EXAMINATION OF NEWLY INSTALLED ANTENNAS
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PURPOSE

The purpose of this analysis was to determine the difference in performance after replacing certain automatic vehicle identification antennas on the Katy (I-10) Freeway and the Northwest (US 290) Freeway HOT lanes in Houston. The antennas connected to readers 39 and 46 (located just northwest of the Pinemont exit on the Northwest Freeway) were replaced on Sunday, October 12, 2003. The antennas connected to readers 15 and 18 (located between the Gessner and Post Oak exits on the Katy Freeway) were replaced on Tuesday, October 14, 2003. The existing Transcore AA3100 Yagi Antennas were replaced with Transcore AA3152 Universal Toll Antennas. The total replacement cost was $10,318.00.

DATA COMPARISON

In an effort to determine changes in performance due to the new antennas, data from the replaced antennas was (1) compared to data from nearby antennas, and (2) compared to data from the same location prior to the installation of the new antennas. On the Katy Freeway, readers 15 and 18 were compared to readers 14 and 19, respectively (see Figure 1). On the Northwest Freeway, readers 39 and 46 were compared to readers 40 and 45, respectively (see Figure 2). The total number of daily reads during the peak period (6:30-8:15 in the morning and 4:45-6:15 in the evening) was collected for both the week prior to installation (Oct. 6 – Oct. 10) and the week following installation (Oct. 20 – Oct. 24). The total of number of daily reads was then averaged for the entire week. The zero values that occurred on readers 14 and 19 were removed when determining the averages.

RESULTS

I-10 Katy Freeway

The resulting data can be seen in Tables 1 and 2. Unfortunately, the data does not provide definitive results. First, the reads on antennas 15 and 18 (which were both replaced) were compared before and after replacement (see Figure 1). They both showed a small increase in average reads during the week following replacement. This may provide an indication that the antennas are capturing additional reads or there were simply more vehicles on the road with transponders. Additionally, the percentage increase was only 1.2% on antenna 15 and 4.4% on antenna 18.

Next, the reads collected on the antennas were compared to those collected by nearby antennas that were not replaced. In this case, antenna 18 was compared to antenna 19, while antenna 15 was compared to antenna 14. When compared to antennas 14 and 19, new antennas 15 and 18 have a greater number of average reads in both the week before replacement and the week after. Therefore, no relative improvement was evident. The difference in the number of reads between antennas 18 and 19 is unusual, because there are no exit points on the HOV lane between the locations of these antennas. Therefore, the number of reads should be equal for these two. However, it has been reported that antennas 14 and 19 are connected to the same reader, which has not been performing consistently.

