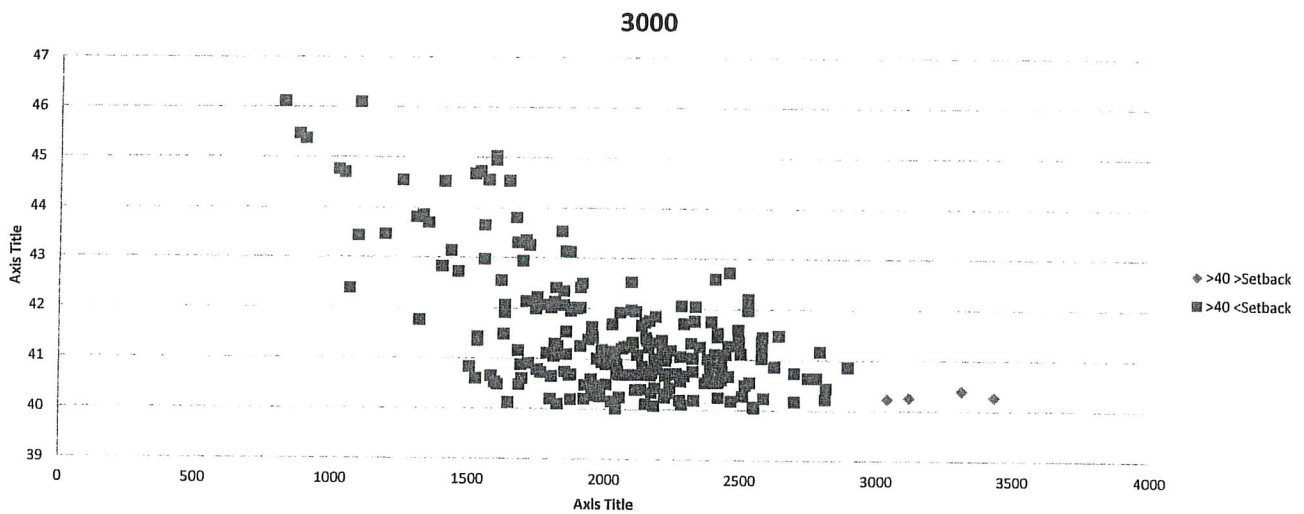
With 2750 ft setback, 10 of 220 remain
210 protected



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)		220	202	124	66	27	10				
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

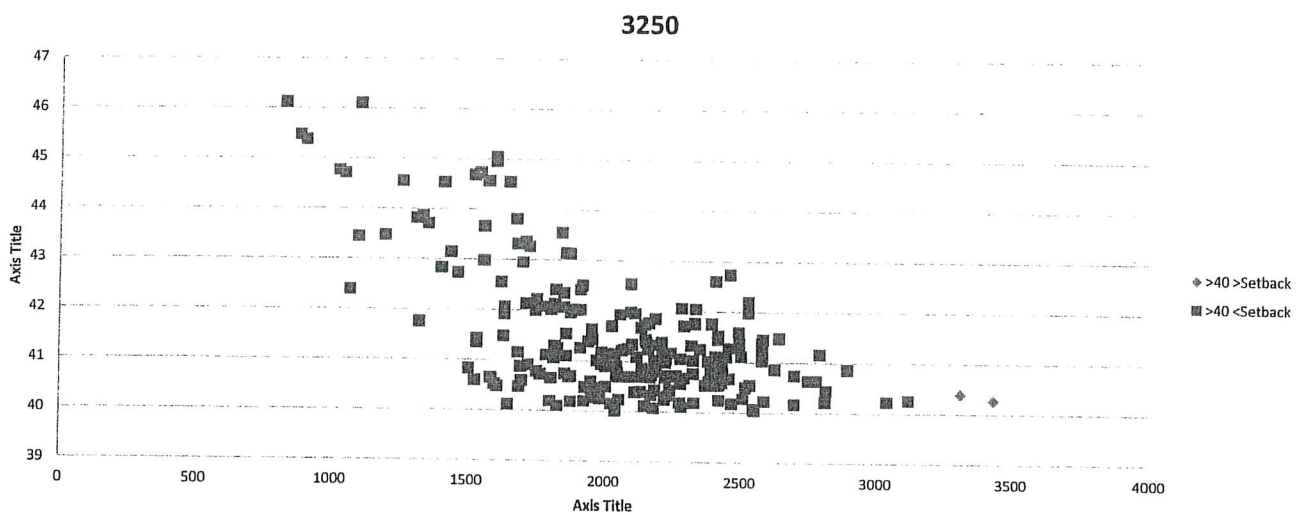
With 3000 ft setback, 4 of 220 remain
216 protected



