

NATIONAL RADIO ASTRONOMY OBSERVATORY
Socorro, New Mexico

VLA Test Memo No. 208

VLA Tie Deterioration Survey 1997

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12/19/97

revised 22 April 1998

I. Introduction

This report summarizes the results of the Track Mainline "Tie" Survey conducted in Oct./Nov. of 1997. The survey was conducted by the Track Crew consisting of Paul Savedra, Pat Trujillo, Mike Torres and Adrain Pino. Only "mainline" track was inspected since work for the past 3 years has been concentrated on Station spur and D-Array locations. Station spur work was completed this year. This report does not address, rail, ballast, joint, sand, brush or any other problems associated with the track system. Bad ties are the dominant problem with the track system and their replacement would significantly improve the overall condition of the track.

In addition to the survey taken this year, information was gathered from the "Preliminary Review of The VLA Rail Track System" written by R. A. Sramek and G. A. Stanzione on July 3, 1986. The report indicates 190,000 ties overall with 180,000 main line ties and 10,000 antenna spur ties. The VLA Track system was installed using "used ties" and was completed in 1980.

In 1986 a detailed inspection was done on 86% of the Array which included Mainline and Station spur ties. The west arm from AW-5 To AW-9 was not inspected so the final tally of bad Ties was interpolated.

1986 Inspection:

1986 BAD TIES (Actual = 31,980, Interpolated = 37,186)

1997 Survey:

1997 BAD TIES (Mainline): 63,167 or 33% of total ties.

See Appendix A.

II. Rate of Tie Deterioration.

Rail Tie replacement records are sketchy, but were adequate enough to make the following general approximations:

TIE REPLACEMENT:	
YEAR	TIES
1980-1986	4000
1987	5500
1988	4500
1989	3000
1990	1600
1991	1500
1992	5000
1993-1997	<u>4510</u>
TOTAL =	30260

Despite replacement of approximately 30,260 bad ties since 1980 (16% overall), we currently have 63,167 bad ties (33% overall). There are still approximately 159,740 used ties on the array. Used Ties are deteriorating at an average rate of approximately 3% per year. All used ties have exceeded their life expectancy of 1 to 15 years. New ties have a life expectancy of 20 to 40 years.

APPROX. RATE OF DETERIORATION PER YEAR:
 1997 Bad Ties + Replaced = 63,167 + 30,260 = 93,427
 Or-- %Bad ties since 1980= 93,427 / 190,000 = 49%
 Avg. % Bad / Per Yr. = 49% / 17 yr. =2.9% /yr.

There are specific areas on the array where tie deterioration has increased considerably. The most probable reason for this is that the oldest ties are in these locations. There is a possibility that brush or sand has accelerated deterioration however, there is not enough survey data to conclusively support this idea.

III. Tie Replacement:

Track maintenance is an on going expense and effort at the VLA which will never end. Our current rate of replacement is approximately 2,000 ties / year or about 1%, (we have averaged about 1,595 in 17 years). Our current replacement effort does not adequately address the problem and we are steadily losing ground. In 15 years from now 50% of all ties on the array would be bad ties. We could never hope to keep up with maintenance and some locations of the array may become degraded to a point which will prohibit antenna moves. Figure 4 illustrates the problem. (Also see appendix B)

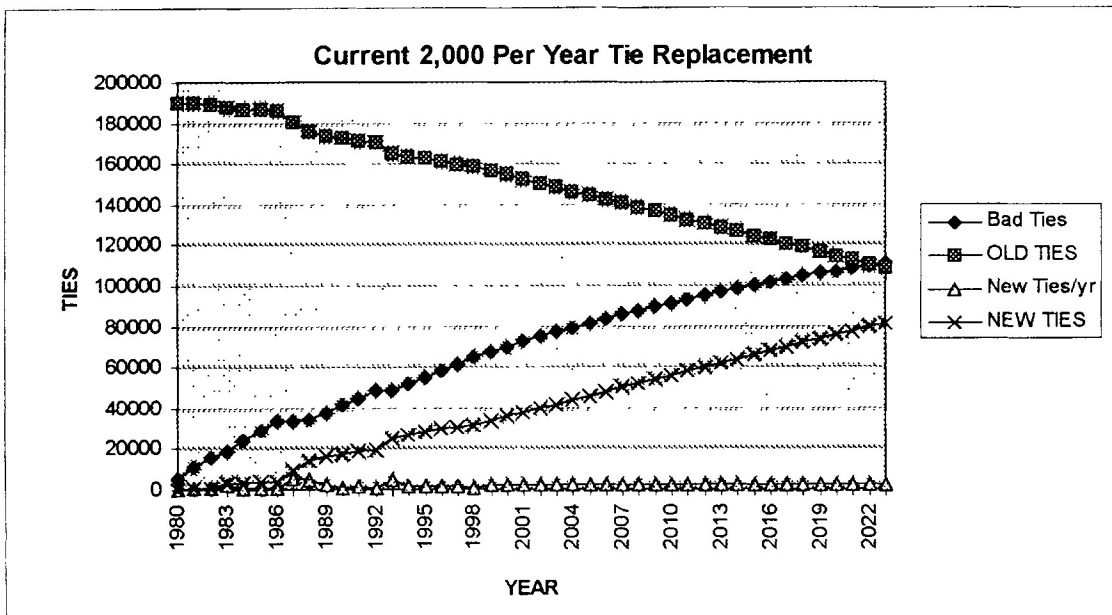


Figure-4

The following are necessary requirements to accomplish the 2,000 tie/year plan:

- | | |
|---|---------------------------------|
| Manpower: Summer 10 people: | Equipment: |
| 5- Spikers (2 on bar, 2 on hammers, 1 gauging) | Backhoe - \$10,000/yr. (Rented) |
| 1- Tie Removal & Scarifying (backhoe) | \$45,000 (Purchased) |
| 2- Spike pullers | |
| 1-Bobcat -(inserting ties) | |
| 1 Trailer- Tie shover (feeds ties to bobcat, Driver hauling ties) | |

Winter: Alignment is also an ongoing job separate from tie replacement. Track alignment/repair consists of gauging, leveling, lifting and repairing intersections, replacing bad rail, bolts, splices etc.. Presently only 4 men have been available to do alignment. At this manpower level the work is very tedious and very little progress is made, usually only the worst areas can be attended to. Some work is saved until summer help is available. A 6 man team is more efficient for this work.

