

What's This Noise Barrier Worth Anyway: Part 2?

Application of noise valuation research

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Overview

- Research question
- Background
- Methodology
- Results
- Conclusions

- Does the construction cost of noise abatement on Federal-aid projects equal the economic benefits of abatement?
- Try to answer the question by
 - Comparing economic benefit of abatement with
 - The actual cost of abatement

23 CFR 772.13(a)

When traffic noise impacts are identified, noise abatement shall be considered and evaluated for feasibility and reasonableness. The highway agency shall determine and analyze alternative noise abatement measures to abate identified impacts by giving weight to the benefits and costs of abatement and the overall social, **economic**, and environmental effects by using feasible and reasonable noise abatement measures for decision-making.

23 CFR 772.13(d)(2)(ii)

Cost effectiveness of the highway traffic noise abatement measures. Each highway agency shall determine, and receive FHWA approval for, the allowable **cost** of abatement by determining a baseline cost reasonableness value.

- Hedonic pricing model
 - Values environmental features
 - $P=f(S,N,A)$

Where:

P=price

S=structural characteristics,

N=Neighborhood characteristics,

A=Amenities

- Hedonic regression model
 - Multiple regression analysis
 - $y = x_0 + b_1x_1 + b_2x_2 + b_3x_3 \dots + \varepsilon$
 - Where y =price, x =independent variables and ε = error term

- Does the construction cost of noise abatement on Federal-aid projects equal the economic benefits of abatement?
- H_0 : The economic value of noise abatement is equal to the amount paid for noise abatement
- H_a : The amount paid for noise abatement is not equal to the economic value of noise abatement
- $H_0: \mu_1 = \mu_2$ and $H_a: \mu_1 \neq \mu_2$

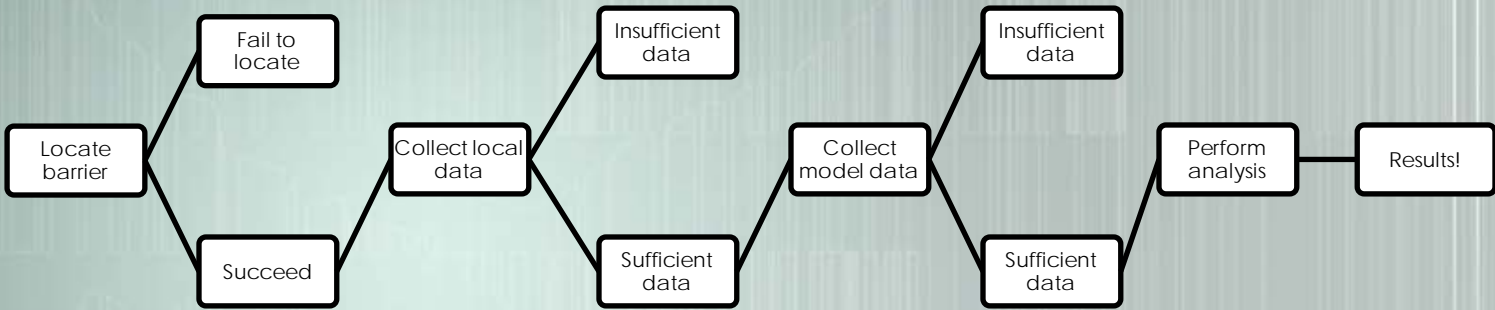
- Site selection
- Determine site suitability for analysis
- Collect relevant data
- Perform noise analysis
- Perform economic pricing analysis
- Methodology Limitations

- Site selection
 - Random sample from FHWA Noise Barrier Inventory
 - Removed entries with insufficient data
 - Assigned random record numbers to reduce bias
 - Initial selection of forty sites
- Site suitability
 - Availability of economic data
 - Availability of modeling data

- Economic data
 - County auditor
 - Multiple listing service
 - Zillow
- Modeling data
 - Finding the right barrier
 - Google Earth
 - Google Map/Earth/Street View
 - Mapping
 - Traffic

- Develop model
 - Google Earth
 - AutoCAD Civil 3D 2012
- Convert traffic data
- Import into TNM 2.5 for calculation
- Export results to spreadsheet

