Technical Memorandum

Comparison of Travel Time Data Sources on I-10

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Acronym List

DMS..Dynamic Message Signs
FDOT..Florida Department of Transportation
ITS.. Intelligent Transportation Systems
LPR..License Plate Reader
O&M .... Operations and Maintenance
SwRI..Southwest Research Institute
TEOO ....Traffic Engineering and Operations Office
TERL .... Traffic Engineering Research Laboratory
TvT ....Travel Time

I. Scope of Analysis

This section of the memorandum provides an overview of the analysis performed on travel time data collected on Interstate 10 (I-10) from three (3) sources between January 19, 2009 and March 21, 2009. The goal of the analysis is to validate the travel time data provided by the Florida Department of Transportation (FDOT) License Plate Reader (LPR) system for travel time reporting purposes.

II. General Information and Project Background

The LPR project resulted from the FDOT's desire to display travel time information on dynamic message signs (DMS) devices. LPRs were chosen to collect traffic information because field studies previously performed in the Orlando and Tallahassee areas with LPRs indicated that the devices provided data of sufficient quality to support the calculation of segment-based travel times. Based on the results of those studies, the decision to install LPRs in the Tallahassee area to collect data to calculate travel times was made.

The LPR Deployment Project was funded by the FDOT Central Traffic Engineering and Operations Office (TEOO) Intelligent Transportation Systems (ITS). The FDOT LPR-based Travel Time Data Collection System includes the design, furnishing, and installation of equipment; integration; testing; and a one-year operations and maintenance (O&M) period for the full set of subsystems described in the LPR Project Invitation to Negotiate (ITN) Procurement Package Scope of Services. There are eight (8) LPR stations deployed along I-10 between exits 192 and 209—four (4) stations are used to calculate travel times in the westbound direction, while the other four (4) are used to calculate travel times in the eastbound direction. Based on the data collected at these stations, three (3) travel time (TvT) links for each direction of travel are generated using FDOT's SunGuide Software.

A. Description of Data Sources

Three (3) disparate sources of data were examined for this analysis:

1. License Plate Reader System

The LPR data used for this analysis was collected from FDOT's SunGuide system between late January 2009 and March 31, 2009, with some critical gaps that will be discussed later in the report. This data was reported in terms of LPR segments. These LPR segments are physically defined by an LPR reader station on each end and are named for the mile mark of the LPR reader serving as the origin of the link. The data provided by SunGuide, an example of which is shown below in Figure 1, includes a timestamp, average speed, and travel time for each LPR segment, reported at 15-minute intervals; the travel time and speeds reported are based on an average of the past 15 minutes.

Created On:	02/16/2009 08:58:52				
Center:	District 3 - Tallahassee				
Filter Parameters Selected:	[From Date Time]: 02/01/2009 00:00				
Period:	February 2009				
Date / Time	**Average Speed (mph)**	**Total Volume (vehicle)**	**Average Occupancy (veh./hr)**	**Average Travel Time (min)**	**Average Density (veh/mi)**
LPR_I10MM192EB-link1					
02/01/2009 00:00	51.00	26.00		1.73	
02/01/2009 00:15	54.00	13.00		1.62	
02/01/2009 00:30	49.00	30.00		2.27	
02/01/2009 00:45	50.00	13.00		1.77	
02/01/2009 01:00	52.00	15.00		1.68	
02/01/2009 01:15	45.00	11.00		4.02	
02/01/2009 01:30	52.00	18.00		1.67	

Figure 1: Sample LPR Data from SunGuide

2. INRIX Data

The second source of data was provided by Inrix, Inc. This data was downloaded from the Inrix Web site for the period from January 18, 2009 through March 21, 2009. The data provided by Inrix is reported in terms of Traffic Message Channel location codes[1]. As shown in Figure 2 below, this data includes a timestamp, speeds, and travel time information reported at five-minute intervals. Like the LPR data, the speeds and travel times reported by Inrix are also based on an aggregation of vehicles.

TmcCode	TimeUTC	DTK	Speed	ReferenceSpeed	AverageSpeed	Score	TravelTimeMinutes
102+04893	1/19/2009 10:55	4234255	66	65	66	20	1.59
102+04893	1/19/2009 11:00	4234260	68	65	68	20	1.54
102+04893	1/19/2009 11:05	4234265	48	65	68	30	2.18
102+04893	1/19/2009 11:10	4234270	49	65	68	30	2.14
102+04893	1/19/2009 11:15	4234275	68	65	70	30	1.54
102+04893	1/19/2009 11:20	4234280	68	65	70	30	1.54
102+04893	1/19/2009 11:25	4234285	69	65	70	30	1.52

Figure 2: Sample Inrix Data

Three (3) speed values are reported by Inrix:

- o “Reference Speed” is analogous to the free-flow speed along the reporting link. According to Inrix, “the reference attribute is the calculated ‘free flow’ mean speed for the roadway segment in miles per hour (capped at 65 miles per hour). This attribute is calculated based upon the 85th-percentile point of the observed speeds on that segment for all time periods, which establishes a reliable proxy for the speed of traffic at free-flow for that segment.”

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[1] Traffic Message Channel location codes are standardized tables used to reference traffic data. Traffic Message Channel tables primarily provide references to point locations along major roads corresponding to intersections with other roads. A table entry identifies a point location using both contextual information (such as, region, road and section of road, name of intersection) and approximate longitude/latitude coordinates.

- "Average Speed" is the historical average mean speed for the reporting segment for that time of the day and day of the week in miles per hour.
- "Speed" represents the average speed for a given Traffic Message Channel code, calculated from live data over the most current time slice.

Inrix also reports data quality in terms of a "confidence score," which is 10, 20, or 30 (with a score of 30 denoting data of the highest quality – making use of the greatest amount of real-time traffic data). An analysis of the reported data reveals that when data is assigned a score of 10, the system reports a speed equal to the reference speed. When the data is assigned a score of 20, the system reports a speed equal to the average speed. When the data is assigned a score of 30, the system reports a speed calculated from live data over the most recent time slice.

3. Floating Vehicle Data

The floating vehicle data used for this analysis came from two (2) sources. One source was a set of floating vehicle data collected by a subcontractor for Inrix from January 19-21, 2009. This dataset, an example of which is shown in Figure 3 below, included a timestamp, latitude/longitude, and speed of the vehicle on a one-to-two second basis as the vehicle traveled down Interstate 10. This data was then converted to travel time and average speed over the LPR segments.

Id	Date	UTCTime	Latitude	Longitude	Heading	SpeedKnots	TimeStampUTC	SpeedMPH	TMC9	Direction
5288	190109	152053	30.48499833	-84.39710167	93.49479484	60.67	20:53.0	69.817787	102+04894	Eastbound
5289	190109	152055	30.48496167	-84.39646167	93.80337812	60.12	20:55.0	69.18486	102+04894	Eastbound
5290	190109	152057	30.48492833	-84.39581333	93.41412979	60.13	20:57.0	69.196365	102+04894	Eastbound
5291	190109	152059	30.48489333	-84.39517167	93.62155409	59.47	20:59.0	68.436852	102+04894	Eastbound
5292	190109	152101	30.48486333	-84.39453833	93.14604308	60.22	21:01.0	69.299942	102+04894	Eastbound
5293	190109	152103	30.484825	-84.39389	93.9247731	61.05	21:03.0	70.255089	102+04894	Eastbound
5294	190109	152105	30.48479	-84.393235	93.54801272	60.79	21:05.0	69.955879	102+04894	Eastbound
5295	190109	152107	30.48475667	-84.392585	93.40538941	60.46	21:07.0	69.576126	102+04894	Eastbound
5296	190109	152109	30.48472167	-84.39193	93.54801024	61.26	21:09.0	70.49675	102+04894	Eastbound

Figure 3: Sample Floating Vehicle Data Collected by Inrix

The second source of data was from floating vehicle runs conducted by personnel working with the FDOT. This data was collected by recording on a log sheet the time at which the vehicle in question passed each LPR reader site, as shown in Figure 4 below. The travel time for each LPR reporting segment was then calculated by taking the difference between the times the vehicle passed the origin reader versus the destination reader of the LPR reporting segment.

LPR Test Vehicle Checklist

Date: 02/04/09

Test Vehicle License Plate F83 OVT

First Pass

									SPD
LPR Site	# 5 (WB DMS)	Direction	WB	Travel Lane	Lane 1	Time Through	10:10:30	70
LPR Site	#4 (Exit 203)	Direction	WB	Travel Lane	Lane 1	Time Through	10:17:07	60
LPR Site	# 3 (Exit 199)	Direction	WB	Travel Lane	Lane 1	Time Through	10:20:41	60
LPR Site	# 2 (Exit 196)	Direction	WB	Travel Lane	Lane 1	Time Through	10:23:44	70
LPR Site	# 1 (EB DMS)	Direction	EB	Travel Lane	Lane 1	Time Through	10:30:00	72
LPR Site	# 2 (Exit 196)	Direction	EB	Travel Lane	Lane 1	Time Through	10:31:35	71
LPR Site	# 3 (Exit 199)	Direction	EB	Travel Lane	Lane 1	Time Through	10:34:32	65
LPR Site	# 4 (Exit 203)	Direction	EB	Travel Lane	Lane 1	Time Through	10:38:02	65

Figure 4: Sample Floating Vehicle Data Collected by FDOT

It is important to note that floating vehicle probe data describes the travel time for one unique vehicle at a single point in time. For the results of floating vehicle probe data to be accurate, the vehicle must be driven at a speed representative of the vehicles surrounding it.

III. Methods of Analysis

The original goal of the analysis was to make a direct comparison of floating car data (collected by Inrix from January 19 – 21, 2009, as part their overall system accuracy report) with LPR data obtained from the SunGuide® system. Unfortunately, the LPR system was offline during the period when Inrix conducted their floating car runs. As a result, a direct comparison of the two datasets could not be made. Even so, data from the Inrix travel time system during this time period was available to support a comparative analysis. Consequently, a revised plan was developed to compare the LPR data generated by the FDOT SunGuide System with the travel time data generated by the Inrix system. However, upon further investigation, a number of anomalies were discovered within the LPR data, requiring that a correction be made in the LPRs' configuration. Once these anomalies were corrected, the plan was to compare the Inrix data to the corrected LPR data. Unfortunately, this only provided two days of overlap between the "good" LPR data and the Inrix data. In spite of this, sufficient data was available to facilitate a comparison of the two data sets.

A. Description of Equivalent LPR Segments

A key factor considered in conducting the analysis was the different geographic intervals over which the various datasets were defined. The LPR data was provided in terms of LPR reporting segments, as shown in Figure 5, whose endpoints were physically defined by the locations of the LPR readers.

Figure 5: LPR Reporting Segments

The Inrix data was provided in terms of Traffic Message Channel location codes, as shown in Figure 6, which were defined as segments between interchanges and segments internal to the interchange.

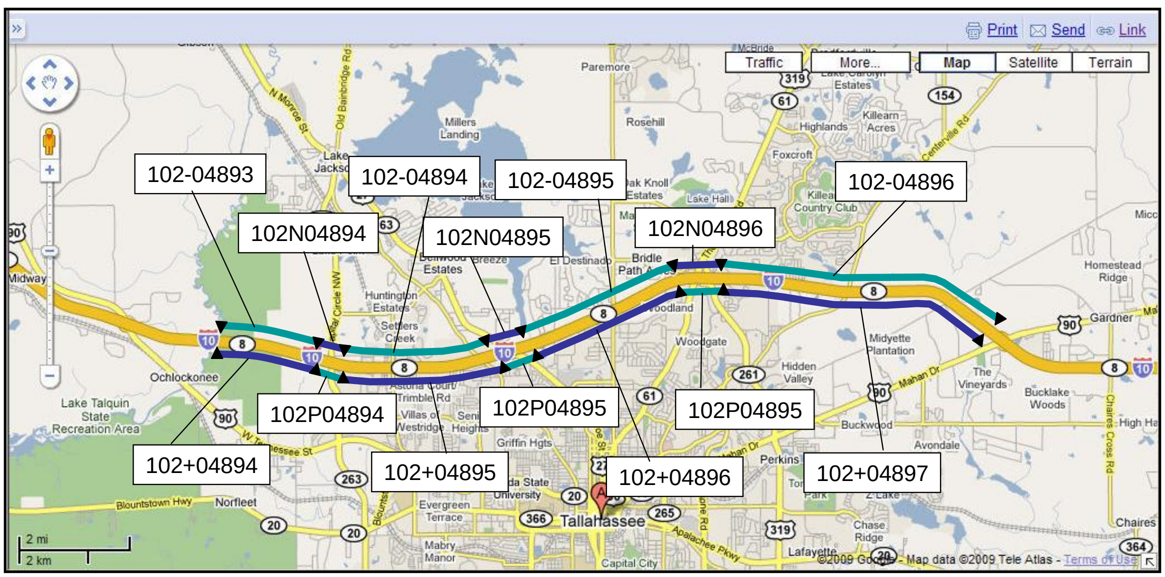


Figure 6: Traffic Message Channel Location Codes

In order to facilitate a comparison between the Inrix data and the LPR data, a methodology was developed to convert the data obtained in terms of Traffic Message Channel location codes into equivalent LPR segments. This conversion was made as follows:

- To build an equivalent LPR segment using Traffic Message Channel location code travel time information, the travel time for a Traffic Message Channel code between two interchanges was added to a percentage of the travel times from the Traffic Message Channel codes on either end. This percentage was based on the physical distance that each Traffic Message Channel code overlapped with the LPR segment, as shown in Figure 7.

- To build an equivalent LPR segment based on Traffic Message Channel location code speed data, a weighted average was computed based upon the physical distance that each Traffic Message Channel code overlapped with the LPR segment, as shown in Figure 8.

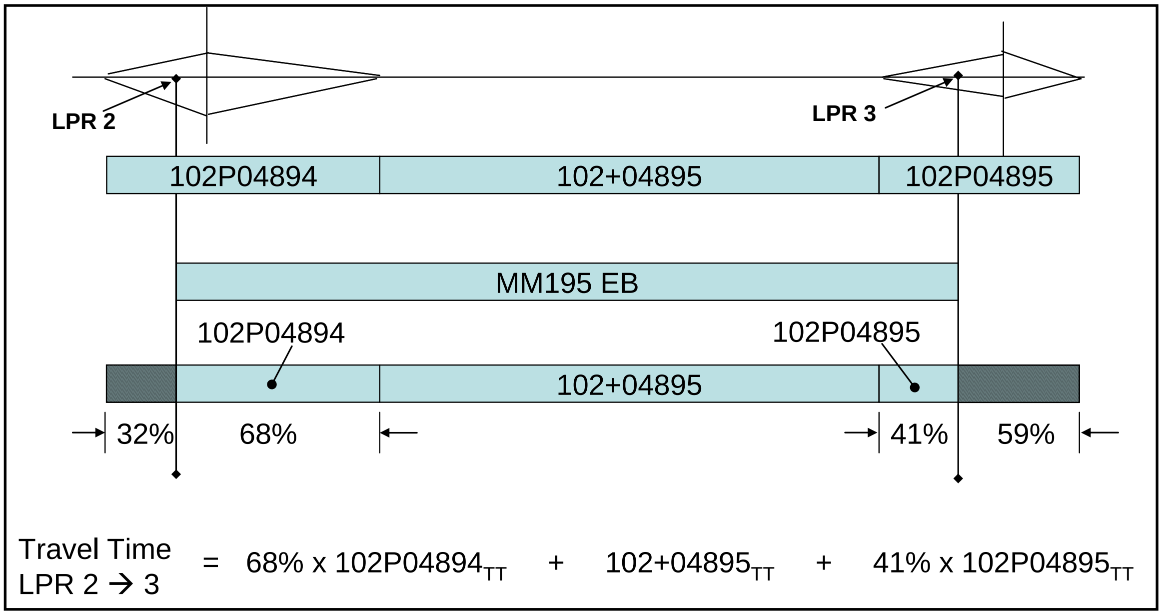


Figure 7: Calculation of Equivalent LPR Segments from Traffic Message Channel Location Code Travel Times

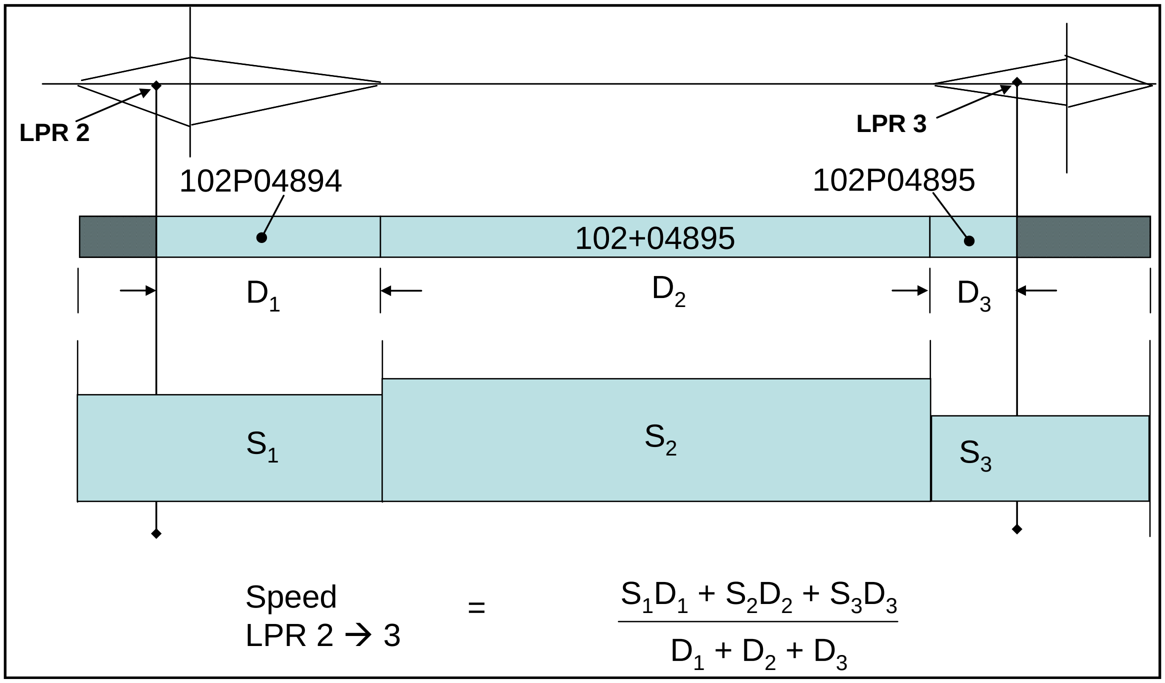


Figure 8: Calculation of Equivalent LPR Segments from Traffic Message Channel Location Code Travel Speeds

B. Floating Vehicle versus INRIX Data (Based on Equivalent LPR Segments)

The first step was to compare the floating vehicle data provided by Inrix with data from the Inrix travel time system for January 19 – 21, 2009. A good correlation between the floating vehicle data and the Inrix travel time system data would lend credibility to using the Inrix system data as a benchmark for the LPR data.

The floating vehicle data provided by Inrix was delivered in terms of GPS coordinates. Since the GPS coordinates of the Traffic Message Channel codes and LPR readers were also known, it was possible to identify when each vehicle passed a reader or Traffic Message Channel code endpoint. Probe vehicle travel times across a segment were determined by calculating the difference between the timestamps at the segment's endpoints. Average probe vehicle speed was determined by calculating the average of each point-based speed reported over the segment.

In order to validate the concept of using equivalent LPR segments (described in Figure 7), the Inrix data was converted into equivalent LPR segments using the methods described above prior to being compared with the floating vehicle data. Converting the Inrix data into equivalent LPR segments also provided for a common basis of analysis between the three (3) data sources.

Floating vehicle data collected by the FDOT on February 4, 2009 was also compared against the Inrix data in terms of equivalent LPR segments. As previously stated, this data was collected by manually recording the time of day at which the FDOT vehicle passed each LPR reader station. Travel times were calculated by taking the difference between the timestamps at the origin reader versus the destination reader of each LPR reporting segment. Average travel speed was calculated by dividing the segment length by the travel time.

Graphs indicating the results of each comparison are contained in Appendix A. In general, the floating vehicle data correlated well with the travel time data generated by the Inrix travel time system. Although there were some discrepancies between certain data points obtained during the February 4 floating vehicle runs and the Inrix travel time data, it is possible that these discrepancies were the result of manual data entry errors made on the data collection sheet[2].

C. Floating Vehicle versus LPR Data

Floating vehicle comparisons were also made against the LPR data obtained from the FDOT SunGuide System using a similar methodology to that used to assess the Inrix data. Unfortunately, LPR data from SunGuide was not available during the period of January 19-21, 2009 when Inrix conducted its floating vehicle runs. However, LPR data was available on February 4, 2009 and March 25, 2009 when FDOT conducted its independent floating vehicle runs.

As indicated in Appendix B, the correlation between the floating vehicle speeds and travel times collected on February 4 and March 25, and the LPR data collected from SunGuide on those dates, was quite good. Further discussion of the February 4 data is included in the next section of the report.

D. INRIX Data versus LPR Data

Since the Inrix data was converted into terms of equivalent LPR segments, a direct comparison was possible between the two data sets. A comparative analysis was made based on data collected between January 19-21, 2009 and on February 4, 2009.