A. 5K Ties/Yr. Plan.

In order to reverse the "trend" it would be necessary to increase our tie replacement to around 5,000 ties a year. This plan reverses the trend, however, we will not reach 1986 levels of track condition until the year 2014. This plan would require additional manpower and equipment. Current manpower levels would need to be increased to 12 full time track crew personnel. The crew would replace Ties in the summer and do alignment, leveling and other maintenance repairs in the winter months. (Also see appendix B)

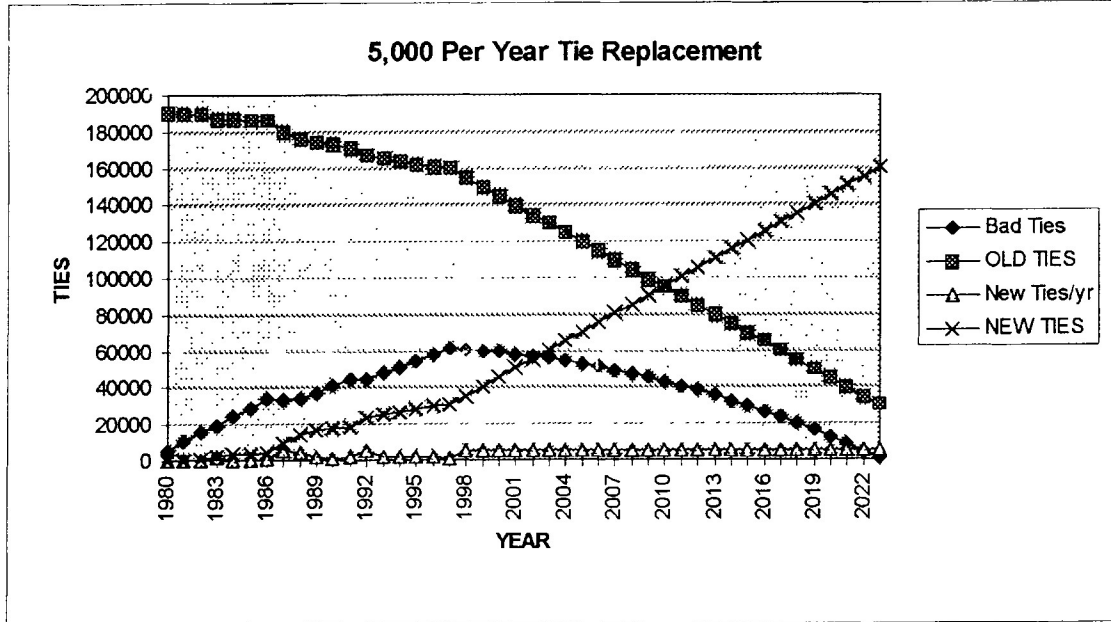


Figure 5.

The following are necessary requirements to accomplish the 5,000 tie/year plan:

Manpower: Summer 12 people required:

5- Spikers (2 on bar, 2 on hammers, 1 gauging)

1- Tie Removal & Scarifying (backhoe)

2- Spike pullers

1- Driver- (Boom truck hauling ties)

1-Bobcat -(inserting ties)

1 Trailer- Tie shover (feeds ties to bobcat)

1- Leadperson

Winter: 12 men required to do Alignment/repair and other maintenance work.

Equipment:

Backhoe - \$45,000

Skidloader (new)- \$23,000

Also desirable but not critical:

Scarifier tie inserter (used) \$16,000

B. 10K/5yr. , 5K/5yr, 2K Plan.

In order to catch up, and make array track maintenance more manageable, a plan to replace 10,000 ties for five years, then 5,000 ties for another five years, then drop to 2,000 ties from then on should be considered. The following graph illustrates a 10, 5, 2 thousand plan. (Also see appendix B)

