TRANSPORTATION POOLED FUND PROGRAM
FINAL REPORT

Lead Agency (FHWA or State DOT): _____Maryland State Highway Administration_____

Transportation Pooled Fund Program Project #	**Transportation Pooled Fund Program – Project Period:**
TPF-5(252)	July 1, 2011 through June 30, 2014

Project Title:

I-95 Corridor Coalition Vehicle Probe Project

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
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Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$637,709	$637,709	100 %

Project Background:

The I-95 Corridor Coalition began an initiative in 2008 called the Vehicle Probe Project with the ambition of providing comprehensive and continuous travel time information on freeways and arterials from Maine to Florida using non-intrusive technologies based on vehicle probe methods. A collaborative effort among the I-95 Corridor Coalition members, the vehicle probe project envisioned a system that provided travel time and speed data for corridors that facilities interstate as well as intra-state movement.

The coverage area of the initial stage of the project was approximately 1,500 centerline freeway miles from New Jersey through North Carolina that began on July 1, 2008. The initial stage emphasized the delivery of quality data on freeways that provided through movement along the I-95 corridor. This included I-95, parallel freeways to I-95, and freeway and arterials that cross-linked these facilities and provided detour routes in the event of heavy congestion or incidents on the primary routes. The first stage has proved effective to monitor freeway travel times and speeds within the accuracy specifications in order to enable a variety of applications, most of which were operations based in nature. Since the initiation of the project, the geographic coverage of the system has been expanded to approximately 7,100 centerline miles of freeway and includes the entire limited access road network in New Jersey, Maryland, Virginia, North Carolina and South Carolina.

Participating I-95 Corridor Coalition member agencies have found numerous uses for the vehicle probe data, including:

- Travel Information for 511 (web and phone) Systems, Dynamic Message Signs, and Kiosks
- Travel Time Calculations for Message Boards
- Performance Measures and Travel Time Reliability Support
- Traffic Pattern Observations (in-state and multi-state)
- Analysis and evaluation of archived data for research on travel behavior

Project Objective for this Pooled Fund Project:

The objective of the second phase of the project was to continue to push forward to realize the entire vision of the Vehicle Probe Project, that of an ubiquitous and high quality source of travel time and speed data creating a seamless traffic monitoring system that spans the entire eastern seaboard using probe technology, and driving a variety of applications. The applications include not only Operations, but also Planning and Engineering, and not only existing applications, but also uses of the data not previously leveraged.

Scope of Work:

The initial vehicle probe project began with six core states that included: New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina. Since the project was initially successful in the core states, the I-95 Corridor Coalition's objective in this second phase was to expand interstate coverage to include all states along the I-95 Corridor, achieving the full geographic reach of the eastern seaboard. This accomplishment of continuous roadway monitoring from Maine to Florida, within a single system, would create tremendous benefits for the Coalition and its members.

The Coalition, in cooperation with member agencies sought to establish a central spine of coverage that included, at a minimum, I-95 in all states. This central spine of coverage will allow all state and transportation agencies to view the products of the vehicle probe project within the context of their own jurisdiction, and evaluate its effectiveness for various uses and applications. In order to fund the core system in Phase II, the Coalition outlined a cost-sharing mechanism as outlined below. Furthermore, the Coalition encouraged states and members to expand coverage to all limited access roadways, and possibly principle arterials (as will be explained later). As the expanse and the density of the network expands, the benefits of the vehicle probe project multiply. Common application and analysis methods, templates, and software can be shared across the entire region, providing tremendous cost reduction and the benefit of standardization of method from one state and MPO to the next for a variety of common tasks such as congestion management plans and traveler information systems, just to name a few.

The Executive Board for the I-95 Corridor Coalition approved a 50/50 cost-share program for the three year project. Coalition member agencies contributed 50% of the total cost for freeway data coverage for an already-identified core coverage and the remaining 50% cost would be funded by the I-95 Corridor Coalition. The I-95 Corridor Coalition's goal was to have every state DOT in the Coalition membership participating in the project by the end of the three year period. The 50% cost sharing allowed the core coverage to include not only I-95 but also primary alternate routes. In order to participate in the project, I-95 Corridor Coalition states were required to fund their portion of the project either through a direct contract with the University of Maryland or though this pooled fund study. An expansion of coverage beyond the core coverage was a key component of the vision, and one that was accommodated through the funding mechanisms that were established. Expansions were funded by the participating agency.

In addition to increasing the geographic scope and density, Phase II also wanted to provide data on a wider variety of roadways. Whereas Phase I concentrated on the data quality and uses of limited access freeways, Phase II was expanded to fully characterize available data quality on arterials. This process monitors the data quality available from the project for signal controlled facilities. The goal was to establish accuracy specifications, validation methodology, and report consistently on data quality so that Coalition members can confidently integrate appropriately into applications similar to the freeway data.