Prior to making the comparison between the Inrix data and the LPR data, the LPR data was analyzed for consistency. This consistency check was performed by simply plotting a week's worth of data from each LPR link in clusters and arranging these data clusters side by side, as shown in Figure 9. Since the three (3) LPR segments in each direction are physically adjacent to one another, and since each link has a similar speed limit, one would expect that the range of speeds recorded from each LPR reporting segment would be similar. However, when the data was plotted in this manner, significant discontinuities in reported speeds were observed when comparing one

[2] As part of the floating vehicle data collection effort, two vehicles travelled in formation along I-10. Occasionally, the travel times reported by these two vehicles would be approximately one minute apart, even though they crossed into a given LPR reporting segment only seconds apart. In each case where there was a discrepancy between the travel times of the two floating vehicle probes; one of the two probes' travel times correlates well with the travel time reported by the Inrix system.

reporting segment to another. In addition, the range of speeds observed during the January 19 - 21 floating vehicle runs (denoted as "GPS" in the figures below) did not correlate well with the speed ranges reported by the LPR system. Since this did not make logical sense, this pointed to a potential error in the LPR system's link configuration.

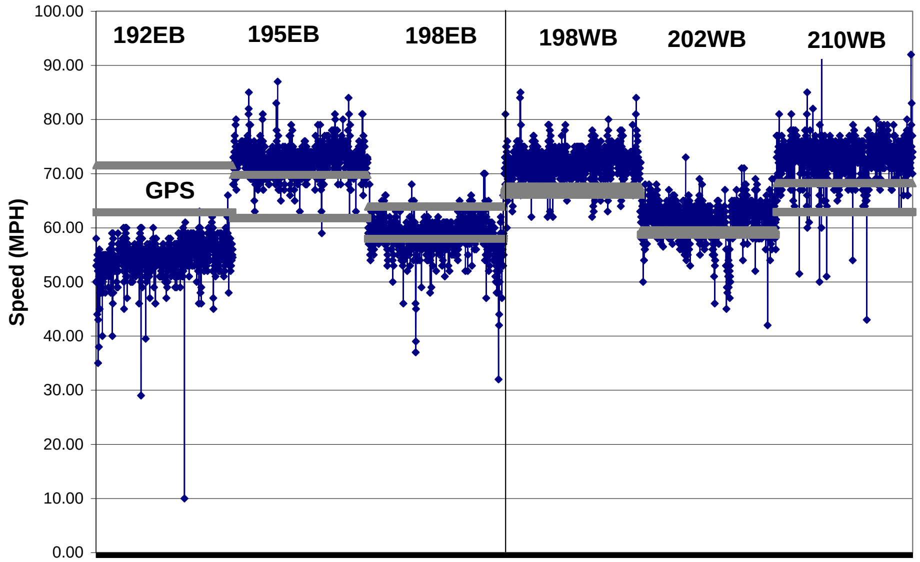


Figure 9: Sample LPR Data before March 18 Configuration Change

As a result, Southwest Research Institute (SwRI) and the FDOT examined the configuration of the LPR system links and determined that some of the distances were programmed incorrectly. Once these configuration settings were corrected on March 18, 2009, the data was plotted again and the significant discontinuities disappeared, as shown in Figure 10. Appendices B and C contain additional charts comparing the range of reported LPR data with the GPS probe vehicle runs conducted in January 2009.[3]

[3] This information is presented in a different format in Appendix C, which shows a weekly summary of the average vehicle speeds reported by the SunGuide system. These aggregate speeds are compared with the range of actual average travel speeds driven by Inrix when they performed their floating vehicle runs in January 2009. As can be seen, the reported travel speeds converge with the range of observed speeds after March 18, 2009.

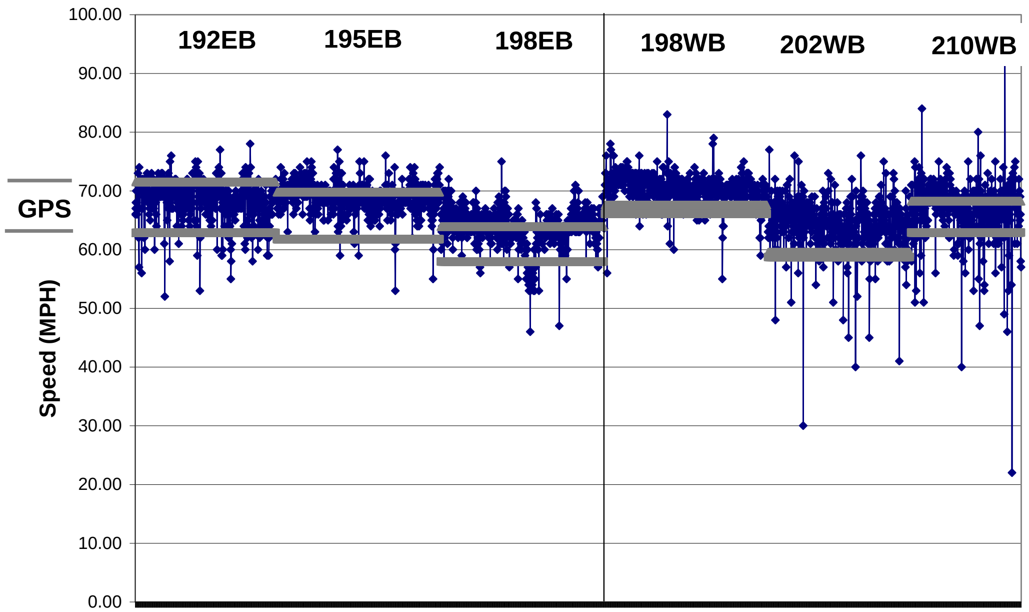


Figure 10: Sample LPR Data after March 18 Configuration Change

Once these configuration issues were resolved, it was possible to make an accurate comparison between the speed data from LPR system and the Inrix system. The results of this comparison are contained in Appendix D. Since the LPR configuration issue was corrected on March 18, 2009, the first full day of good LPR data was available on March 19, 2009. Unfortunately, Inrix terminated their data feed for the test on March 21, 2009, providing only a two-day window within which to compare the LPR data feed with the Inrix data feed.

Examination of the data in Appendix D indicates that there is generally a good correlation between the LPR data and the Inrix data. During the overnight hours, when traffic was light, the Inrix data tended to revert to reporting the default free-flow speed, which in some cases over-reported the travel time.

Since the travel time data generated by the LPR system is calculated directly from the timestamps of the vehicle matches, it was also possible to compare the travel time data generated by the LPR system with that produced by Inrix on February 4, 2009[4]. February 4, 2009 was chosen for analysis as floating vehicle runs performed by the FDOT were available for that day. As indicated in Appendix B, this analysis shows a generally good correlation between the travel times generated by the LPR system and those published by Inrix. Even so, there are several instances where the LPR data diverges from that reported by Inrix. In almost all cases, this occurred when the number of LPR vehicle matches for the previous 15 minutes was low (typically less than 20 - see the light blue data points on the secondary axis of the graphs contained in Appendix B).

[4] Comparison of the speed data generated by the LPR system on this date against that provided by Inrix is not advisable due to the configuration error in the LPR system that was not corrected until March 18, 2009.

IV. Conclusions

In the majority of cases, an examination of the data demonstrated that the LPR system provided travel times and speeds consistent with those driven by floating vehicle probes and with data provided by the Inrix travel time reporting system. However, because low numbers of matches appear to have the potential to cause unpredictable travel time results to be generated by the LPR system, it is recommended that LPR reader data be periodically monitored to detect low-data conditions. In addition, regular maintenance of the LPR reader stations will be an important part of ensuring that the maximum number of vehicle plates possible is accurately being provided to the SunGuide System for analysis.

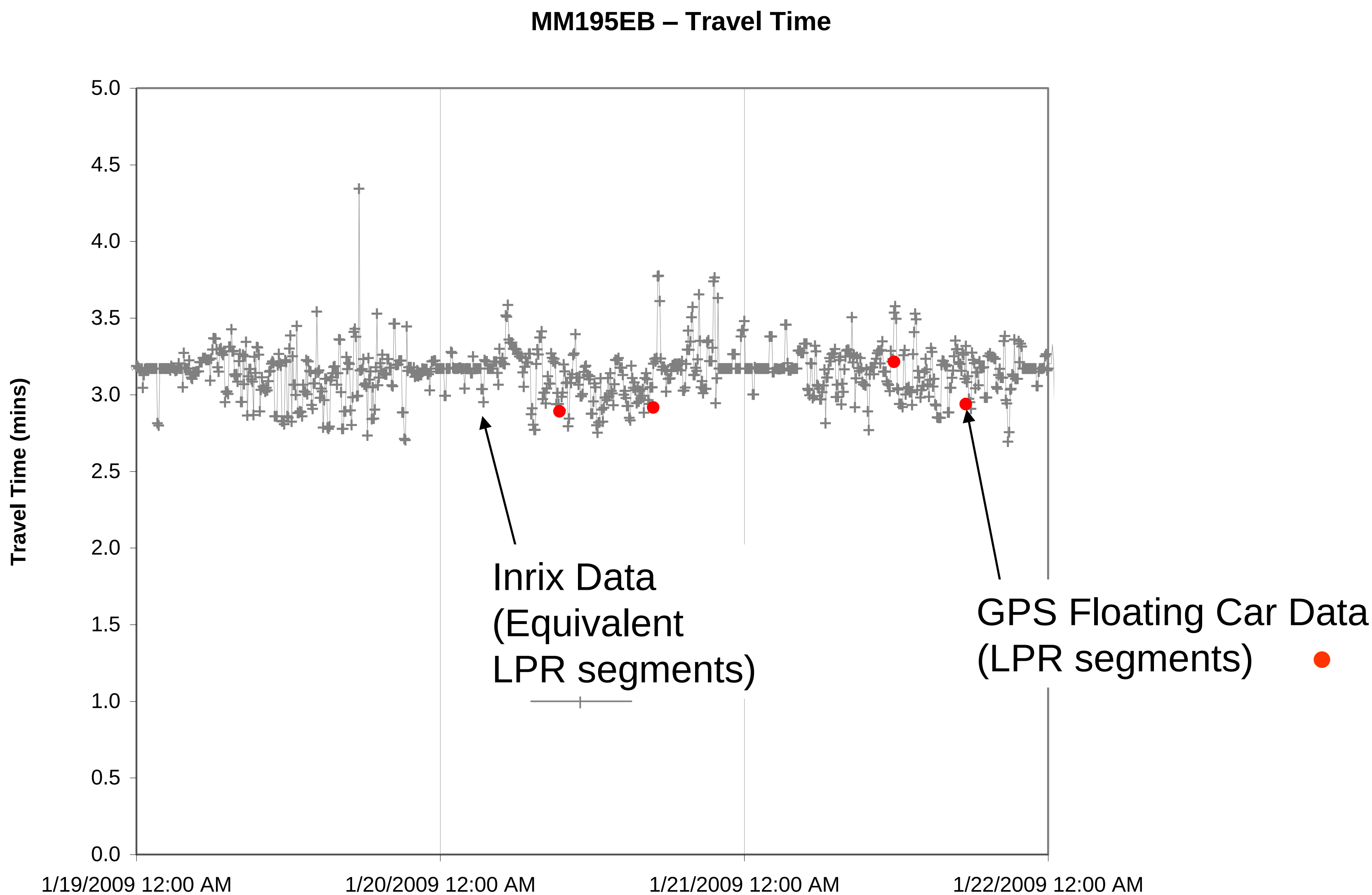
Finally, for each day examined, it appears that traffic was flowing under relatively unobstructed conditions. While the data indicates that the LPR system fed by an adequate number of matches produces accurate travel times, it would be beneficial to examine the travel times produced by the LPR system during a known incident with a major impact to traffic. Doing so would help to validate the data under conditions when travel times based on that data would be of greatest use to the motorist.

Appendix A

Floating Vehicle Data
Versus
Inrix Data

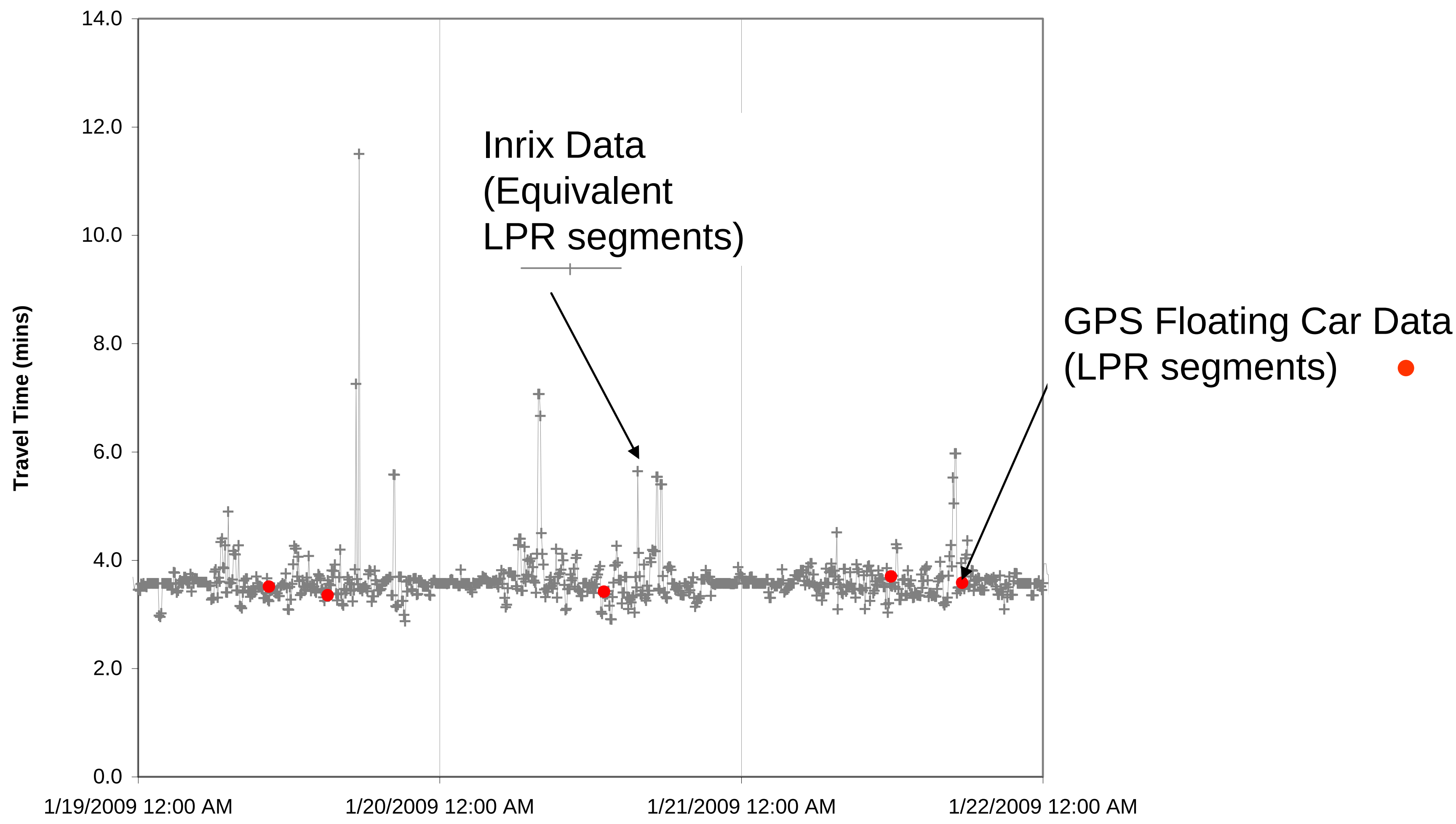
January 19-21, 2009

Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)



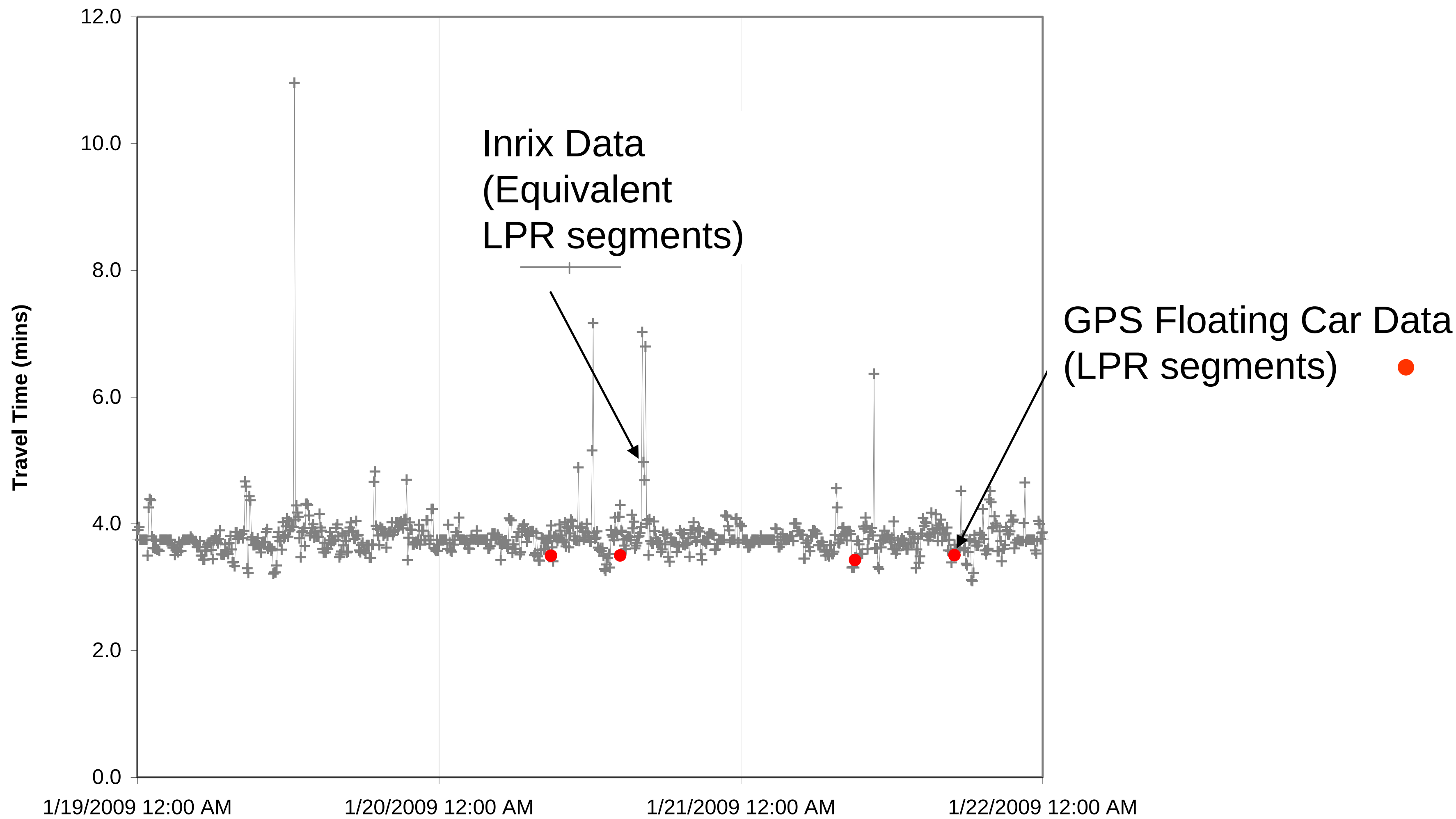
Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)

MM198EB – Travel Time



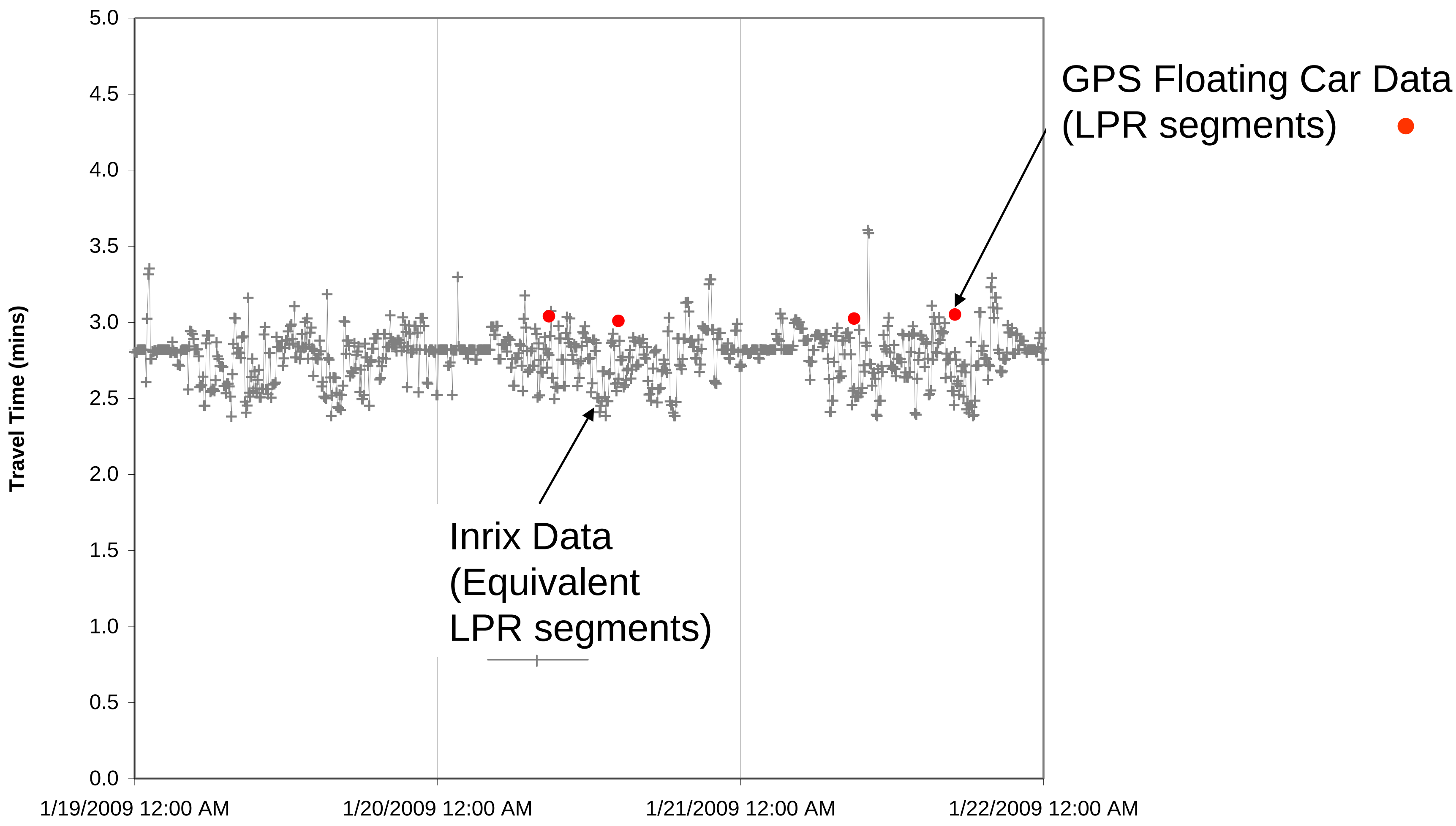
Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)