Methodology



- Variability in data quality
 - Elevation data
 - Traffic data
- Hedonic model limitations
 - Not a good model for rental properties
 - Does not account for all variables
 - Geographically dependent variables
 - Unknowns
 - Inflation adjustment for price
 - Year to year comparisons
 - Inflation adjusted prices
 - Zillow estimated price
 - Number of variables cannot exceed number of samples
- Site elimination
 - Lack of data
 - Real estate
 - Traffic
 - Final analysis used 11 sites out of original 40

- Variables
 - Price_{adjusted} – expressed as P_a
 - Price_{Zillow} – expressed as P_z
 - Number of Bedrooms – expressed as BR
 - Number of Bathrooms – expressed as BA
 - Number of Stories – expressed as #S
 - House Size (SF) – expressed as HS
 - Lot Size (SF) – expressed as LS
 - Access (Miles) – expressed as AS
 - Park (Miles) – expressed as PK
 - City Center (Miles) – expressed as CC
 - Emergency Access (Miles) – expressed as EA
 - Schools (Miles) – expressed as S
 - Noise Reduction (dBA) – expressed as NR
 - Fireplace – expressed as F
 - Garage – expressed as G
 - Basement – expressed as B
 - Swimming Pool – expressed as SP
 - Cooling – expressed as C

- Final equations

- $P_a = a + BRx + BAx + \#Sx + HSx = LSx + ASx + PKx + C$
 $Cx + EAx + Sx + Fx + Gx + Bx + SPx + Cx + NRx$

- $P_z = a + BRx + BAx + \#Sx + HSx = LSx + ASx + PKx + C$
 $Cx + EAx + Sx + Fx + Gx + Bx + SPx + Cx + NRx$

- Best subsets analysis for each site
 - Use P as response variable and NR as control variable
 - Determine the best R^2
 - Mallows Cp statistic (closest to $p+1$, where p = the number of variables + y)
- Analysis using Excel and Minitab 15
 - Excel limits number of variables

Methodology: Analysis

RandomID	RecordID	state	city/county	route	material	type	year_constructed	length_feet	height_feet	cost_original
636	3562	Arizona	Maricopa	US-60	Block	I	2003	4156	15	1,524,030.00
2131	3320	Arizona	Maricopa	S-101	Concrete/Unspecified	I	1998	743	12	213,994.00
2457	878	Connecticut	East Hartford	I-84	Wood/Post & Plank	I	1985	879	13	60,720.00
295	1079	Georgia	Atlanta	I-75	Concrete/Precast	I	1982	1171	13	61,530.00
3044	3759	Iowa	Polk County	I-235	Concrete/Precast	I	2004	2149	11	460,676.00
2299	1322	Massachusetts	Somerville	I-93	Comb/Other	II	1995	2417	10	1,000,000.00
1029	1838	New York	Westchester (Rye)	I-95	Wood/Post & Plank	II	1999	4065	10	849,100.00
2934	2439	Pennsylvania	Ross Twp	I-279	Concrete/Precast	I	1988	1470	9	396,900.00
1196	2871	Virginia	Fairfax Co	Rt 7100	Concrete/Precast	I	1995	899	13	222,040.00
1715	2901	Virginia	Herndon	Herndon Pkwy	Concrete/Precast	I	1996	859	11	140,860.00
691	3109	Washington	Pasco	SR 12	Concrete/Precast	I	1984	6924	9	633,000.00

Final study locations

The background of the slide features a whiteboard with a grid pattern. A blue line graph is plotted on the grid, showing a fluctuating upward trend. The graph starts at a low point on the left, rises to a peak, dips slightly, rises again to a higher peak, and then continues to rise towards the right edge of the frame. The overall color scheme is light blue and white.