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)		220	202	124	66	27	10	4			
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

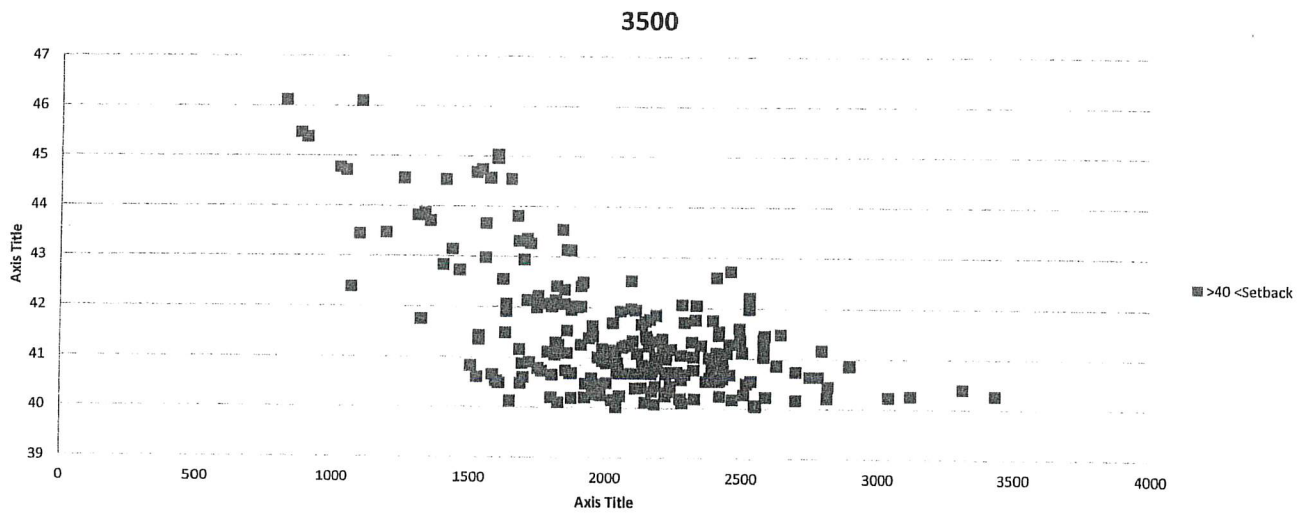
With 3250 ft setback, 2 of 220 remain
218 protected



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)	220	202	124	66	27	10	4	2			
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