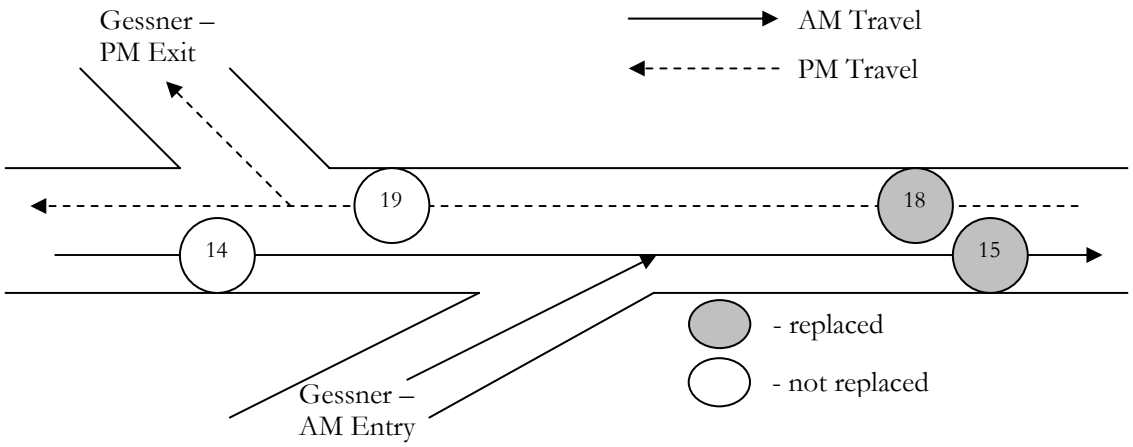

Figure 1: Readers on Katy Freeway

Table 1. Data Collected Before Antenna Installation – Katy Freeway Comparison

Antenna	Oct. 6	Oct. 7	Oct. 8	Oct. 9	Oct. 10	Average
15	682	761	660	673	608	677
14	538	573	547	0	0	553
18	516	522	491	388	472	478
19	563	84	487	0	475	402

*shading indicates an antenna that was replaced

Table 2. Data Collected After Antenna Installation – Katy Freeway Comparison

Antenna	Oct. 20	Oct. 21	Oct. 22	Oct. 23	Oct. 24	Average
15	688	698	707	714	616	685
14	544	489	615	571	424	529
18	500	497	520	476	502	499
19	514	486	509	421	499	486

*shading indicates an antenna that was replaced

I-10 Katy Freeway – Extended Data

An additional comparison was done for antennas 18 and 19 using more data from before and after the antenna installation. In this comparison, data was used from the three weeks before and three weeks after installation, excluding weekends. The data from these thirty days and their averages can be seen in Tables 3 and 4. Using this larger set of data, it was

Table 3. Extended Data: Antennas 18 and 19 Before Installation

Date	Antenna 18	Antenna 19
9/22	516	529
9/23	512	0
9/24	578	590
9/25	546	521
9/26	512	0
9/29	547	582
9/30	548	562
10/1	558	295
10/2	570	551
10/3	547	292
10/6	516	563
10/7	522	84
10/8	491	487
10/9	388	0
10/10	472	475
AVERAGE	**522**	**461**

Table 4. Extended Data: Antennas 18 and 19 After Installation

Date	Reader 18	Reader 19
10/20	500	514
10/21	497	486
10/22	520	509
10/23	476	421
10/24	502	499
10/27	531	521
10/28	586	543
10/29	587	524
10/30	527	513
10/31	489	514
11/3	464	457
11/4	502	0
11/5	506	562
11/6	461	527
11/7	538	562
AVERAGE	**512**	**511**

found that the average number of reads on antenna 18 decreased by 1.9% after the installation of the new antenna while the number of reads on antenna 19 increased by 10.8%. This could indicate a decreased reading success rate, or simply a smaller number of vehicles with transponders. Additionally, the difference in reads on antenna 19 is possibly explained by the unreliability of the reader performance. When comparing antennas 18 and 19, it was found that the difference in the number of reads collected by each was 11.7% before installation and dropped to just 0.2% after installation.

Another potential factor influencing the number of recorded tag reads is the reader's ability to dial into the modem bank and download its data. If the modem bank is busy then the data cannot be transmitted. If this happens too many times in a row the storage capacity of the reader can be exceeded and data is lost.

US 290 Northwest Freeway

A similar investigation was performed on the new antennas installed on the Northwest Freeway (see Figure 2). The resulting data can be seen in Tables 5 and 6. Similar to the Katy Freeway scenario, this data did not provide definitive results. First, the change in number of transponder reads on antennas 39 and 46 (both of which were replaced) after installation was calculated. There was a decrease in the average number of daily reads at both antennas after they were replaced. The number of reads on antenna 39 decreased by 30.3%, and the number of reads on antenna 46 decreased by 7.7%. This could indicate a reduced ability to identify transponders or simply fewer vehicles with transponders on the lanes.