MM198WB – Travel Time



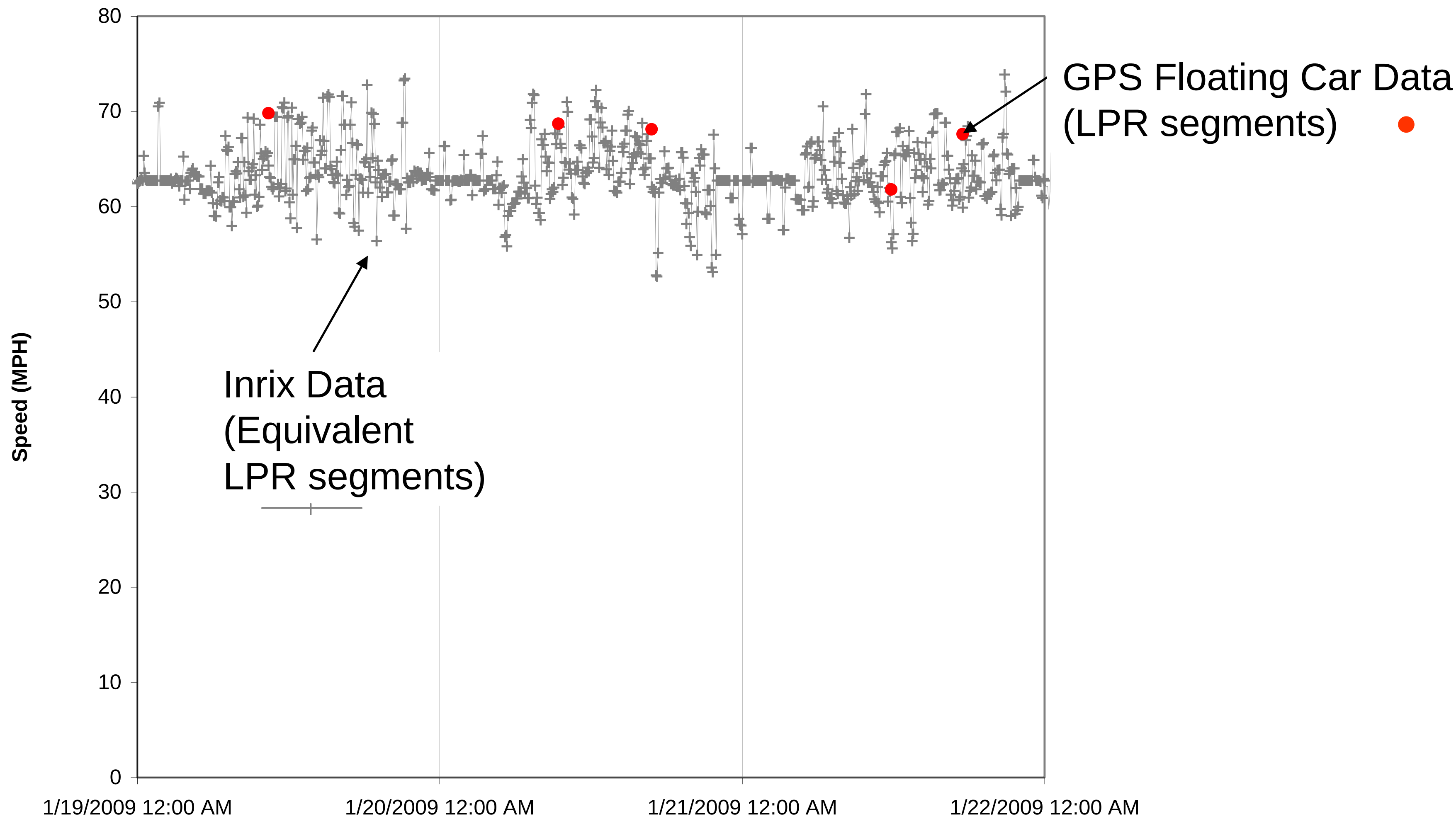
Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)

MM202WB – Travel Time



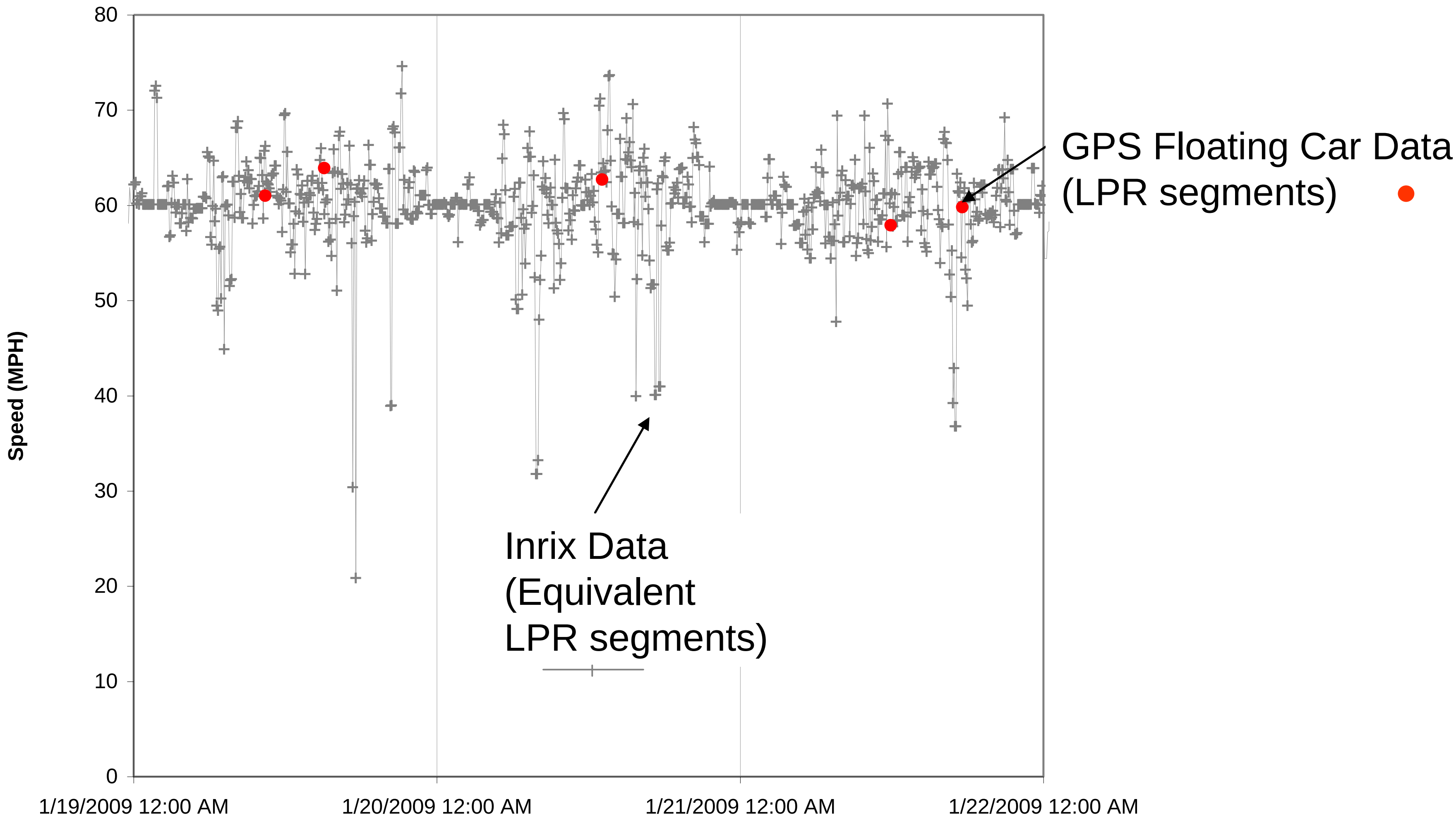
Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)

MM195EB – Speed



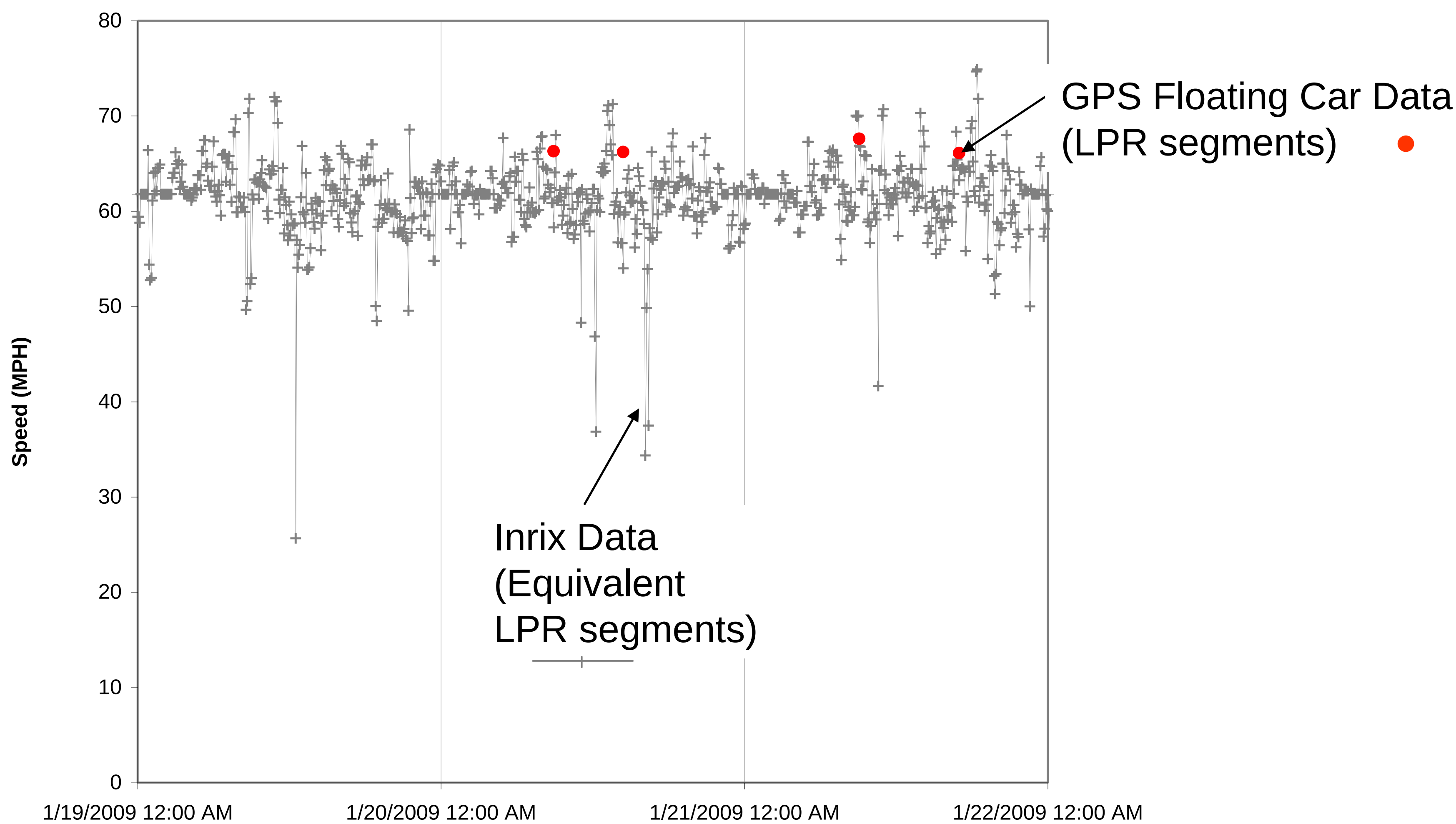
Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)

MM198EB – Speed



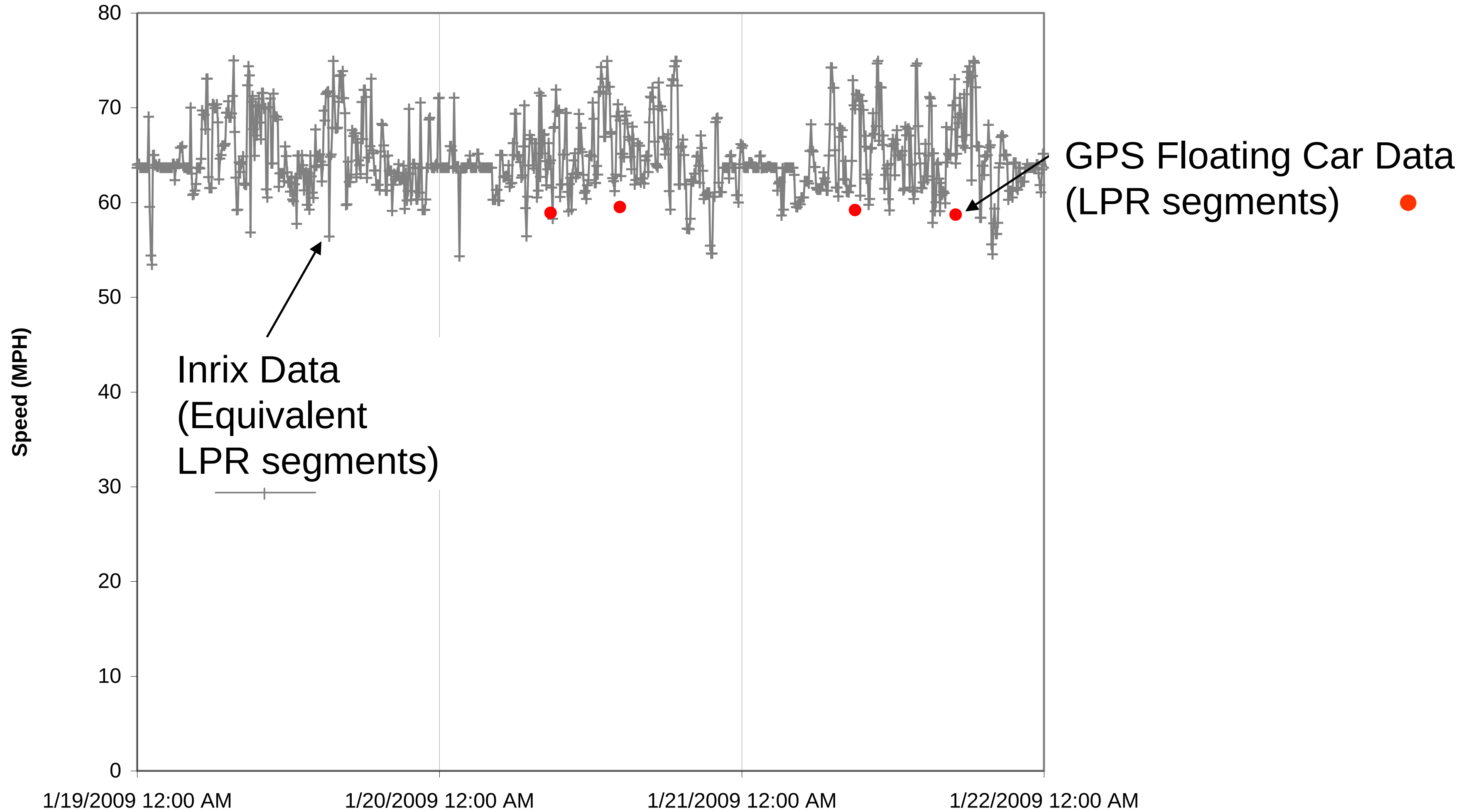
Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)

MM198WB – Speed



Floating Vehicle vs. INRIX Data (in terms of Equivalent LPR Segments)

MM202WB – Speed



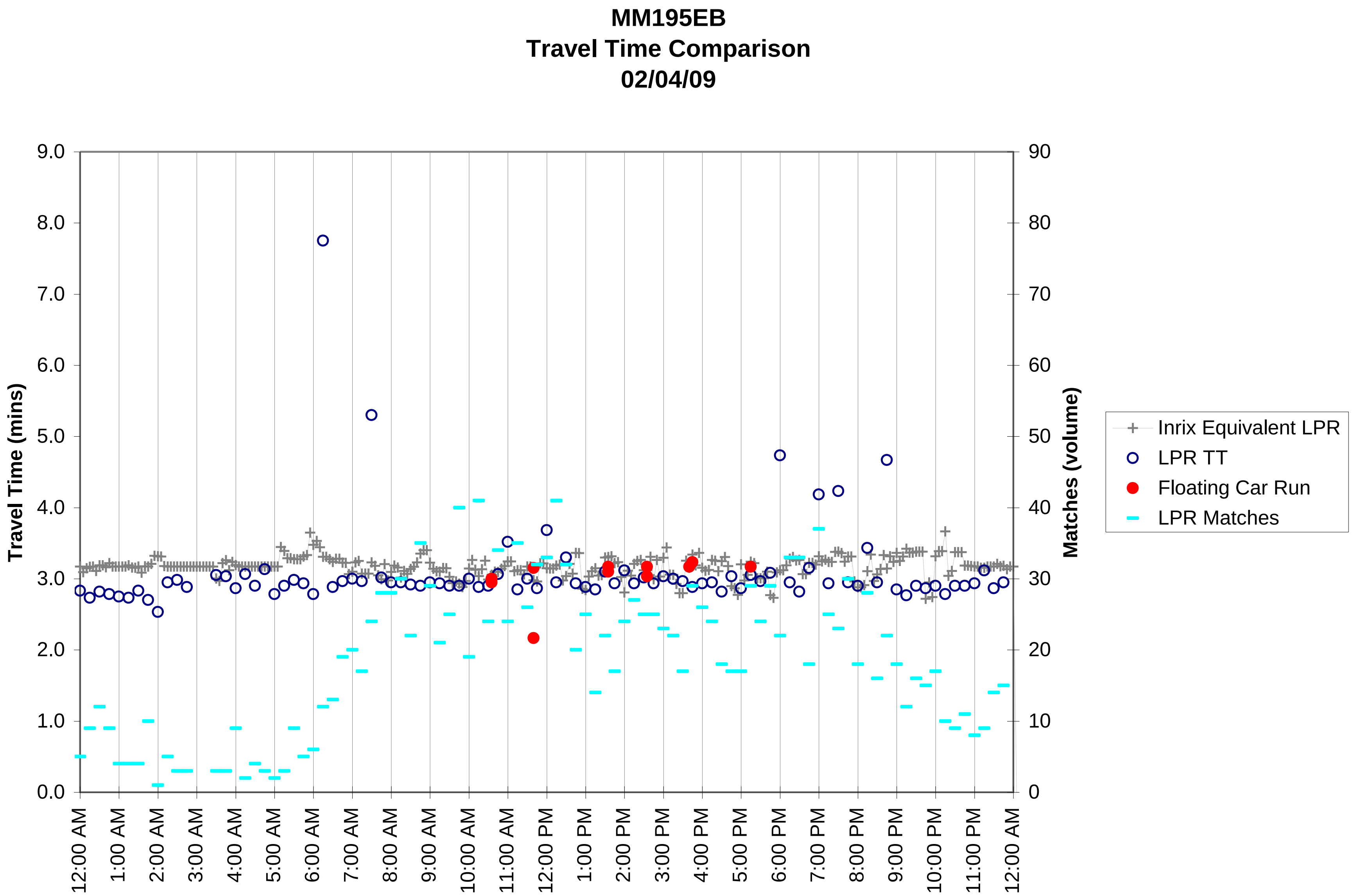
Appendix B:

Comparison between Floating Vehicle Data, Inrix Data and LPR Data

February 4, 2009

&

March 25, 2009


MM195EB
Travel Time Comparison
02/04/09
Travel Time (mins)
Matches (volume)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
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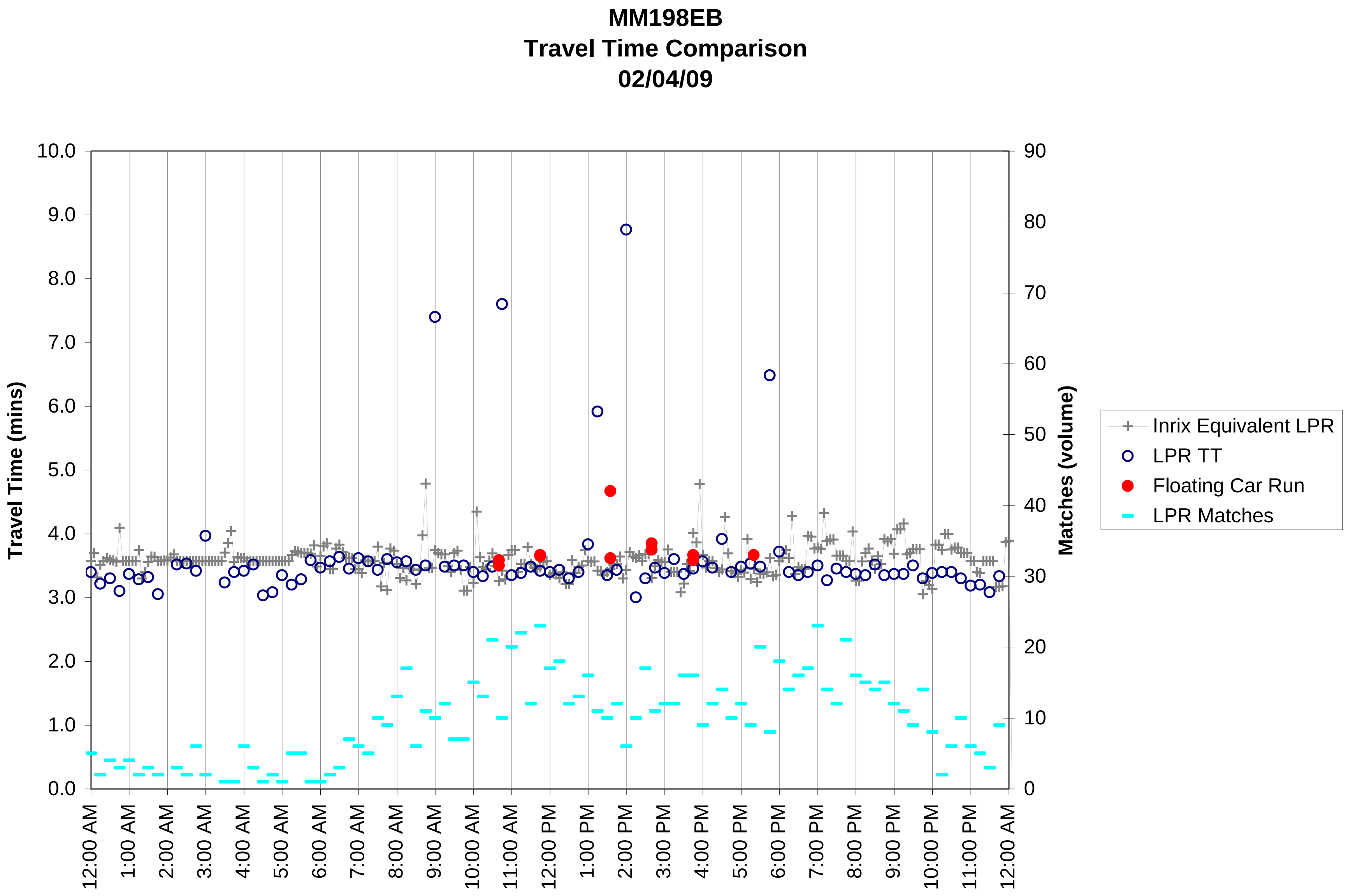
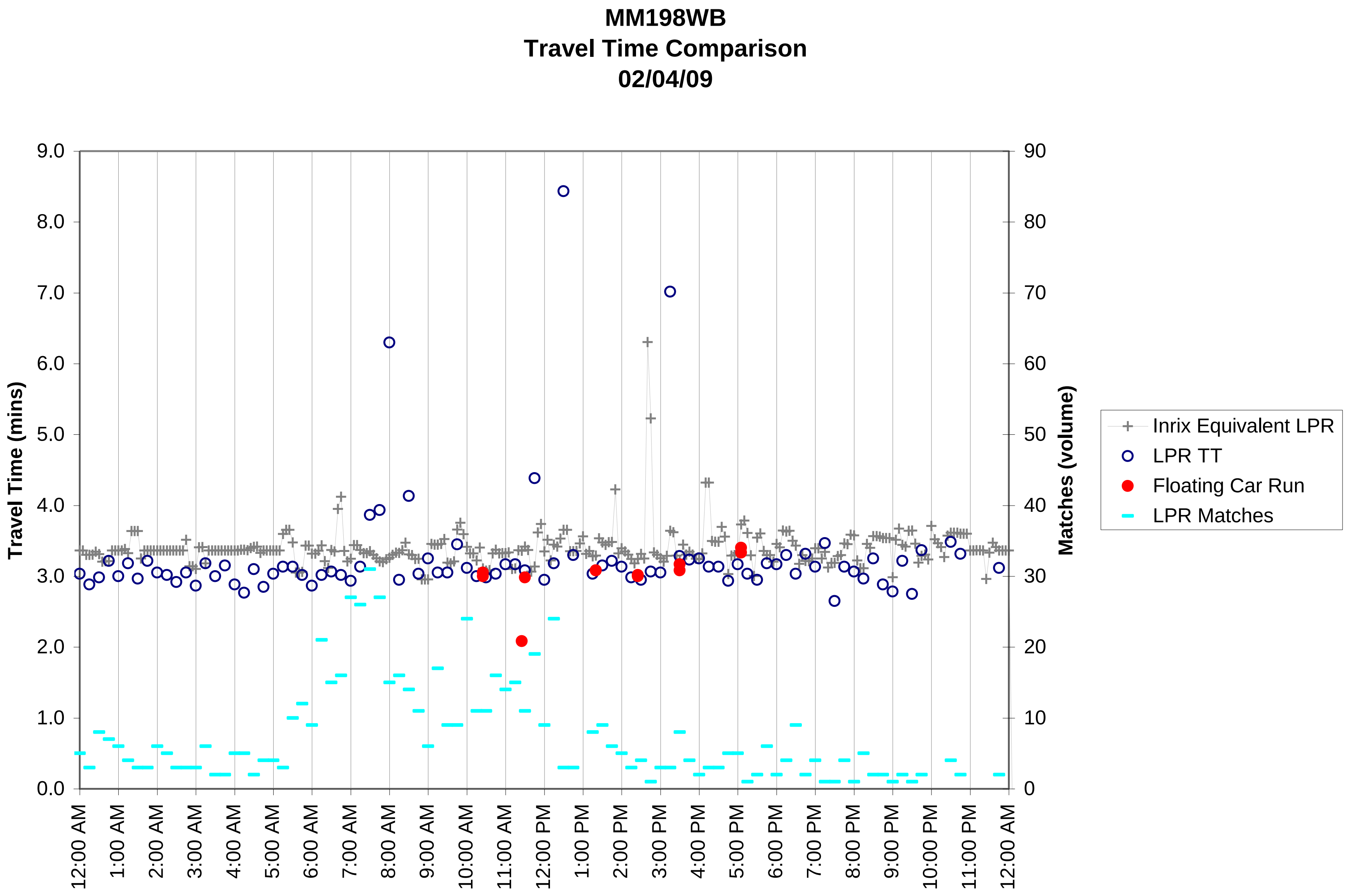
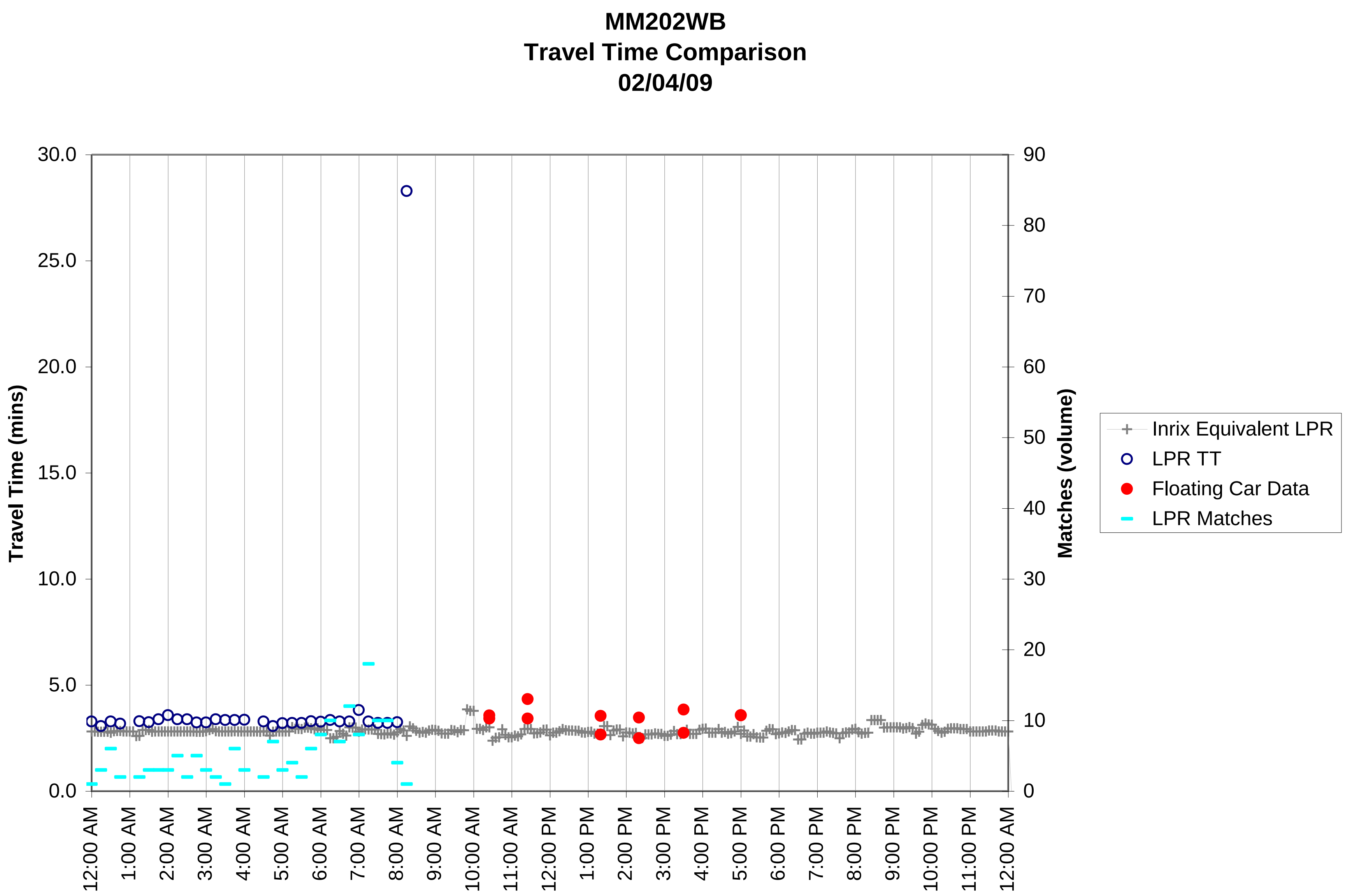
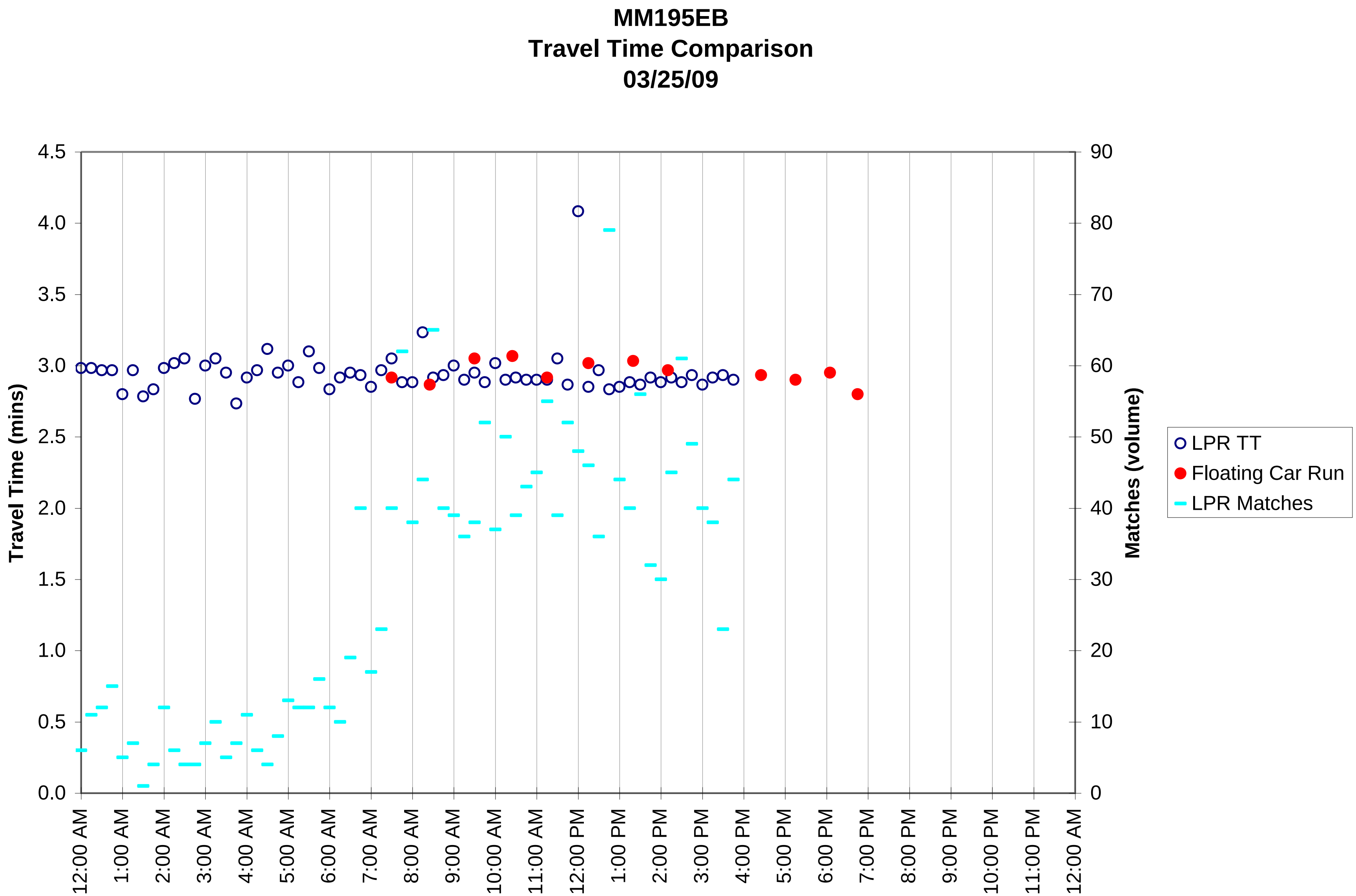
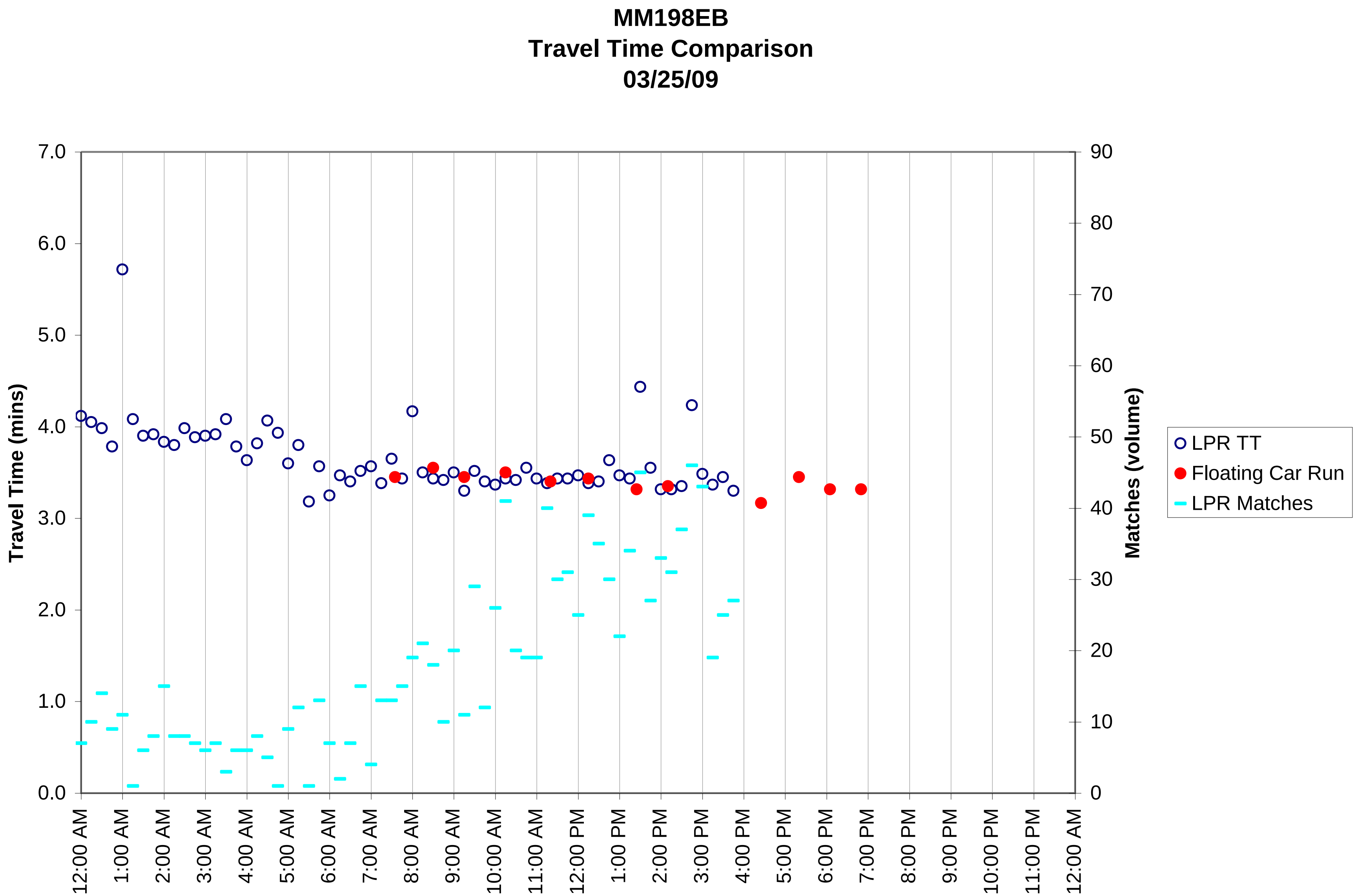
10:00 PM
11:00 PM
12:00 AM
Inrix Equivalent LPR
LPR TT
Floating Car Run
LPR Matches

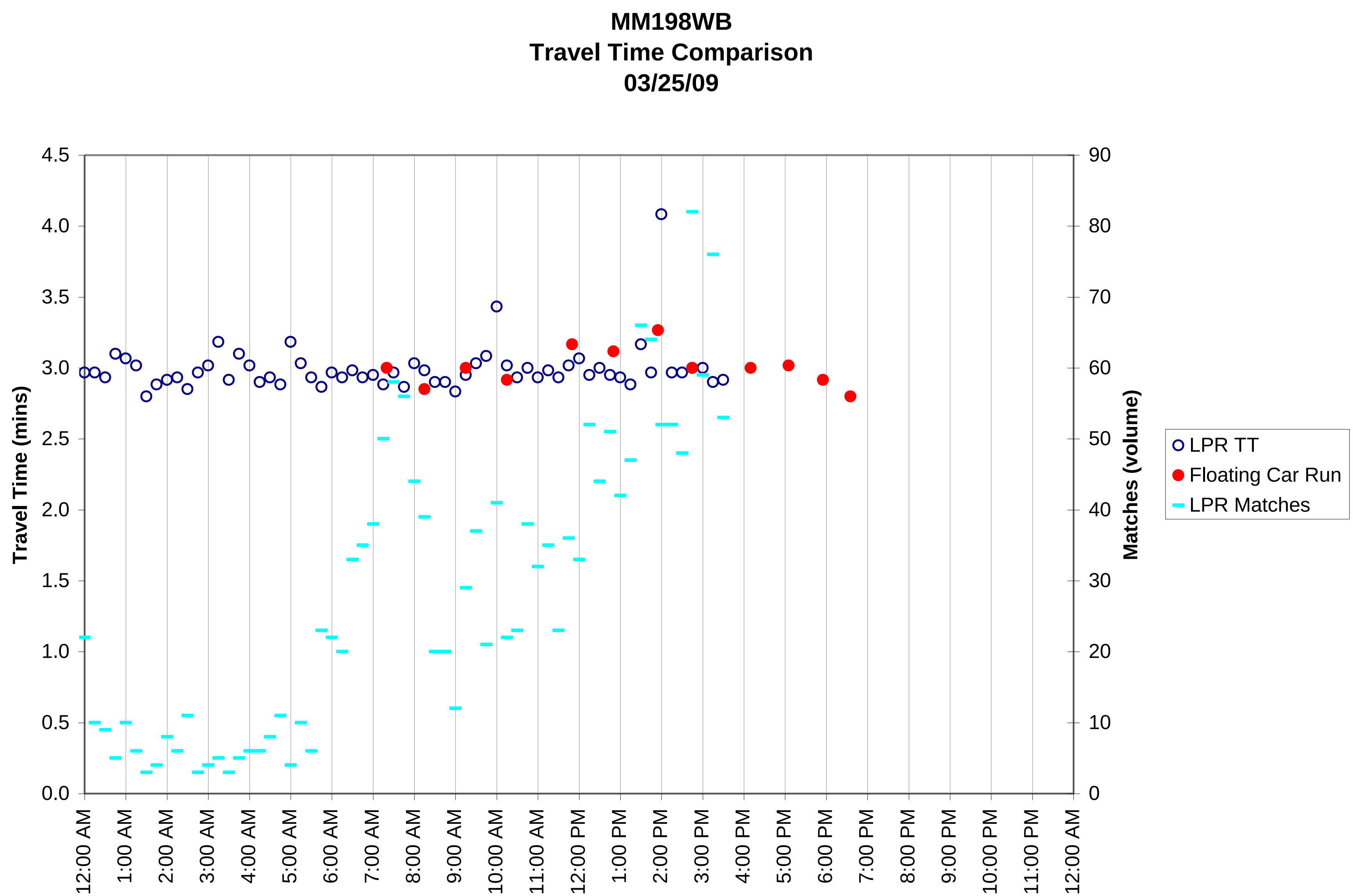

MM198EB
Travel Time Comparison
02/04/09
Travel Time (mins)
Matches (volume)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
Inrix Equivalent LPR
LPR TT
Floating Car Run
LPR Matches