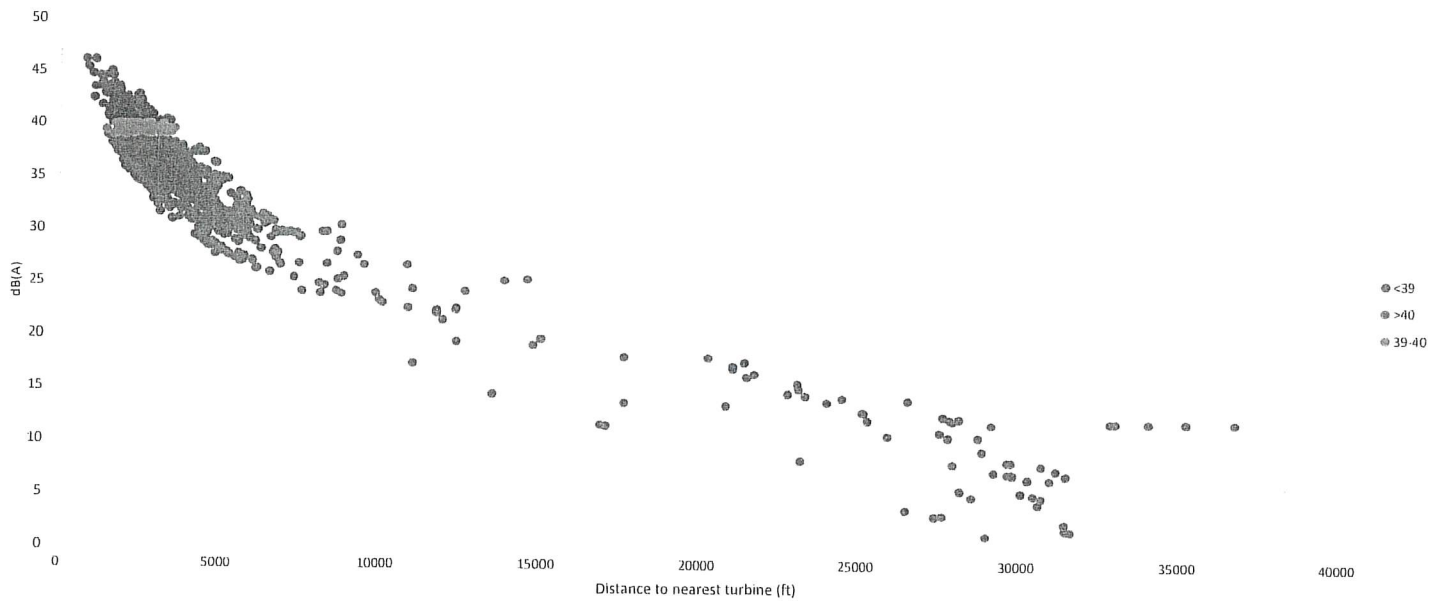
With 3500 ft setback, 0 of 220 remain
220 protected



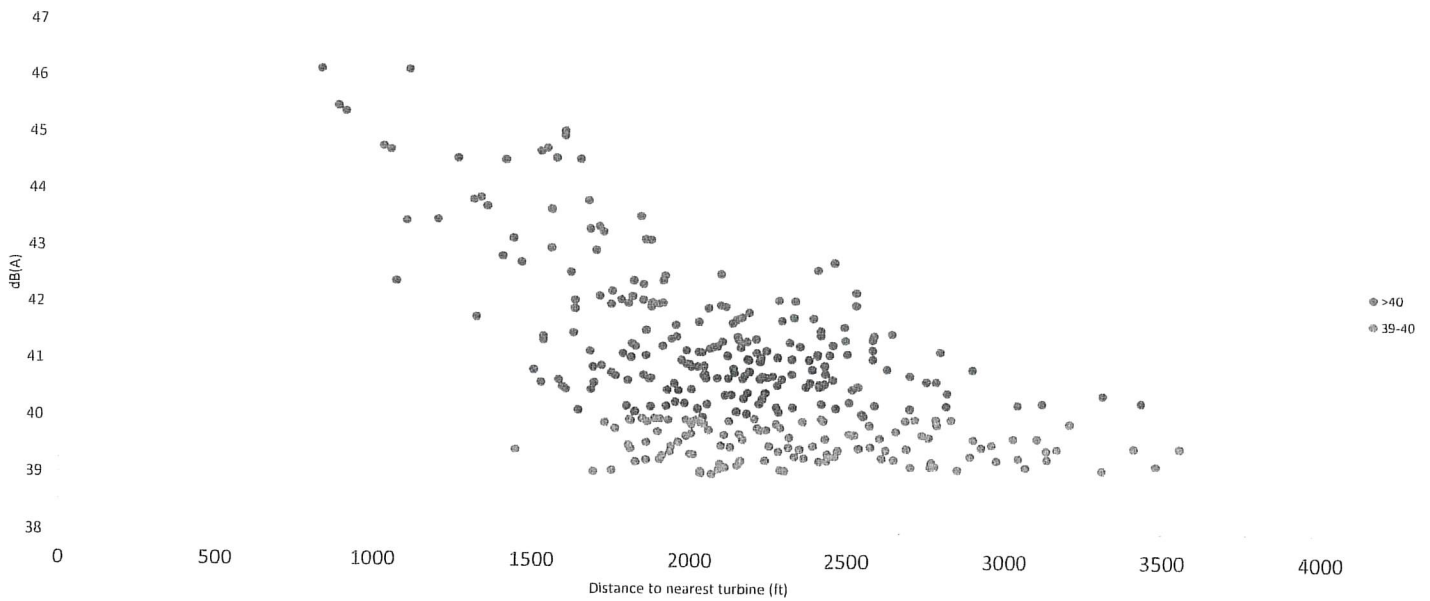
Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)		220	202	124	66	27	10	4	2	0	0
39 dB(A)											
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