Single site results

- Site 7: Record ID 2109, Herndon, VA
 - 38 residences
 - Barrier construction in 1995
 - 19 sales since barrier construction
 - Best subsets analysis resulted in equation:
 $P_z = BRx + \#Sx + HSx + LSx + ASx + NRx$

Regression Statistics for Site 7	
R Square	0.9784604
Adjusted R Square	0.9676905
Standard Error	5896.8133
Observations	19

Results: Single site



© 2013 Google

Google earth

Imagery Date: 10/12/2012 38°58'57.62" N 77°22'48.87" W elev 386 ft eye alt 1440 ft

Results: Single site

Zillow Homes Rentals Mortgage Rates Advice Find a Pro Local Info Digs™ More For Pros Mobile Sign In

Location: City, State, or ZIP

Virginia · Herndon · 20170 · 1206 Grant St Views: 48

Not for Sale
 Zestimate: \$464,551
 Rent Zestimate: \$2,378/mo
 Est. Rent Payment: \$1,856/mo*

See current rates on Zillow

Bedrooms: 4 beds
 Bathrooms: 3 baths
 Single Family: 1,882 sq ft
 Lot: 13,271 sq ft
 Year Built: 1984
 Last Sold: Nov 1984 for \$123,268
 Heating Type: Contact for details

Correct home facts Save

Description
 This 1882 square foot single family home is located in Herndon, Virginia.

Cooling: Unknown
 Fireplace: Unknown

More County website See data sources

Estimates

	Value	Range	30 day change	\$/sqft	Last updated
Zestimate	\$464,551	\$418K - \$502K	+32,488	\$246	07/09/2013
Rent Zestimate	\$2,378/mo	\$2.1K - \$2.6K/mo	+514	\$1.26	07/08/2013

Owner tools [Post your own estimate](#)

Market guide
 Zillow predicts 20170 home values will rise 0.6% next year, compared to a 0.2% increase for Herndon as a whole. Among 20170 homes...

Home facts by data source

	All sources combined <input type="button"/>	County records Visit county website
Beds:	4	4
Baths:	3.0	3.0
Sqft:	1,882	1,882
Lot:	13,271 sq ft / 0.30 acres	13,271 sq ft / 0.30 acres
Type:	Single Family	Single Family
Year Built:	1984	1984
Last Sold:	Nov 1984 for \$123,268	-
Parking:	Garage - Attached	Garage - Attached
Cooling:	-	-
Heating:	-	-
Fireplace:	-	Yes
Days on Zillow:	-	-
MLS #:	-	-
Other facts	-	-
County Name:	Fairfax	Fairfax