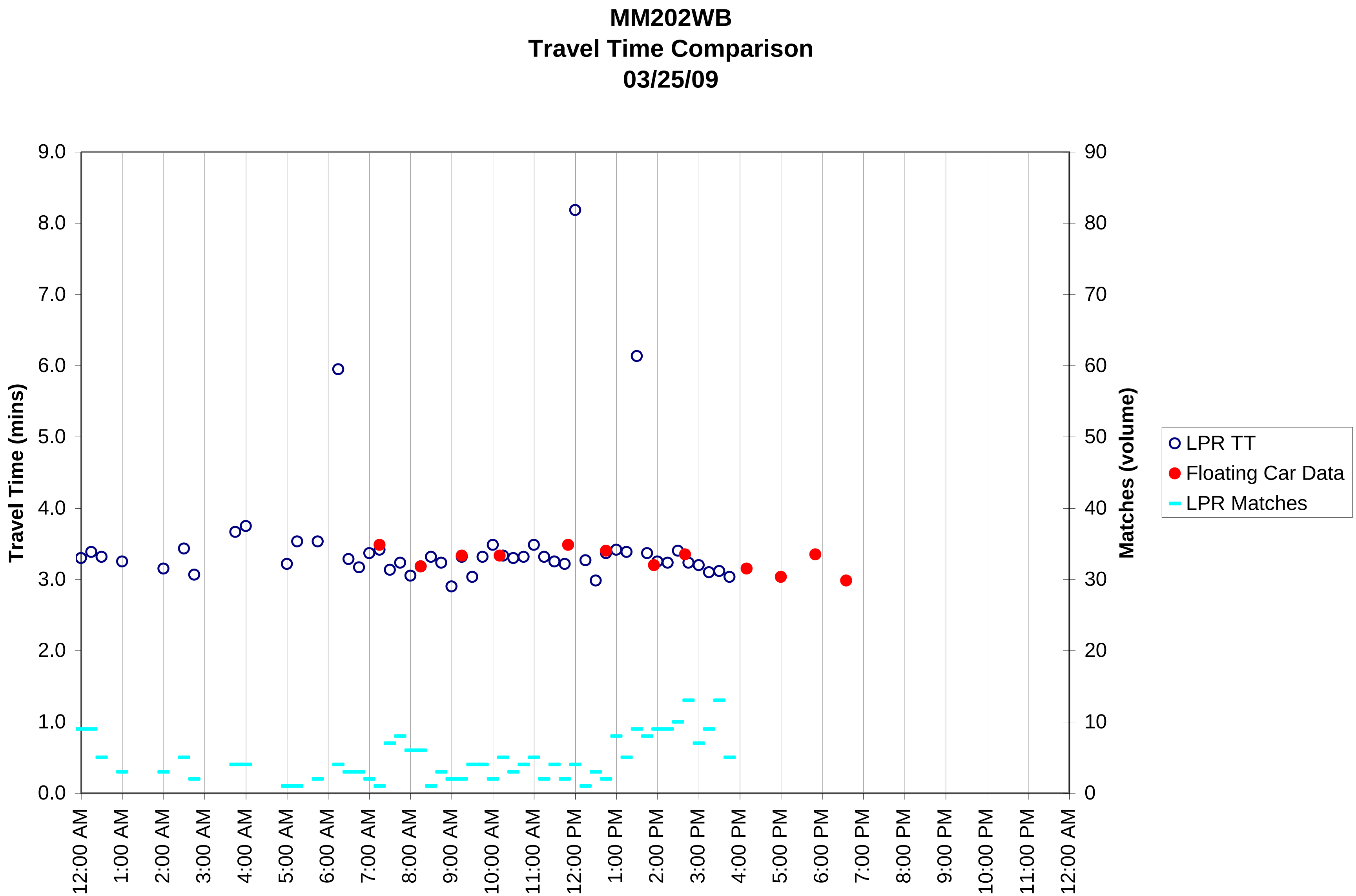

MM198WB
Travel Time Comparison
02/04/09
Travel Time (mins)
Matches (volume)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
Inrix Equivalent LPR
LPR TT
Floating Car Run
LPR Matches

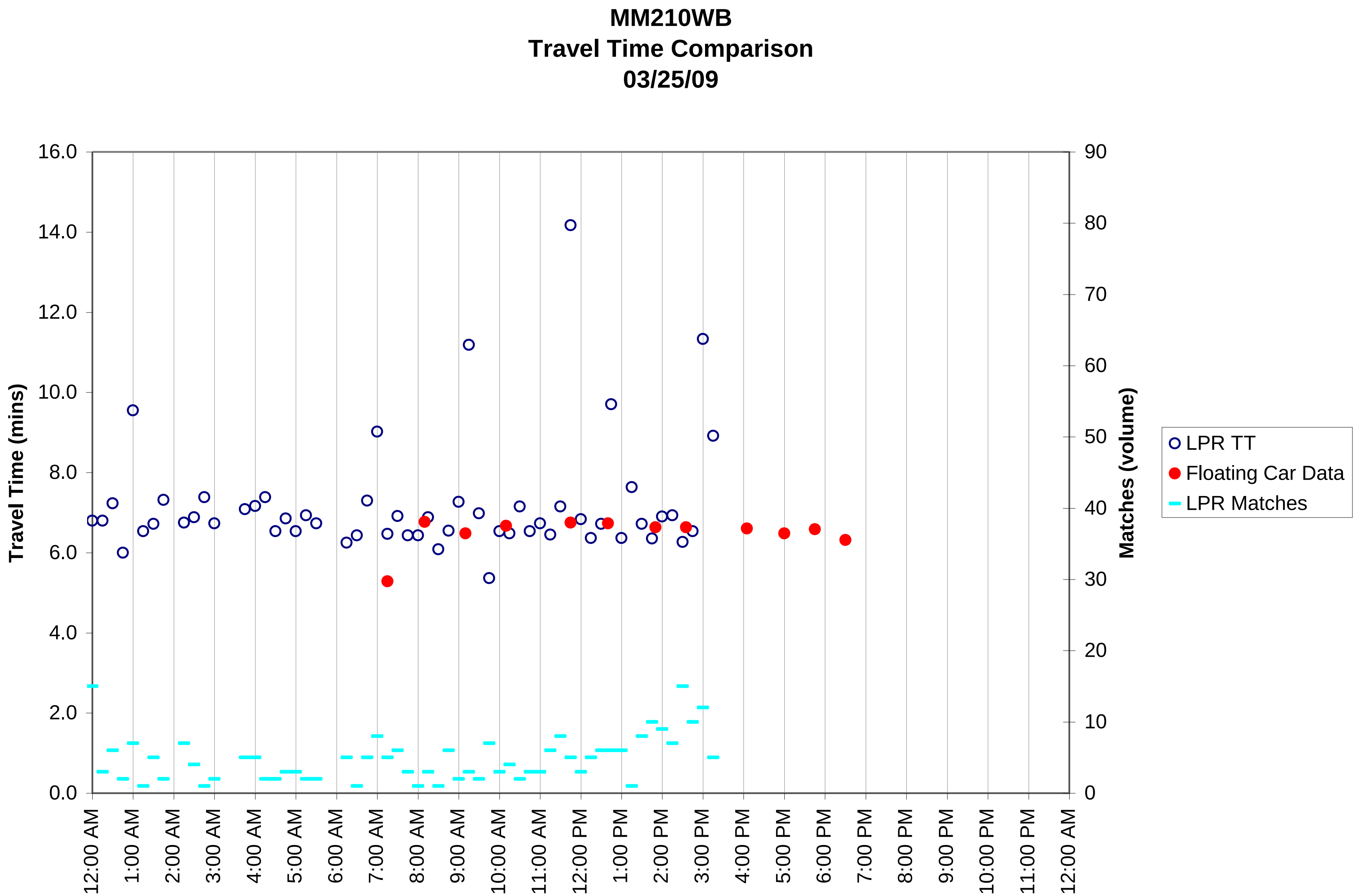

MM202WB
Travel Time Comparison
02/04/09
Travel Time (mins)
Matches (volume)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
Inrix Equivalent LPR
LPR TT
Floating Car Data
LPR Matches

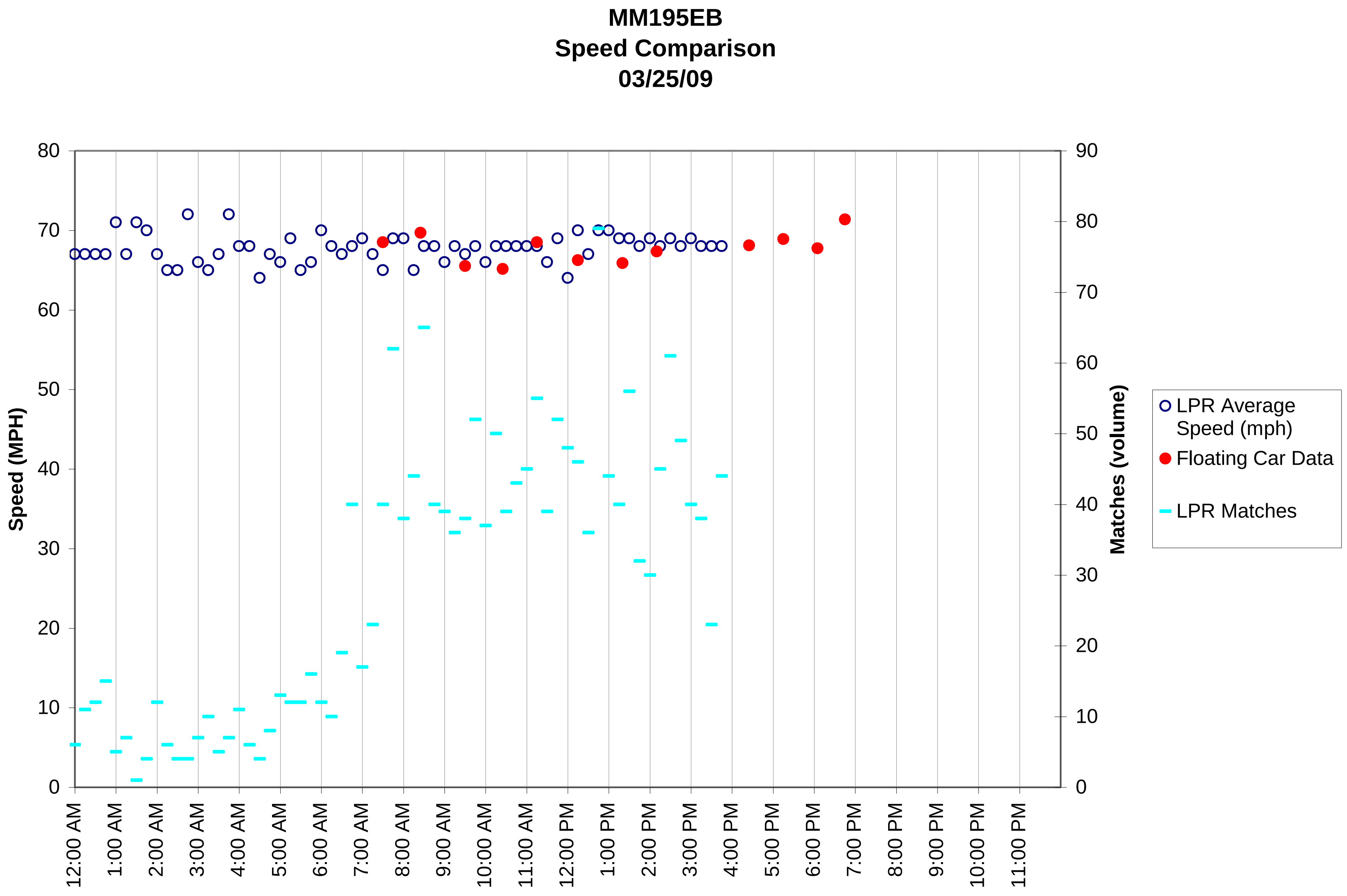

MM195EB
Travel Time Comparison
03/25/09
Travel Time (mins)
Matches (volume)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
LPR TT
Floating Car Run
LPR Matches

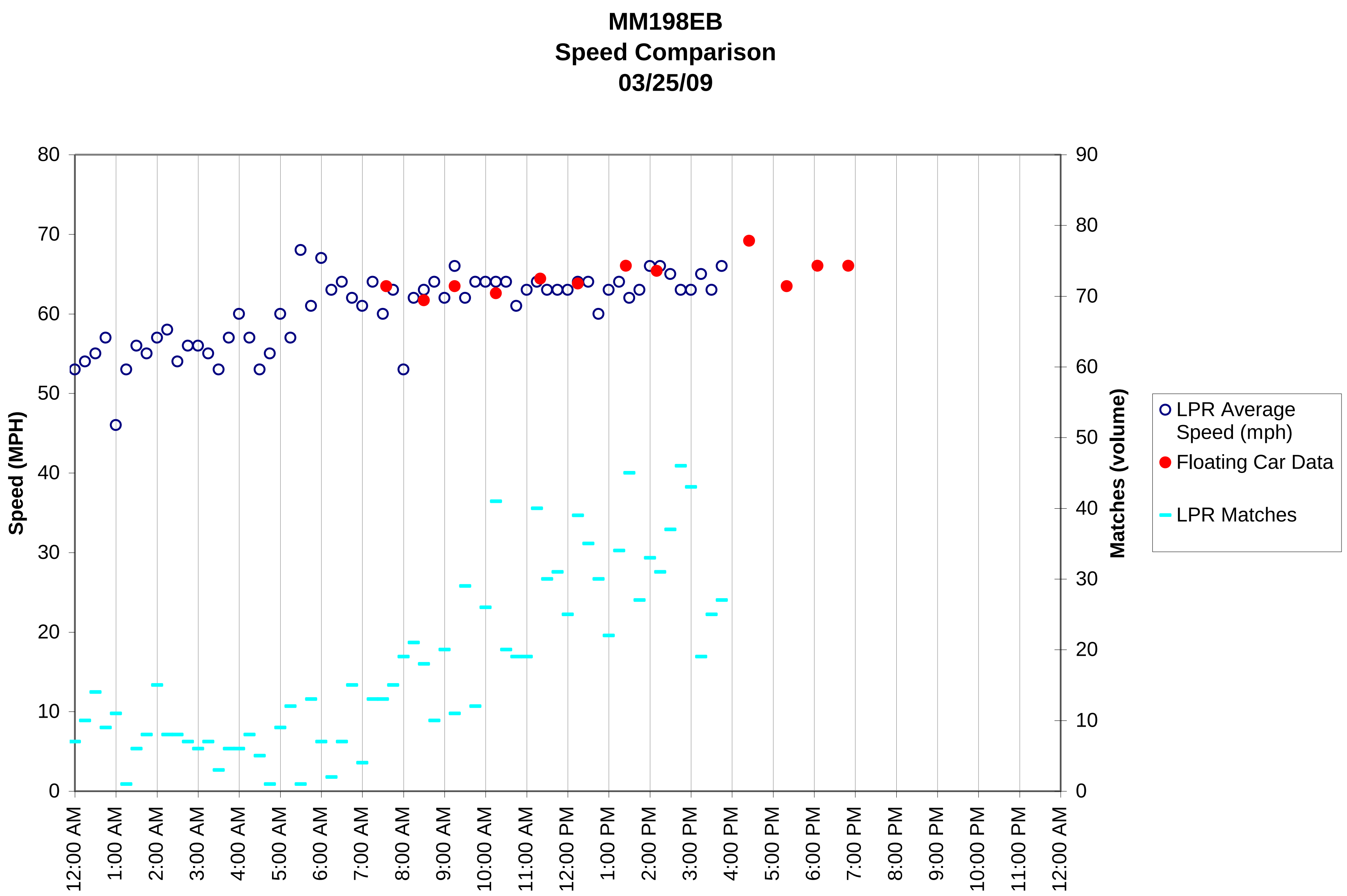

MM198EB
Travel Time Comparison
03/25/09
Travel Time (mins)
Matches (volume)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
LPR TT
Floating Car Run
LPR Matches

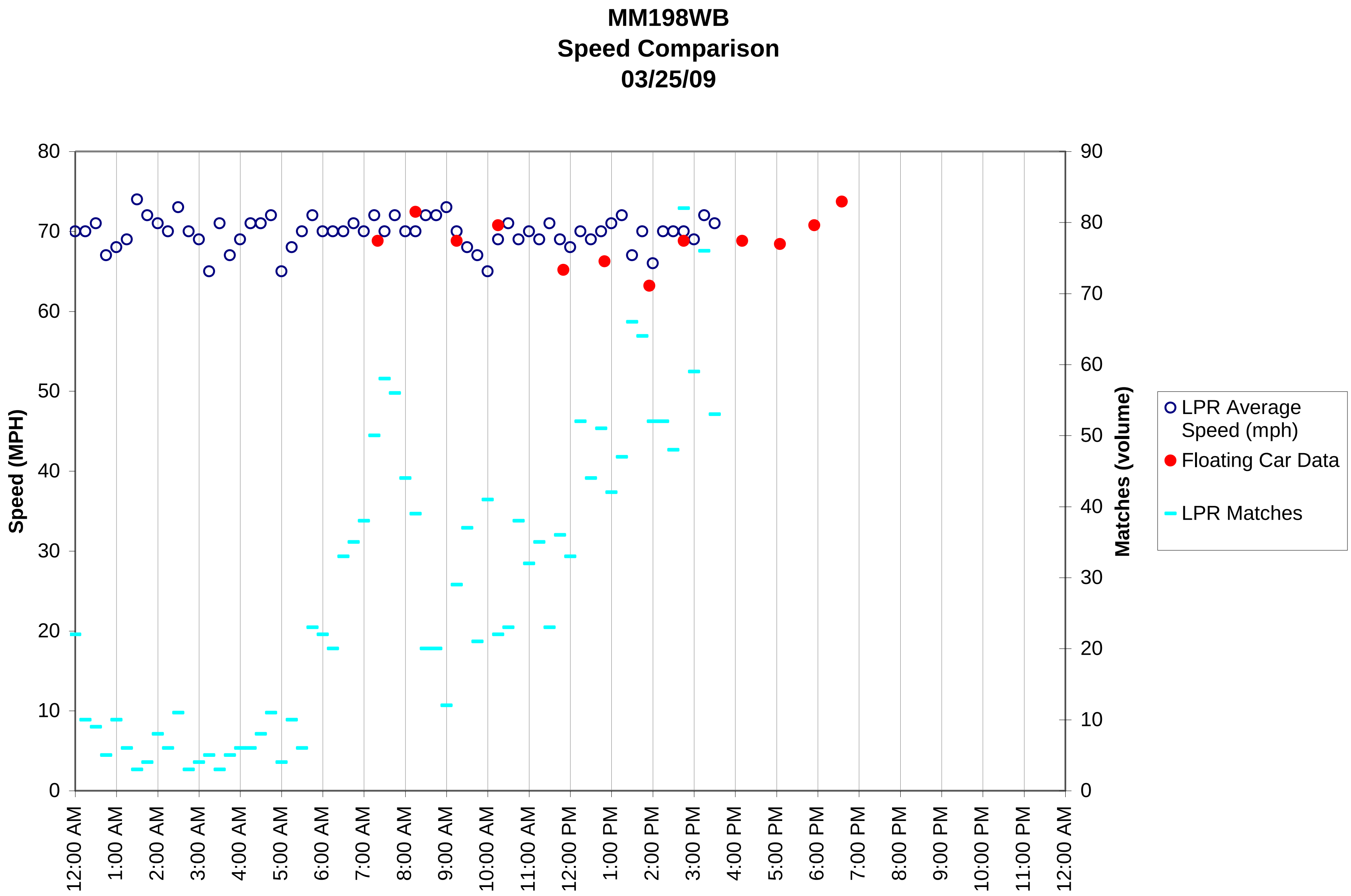

MM198WB
Travel Time Comparison
03/25/09
Travel Time (mins)
Matches (volume)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
LPR TT
Floating Car Run
LPR Matches