Number of houses exceeding limit, 39 dB(A)



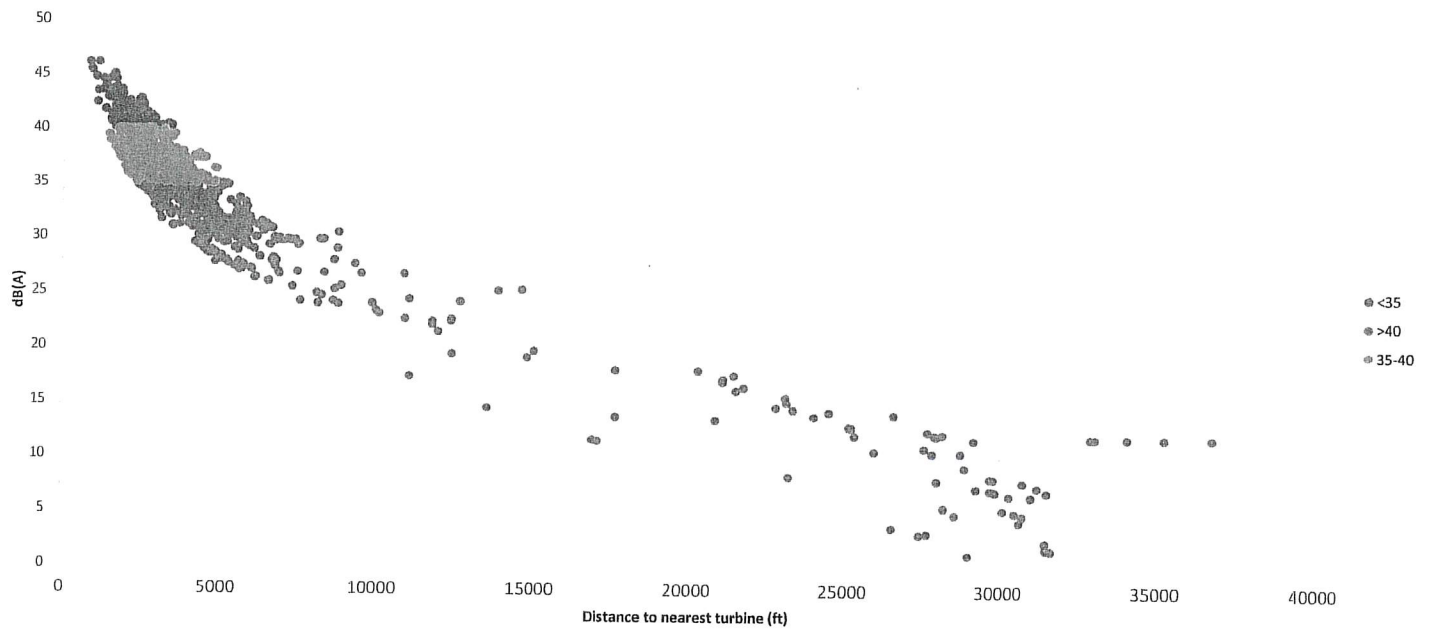
Only data above 39 dB(A) shown, 335 houses No Setback