One last aspect of the scope of Phase II was the user community. The project was initiated from Operations interest, though the vision was much greater. At the end of Phase I, personnel and applications from Planning, Engineering, and Traffic Engineering were beginning to inquire as to the use and availability of the data. The Coalition anticipated growth, not only in the Geographic expanse of the vehicle probe project system, but also in the application interests that the data would serve. As such, the Coalition anticipated a growing effort to address quality and integration issues into a variety of new applications apart from Operations interest. This movement began at the close of Phase I – and escalated into Phase II of the project.

Summary of Coverage and State Participation

Through this project, the Coalition was able to expand the data coverage to all sixteen Coalition member states (see table below). The Coalition purchased some data for all states which was considered "core" coverage along the I-95 Corridor. Many of the states purchased additional coverage outside of the "core." The states that purchased additional data included: New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, and Florida. The states used various contracting methods to participate in the project – see "Contracting Methods Used to Achieve State Participation" that follows. Below is a list of all states that participated in the project and the miles that were purchased.

	Freeways	Arterials
Maine	66.0	
New Hampshire	16.0	
Massachusetts	88.0	
Rhode Island	162.0	762
Connecticut	111.0	
New York	264.0	
New Jersey	894.7	5,613
Pennsylvania	148.0	
Delaware	46.0	
Maryland	796.2	2,971
District of Columbia	31.0	
Virginia	309.5	
North Carolina	1,553.0	6,895
South Carolina	934.0	4,225
Georgia	365.0	0
Florida	728.0	0
Total	6,512	20,466

How Probe Data was/is used by Participating States

I-95 Corridor Coalition members that received real-time data utilized the information in the following ways:

- Operations Center: Real-Time Traffic Monitoring
- TMC Software Integration
- Cross-border Incident and Traffic Monitoring
- Travel time on signs, websites, 511 IVR, traffic tile overlay on 511 site

The Coalition and the University of Maryland have also developed a *Probe Data Analytics Suite* that allows Coalition member agencies even greater usage of the vehicle probe data. The suite allows agencies to support operations, undertake planning activities, perform analysis and research activities, and develop performance measurement reports.

The probe analytics tools make use of 3rd party probe data, fused with other agency transportation data, in a true "big data" analytics platform. The suite consists of a collection of data visualization and retrieval tools. These web-based tools allow users to download reports, visualize data on maps or in other interactive graphics, and even download raw data for off-line analysis.

Common uses of the probe data analytics suite include:

- Responding to MAP-21 reporting requirements

- Developing system performance reports
- Identifying problems
- Prioritizing projects
- Performing After Action Incident Review
- Conducting Before & After Studies
- Making informed, real-time operations decisions
- Travel time and reliability analysis
- Work zone monitoring
- Developing and publishing press releases for public and media consumption
- Measuring the economic and environmental impacts of passenger and commercial vehicle user delay

The Coalition created a vehicle probe suite users group which was a collaborative approach to expand and improve the use and benefit of the suite by addressing user and developer needs. It was useful for users because they were able to get assistance with software issues and detailed explanations/guidance on using the tools. It was useful for developers because they were able to gain feedback on the usability of the tools plus gather requests for additional functionality.

Specific Examples of the Use of the Data

The Metropolitan Washington Council of Governments has used the vehicle probe suite tools to track and analyze the top ten bottleneck. This information was included in its quarterly updated Congestion Dashboard found at www.mwcog.org/congestion and the Congestion Management Process (CMP). They feel that the benefits of the suite include:

- Intuitive visualization
- Information-rich
- Can be used as a basis for bottleneck mitigation studies

The New Jersey Department of Transportation has used the vehicle probe suite tools to identify areas of congestion. A Bottleneck and Congestion Scan Analysis was assembled for the Route 3/46 project to help confirm congested conditions and existing project intent. They feel that the benefits of the suite include:

- Easy to generate the data
- Easy to assemble a summary
- Clear, concise graphics
- Substantial time savings for planners
- Supported the project intent (elimination of WB bottleneck)
- Can be used to develop Before & After Studies

Contracting Methods Used to Achieve State Participation

Every state agency has different contracting rules and because of this issue, the Coalition member agencies were provided different mechanisms to procure the vehicle probe data. There were three ways in which Coalition members could participate in the Coalition's vehicle probe project and purchase data. Below is a list of the three methods, along with a description of each.

(1) Through this pooled fund study – Maryland SHA was the lead state and the four states that participated in the pooled fund study were: Rhode Island, Delaware, Virginia and Georgia. Once the funds were collected from the four states, Maryland SHA issued a Task Order to the University of Maryland (UMD) under their existing contract. UMD was then able to procure the data desired by the states.

