HIGHWAY TRAFFIC NOISE BARRIER CONSTRUCTION TRENDS

BY

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WASHINGTON, D.C.

APRIL 2000

INTRODUCTION

The Federal-aid highway program has always been based on a strong State-Federal partnership. At the core of that partnership is a philosophy of trust and flexibility, and a belief that the States are in the best position to make investment decisions that are based on the needs and priorities of their citizens. The FHWA noise regulations give each State department of transportation (DOT) flexibility in determining the reasonableness and feasibility of noise abatement and, thus, in balancing the benefits of noise abatement against the overall adverse social, economic, and environmental effects and costs of the noise abatement measures. The State DOT must base its determination on the interest of the overall public good, keeping in mind all the elements of the highway program (need, funding, environmental impacts, public involvement, etc.). Congress affirmed and extended the philosophy of partnership, trust, and flexibility in the enactment of the Transportation Equity Act for the 21st Century.

The flexibility in noise abatement decisionmaking is reflected by data indicating that some States have built many noise barriers and some have built none. Through the end of 1998, forty-four State DOTs and the Commonwealth of Puerto Rico have constructed over 2,610 linear kilometers of barriers at a cost of over $1.4 billion ($1.9 billion in 1998 dollars). Six States and the District of Columbia have not constructed noise barriers to date. A detailed listing of noise barrier data may be found in "Summary of Noise Barriers Constructed by December 31, 1998." The paper that follows presents a brief analysis of the data contained in the detailed barrier listing.

It should be noted that the data represent best estimates on barrier construction supplied by State DOTs . There may be nonuniformity and/or anomalies in the data, due to differences in individual State DOT definitions of barrier information and costs. However, some trends are evident.

NOISE BARRIER CONSTRUCTION

Tables 1-9 provide data on barrier construction, height, materials, and unit costs (all cost information is in 1998 dollars). The following points may be made concerning noise barriers:

1. More than thirty-one percent (31%) of total expenditures have occurred in the last five years [sixty-six (66%) in the last ten years; eight-six (86%) in the last fifteen years].

2. Through the end of 1998, the overall average unit cost, combining all materials, is $179 per square meter. The average unit cost, combining all materials, for the last ten years is $184 per square meter.

3. Approximately fifty-nine (59) kilometers of barriers have been built with highway program monies other than Federal-aid. Approximately sixty-four (64) kilometers of barriers have been built with Toll facility funds, which may or may not be Federal-aid monies.

4. Overall by length, approximately seventy-five percent (75%) of Federal-aid barriers have been Type I (a barrier built on a highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes).

5. Forty-four (44) States and the Commonwealth of Puerto Rico have constructed more than 1,850 linear kilometers of Type I barriers, at a total cost of more than $1.2 billion.

6. Twenty-two (22) States have constructed at least one Type II noise barrier (a barrier built along an existing highway, i.e., a retrofit noise barrier), at a total cost of more than $580 million.

7. Six (6) States have not constructed any noise barriers to date: Alabama, Mississippi, Montana, North Dakota, Rhode Island, and South Dakota.

8. Ninety-four percent (94%) of barriers that have been constructed range in height from 2-6.9 meters. Two percent (2%) of barriers are less than 2 meters tall and four percent (4%) are more than 6.9 meters tall. The overall average barrier height is 4.1 meters.

9. Barriers have been made from materials that include concrete, masonry block, wood, metal, earth berms, brick, and combinations of all these materials. Concrete and block represent more than two-thirds of total material usage [forty-four percent (44%) and twenty-five percent (25%), respectively] and wood ten percent (10%). Metal, berm, and brick together account for approximately six percent (6%) of the total. Twelve percent (12%) of all barriers have been constructed with a combination of an earth berm and a wall. One percent (1%) have been constructed with other materials, such as recycled materials, plastics, composite polymers, etc. Slightly more than one percent (1%) have been constructed with absorptive materials.

10. Average unit costs for all years for all barrier materials range between $137-244 per square meter, except for earth berms which average only $51 per square meter. Concrete has been the most popular material; however, its cost, $198 per square meter, is only slightly less than that of brick, $214 per square meter. Overall average costs for wood, metal, and combination barriers are approximately the same ($155, $137, and $163 per square meter, respectively). Absorptive barriers average $244 per square meter in cost.

11. There are no brick barriers over 6.9 meters tall or wooden or metal barriers over 7.9 meters tall. A berm/metal combination barrier has been constructed to a height of 12.0 meters, and a cast-in-place concrete barrier to a height of 11.9 meters.

12. Unit costs for barriers do not always appear to increase as the barrier height increases (Note: This may be due to nonuniformity and/or anomalies in the data reported by State DOTs).

13. Barrier height averages more than 5 meters in eight (8) States. Barrier height averages 4-5 meters in fourteen (14) States, 3-4 meters in sixteen (16) States, and less than 3 meters in six (6) States.

14. Barrier costs average $170-265 per square meter in twenty (21) States. In twenty-one (21) other States, barrier costs average $82-168 per square meter.