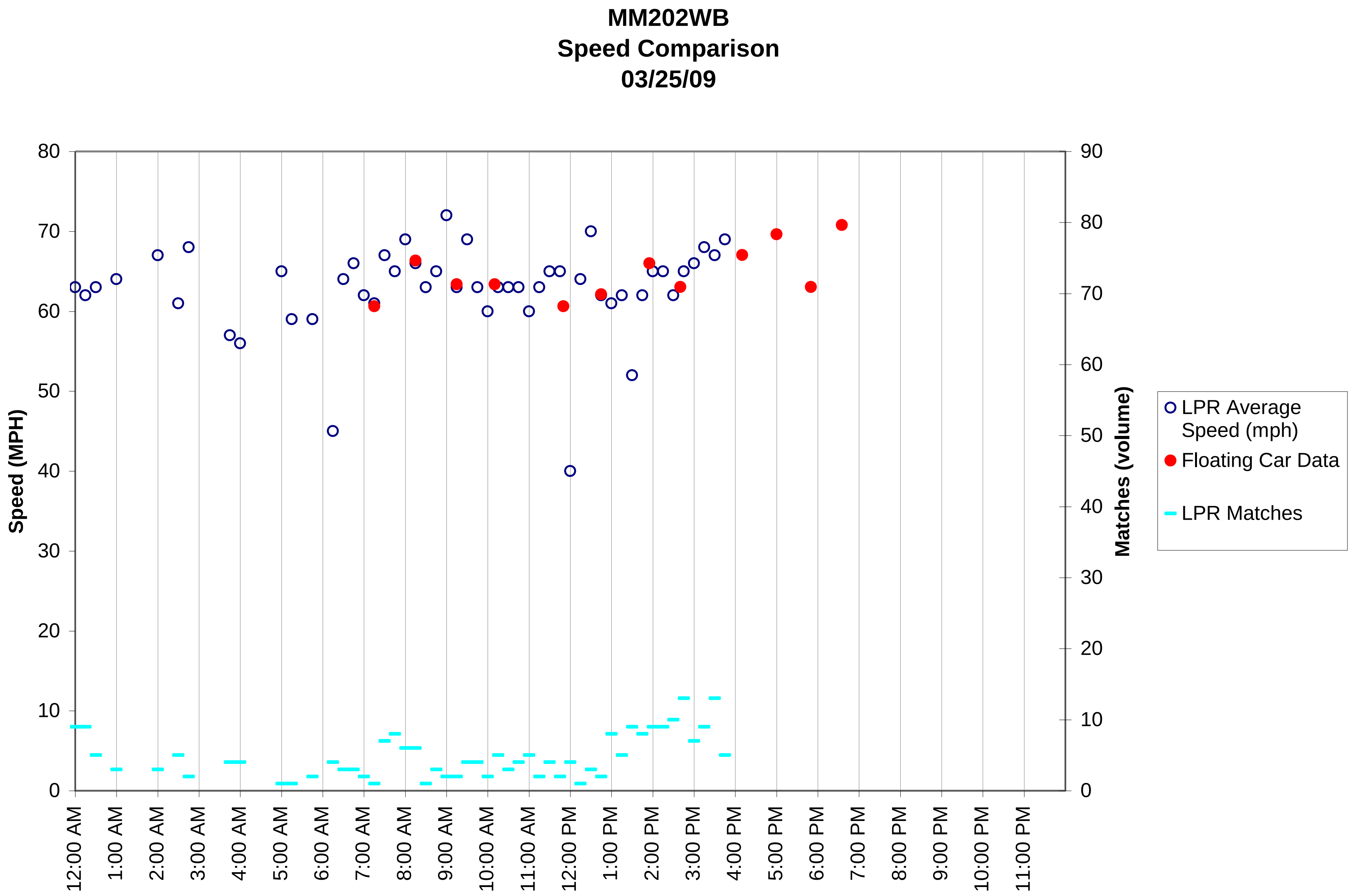

MM202WB
Travel Time Comparison
03/25/09
Travel Time (mins)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Matches (volume)
90
80
70
60
50
40
30
20
10
0
LPR TT
Floating Car Data
LPR Matches
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM

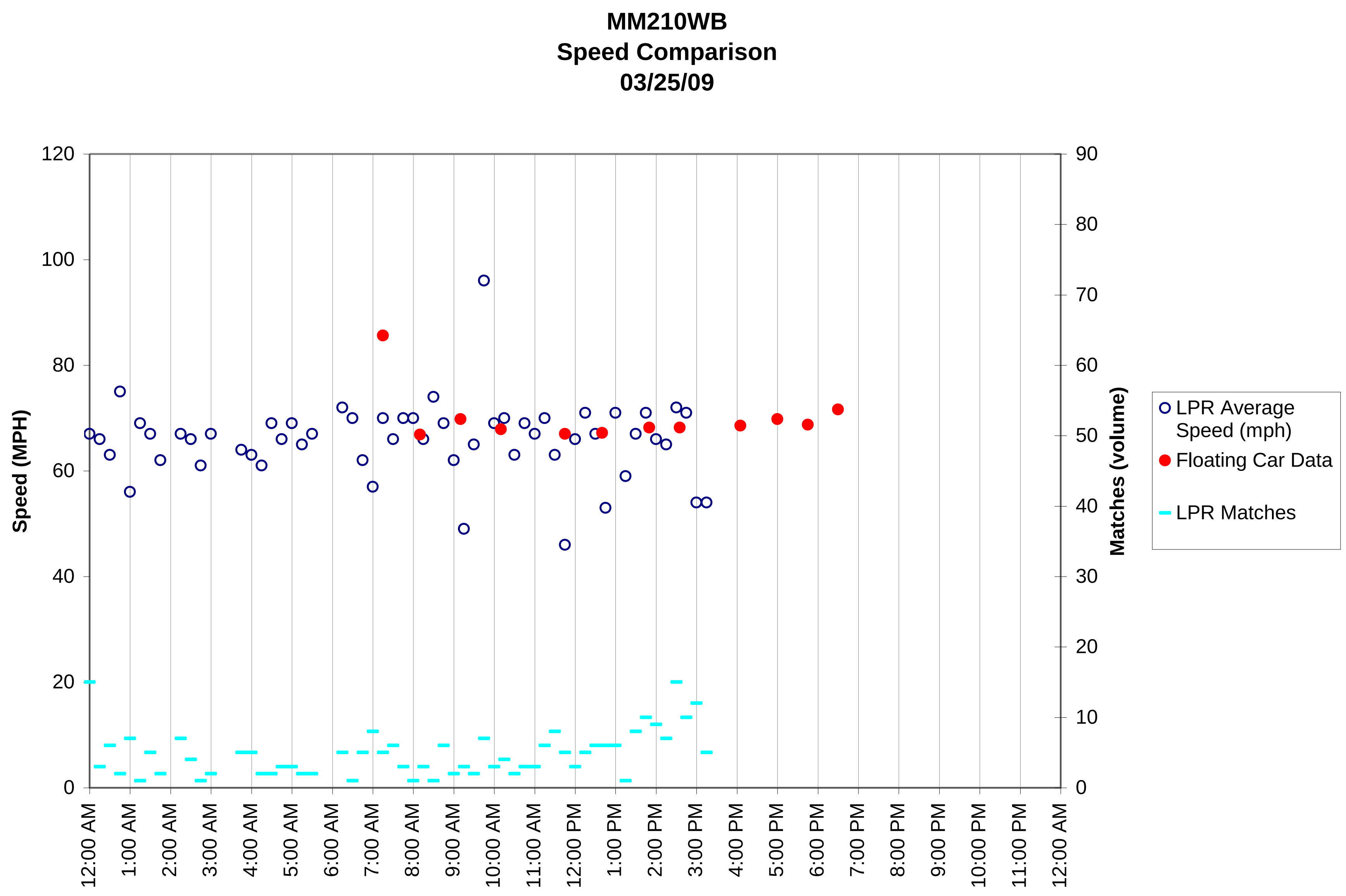

MM210WB
Travel Time Comparison
03/25/09
Travel Time (mins)
Matches (volume)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
90
80
70
60
50
40
30
20
10
0
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
LPR TT
Floating Car Data
LPR Matches


MM195EB
Speed Comparison
03/25/09
Speed (MPH)
Matches (volume)
0
10
20
30
40
50
60
70
80
90
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
LPR Average Speed (mph)
Floating Car Data
LPR Matches


MM198EB
Speed Comparison
03/25/09
Speed (MPH)
Matches (volume)
LPR Average Speed (mph)
Floating Car Data
LPR Matches
0
10
20
30
40
50
60
70
80
90
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM


MM198WB
Speed Comparison
03/25/09
Speed (MPH)
Matches (volume)
0
10
20
30
40
50
60
70
80
90
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
LPR Average Speed (mph)
Floating Car Data
LPR Matches

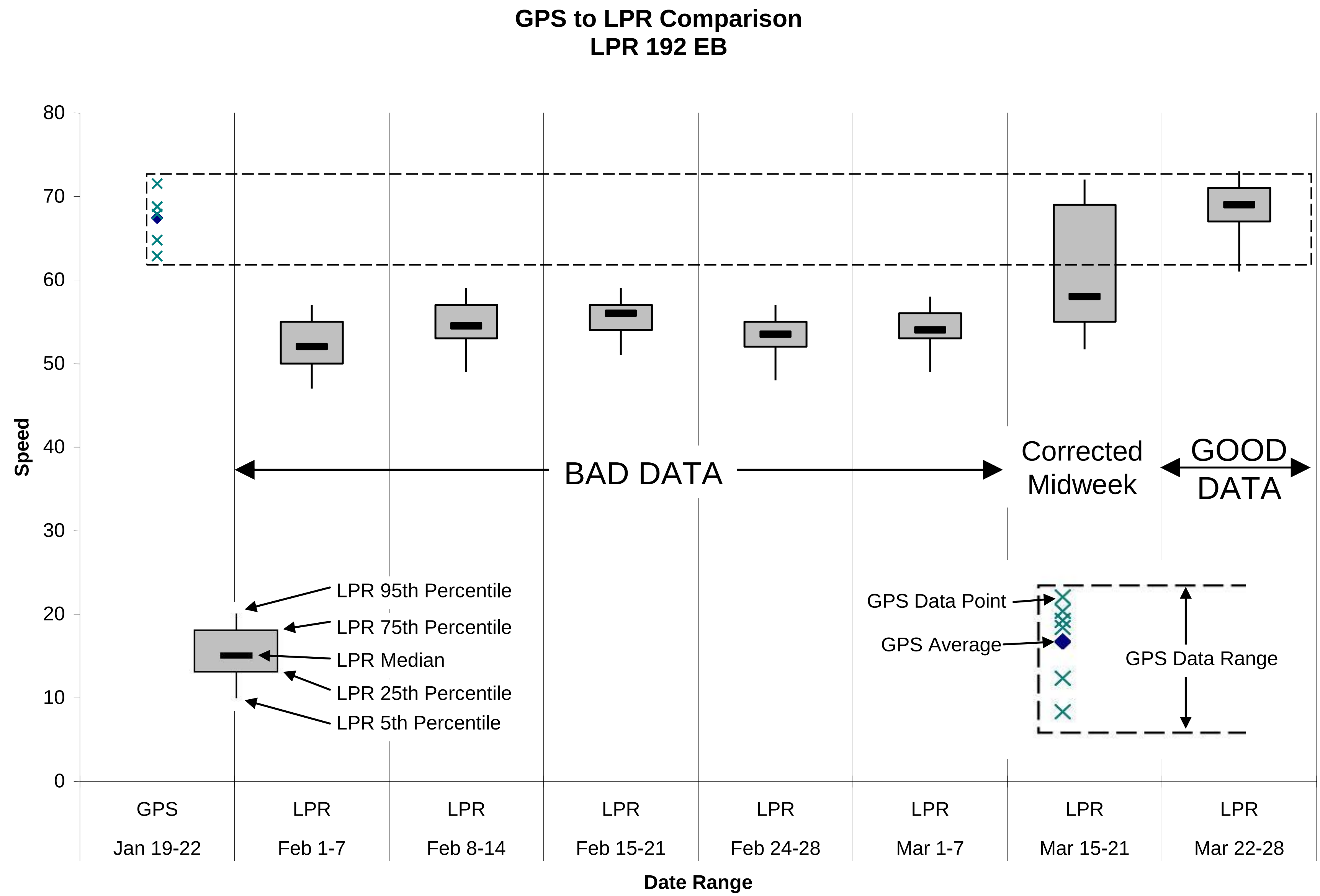

MM202WB
Speed Comparison
03/25/09
Speed (MPH)
Matches (volume)
80
70
60
50
40
30
20
10
0
90
80
70
60
50
40
30
20
10
0
LPR Average Speed (mph)
Floating Car Data
LPR Matches
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM


MM210WB
Speed Comparison
03/25/09
Speed (MPH)
Matches (volume)
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
12:00 AM
LPR Average Speed (mph)
Floating Car Data
LPR Matches

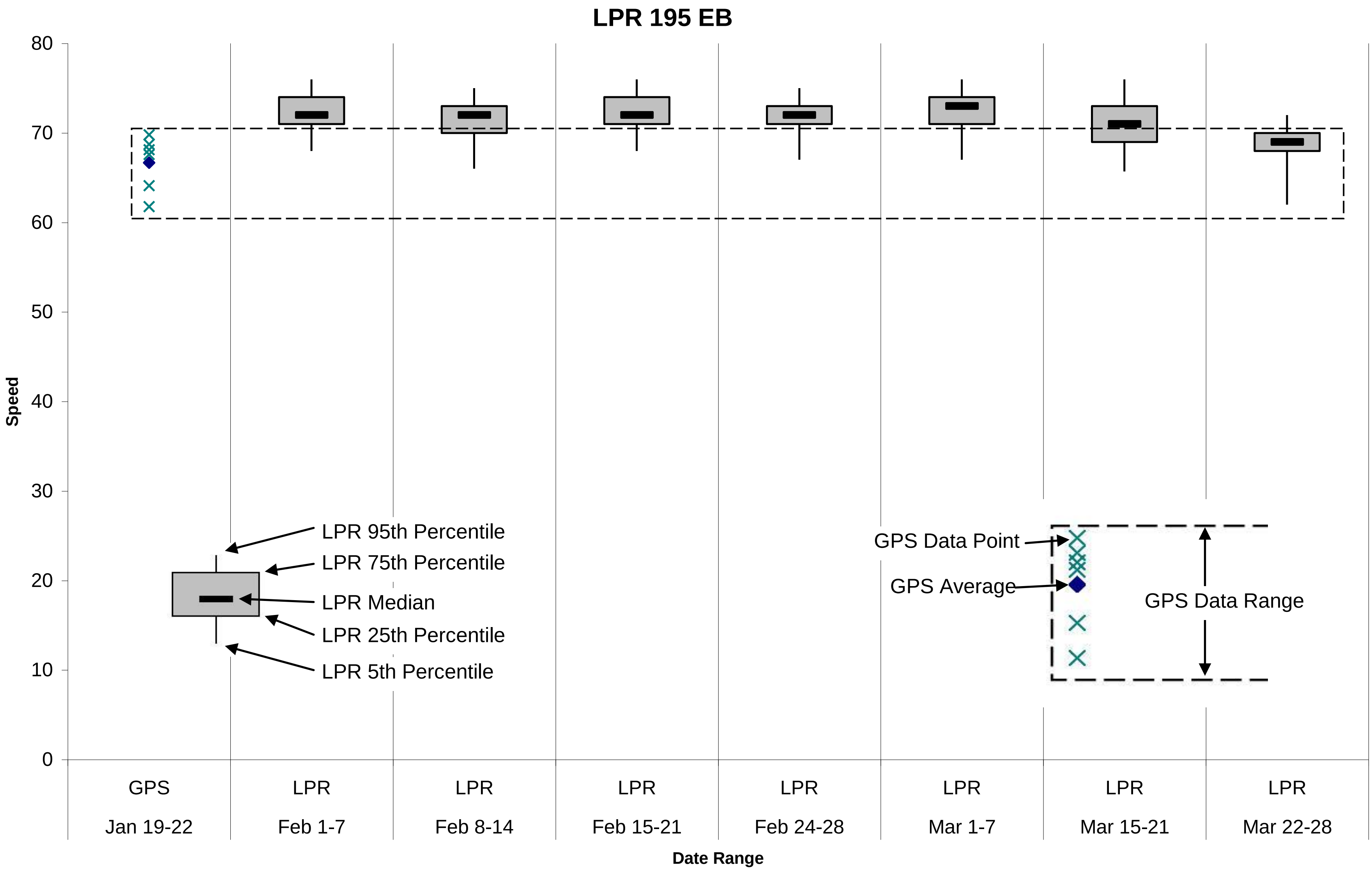
Appendix C:

Consistency Check of LPR Data

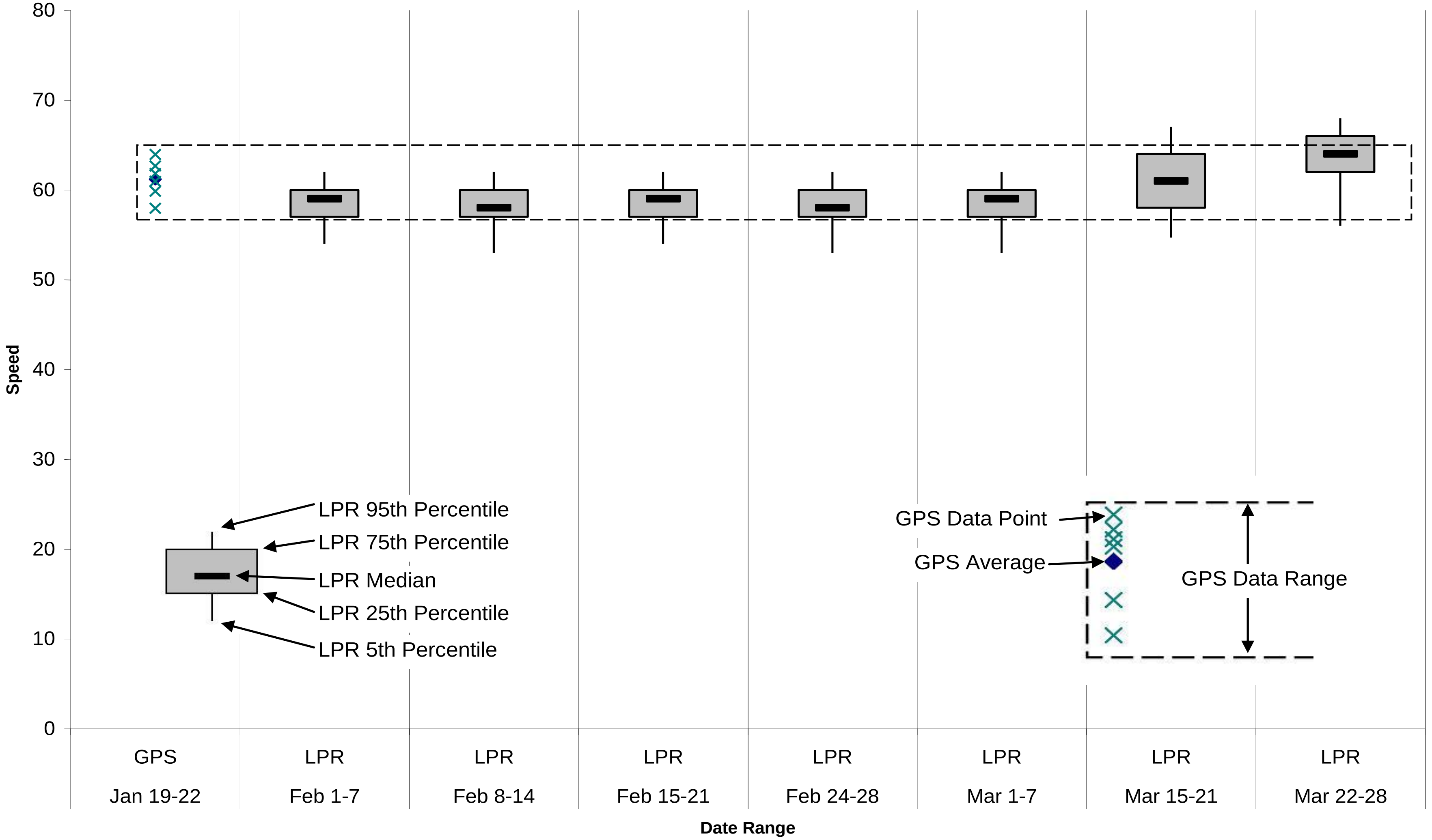
February 1, 2009
to
March 28, 2009



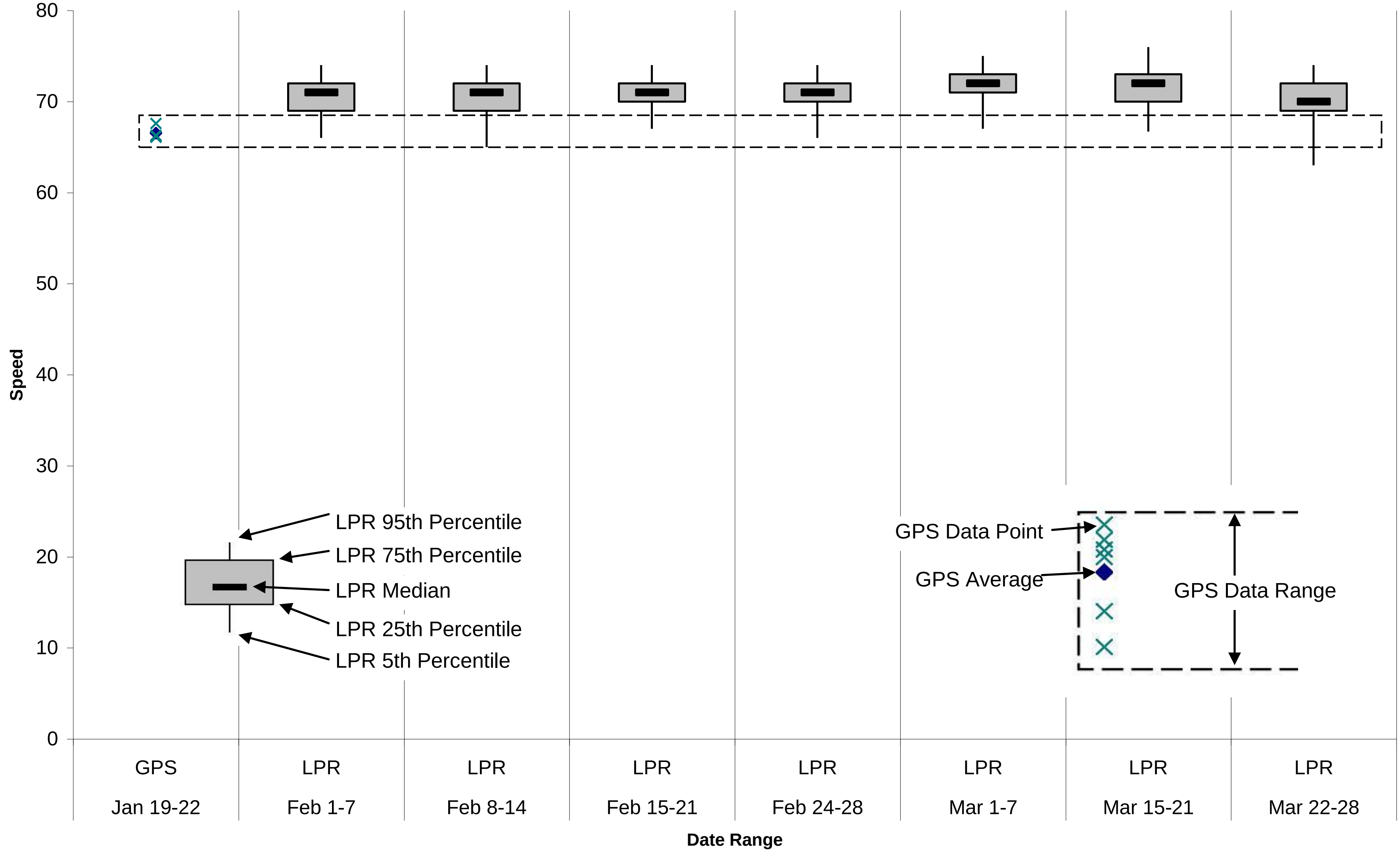
GPS to LPR Comparison



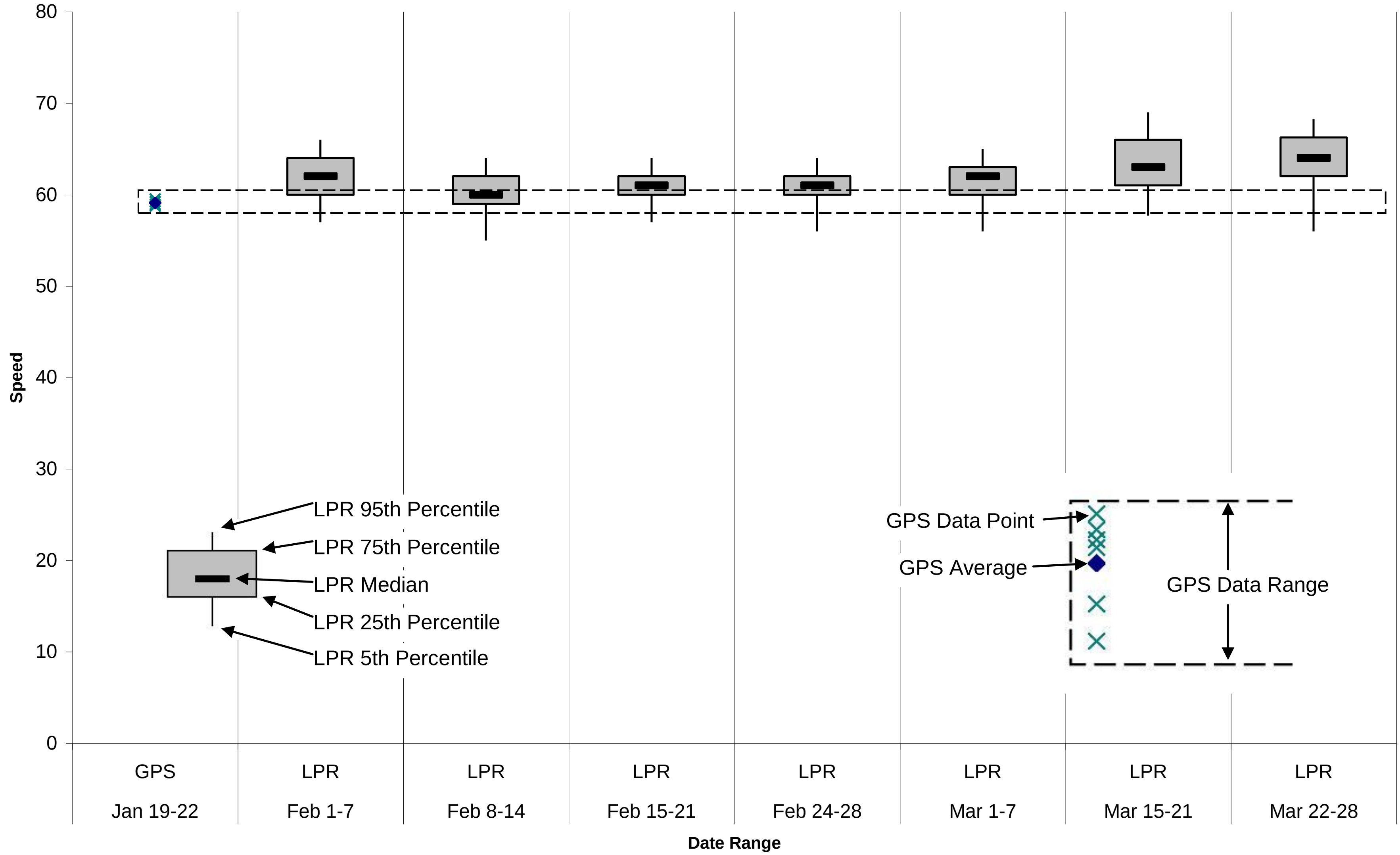
GPS to LPR Comparison
LPR 198 EB

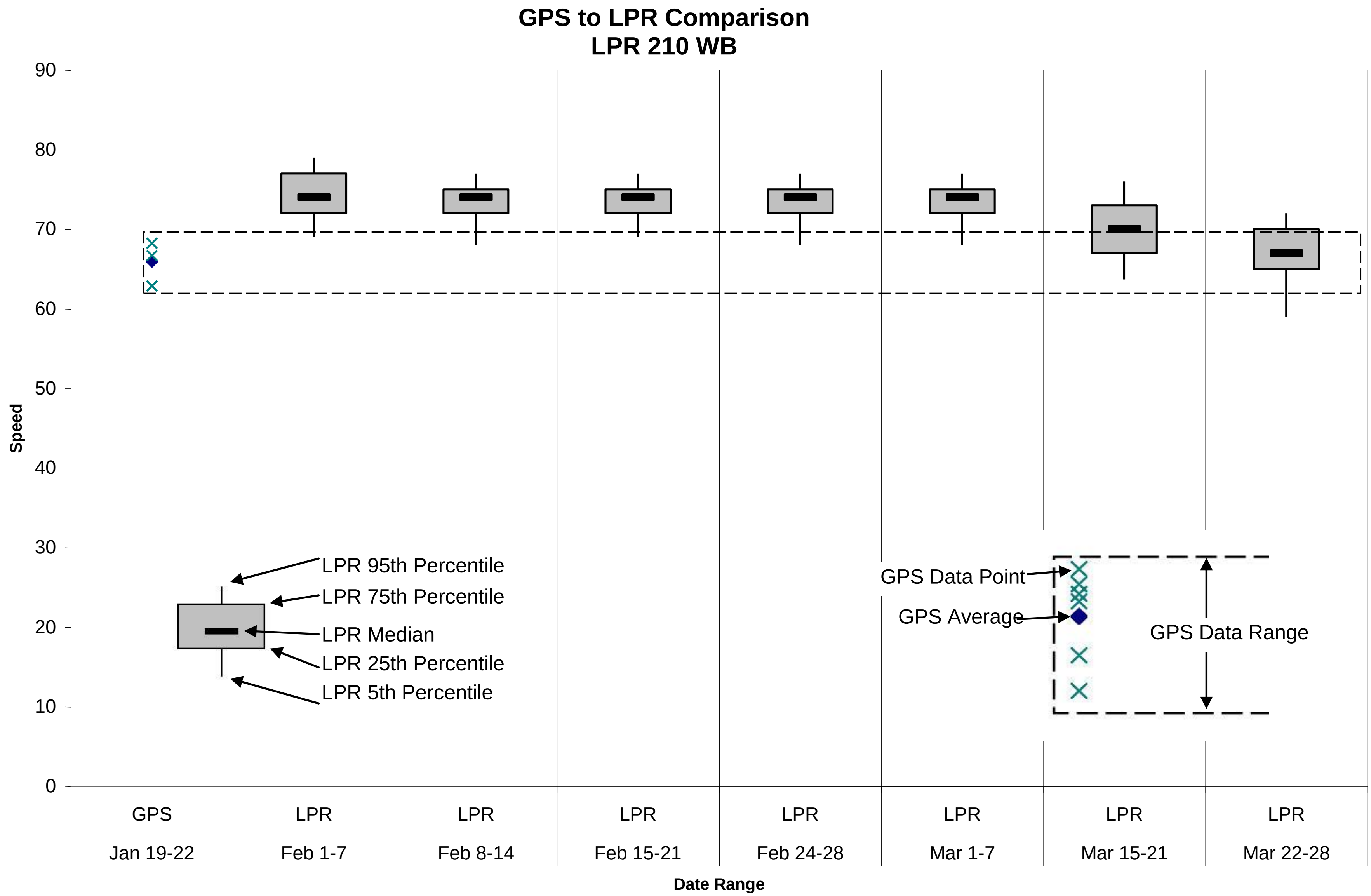


GPS to LPR Comparison
LPR 198 WB



GPS to LPR Comparison
LPR 202 WB

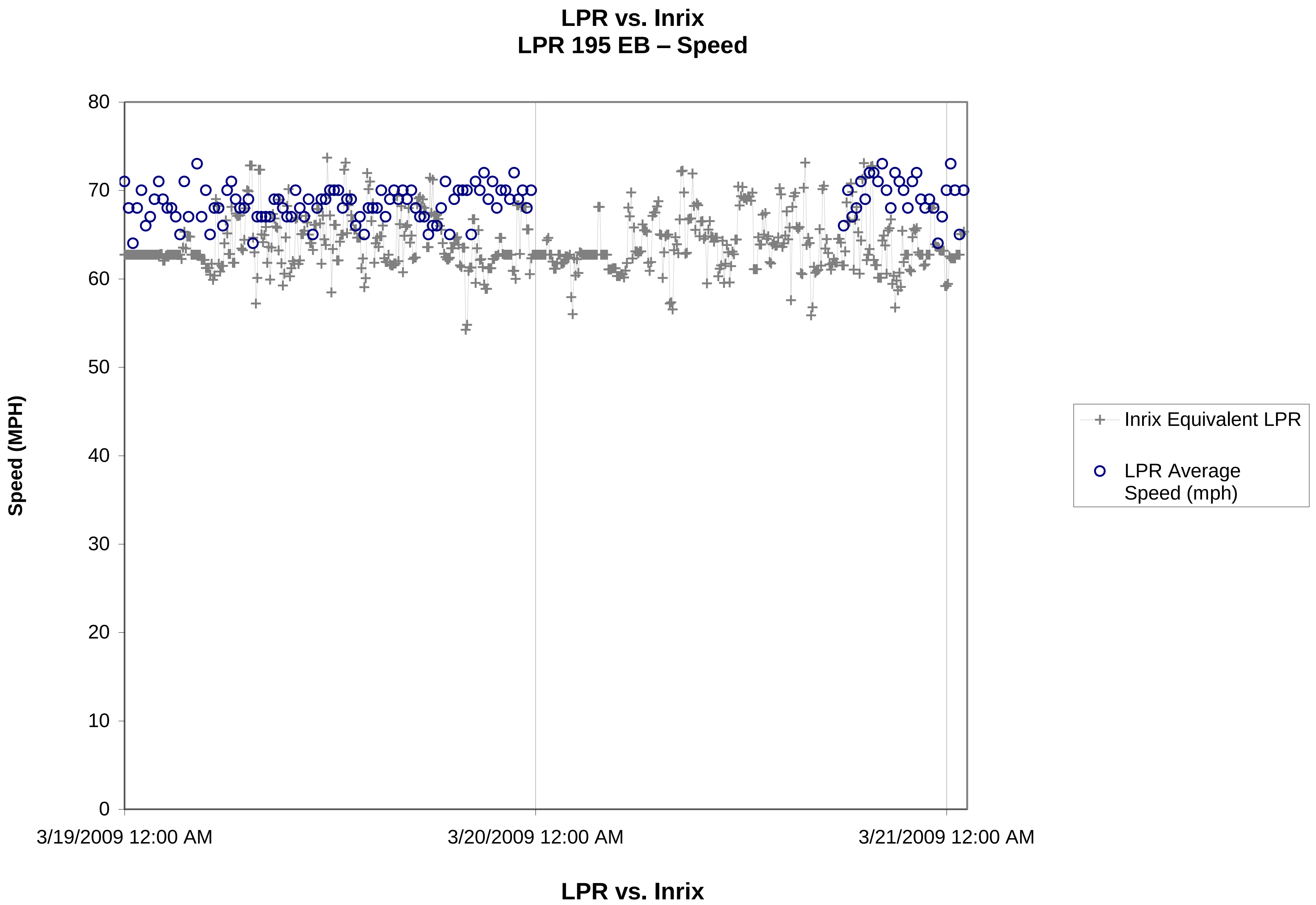

80
70
60
50
40
30
20
10
0
Speed
LPR 95th Percentile
LPR 75th Percentile
LPR Median
LPR 25th Percentile
LPR 5th Percentile
GPS Data Point
GPS Average
GPS Data Range
GPS
Jan 19-22
LPR
Feb 1-7
LPR
Feb 8-14
LPR
Feb 15-21
LPR
Feb 24-28
LPR
Mar 1-7
LPR
Mar 15-21
LPR
Mar 22-28
Date Range

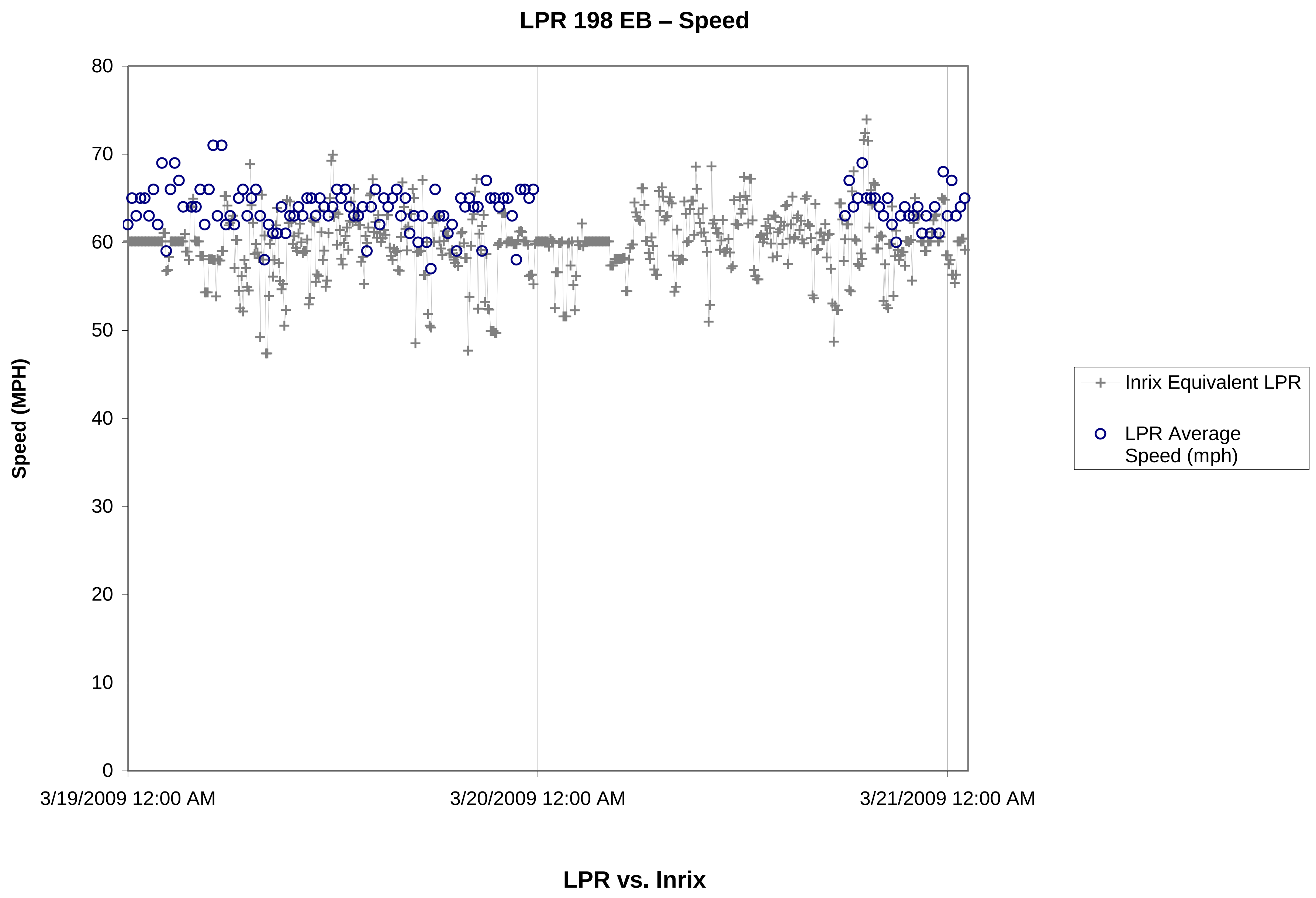

GPS to LPR Comparison
LPR 210 WB
Speed
90
80
70
60
50
40
30
20
10
0
LPR 95th Percentile
LPR 75th Percentile
LPR Median
LPR 25th Percentile
LPR 5th Percentile
GPS Data Point
GPS Average
GPS Data Range
GPS
Jan 19-22
LPR
Feb 1-7
LPR
Feb 8-14
LPR
Feb 15-21
LPR
Feb 24-28
LPR
Mar 1-7
LPR
Mar 15-21
LPR
Mar 22-28
Date Range

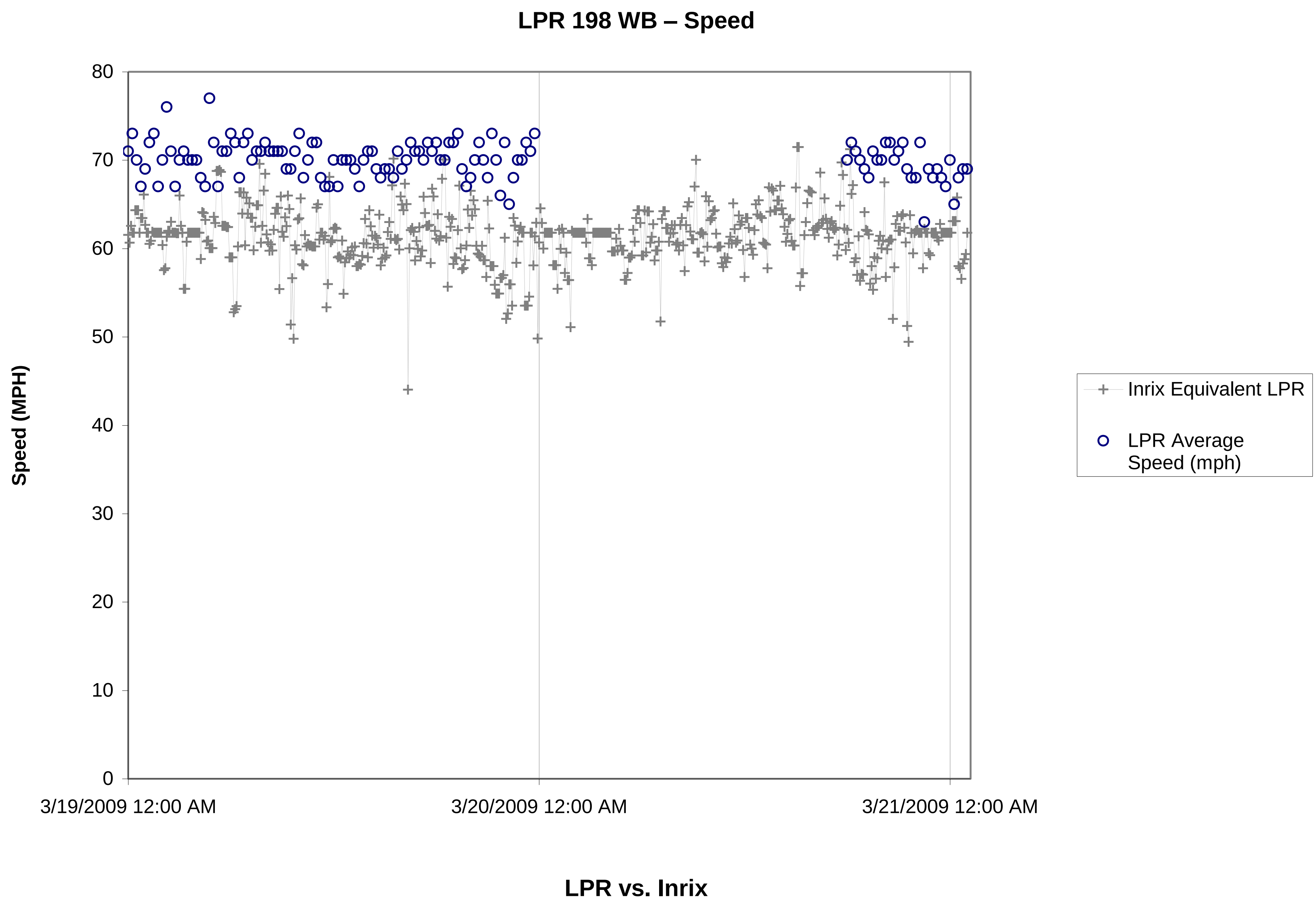
Appendix D:

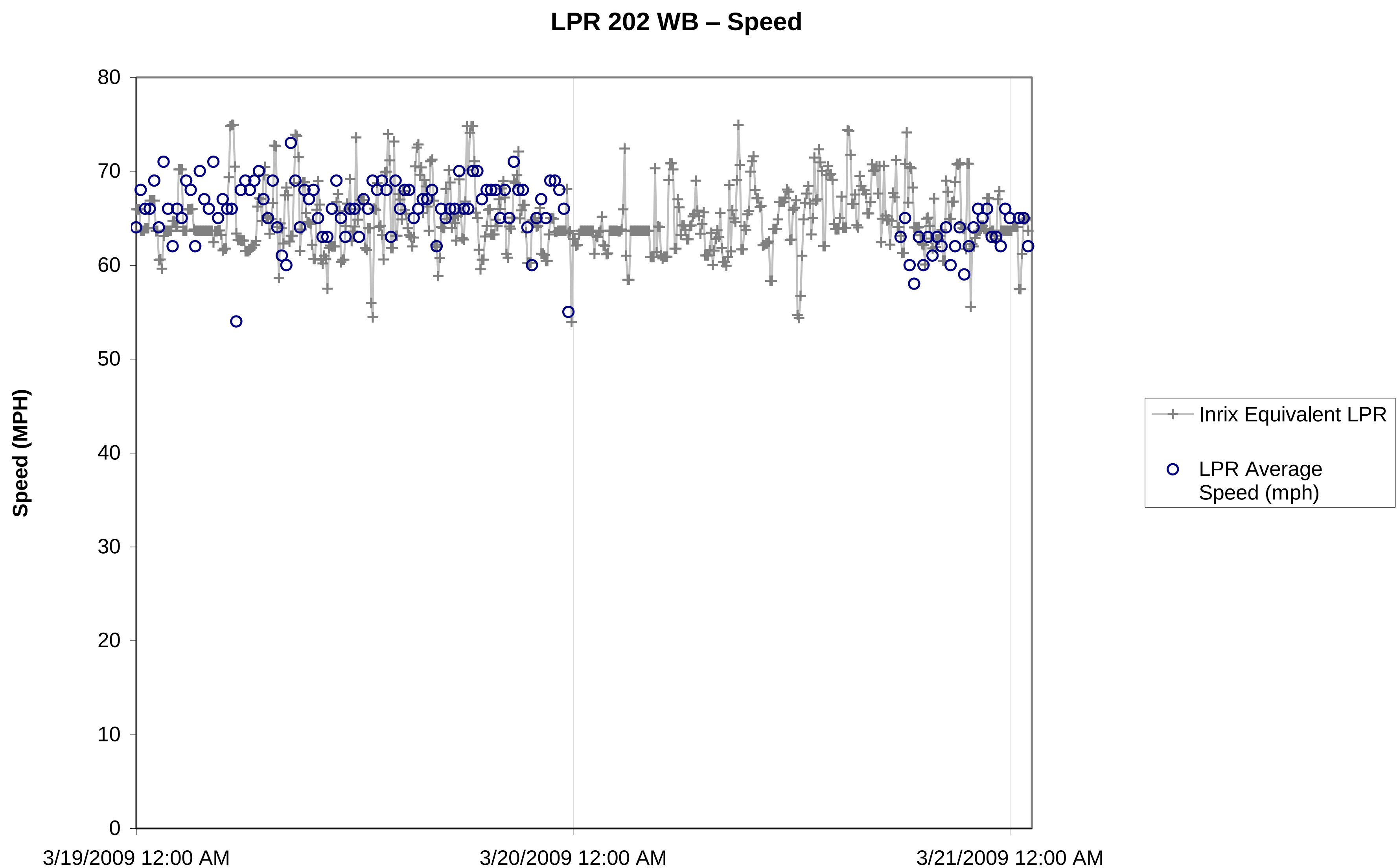
Comparison between
Inrix Data and LPR Data

March 19-21, 2009

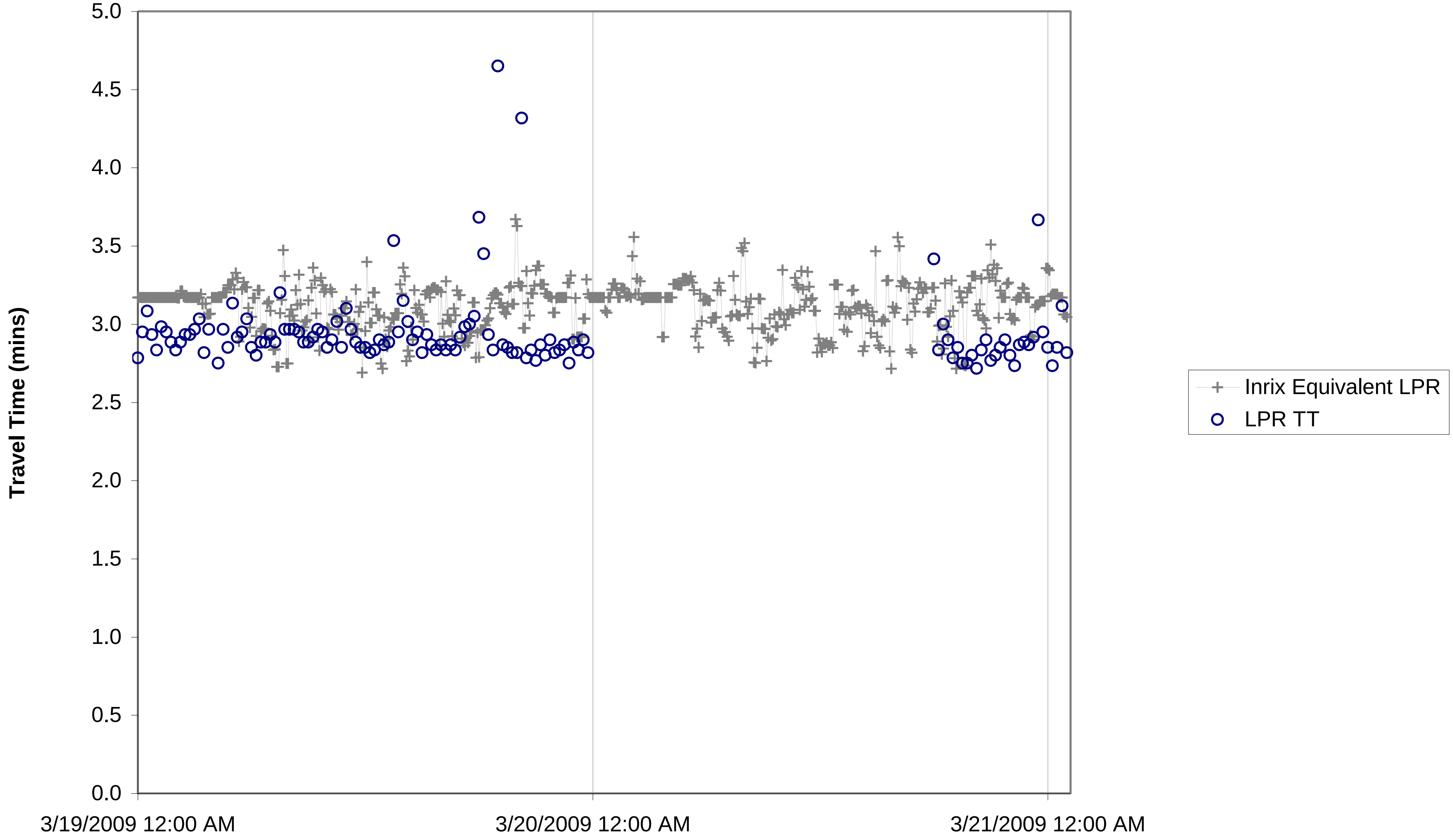

LPR vs. Inrix
LPR 195 EB – Speed
Speed (MPH)
80
70
60
50
40
30
20
10
0
3/19/2009 12:00 AM
3/20/2009 12:00 AM
3/21/2009 12:00 AM
LPR vs. Inrix
Inrix Equivalent LPR
LPR Average Speed (mph)


LPR 198 EB – Speed
80
70
60
50
40
30
20
10
0
Speed (MPH)
3/19/2009 12:00 AM
3/20/2009 12:00 AM
3/21/2009 12:00 AM
LPR vs. Inrix
Inrix Equivalent LPR
LPR Average Speed (mph)

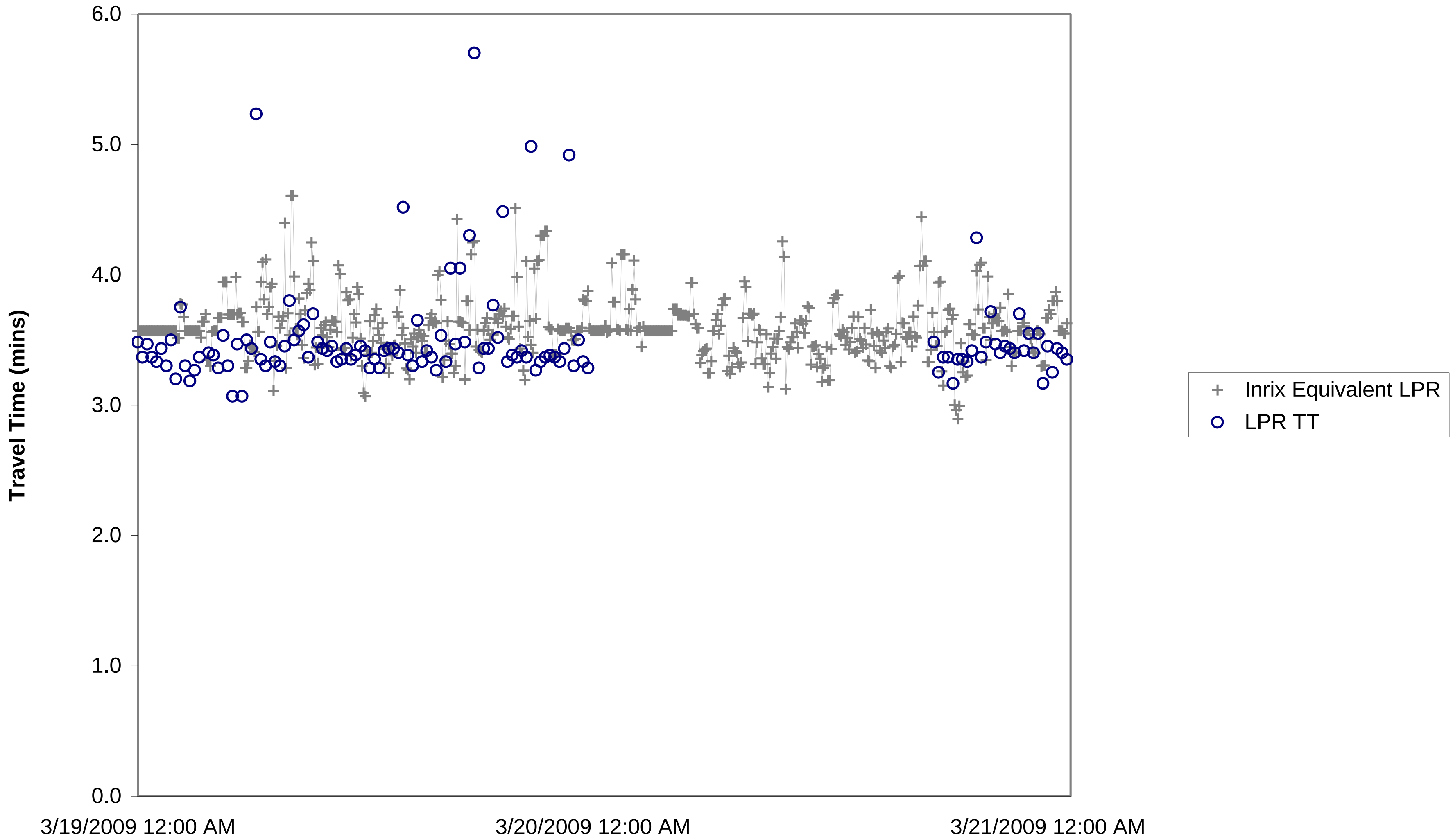

LPR 198 WB – Speed
Speed (MPH)
80
70
60
50
40
30
20
10
0
3/19/2009 12:00 AM
3/20/2009 12:00 AM
3/21/2009 12:00 AM
LPR vs. Inrix
Inrix Equivalent LPR
LPR Average Speed (mph)



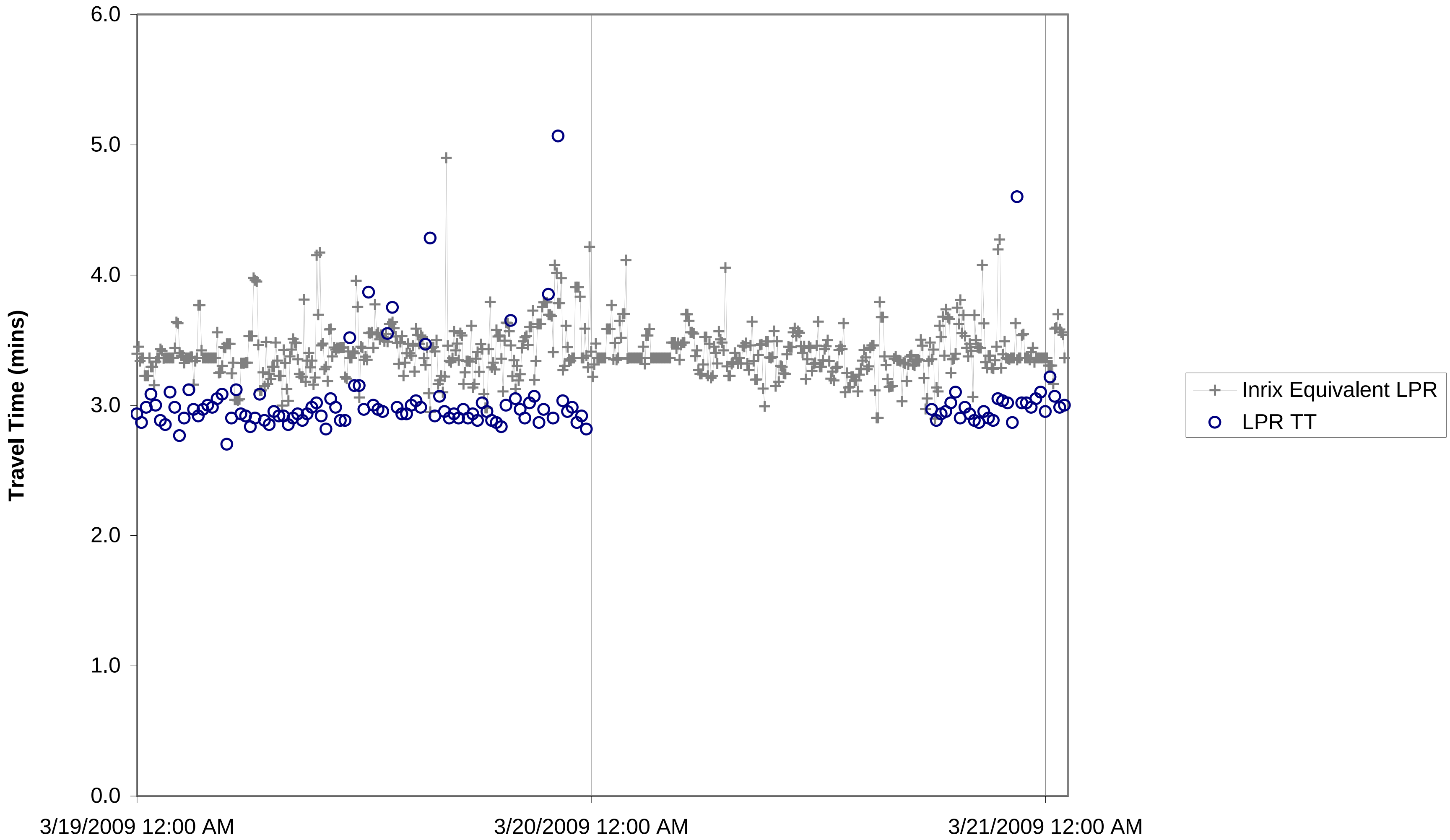
LPR vs. Inrix
LPR 195 EB – Travel Time

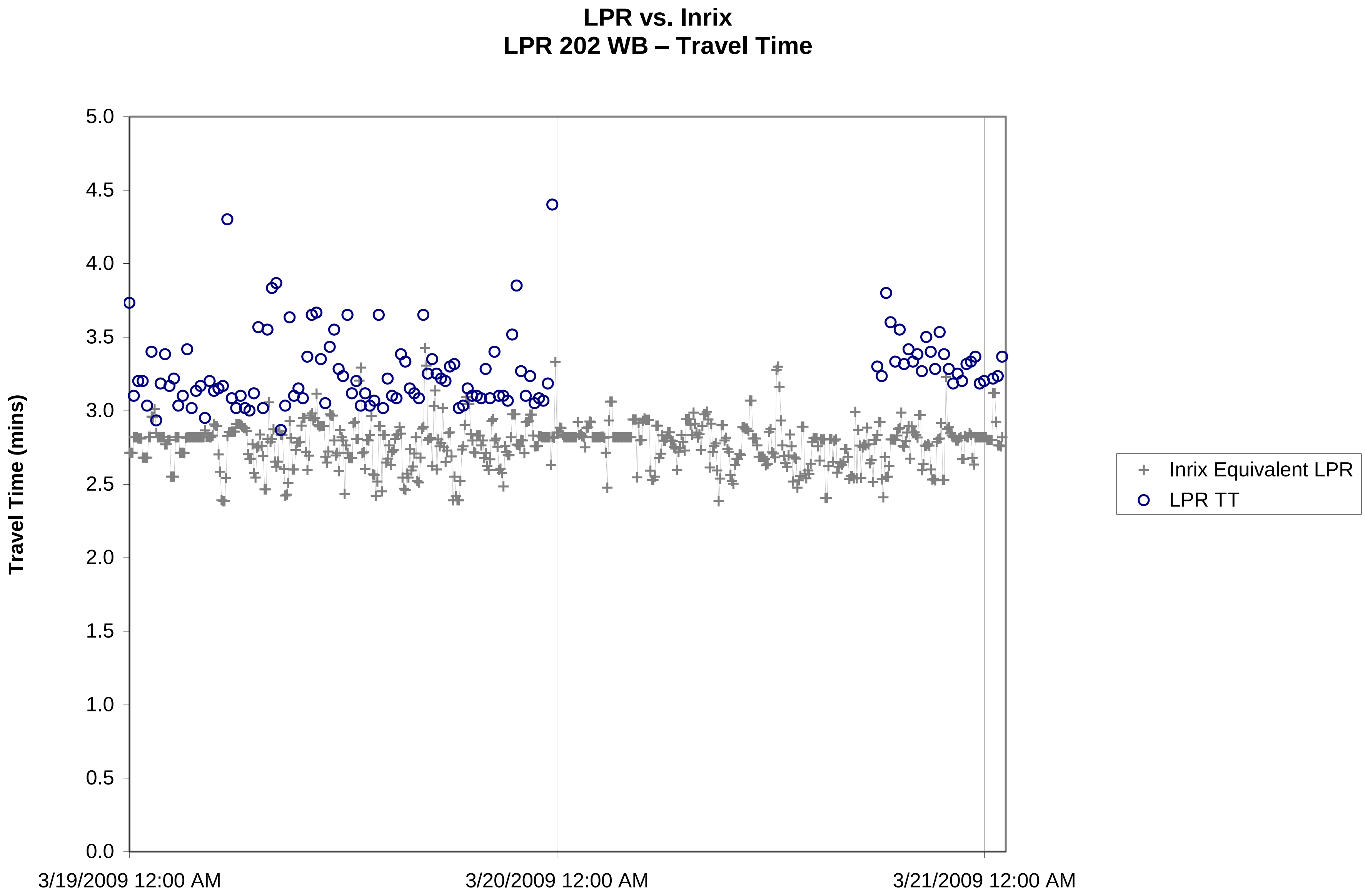


LPR vs. Inrix
LPR 198 EB – Travel Time



LPR vs. Inrix
LPR 198 WB – Travel Time


6.0
5.0
4.0
3.0
2.0
1.0
0.0
Travel Time (mins)
3/19/2009 12:00 AM
3/20/2009 12:00 AM
3/21/2009 12:00 AM
Inrix Equivalent LPR
LPR TT


LPR vs. Inrix
LPR 202 WB – Travel Time
Travel Time (mins)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3/19/2009 12:00 AM
3/20/2009 12:00 AM
3/21/2009 12:00 AM
Inrix Equivalent LPR
LPR TT