(2) Direct Contracts with the University of Maryland – Five of the states were able to do a direct contract between their agency and UMD. The states included: New Jersey, Maryland, North Carolina, South Carolina and Florida. UMD's contracts office developed a Memorandum of Agreement (MOA) that the agencies were able to sign and execute. Once the contract was signed, UMD was able to purchase the required data.

(3) State consultant contract who subcontracted with the data provider – This method was accomplished without any assistance from UMD. Two states used existing consultant agreements to contract with the vehicle probe data provider.

The data that was purchased from the contract was however, added into the vehicle probe suite at UMD so all the other Coalition member agencies had access to the data they purchased.

Benefit of the Vehicle Probe Project to the Coalition and Its Members

The VPPII resulted in better pricing and more choices for the I-95 Corridor Coalition and its members. While maintaining the high quality program, the price per mile for data coverage decreased by approximately 40%. Three vendors, INRIX, HERE and TomTom, are part of the program providing states a choice of core data products of speed, travel-time, a real-time monitoring sight and a thorough data archive. Also, each vendor brings unique strengths for the Coalition to access.

The validation program likewise was extended to three vendors. The first validation was in Harrisburg, Pennsylvania which significant rush hour congestion is predominant on the freeway systems, particularly at major river crossings. The validations indicated that all three vendors have mature products that report good quality data on freeway roadways. The validation will continue on US-1 in Virginia, a challenging arterial corridor with a range of signal densities and volumes.

The validation effort continues to provide the Coalition, as well as the rest of the county, quantitative assessment of the fidelity of the vehicle probe data. A full report on the fidelity of probe data, currently in draft will be released in April of 2015 that provides a benchmark for the probe data accuracy.

Through the pooled effort of the states, the Coalition has been able to minimize the program overhead, provide common data reporting and analysis through VPP project and subsequent VPP suite of products, leading the nation in operations and performance measures.

The VPP suite, once envisioned a simple viewing and archive tool, and developed into a world leading analytics suite for probe traffic data. Guided by committees of state users, the suite continues to in functionality and utility to its members.

Arterial Data Quality

A portion of the pool fund study was the investigation of probe data accuracy on single-controlled arterials. The Vehicle Probe Project routinely monitors the quality of probe based data on freeways, and has been since 2008. The extension to interrupted flow arterials has been an evolution, and from 2013 through mid 2014 the Coalition made it a priority. Nine data collections were conducted from North Carolina through New Jersey on different types of non-freeway facilities. The data from these activities were analyzed to determine the extent to which probe based data would be useful for various planning and operations applications. Previous work had indicated that probe vehicle data performance was better on higher end arterial corridors in which the average annual daily traffic (AADT) was greater than 30,000 and the low signal density and mid-block friction. The nine data collection activities confirmed these finding and began to put better bound on the types of signalized arterials in which the probe data was expected to be of sufficient quality to use for applications.

A full report is in draft, and a briefing is being prepared for the I95 Corridor Coalition on April 30, of 2015. Preliminary findings have begun to be shared with individual Coalition members upon request. The results of the findings are summarized at the top level as follows:

The performance of the VPP probe data is anticipated to be of adequate quality on arterial roadways which the AADT exceeds 40,000, the signal density is one signal per mile or less, and the number of lanes in each direction is two or greater. The samples of data collection on roadways with these attributes indicated that the congestion events were captured accurately, and could be used for corridor monitoring and/or traveler information to report congestion event. The extent of slow down (such as total delay) may differ from that of the reference data, but the VPP data still identified significant events.

The performance of the VPP probe data on roadways above 20,000 AADT, with signal densities up to 4 signals per mile, and at least two lanes in each direction (but did not fall into the first category) generally had mixed performance. The test results indicated that on such roadways the VPP could at times reflect actual conditions, well, but at other times

significantly under report the extent of delay, and at other times completely miss congestion events. Data from such roadways are not recommended for applications without first testing the fidelity. Also, as probe data quality is anticipated to improve, such roadways should be monitored to assess improvements.

- Any arterial roadway that falls outside of the above two classifications rarely performed well, and are not likely to produced useable data either now, or in the near future.

Additional insight on the performance of probe data were also gained on signal controlled roadways. Many times not only the central tendency of travel time is needed, but also the dispersion of travel time about that central tendency is required to accurately describe arterial traffic flow. Current practice of reporting only a mean speed may be inadequate to support traffic signal control analysis metrics such as quality of platoon progression or percent stopped on red.

Even on the top tier arterials (above 40000 AADT) it was observed that significant changes in traffic imposed by construction had a significant impact on the probe data's ability to accurately report traffic.

Frequently the travel time on arterials is structured into two modes, one in which a portion of the vehicle stream or platoon advanced through on a green phase while the remainder of the platoon is forced to wait another signal cycle. When this bi-modal distribution of travel time occurs, the VPP data tends to an optimistic bias of reporting, or favoring the faster of the two modes.