SUMMARY

Forty-four (44) States and the Commonwealth of Puerto Rico have constructed highway traffic noise barriers; six (6) States have not. The most notable trend in highway traffic noise barrier construction is that State DOTs spend more than $100 million of highway program funds annually for this form of noise abatement. Starting in 1990, State DOTs have averaged spending more than $126 million per year. Since the first highway traffic noise barrier was constructed, sixty-five percent (65%) of all spending has been for Type I projects, and thirty percent (30%) for Type II projects.

Most barriers have been made from concrete or masonry block, range from 3-5 meters in height, and average $175-200 per square meter in cost.

TABLE 1
NOISE BARRIER CONSTRUCTION BY YEAR

Year	Linear Length of Noise Barriers (km)	Actual Cost ($Millions)	1998 Cost ($Millions)
Unknown	9	0	0
1970	1	0	0
1971	0	0	0
1972	2	0.5	1
1973	3	0.5	2
1974	22	5	12
1975	31	5	12
1976	9	1	3
1977	23	8	17
1978	95	28	50
1979	95	25	37
1980	72	23	30
1981	61	26	35
1982	41	19	26
1983	66	31	45
1984	86	40	55
1985	72	37	47
1986	104	70	87
1987	87	46	58
1988	172	117	139
1989	164	113	134
1990	102	76	89
1991	158	122	144
1992	228	154	186
1993	139	101	118
1994	143	102	112
1995	201	146	152
1996	79	57	60
1997	126	114	111
1998	221	169	169
1970-1998	2,612	1,636	1,931

Note 9 kilometers of noise barriers can neither be assigned a year of construction nor a cost. Additionally, approximately 38 kilometers of barriers, while assigned a year of construction, cannot be assigned a cost.

TABLE 2
NOISE BARRIER CONSTRUCTION
AVERAGE UNIT COST BY YEAR

Year	Area in Square Meters (1,000)	Cost in 1998 Dollars ($Millions)	Cost Per Square Meter ($)
Unknown	41	0	0
Prior to 1972	1	0	0
1972	6	1	211
1973	10	2	170
1974	72	12	171
1975	106	12	111
1976	27	3	102
1977	96	18	184
1978	365	50	137
1979	341	37	110
1980	276	30	109
1981	205	35	171
1982	160	27	167
1983	248	45	180
1984	293	55	187
1985	261	47	178
1986	384	87	228
1987	333	59	176
1988	658	139	211
1989	682	134	196
1990	482	89	184
1991	742	144	194
1992	970	186	192
1993	584	118	202
1994	615	112	182
1995	835	152	182
1996	358	60	166
1997	607	111	183
1998	1,044	169	162
ALL	10,802	1,931	179

TABLE 3
TYPE I AND TYPE II NOISE BARRIER CONSTRUCTION BY YEAR

Year	Type I Linear Length (km)	Type II Linear Length (km)	Type I (%)	Type II (%)
Unknown	9	0	100	0
1970-1979	164	113	59	41
1980	60	12	84	16
1981	27	34	45	55
1982	29	10	74	26
1983	48	14	78	22
1984	63	23	73	27
1985	49	23	68	32
1986	65	39	62	38
1987	57	25	69	31
1988	135	13	91	9
1989	141	13	92	8
1990	71	31	70	30
1991	125	29	81	19
1992	182	29	86	14
1993	99	35	74	26
1994	77	26	74	26
1995	140	51	73	27
1996	55	24	70	30
1997	75	50	60	40
1998	184	36	83	17
1970-1998	1,846	630	75	25
Total Types I & II		2,485		
Total All Other Types		127		
Total Types I & II Plus All Other Types		2,612		

TABLE 4
NOISE BARRIER CONSTRUCTION BY HEIGHT

Height Range	Linear Length (km)	% of Total
Under 2 meters	50	2
2 to 2.9 meters	279	11
3 to 3.9 meters	841	32
4 to 4.9 meters	825	31
5 to 5.9 meters	305	12
6 to 6.9 meters	207	8
Over 6.9 meters	105	4
All Heights	2,612	100

TABLE 5
NOISE BARRIER CONSTRUCTION MATERIAL BY YEAR

Year	Material Area (1,000 Square Meters) Concrete	Block	Wood	Metal	Berm	Brick	Combination	Absorptive
Unknown	21	0	0	13	0	0	7	0
Prior to1989	924	1,168	553	139	254	23	715	27
1989	284	133	137	25	12	10	65	11
1990	183	161	88	0	17	0	34	0
1991	292	204	54	4	1	24	144	18
1992	502	274	52	15	18	4	75	26
1993	302	174	33	1	10	11	28	20
1994	335	125	82	1	11	13	21	14
1995	457	171	20	21	15	9	126	3
1996	218	50	8	0	0	0	37	12
1997	381	179	1	0	0	0	45	0
1998	849	92	13	21	6	0	14	23
All Known Years	4,727	2,731	1,041	227	344	94	1,304	154

Note there are 139,000 square meters of noise barriers constructed with other materials.