Contact a local agent

Debbie Harris
 48 reviews
 Call: (703) 864-1725

Fairfax Homes
 14 reviews
 Call: (877) 385-0476

Elagott
 17 reviews
 Call: (202) 428-0428

Personal estimate of my home: \$464,551
 1206 Grant St, Herndon, VA 20170

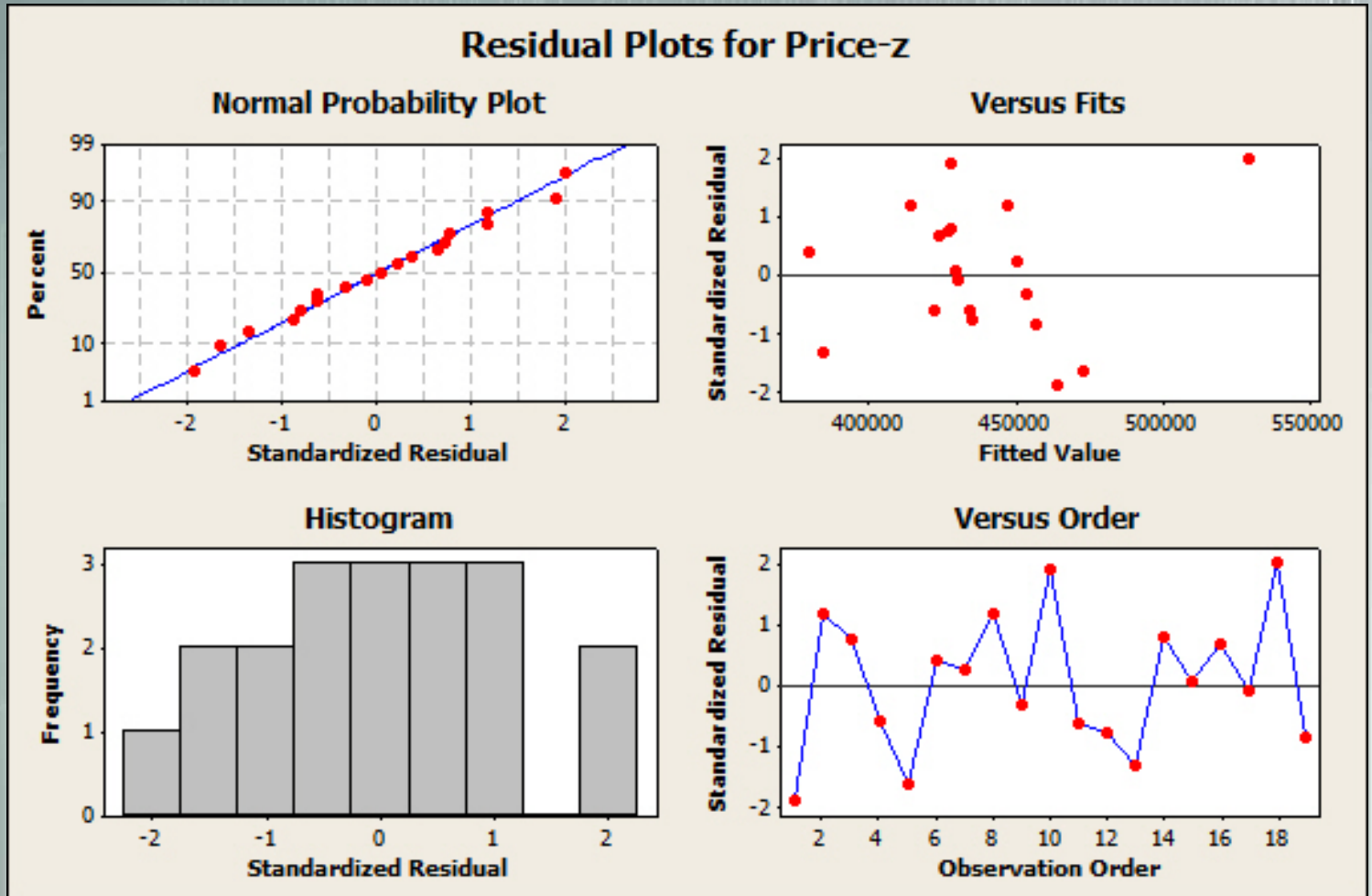
See photos above

The road map to a simpler life.
embrey mill Find your balance.
 At Embrey Mill Community in Herndon, VA.