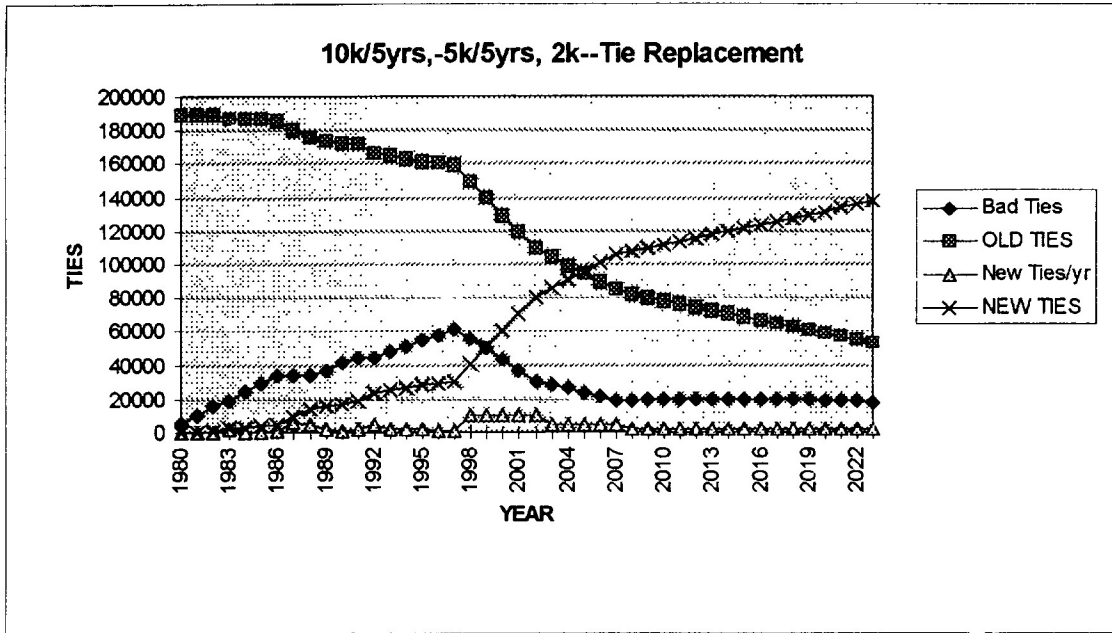


Figure 6

Summer:

Manpower: Two 12 man Teams (24 people for 5 yr.)

5- Spikers (2 on bar, 2 on hammers, 1 gauging)

1- Tie Removal & Scarifying

2- Spike pullers

1- Driver- (Boom truck hauling ties)

1-Bobcat -(inserting ties)

1-Trailer- Tie shover (feeds ties to bobcat)

1-Leadperson

Winter: 12 men required to do Alignment/repair and other maintenance work.

Equipment:

Backhoe - \$45,000

Skidloader (new)- \$23,000

2 Ballasters - \$30,000

40 track jacks - \$16,000

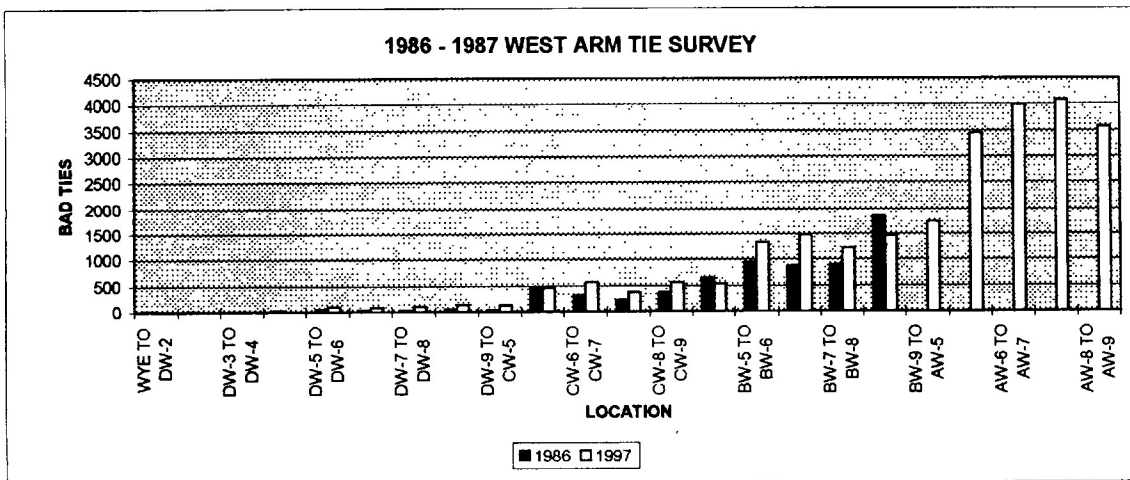
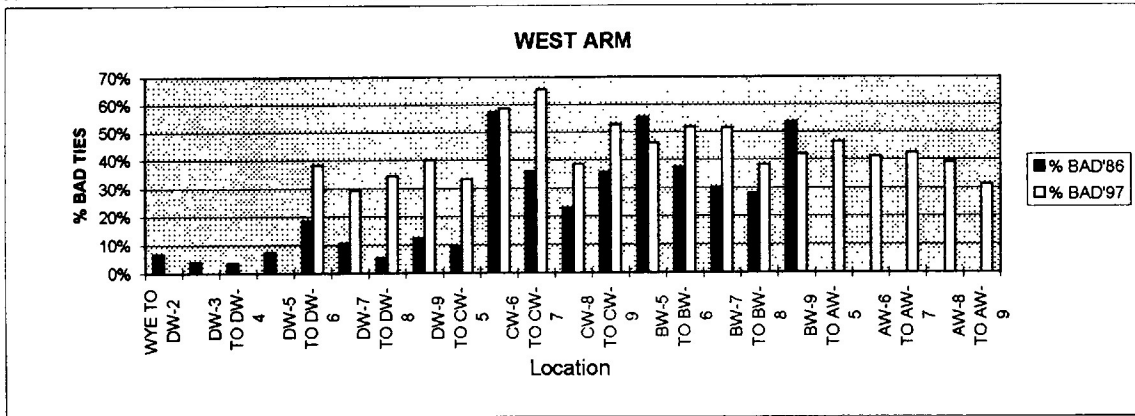
Tamper- (Surplus)

