

BLUETOOTH OBSERVATION SYSTEM

**\*\*From Berlin STP 2935(1)  
Berlin NH STP 2938(1)  
Berlin NH STP 2947(1)**

- xx. DESCRIPTION. This work shall consist of submitting for approval a Bluetooth Monitoring System Plan; furnishing, installing, operation and acceptance testing, relocating, operating, maintaining, monitoring, and removing a Bluetooth detector-based travel time reporting system meeting the requirements specified herein, and providing a System Manager to maintain the system during the duration of the project.

The system will provide Work Zone traffic monitoring to gather work zone traffic delay, travel speed, and travel time (and, if possible, queue lengths) due to construction activity and/or as directed by the Engineer. (If the project involves a multi-lane facility, e.g., Interstate, limited access, etc., provisions shall be made to monitor both barrels simultaneously).

The portable origin-destination survey equipment will anonymously detect media access control (MAC) addresses and wireless identifications used to connect Bluetooth technologies on mobile devices in vehicles such as phones, headsets, and music players, to uniquely identify vehicles entering a construction work zone.

The Bluetooth Software shall aggregate, monitor, record, and report the data retrieved from the field deployed Bluetooth detectors. The software shall provide an intuitive graphical interface and shall be fully capable of integrating with existing Agency's software.

The Bluetooth travel time system shall include the following:

- (a) Bluetooth Antennas. Antennas shall include all hardware, testing, setup, integration, mounting hardware, adapters, power supplies, and integration of antenna within cabinet electronics.
- (b) Bluetooth Detectors. Detectors shall include all detector hardware, testing, setup, integration, mounting hardware, adapters, power supplies, and integration of detector with the software.
- (c) Solar Panels. Solar panels shall include all hardware, testing, setup, integration, mounting hardware, adapters, power supplies, and integration of solar panel electronics.
- (d) Bluetooth Lead-in Cable. Lead-in cable shall include all terminations at the Bluetooth antenna, Bluetooth Detector, wireless modem, and the in-cabinet electronics including device power and communications.
- (e) Bluetooth specific housing unit to install all the prescribed equipment.

- (f) Bluetooth Detector Software. Detector software shall include installation on the server, testing, labor, and all incidental or third-party software required to make the Bluetooth Travel Time Reporting System fully operational.
- (g) Bluetooth Detector Travel Time System. Detector travel time system shall consist of Bluetooth Software to operate and manage the deployed system. This system is to provide communication with the Agency's Traffic Operation Center (TOC) software, and the field detectors, as will be demonstrated in the acceptance and integration testing.
- (h) Acceptance Testing. Bluetooth data shall have the following minimum accuracy during testing:
  - (1) Travel Time. 95% accurate for probe vehicle traveling time between two test sites.
  - (2) Travel Speeds. 95% accurate for probe vehicle speeds between two test sites.
  - (3) Origin/Destination. 95% accurate for probe vehicle traveling through multiple corridors.
  - (4) Transit Filtering. 95% accurate in filtering out transit data at test site.

The Contractor shall provide a recommended test procedure to the Agency. The Agency will determine the adequacy of the recommended test procedure and whether modifications are necessary. Once concurrence has been achieved between the Contractor and Agency, the ability to accept or reject procured Bluetooth devices will be achieved.

Any devices not meeting the above mentioned accuracies may be rejected by the Agency. Should rejection occur, the Contractor shall provide a replacement device at no additional cost to the Agency.

- (i) Documentation. The Contractor shall provide the Agency with both electronic and hard copy report documentation presenting graphic and tabular real-time data records, and hourly and daily summaries of the following:
  - (1) travel time and delays;
  - (2) queue length, including daily average and standard deviation;
  - (3) travel speeds; and
  - (4) traffic volumes through the work zones.