Similar Homes for Sale

1201 Grant St, Herndon...
 For Sale: \$439,000
 Beds: 4 Sqft: 1980
 Baths: 3.0 Lot: 10367

1026 Tyler St, Herndon...

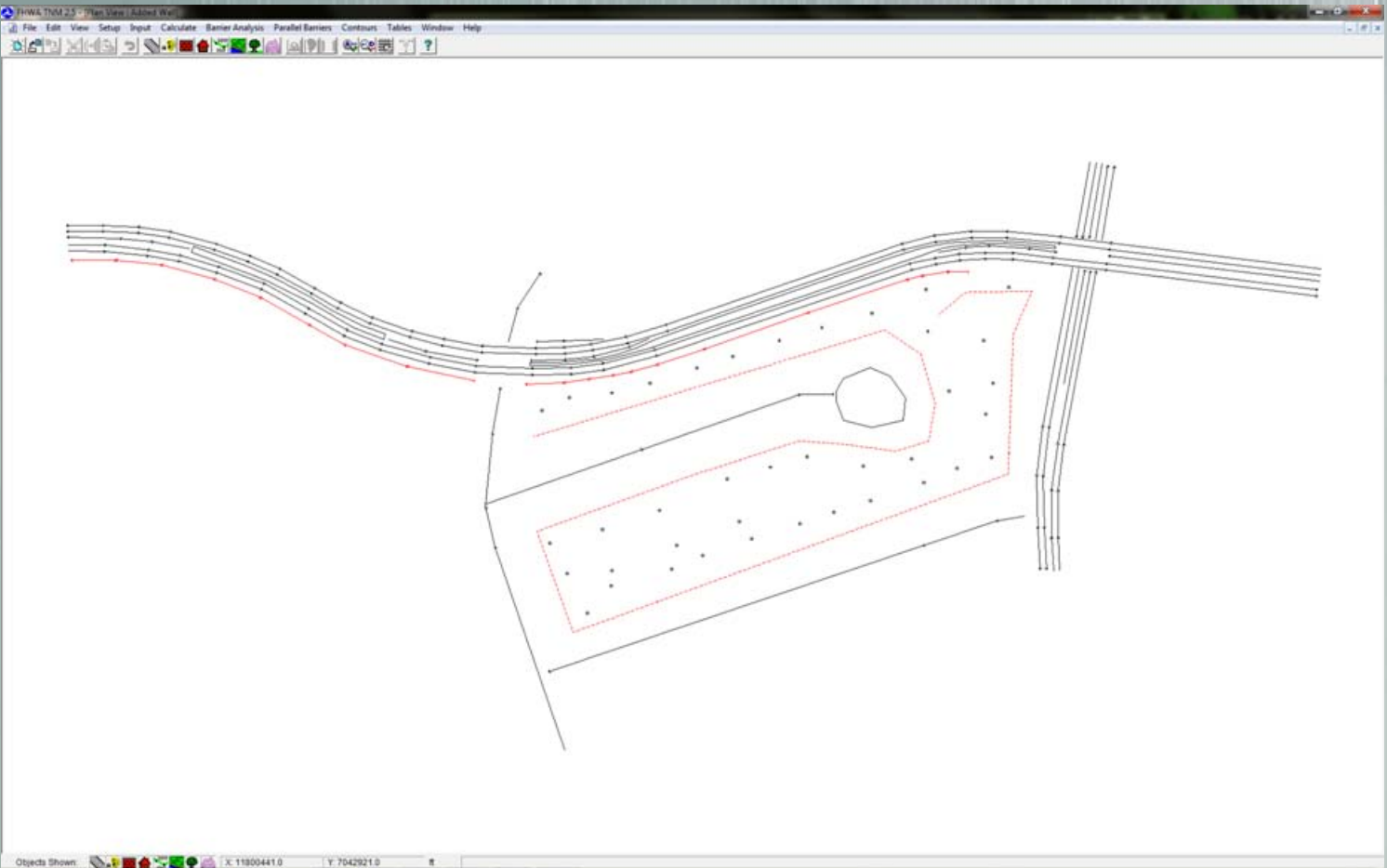


Minitab 15 plots for Site 7: Herndon, VA

Results: Single site

	Coefficients	Standard Error	t Stat	P-value
Intercept	310042.82	18414.733	16.836672	1.03E-09
Number of Bedrooms	8864.1371	3345.5524	2.6495287	0.0211975
# Stories	-16070.016	4799.7969	3.3480618	0.0058009
House Size (SF)	54.577296	5.5512294	9.831569	4.301E-07
Lot Size (SF)	1.5259963	1.1984337	1.2733256	0.227016
Access (Miles)	-139958.28	27338.497	5.1194578	0.0002535
Noise Reduction in dB(A)	1440.6494	504.84326	2.8536569	0.0145239

Coefficients and statistics for Site 7



Results: Single Site

Results: Single Site

MIA 699 Sample Database (Julia - LibreOffice Calc)