IV. Ballast:

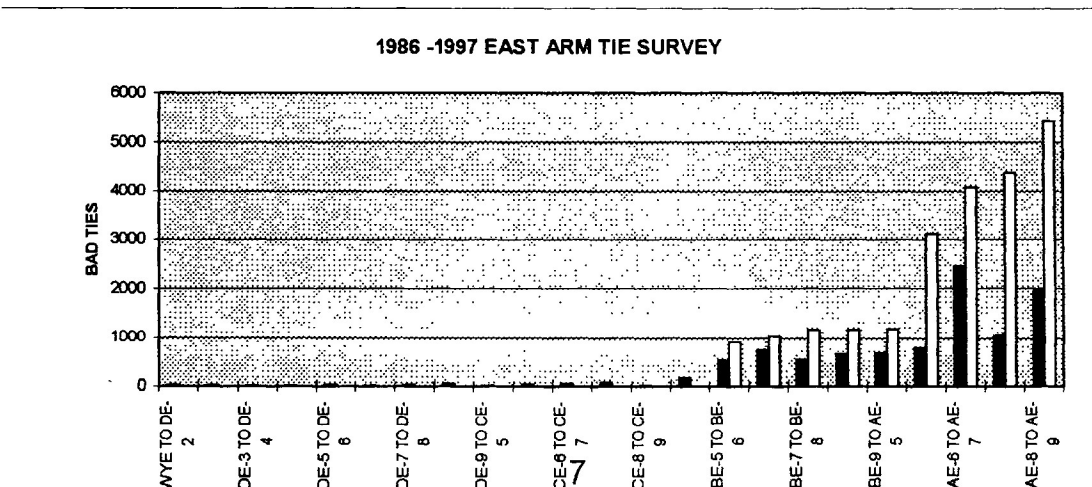
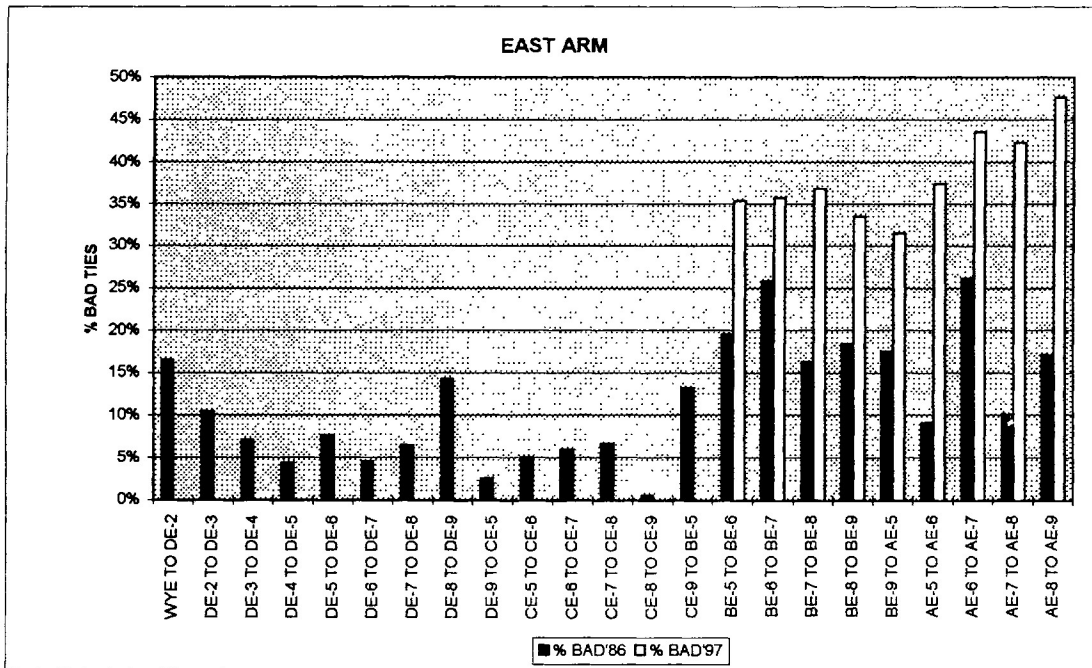
Current price for ballast is \$18/ton. Minimum recommended stockpile of ballast per year for the 5,000 Tie Replacement is 2,000 ton (\$36,000). Minimum recommended for the 10K, 5K, 2K Plan is 3,000 tons/ year (\$54,000/year).