(j) Training and Support. Training and support for the Bluetooth Monitoring System is subject to the following requirements:

- (1) The Bluetooth Monitoring System specified under the Contract shall be furnished, installed, and maintained by personnel who are experienced in this type of work. Deploying firm/personnel shall have a minimum of five (5) similar deployments.
- (2) A technician skilled in the operation of all required Bluetooth equipment and software shall be available 24 hours per day, 7 days per week to maintain the system components, move Contractor-provided portable devices as necessary, and to respond to emergency situations within 4 hours. The technician shall be equipped with sufficient resources to make needed corrections of deficiencies within 8 hours of notification.
- (3) Training shall be provided to Agency project staff on the use and operation of both the hardware and software components of the Smart Work Zone. Training shall consist of both hands-on training and written manual(s) for the operation of the system.

xx. GENERAL REQUIREMENTS. The travel time system shall be a portable, real-time, automated, solar-powered system that utilizes Bluetooth detectors to collect data for travel time reporting purposes that is non-intrusive, does not present a safety hazard, and is relatively easy to set up and maintain. The detectors shall collectively report anonymous Bluetooth device data in the form of Media Access Control Addresses (MAC addresses) to a central server at a centralized location where the data will be processed using filters and algorithms calibrated specifically for the subject corridor. The central system shall match time stamped MAC addresses that pass two consecutive data collection points of a known distance to calculate the time it takes for a vehicle to travel from one point to the next.

Travel times shall be processed through a series of checks to verify that they are reasonable and accurate given the current conditions. The central system shall archive all collected data. All data shall be accessible through a web-based interface for reporting purposes.

The Contractor shall assume responsibility for any damaged equipment due to crashes, vandalism, adverse weather, etc. that may occur during the system's deployment.

The Contractor shall furnish and maintain this system for measuring and delivering real-time messages. This system shall be in operation 24 hours per day, seven days per week, during the determined monitoring period for the project.

The Contractor is responsible for coordinating any work adjacent to the monitoring equipment so as not to interfere with the construction project itself.

The Contractor will be responsible for relocating the devices as directed by the Engineer. When the devices are no longer required for the project, the Contractor shall remove them and retain ownership.

xx. BLUETOOTH MONITORING SYSTEM PLAN.

(a) General. The Contractor shall submit to the Engineer for approval a written and illustrated Bluetooth Monitoring System Plan a minimum of three (3) weeks prior to mobilization of any component for the Bluetooth system. The Bluetooth Monitoring System Plan shall include the items specified herein. The Contractor will not be allowed to start any construction activities that will affect traffic on the project until the Bluetooth Monitoring System Plan is approved by the Engineer.

(b) Plan. The Bluetooth Monitoring System Plan shall include the following as a minimum:

- (1) Detailed description of proposed locations of all Bluetooth monitoring system devices.
- (2) Detailed equipment descriptions, including make and model.
- (3) Name and contact information of the Bluetooth Monitoring System Manager.
- (4) Detailed description of the proposed methods of communication between the Bluetooth monitoring system devices and the Engineer.
- (5) Proposed correction, including response times, and notification process for when the system malfunctions.

(c) Approval of Plan. Approval of the Bluetooth Monitoring System Plan by the Engineer is required prior to the placement of any Bluetooth monitoring system devices. Approval is conditional and will be predicated on satisfactory performance during construction. The Engineer reserves the right to require the Contractor to make changes to the Bluetooth Monitoring System Plan and operations, at no additional cost to VTrans, including removal of personnel, as necessary, to obtain the quality specified. The Contractor shall notify the Engineer in writing a minimum of seven (7) calendar days prior to any proposed changes in the Bluetooth Monitoring System Plan. Proposed changes are subject to approval by the Engineer.

xx. MONITORING TIMEFRAME. Non-work zone traffic flow shall be monitored to determine traffic delay, travel speed, and travel time conditions for a minimum of two (2) weeks prior to work zone operation. If this is not feasible, monitor non-work zone conditions for a minimum of one (1) week after project work is complete when the work zone is no longer in operation.

Monitor work zone operation during project activity to determine traffic delay, travel speed, and travel time (and, if possible, queue length) conditions during the active work zone.

xx. REPORT REQUIREMENTS. Daily reports shall consist of hourly and daily summaries of the following data:

- (a) Total vehicular traffic passing through the work zone.
- (b) Vehicular average and standard deviation for delay, travel speed, and travel time through the work zone, and daily average and standard deviation for queue lengths for the time period a queue exists.
- (c) A spreadsheet file of daily recorded data.
- (d) Monthly report submissions in both electronic and hard-copy format shall be provided to the Contractor's Project Supervisor, the Resident Engineer, and the Agency's Traffic Research and Quality Assurance Sections.