File Edit View Insert Format Tools Data Window Help

Location

Location: hmdon VA

Address: <http://www.zillow.com/homes/345-Moffett-Forge-Rd-hmdon-va/>

Banner Length: 859

Height: 11

Cost: 140,800.00

Year Banner Constructed: 1991

* Cooling includes air conditioning and heat pumps

Meta-data				Price				Structure				Neighborhood						Amenities					
Address	Parcel Number	Elevation	Last Sold	Last Sale Price	Zillow Price Estimate	Adjusted Sale Price (2011 \$)	Number of Bedroom	Number of Bathroom	# Stories	House Size (SF)	Lit Size (SF)	Access (Meters)	Park (Meters)	Emergency Services	Schools	CR/Center	Noise Reduction in dB(A)	Noise Level	Fireplace	Swimming Pool	Garage	Basement	Cooling*
12	1206 Grant St	307		123268			4	3		1882	13271	0.02					1.6	1.6	1	0	1		
13	850 Moffett Forge Rd	392		108550			3	2.5		1190	13212	0.07					3.1	3.1	1	0	1		
14	848 Moffett Forge Rd	397		143290			4	2.2		2172	10501	0.09					3.8	3.8	1	0	1		
15	846 Moffett Forge Rd	397	2000	339600	455200		5	3.5	2	2420	10396	0.11	0.3	1.6	0.4	1.9	6.5	6.5	1	0	1	0	1
16	844 Moffett Forge Rd	394	2004	486000	450900		5	2.5	3	2420	10240	0.13	0.3	1.6	0.4	1.9	7.7	7.7	1	0	1	0	1
17	842 Moffett Forge Rd	390		148196			4	2.5		2172	10240	0.15					8.1	8.1	1	0	1		
18	840 Moffett Forge Rd	387		10			5	3		3420	10326	0.17					8.8	8.8	1	0	1		
19	838 Moffett Forge Rd	384	2000	264900	430500		4	2.5	2	1980	10879	0.17	0.4	1.6	0.4	1.9	8.9	8.9	1	0	1	0	1
20	836 Moffett Forge Rd	378	2000	204900	419100		4	3	2	1870	12896	0.18	0.4	1.6	0.4	1.9	8.3	8.3	1	0	1	0	1
21	834 Moffett Forge Rd	379	1997	185000	467800		4	3.5	2	2932	12777	0.18	0.4	1.6	0.4	1.9	3.8	3.8	1	0	1	0	1
22	829 Moffett Forge Rd	379	2007	447900	390900		3	2.5	2	1439	12777	0.18	0.4	1.6	0.4	1.9	1.4	1.4	1	0	1	0	1
23	831 Moffett Forge Rd	380	1997	195000	451700		5	2.5	2	2420	12315	0.17	0.4	1.6	0.4	1.9	0.9	0.9	1	0	1	0	1
24	833 Moffett Forge Rd	378	1998	226000	418400		4	2.5	1	1642	11331	0.17	0.4	1.6	0.4	1.9	1.4	1.4	1	0	1	1	1
25	835 Moffett Forge Rd	376	2006	370000	452300		5	2.5	2	2420	14280	0.17	0.4	1.6	0.4	1.9	0.9	0.9	1	0	1	0	1
26	837 Moffett Forge Rd	380		168706			5	3.5		2438	14200	0.17					0.9	0.9	1	0	1		
27	839 Moffett Forge Rd	381	2005	600845	437900		4	3	2	2172	10900	0.15	0.3	1.6	0.4	1.9	0.4	0.4	1	0	1	0	1
28	841 Moffett Forge Rd	385	2007	500000	430300		4	2.5	2	2172	12500	0.13	0.3	1.6	0.4	1.9	0.6	0.6	1	0	1	0	1
29	843 Moffett Forge Rd	387	2002	330000	430600		4	2.5	2	2172	11880	0.11	0.3	1.6	0.4	1.9	0.3	0.3	1	0	1	0	1
30	845 Moffett Forge Rd	382	2008	325900	377500		3	2.5	2	1439	10080	0.11	0.3	1.6	0.4	1.9	0.7	0.7	1	0	1	0	1
31	847 Moffett Forge Rd	396		151591			5	2.5		2420	12600	0.09					0.2	0.2	1	0	1		
32	849 Moffett Forge Rd	399	2003	346000	431900		4	3.5	2	1980	10200	0.07	0.3	1.6	0.4	1.9	0.3	0.3	1	0	1	1	1
33	851 Moffett Forge Rd	401	2009	350000	430000		4	2.5	2	1971	11157	0.06	0.2	1.6	0.4	1.9	0.1	0.1	1	0	1	1	1
34	1202 Grant St	403		231000			5	3		2420	10816						0.1	0.1	1	0	1		
35	1200 Grant St	405	2001	314000	426900		4	4	2	1894	10547	0.07	0.3	1.6	0.4	1.9	0.1	0.1	1	0	1	0	1
36	790 3rd St	402		204000			4	3.5		1969	11400						0.2	0.2	1	0	1		
37	788 3rd St	399	1999	240000	429900		4	2.5	2	1980	10080	0.05	0.3	1.6	0.4	1.9	0.4	0.4	1	0	1	1	1
38	786 3rd St	394		162730			5	3.5		2420	10080						0.5	0.5	1	0	1		
39	784 3rd St	390		10			4	4		2172	10080						0.8	0.8	1	0	1		
40	782 3rd St	386		151577			4	2.5		1980	10920						1	1	1	0	1		
41	780 3rd St	383		191550			5	2.5		2420	10920						1.1	1.1	1	0	1		
42	778 3rd St	379		205000			4	2.5		1980	10762						1	1	1	0	1		
43	776 3rd St	375		195000			4	3		1642	11078						0.9	0.9	1	0	1		
44	774 3rd St	376		196000			4	3		2172	10937						0.5	0.5	1	0	1		
45	772 3rd St	377					4	3.5		1812	10001						0.3	0.3	1	0	1		
46	803 Dranesville Rd	374					3	3.5		1812	10001						0.6	0.6	1	0	1		
47	805 Dranesville Rd	373					4	3.5		2762	13756						0.7	0.7	1	0	1		
48	807 Dranesville Rd	372		76223			4	2.5		2492	10425						1	1	1	0	1		
49	809 Dranesville Rd	375	1997	290000	534500		4	3	2	3320	16487	0	0.4	1.6	0.3	1.9	6.7	6.7	1	0	1	0	1
50	811 Dranesville Rd	369	2003	354900	452300		4	3	2	2272	12406	0	0.4	1.6	0.3	1.9	0.2	0.2	1	0	1	1	1