APPENDIX A

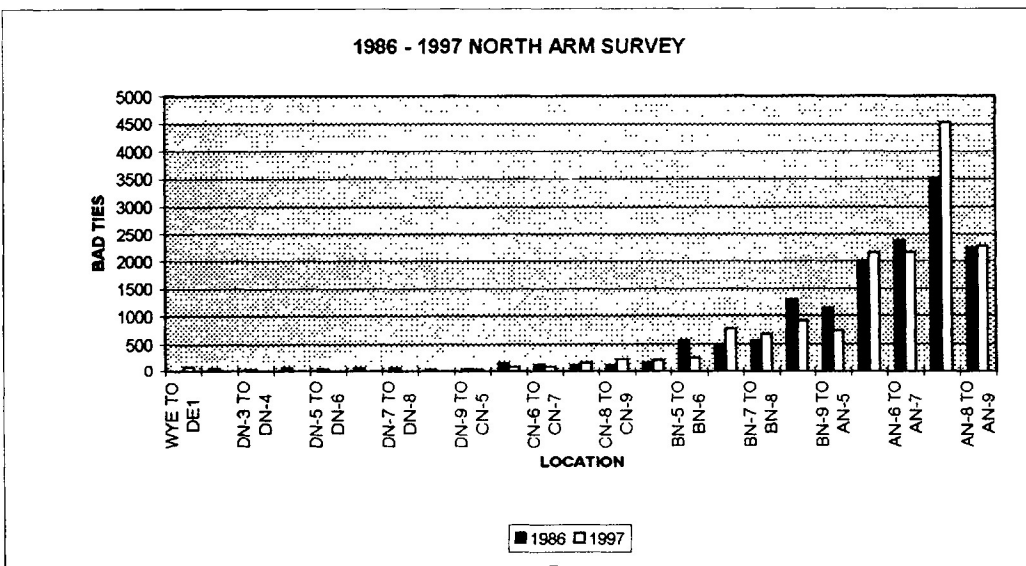
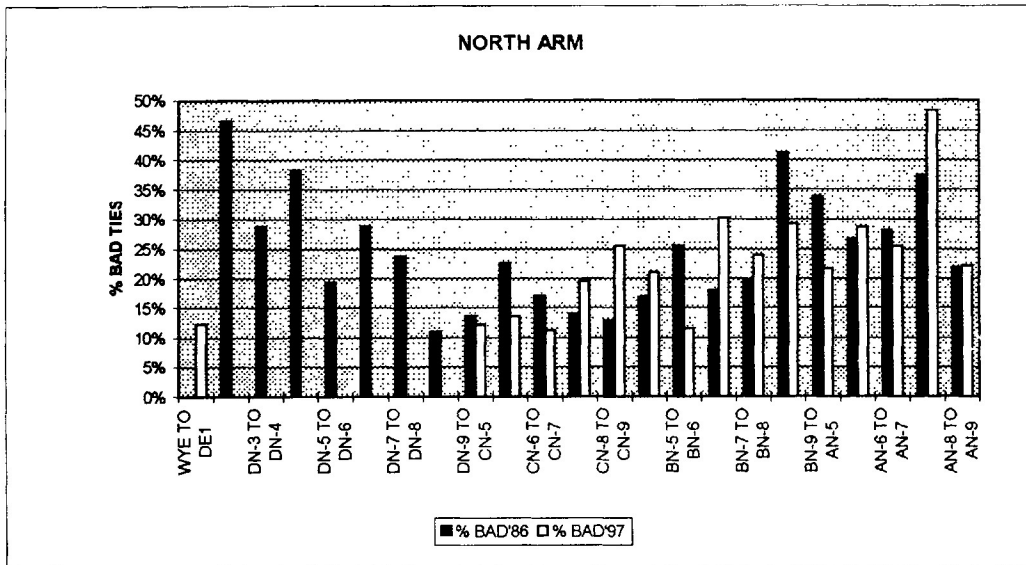
DATE				Aug-86	Aug-86	Nov-97	Nov-97			
LOCATION	% BAD'86	% BAD'97	% inc.	INSIDE	OUTSIDE	INSIDE	OUTSIDE	FT	TIES	Sand/Brush
WYE TO DW-2	7%		-100%	1	8			148	134	N
DW-2 TO DW-3	4%		-100%	2	3			148	134	N
DW-3 TO DW-4	4%		-100%	1	5			188	170	N
DW-4 TO DW-5	7%		-100%	5	10			226	204	N
DW-5 TO DW-6	18%	38%	109%	8	35	58	32	260	235	N
DW-6 TO DW-7	11%	29%	179%	7	21	42	36	294	265	N
DW-7 TO DW-8	5%	34%	531%	6	10	54	47	325	293	Y Both
DW-8 TO DW-9	12%	40%	231%	11	28	64	65	356	321	N
DW-9 TO CW-5	10%	33%	241%	5	29	61	55	385	347	Y Both
CW-5 TO CW-6	57%	59%	2%	188	255	216	237	855	771	Y Both
CW-6 TO CW-7	36%	65%	81%	111	203	296	272	964	870	Y Both
CW-7 TO CW-8	23%	39%	67%	95	128	178	194	1068	964	Y Inside
CW-8 TO CW-9	36%	53%	49%	185	190	283	274	1168	1054	Y Inside
CW-9 TO BW-5	55%	46%	-17%	432	200	222	305	1265	1141	Y Inside
BW-5 TO BW-6	37%	52%	39%	499	448	628	691	2810	2535	Y Inside
BW-6 TO BW-7	30%	52%	71%	434	426	757	715	3167	2857	Y Inside
BW-7 TO BW-8	28%	38%	36%	508	384	574	639	3509	3166	Y Inside
BW-8 TO BW-9	54%	42%	-21%	781	1081	729	734	3838	3463	Y Inside
BW-9 TO AW-5		46%				772	965	4156	3750	Y Inside
AW-5 TO AW-6		41%				1456	1989	9230	8328	Y Inside
AW-6 TO AW-7		43%				1827	2165	10404	9387	Y Inside
AW-7 TO AW-8		39%				1993	2091	11527	10400	Y Inside
AW-8 TO AW-9		31%				1951	1623	12608	11376	Y Inside
TOTALS				3279	3464	12161	13129	68899	62165	