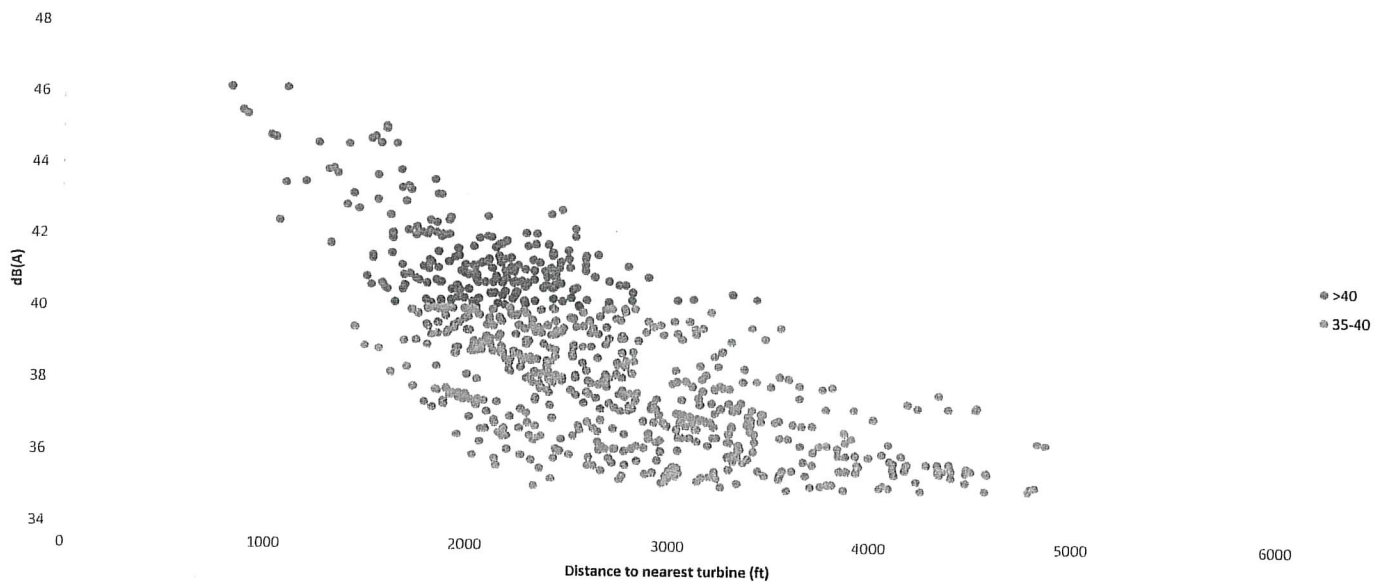
Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)		220	202	124	66	27	10	4	2	0	0
39 dB(A)		335	316	214	128	68	35	16	6	1	0
38 dB(A)											
37 dB(A)											
36 dB(A)											
35 dB(A)											

Number of houses exceeding limit, 35 dB(A)



Only data above 39 dB(A) shown, 745 houses
No Setback



Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)		220	202	124	66	27	10	4	2	0	0
39 dB(A)		335	316	214	128	68	35	16	6	1	0
38 dB(A)		430	410	300	193	107	56	30	12	3	0
37 dB(A)		534	514	390	277	178	113	72	38	16	10
36 dB(A)		643	623	498	373	263	184	129	74	36	21
35 dB(A)		745	725	600	472	356	270	204	139	89	65

Number of houses exceeding limits per setback distance

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)	220	202	124	66	27	10	4	2	0	0	
39 dB(A)	335	316	214	128	68	35	16	6	1	0	
38 dB(A)	430	410	300	193	107	56	30	12	3	0	
37 dB(A)	534	514	390	277	178	113	72	38	16	10	
36 dB(A)	643	623	498	373	263	184	129	74	36	21	
35 dB(A)	745	725	600	472	356	270	204	139	89	65	