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- At the 90% CI, the value of 1 dBA of noise reduction = \$1440.65 +/- \$504.84
- Consistent with findings of some literature
- The range of the economic value of noise abatement for a residence receiving a 10 dBA reduction is:

\$9,358.10 - \$19,454.90 (90% CI)



Summary of results

Results

Site	Equation Option	Adjusted R Square	Noise Reduction Coefficient	P-value	Is NR a Significant Predictor of Price?
1	1	53.4%	896.86	0.33	N
2	1	83.8%	362.19	0.93	N
3	1	75.3%	402.43	0.94	N
4a	1	91.5%	-3074.04	0.51	N
4b	2	67.4%	59050	0.12	N
5	1	90.0%	-29318.13	0.000395	Y
6	1	87.7%	-1233.16	0.21	N
7	1	96.7%	1440.65	0.015	Y
8	1	55.5%	1552.3	0.099	Y
9	1	92.7%	-2717.12	0.051	Y
10	1	86.1%	-434.09	0.485	N
11	1	96.2%	-62.11	0.96	N

Results Summary Table: All sites

Results: Hypothesis test

F-Test Two-Sample for Variances	a	0.05			
	Estimated Economic Value	Estimated Barrier Cost (Current \$)			
Mean	-548662.2	655589.33			
Variance	4.465E+12	2.855E+11			
Observations	4	4			
df	3	3			
F	15.64				
P(F<=f) one-tail	0.025	0.049	Two-tail		
F Critical one-tail	9.28	15.44	Two-tail		
One-tail	Reject Null Hypothesis because $p < 0.05$ (Variances are Different)				
Two-tail	Reject Null Hypothesis because $p < 0.05$ (Variances are Different)				

Results: Hypothesis test

t-Test: Two-Sample Assuming Unequal Variances	a	0.05
Equal Sample Sizes		
	Data1	Data2
Mean	-548662.2	655589.33
Variance	4.465E+12	2.855E+11
Observations	4	4
Hypothesized Mean Difference	0	
Df	3	
t Stat	-1.105	
P(T<=t) one-tail	0.175	
T Critical one-tail	2.353	
P(T<=t) two-tail	0.350	
T Critical Two-tail	3.182	

- Results are geographically dependent
- The question remains unanswered
 - Geographic sensitivity
 - Unexpected results
- Data quality
 - 1/3 of the FHWA barrier inventory removed due to poor data quality
 - Lost 29 sites due to lack of data
- Need more efficient evaluation method
- Literature mixed on economic vs. construction cost
 - Some show construction cost exceeds economic value
 - Some show the opposite



Questions?

Reality Check