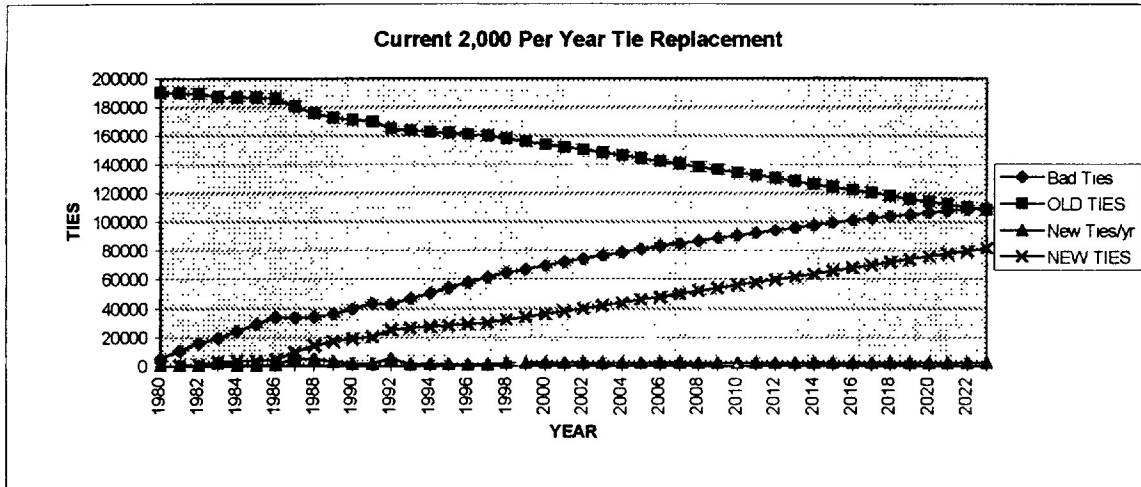
DATE LOCATION	% BAD'86	% BAD'97	% Incr.	Aug-86 INSIDE	Aug-86 OUTSID	Nov-97 INSIDE	Nov-97 OUTSIDE	FT	TIES	Sand/Brush
WYE TO DE-2	16%	0%	-100%	9	13			148	134	N
DE-2 TO DE-3	10%	0%	-100%	5	9			148	134	N
DE-3 TO DE-4	7%	0%	-100%	2	10			188	170	N
DE-4 TO DE-5	4%	0%	-100%	4	5			226	204	N
DE-5 TO DE-6	8%	0%	-100%	11	7			260	235	N
DE-6 TO DE-7	5%	0%	-100%	8	4			294	265	N
DE-7 TO DE-8	6%	0%	-100%	9	10			325	293	N
DE-8 TO DE-9	14%	0%	-100%	16	30			356	321	N
DE-9 TO CE-5	3%	0%	-100%	5	4			385	347	N
CE-5 TO CE-6	5%	0%	-100%	14	25			855	771	N
CE-6 TO CE-7	6%	0%	-100%	21	31			964	870	N
CE-7 TO CE-8	7%	0%	-100%	34	30			1068	964	Y Inside
CE-8 TO CE-9	1%	0%	-100%	6	6			1168	1054	Y Inside
CE-9 TO BE-5	13%	0%	-100%	59	92			1265	1141	Y Inside
BE-5 TO BE-6	20%	35%	81%	232	264	435	463	2810	2535	N
BE-6 TO BE-7	26%	36%	39%	319	418	517	504	3167	2857	N
BE-7 TO BE-8	16%	37%	127%	212	302	585	582	3509	3166	N
BE-8 TO BE-9	18%	34%	83%	270	366	568	594	3838	3463	N
BE-9 TO AE-5	17%	32%	81%	284	369	562	620	4156	3750	N
AE-5 TO AE-6	9%	37%	310%	411	350	1348	1771	9230	8328	N
AE-6 TO AE-7	26%	44%	66%	1040	1417	1438	2652	10404	9387	Y Inside
AE-7 TO AE-8	10%	42%	316%	431	627	2172	2224	11527	10400	N
AE-8 TO AE-9	17%	48%	179%	827	1118	2623	2805	12608	11376	N
TOTALS				4223	5494	10248	12215	68899	62165	



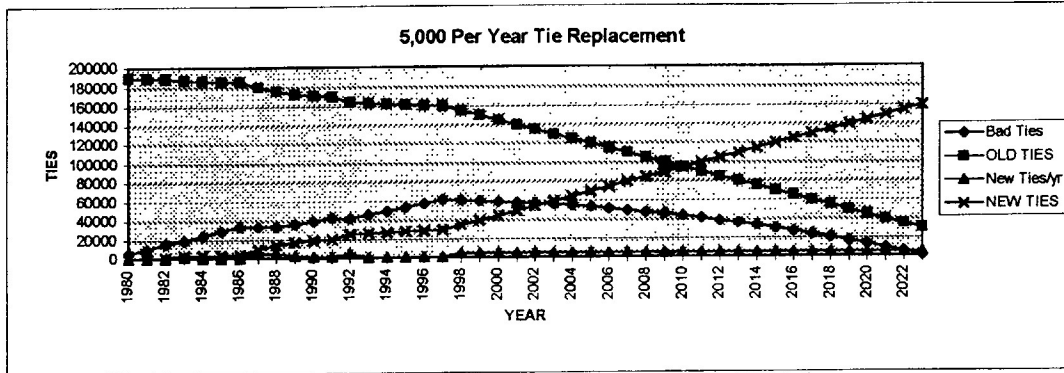
DATE LOCATION				Aug-96		Nov-97		FT	TIES	Sand/Brush
	% BAD'86	% BAD'97	% Incr.	INSIDE	OUTSIDE	INSIDE	OUTSIDE			
WYE TO DE1	0%	12%				27	50	695	627	N
DN-2 TO DN-3	47%	0%	-100%	38	17			131	118	N
DN-3 TO DN-4	29%	0%	-100%	14	20			131	118	N
DN-4 TO DN-5	38%	0%	-100%	28	40			197	178	N
DN-5 TO DN-6	19%	0%	-100%	15	26			235	212	N
DN-6 TO DN-7	29%	0%	-100%	12	57			265	239	N
DN-7 TO DN-8	24%	0%	-100%	11	52			293	264	N
DN-8 TO DN-9	11%	0%	-100%	14	18			321	290	N
DN-9 TO CN-5	14%	12%	-12%	14	29	14	24	347	313	N
CN-5 TO CN-6	23%	14%	-41%	59	99	50	44	771	696	N
CN-6 TO CN-7	17%	11%	-34%	55	79	46	42	869	784	Y Inside
CN-7 TO CN-8	14%	20%	39%	45	77	86	84	963	869	N Water
CN-8 TO CN-9	13%	25%	97%	45	78	188	54	1053	950	N Water
CN-9 TO BN-5	17%	21%	25%	76	98	127	90	1141	1029	Y Inside
BN-5 TO BN-6	26%	12%	-55%	253	332	114	151	2534	2286	Y Inside
BN-6 TO BN-7	18%	30%	68%	144	320	398	380	2856	2577	Y Inside
BN-7 TO BN-8	20%	24%	21%	263	304	360	325	3164	2855	Y Inside
BN-8 TO BN-9	41%	29%	-29%	631	655	501	410	3461	3123	N
BN-9 TO AN-5	34%	22%	-36%	622	523	389	344	3747	3381	N
AN-5 TO AN-6	27%	29%	8%	903	1097	1152	1002	8323	7509	Y Outside
AN-6 TO AN-7	28%	26%	-9%	982	1405	1094	1067	9381	8464	Y Outside
AN-7 TO AN-8	37%	48%	29%	1809	1700	2518	2010	10393	9377	N
AN-8 TO AN-9	22%	22%	1%	1020	1226	1110	1163	11368	10257	N
TOTALS				7053	8252	8174	7190	62639	56516	