dB(A) and Setback Criterion

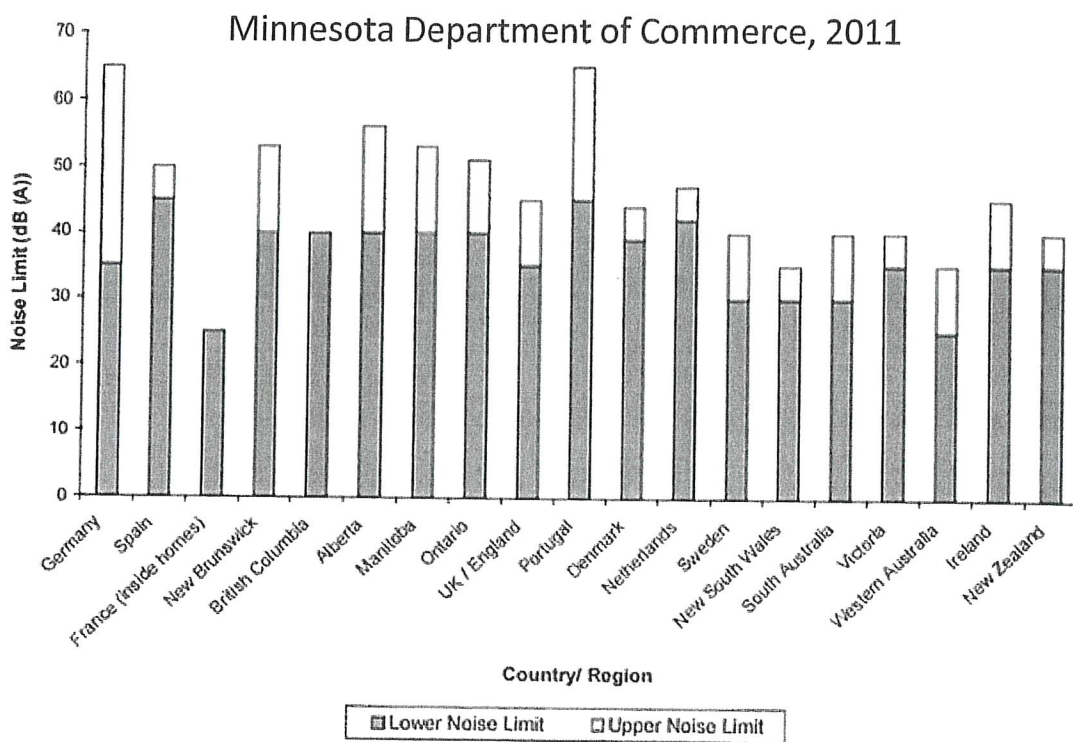


Figure 3: Country Wind Turbine Noise Limits at Residences

Example of Land use designations

- South Australia limit based on highest applicable:
 - Rural: 35 dB(A), or
 - Non-rural: 40 dB(A), or
 - 5 dB(A) above background measured as L90, 10 min
 - Note: USA background measurement standards includes the use of I-weighting when bird and/or insect noise is a problem and substantially longer measurement times

Recommended dB(A) limits, Health Canada Study

- “Consistent with Pedersen et al. (2009), the increase in WTN annoyance was clearly evident when moving from [30–35] dB to [35–40] dB, where the prevalence of WTN annoyance increased from 1% to 10%. This continued to increase to 13.7% for areas where WTN levels were [40–46] dB. The prevalence of WTN annoyance was higher outdoors, during the summer, and during evening and nighttime hours. Pedersen et al. (2009) also found that annoyance with WTN was greater outdoors compared to indoors.”
- The limit should be around 5-6% Highly annoyed (FAA, DoD)
- The dB(A) limit based upon Health Canada data should be between 36-39 dB(A)

ANSI S 12.9 Part 4

- Basic Limit: 55 DNL
- Quiet Rural areas: -10 dB(A); so $55-10=45$ DNL
- 45 DNL is 35-39 dB(A) at night

Recommended dB(A) limit and corresponding setback

- Based on the Minnesota report, ANSI S 12.9 Part 4, and the Health Canada Study, I recommend that the dB(A) limit should be **38 dB(A)**

SETBACKS	Kilometers	--	0.46	0.61	0.69	0.76	0.84	0.91	0.99	1.07	1.14
	Feet	--	1500	2000	2250	2500	2750	3000	3250	3500	3750
40 dB(A)											
39 dB(A)											
38 dB(A)	430	410	300	193	107	56	30	12	3	0	
37 dB(A)											
36 dB(A)											
35 dB(A)											

References

- Minnesota Department of Commerce, Energy Facility Permitting. (2011). International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences: Setbacks, Noise, Shadow Flicker, and Other Concerns. Retrieved from [http://mn.gov/commerce/energyfacilities/documents/International Review of Wind Policies and Recommendations.pdf](http://mn.gov/commerce/energyfacilities/documents/International_Review_of_Wind_Policies_and_Recommendations.pdf)
- “Exposure to wind turbine noise: Perceptual responses and reported health effects.” Michaud, David S., Feder, Katya, Keith, Stephen E., Voicescu, Sonia A., Marro, L., Than, J., Guay, M., Denning, A., McGuire, D., Bower, T., Lavigne, E., Murray, Brian J., Weiss, Shelly K., van den Berg, F.. The Journal of the Acoustical Society of America, 139, 1443-1454 (2016), DOI:<http://dx.doi.org/10.1121/1.4942391>