TABLE 6
NOISE BARRIER CONSTRUCTION MATERIAL
AVERAGE UNIT COST BY YEAR

Year	Material Average Unit cost (1998 $/m^2) Concrete	Block	Wood	Metal	Berm	Brick	Combination	Absorptive
1989	235	171	178	117	35	268	142	300
1990	232	170	168	0	25	0	106	230
1991	215	205	201	220	125	172	129	219
1992	208	175	169	192	78	210	166	223
1993	197	211	196	659	41	218	236	232
1994	188	165	139	138	66	274	207	173
1995	178	175	92	136	82	155	227	143
1996	145	185	139	0	0	0	207	246
1997	221	90	345	0	0	0	233	0
1998	167	130	168	104	49	0	176	261
All Known Years	198	174	155	146	51	214	164	245

Note there are 139,000 square meters of noise barriers constructed with other materials costing approximately $256 per square meter.

TABLE 7
NOISE BARRIER CONSTRUCTION MATERIAL
BY HEIGHT

	Material Area ($1,000 m^2$)								
	Concrete	Block	Wood	Metal	Berm	Brick	Combination	Absorptive	All Mat'ls
>9.9 meters	56	5	29	0	5	0	75	0	170
9-9.9 meters	22	0	4	0	4	0	16	0	46
8-8.9 meters	35	0	0	0	0	0	17	0	52
7-7.9 meters	400	5	89	7	26	0	44	5	576
6-6.9 meters	672	29	190	36	22	16	263	45	1,272
5-5.9 meters	1,225	27	161	10	7	12	72	60	1,574
4-4.9 meters	1,217	1,365	235	116	60	25	480	26	3,524
3-3.9 meters	926	1,097	200	61	157	29	255	13	2,738
2-2.9 meters	167	184	129	8	52	12	87	5	644
<2 meters	28	19	4	2	11	0	2	0	66
All Heights	4,748	2,731	1,041	240	344	94	1,311	154	10,663

Note there are 139,000 square meters of noise barriers constructed with other materials.

TABLE 8
NOISE BARRIER CONSTRUCTION MATERIAL
AVERAGE UNIT COST BY HEIGHT

	Material Average Unit Cost ($1998 \$/m^2$)								
	Concrete	Block	Wood	Metal	Berm	Brick	Combination	Absorptive	All Mat'ls
>9.9 meters	185	52	48	0	0	0	98	0	113
9-9.9 meters	256	0	8	0	17	0	61	0	147
8-8.9 meters	152	0	0	0	0	0	133	0	146
7-7.9 meters	193	103	218	183	25	0	146	132	184
6-6.9 meters	222	176	129	101	92	182	134	217	182
5-5.9 meters	209	233	173	142	47	214	216	237	210
4-4.9 meters	194	154	163	131	54	197	185	254	173
3-3.9 meters	174	197	138	160	37	221	157	296	172
2-2.9 meters	189	184	169	152	84	273	193	480	178
<2 meters	171	124	175	259	89	0	319	950	159
All Heights	198	174	155	137	51	214	163	244	179

Note there are 139,000 square meters of noise barriers constructed with other materials costing approximately $256 per square meter.

TABLE 9
NOISE BARRIER CONSTRUCTION BY STATE, AVERAGE HEIGHT, AND AVERAGE UNIT COST

State	Average Height (m)	Average Unit Cost ($1998/m^2)	State	Average Height (m)	Average Unit Cost ($1998/m^2)
Alabama	-	-	Montana	-	-
Alaska	3.1	96	Nebraska	4.2	191
Arizona	3.1	102	Nevada	2.9	213
Arkansas	4.0	82	New Hampshire	4.1	220
California	3.7	171	New Jersey	5.7	261
Colorado	3.2	138	New Mexico	2.6	168
Connecticut	5.5	111	New York	4.5	235
Delaware	4.1	47	North Carolina	5.5	98
District of Columbia	-	-	North Dakota	-	-
Eastern Direct Federal	3.4	148	Ohio	4.4	111
Florida	4.6	191	Oklahoma	3.2	101
Georgia	5.5	109	Oregon	3.3	125
Hawaii	2.1	263	Pennsylvania	4.0	265
Idaho	3.0	972	Puerto Rico	4.1	303
Illinois	3.5	205	Rhode Island	-	-
Indiana	4.7	232	South Carolina	5.7	113
Iowa	3.9	105	South Dakota	-	-
Kansas	4.6	215	Tennessee	4.2	170
Kentucky	4.5	142	Texas	3.7	193
Louisiana	3.5	143	Utah	3.4	103
Maine	4.4	118	Vermont	1.8	199
Maryland	5.8	264	Virginia	5.2	181
Massachusetts	2.8	186	Washington	3.1	137
Michigan	3.6	251	West Virginia	3.2	132
Minnesota	4.8	128	Wisconsin	5.3	183
Mississippi	-		Wyoming	2.3	149
Missouri	3.8	179			