APPENDIX B

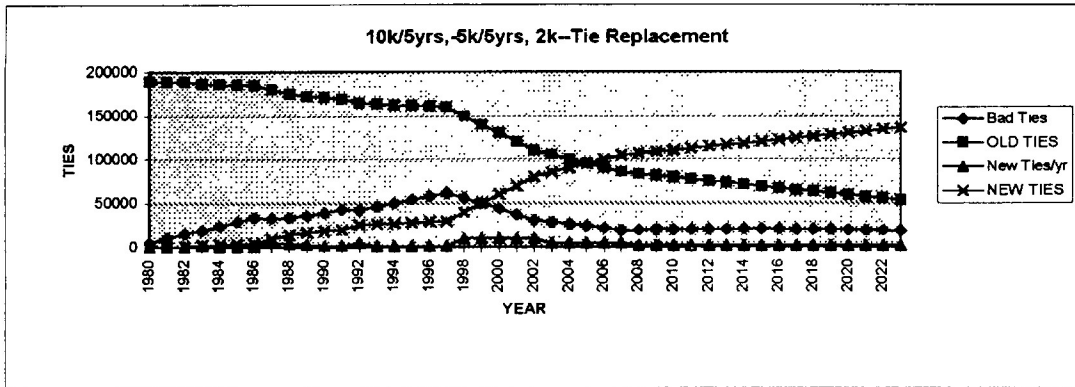


YEAR	Bad Ties	OLD TIES	New Ties/yr	NEW TIES	Ties, Spikes, Bolts Approx. Mt'l Cost	3% Inflation Cost/tie
1980	5510	190000	0	0		
1981	10608	189600	400	400		
1982	15695	189200	400	800		
1983	19124	187200	2000	2800		
1984	24141	186800	400	3200		
1985	29147	186400	400	3600		
1986	33884	185750	650	4250		
1987	33611	180250	5500	9750		
1988	34208	175750	4500	14250		
1989	36217	172750	3000	17250		
1990	39581	171150	1600	18850		
1991	43001	169650	1500	20350		
1992	42775	164650	5000	25350		
1993	46521	163650	1000	26350		
1994	50341	162750	900	27250		
1995	54135	161850	900	28150		
1996	57943	160990	860	29010		
1997	61737	160140	850	29860		
1998	64323	158140	2000	31860	\$ 61,700.00	\$ 30.25
1999	66851	156140	2000	33860	\$ 63,515.00	\$ 31.16
2000	69322	154140	2000	35860	\$ 65,384.45	\$ 32.09
2001	71734	152140	2000	37860	\$ 67,309.98	\$ 33.05
2002	74088	150140	2000	39860	\$ 69,293.28	\$ 34.05
2003	76384	148140	2000	41860	\$ 71,336.08	\$ 35.07
2004	78622	146140	2000	43860	\$ 73,440.16	\$ 36.12
2005	80802	144140	2000	45860	\$ 75,607.37	\$ 37.20
2006	82924	142140	2000	47860	\$ 77,839.59	\$ 38.32
2007	84988	140140	2000	49860	\$ 80,138.78	\$ 39.47
2008	86994	138140	2000	51860	\$ 82,506.94	\$ 40.65
2009	88942	136140	2000	53860	\$ 84,946.15	\$ 41.87
2010	90832	134140	2000	55860	\$ 87,458.53	\$ 43.13
2011	92664	132140	2000	57860	\$ 90,046.29	\$ 44.42
2012	94438	130140	2000	59860	\$ 92,711.68	\$ 45.76
2013	96154	128140	2000	61860	\$ 95,457.03	\$ 47.13
2014	97812	126140	2000	63860	\$ 98,284.74	\$ 48.54
2015	99412	124140	2000	65860	\$ 101,197.28	\$ 50.00
2016	100955	122140	2000	67860	\$ 104,197.20	\$ 51.50
2017	102439	120140	2000	69860	\$ 107,287.12	\$ 53.04
2018	103865	118140	2000	71860	\$ 110,469.73	\$ 54.63
2019	105233	116140	2000	73860	\$ 113,747.82	\$ 56.27
2020	106543	114140	2000	75860	\$ 117,124.26	\$ 57.96
2021	107795	112140	2000	77860	\$ 120,601.98	\$ 59.70
2022	108989	110140	2000	79860	\$ 124,184.04	\$ 61.49
2023	110125	108140	2000	81860	\$ 127,873.56	\$ 63.34
					\$ 2,363,659.06	