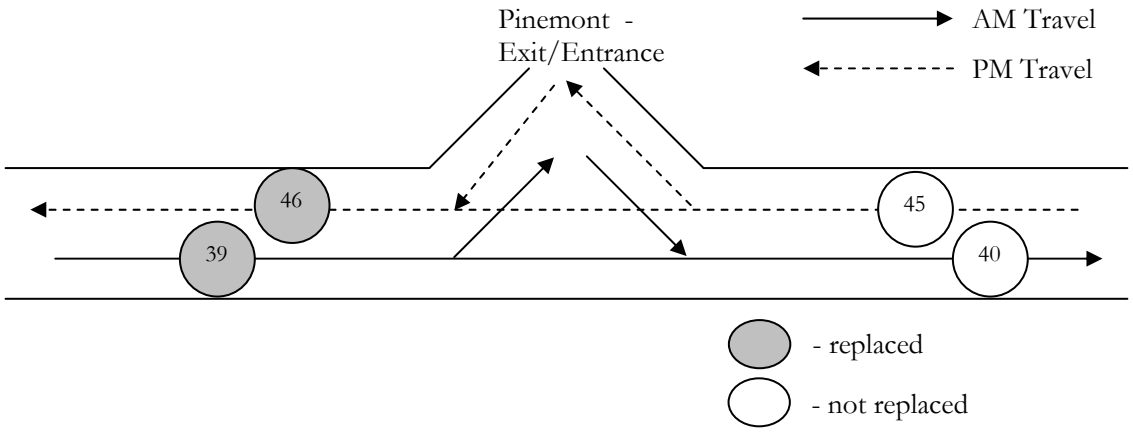

Figure 2: Readers on Northwest Freeway

These antennas also had a larger number of average reads than their comparison antennas (40 and 45). In this case, antenna 39 was compared to antenna 40, while antenna 46 was compared to antenna 45. However, unlike the situation at antennas 18 and 19, these pairs

of readers have an HOV lane entry/exit point located between them. Antennas 39 and 46 are located just northwest of the Pinemont Park & Ride location, while antennas 40 and 45 are located southeast of it. Based on typical traffic flows, the number of reads on antenna 39 should exceed those at 40. Also, the number of reads on antenna 45 should be nearly the same (but not exactly the same) as the number of reads at antenna 46.

Table 5. Data Collected Before Installation – Northwest Freeway Comparison

Antenna	Oct. 6	Oct. 7	Oct. 8	Oct. 9	Oct. 10	Average
39	203	215	232	265	191	221
40	211	174	171	198	232	197
46	194	211	200	218	218	208
45	70	64	88	38	57	63

*shading indicates an antenna that was replaced

Table 6. Data Collected After Installation – Northwest Freeway Comparison

Antenna	Oct. 20	Oct. 21	Oct. 22	Oct. 23	Oct. 24	Average
39	150	175	151	180	115	154
40	169	168	153	108	135	147
46	186	229	198	186	159	192
45	81	106	127	165	26	101

*shading indicates an antenna that was replaced

SUGGESTIONS FOR ADDITIONAL ANALYSIS

Unfortunately, the data collected does not accurately provide a definitive answer to whether or not the new antennas are more accurate than the old ones. One possible cause of this is the time period that was analyzed. Each data point is the number of reads made by the antenna during the QuickRide period. It is possible that the reader or antenna may have random down times during this time. For instance, antennas 18 and 19 should have exactly the same number of reads. However, the data shows that they do not. Perhaps by using a smaller time segment, the two antennas can more accurately be compared. It may be possible to analyze the data in 15-minute segments, but the distance between the two antennas would likely become a factor. Alternatively, obtaining the number of reads for the entire day might provide sufficient information.

The antennas on the Northwest Freeway present another problem as there are no antennas that should provide the exact same reads as the new antennas. Antennas 39 and 46 are mounted on the same gantry just northwest of the Pinemont Park & Ride entrance/exit. Unfortunately, there is not another pair of antennas (upstream or downstream) between antennas 39/46 and an entry/exit point. Therefore, it would very difficult to gather

accurate data from the readers to with which to compare antennas. One possible solution is to connect both the new and old antennas to the same reader. However, this may prove too expensive.

The next step would likely be an in-depth analysis of transponder reads on both the mainlanes and the HOV lane to try to determine if the new antennas are better tuned to focus on the HOV lane only. Additionally, the possible loss of data due to communication failure (busy modem banks) should be examined.