YEAR	Bad Ties	OLD TIES	New Ties/yr	NEW TIES	Ties, Spikes, Bolts Approx. Mtl Cost	3% Inflation Cost/tie
1980	5510	190000	0	0		
1981	10608	189600	400	400		
1982	15695	189200	400	800		
1983	19124	187200	2000	2800		
1984	24141	186800	400	3200		
1985	29147	186400	400	3600		
1986	33884	185750	650	4250		
1987	33611	180250	5500	9750		
1988	34208	175750	4500	14250		
1989	36217	172750	3000	17250		
1990	39581	171150	1600	18850		
1991	43001	169650	1500	20350		
1992	42775	164650	5000	25350		
1993	46521	163650	1000	26350		
1994	50341	162750	900	27250		
1995	54135	161850	900	28150		
1996	57943	160990	860	29010		
1997	61737	160140	850	29860		
1998	61236	155140	5000	34860	\$ 154,250.00	\$ 30.25
1999	60590	150140	5000	39860	\$ 158,787.50	\$ 31.16
2000	59800	145140	5000	44860	\$ 163,461.13	\$ 32.09
2001	58864	140140	5000	49860	\$ 168,274.96	\$ 33.05
2002	57783	135140	5000	54860	\$ 173,233.21	\$ 34.05
2003	56557	130140	5000	59860	\$ 178,340.20	\$ 35.07
2004	55186	125140	5000	64860	\$ 183,600.41	\$ 36.12
2005	53670	120140	5000	69860	\$ 189,018.42	\$ 37.20
2006	52009	115140	5000	74860	\$ 194,598.97	\$ 38.32
2007	50203	110140	5000	79860	\$ 200,346.94	\$ 39.47
2008	48252	105140	5000	84860	\$ 206,267.35	\$ 40.65
2009	46156	100140	5000	89860	\$ 212,365.37	\$ 41.87
2010	43915	95140	5000	94860	\$ 218,646.33	\$ 43.13
2011	41529	90140	5000	99860	\$ 225,115.72	\$ 44.42
2012	38998	85140	5000	104860	\$ 231,779.20	\$ 45.76
2013	36322	80140	5000	109860	\$ 238,642.57	\$ 47.13
2014	33501	75140	5000	114860	\$ 245,711.85	\$ 48.54
2015	30535	70140	5000	119860	\$ 252,993.20	\$ 50.00
2016	27425	65140	5000	124860	\$ 260,493.00	\$ 51.50
2017	24169	60140	5000	129860	\$ 268,217.79	\$ 53.04
2018	20768	55140	5000	134860	\$ 276,174.32	\$ 54.63
2019	17222	50140	5000	139860	\$ 284,369.55	\$ 56.27
2020	13531	45140	5000	144860	\$ 292,810.64	\$ 57.96
2021	9695	40140	5000	149860	\$ 301,504.96	\$ 59.70
2022	5714	35140	5000	154860	\$ 310,460.11	\$ 61.49
2023	1588	30140	5000	159860	\$ 319,683.91	\$ 63.34

\$ 5,909,147.64



YEAR	Bad Ties	OLD TIES	New Ties/yr	NEW TIE	Ties, Spikes, Bolts Approx. Mt'l Cost	3% Inflation Cost/tie
1980	5510	190000	0	0		
1981	10608	189600	400	400		
1982	15695	189200	400	800		
1983	19124	187200	2000	2800		
1984	24141	186800	400	3200		
1985	29147	186400	400	3600		
1986	33884	185750	650	4250		
1987	33611	180250	5500	9750		
1988	34208	175750	4500	14250		
1989	36217	172750	3000	17250		
1990	39581	171150	1600	18850		
1991	43001	169650	1500	20350		
1992	42775	164650	5000	25350		
1993	46521	163650	1000	26350		
1994	50341	162750	900	27250		
1995	54135	161850	900	28150		
1996	57943	160990	860	29010		
1997	61737	160140	850	29860		
1998	56091	150140	10000	39860	\$ 308,500.00	\$ 30.25
1999	50155	140140	10000	49860	\$ 317,575.00	\$ 31.16
2000	43930	130140	10000	59860	\$ 326,922.25	\$ 32.09
2001	37414	120140	10000	69860	\$ 336,549.92	\$ 33.05
2002	30608	110140	10000	79860	\$ 346,466.42	\$ 34.05
2003	28657	105140	5000	84860	\$ 178,340.20	\$ 35.07
2004	26561	100140	5000	89860	\$ 183,600.41	\$ 36.12
2005	24320	95140	5000	94860	\$ 189,018.42	\$ 37.20
2006	21934	90140	5000	99860	\$ 194,598.97	\$ 38.32
2007	19403	85140	5000	104860	\$ 200,346.94	\$ 39.47
2008	19814	83140	2000	106860	\$ 82,506.94	\$ 40.65
2009	20167	81140	2000	108860	\$ 84,946.15	\$ 41.87
2010	20462	79140	2000	110860	\$ 87,458.53	\$ 43.13
2011	20699	77140	2000	112860	\$ 90,046.29	\$ 44.42
2012	20878	75140	2000	114860	\$ 92,711.68	\$ 45.76
2013	20999	73140	2000	116860	\$ 95,457.03	\$ 47.13
2014	21062	71140	2000	118860	\$ 98,284.74	\$ 48.54
2015	21067	69140	2000	120860	\$ 101,197.28	\$ 50.00
2016	21015	67140	2000	122860	\$ 104,197.20	\$ 51.50
2017	20904	65140	2000	124860	\$ 107,287.12	\$ 53.04
2018	20735	63140	2000	126860	\$ 110,469.73	\$ 54.63
2019	20508	61140	2000	128860	\$ 113,747.82	\$ 56.27
2020	20223	59140	2000	130860	\$ 117,124.26	\$ 57.96
2021	19880	57140	2000	132860	\$ 120,601.98	\$ 59.70
2022	19479	55140	2000	134860	\$ 124,184.04	\$ 61.49
2023	19020	53140	2000	136860	\$ 127,873.56	\$ 63.34

\$ 4,240,012.89