The system shall calculate travel time through analysis of subsequent detections at the exit of the work zone using a second monitoring device. The subsequent data will then be compared to the baseline data in order to estimate travel time delay due to construction activities.

xx. SYSTEM REQUIREMENTS.

- (a) General. All materials for the Bluetooth travel time reporting system components shall be commercial off-the-shelf products, new or like-new products, or reused or reconditioned equipment or system components, providing all products have been inspected and are in working condition as determined by the Engineer prior to installing at project locations specified in the Contract Documents.

The system shall have the capability to output raw data in CSV and XML format. The central system shall report a filtered travel time for the project in an XML format. The travel time may then be integrated with the Agency's traveler information system, 511, or various other interfaces. The Contractor shall coordinate with the Engineer to determine the appropriate information that is required.

- (b) The system shall possess the ability to filter anomalies in data from the travel time calculations using an Engineer-approved method.
- (c) Filtering algorithms in the host software shall have the capability to be configured separately for each individual roadway segment being monitored.
- (d) The software shall maintain a list of the last time each detector communicated with the central system, and send timely alerts to both the Contract Project Supervisor and Resident Engineer when outages are detected.

xx. MAINTENANCE AND SUPPORT. The Contractor shall employ a System Manager for the Bluetooth system. The System Manager shall be locally available to maintain system components, maintain the data, move portable devices as necessary, and respond to emergency situations.

The System Manager shall be responsible for coordinating the placement of the devices in the project area. It is the responsibility of the System Manager to move the system components that interfere with construction operations and relocate the components to another area. The System Manager shall supply a local telephone number and/or toll free number to the Engineer to contact the System Manager or other system representative at any time.

The system shall be maintained, supported, and guaranteed against material defects by its supplier through the duration of the deployment.

The Contractor shall be required to respond immediately to any call from the Engineer or his/her designated representative concerning any equipment/software malfunction and request for correcting any deficiency in the system.

Any software licenses that may be needed for communication with the TOC central system software and for field communications shall be provided by the Contractor. The Bluetooth software shall offer an XML schema available to the Agency at no cost for integration with third party software and systems.

- xx. OPERATIONAL TEST. Once the Bluetooth System is installed in the field, it shall undergo a five (5) day operational test. The operational test shall include a test of the system in operation during a lane closure to ensure that all the equipment is operating in a fully functional manner and in accordance with the approved Bluetooth Monitoring System Plan. The Contractor shall provide both complete operations support from the vendor during the operational test and verification that the reported time driven through the work zone accurately reflects field conditions. If any equipment malfunctions occur for a combined period of four (4) hours or more during this operational test on any day, no credit will be given for that day for the operation test period, and the five-day operational test will reset.

The Contractor shall maintain records of equipment stoppages and resumptions during the five-day operational test for submission to the Engineer for the Engineer's approval. In the event that ten (10) percent or more of the time similar malfunctions occur that affect the proper operation of the Bluetooth system, the Engineer may declare a system component defective and require replacement of the equipment at no additional cost to the Agency. When a system component defect is declared, the five-day operational test shall begin again after all defective equipment is replaced and the system is fully operational.

If a device fails any portion of the test, that device shall be retested for compliance with the test. If the same device fails three times, the device shall be replaced with a new device and the testing shall begin again at the start of the test.

(a) Report. The Contractor shall submit a report to the Engineer detailing the daily activity of the system during the operational test. The report shall indicate the date and time of any activity necessary to maintain operation of the Bluetooth system during the operational test period. Each entry shall include the following information:

- (1) Time required to repair equipment malfunction.
- (2) Identity of the equipment on which work was performed.
- (3) Causes of equipment malfunction (if known).
- (4) A description of the type of work performed.

Once the operational test report is received and approved by the Engineer, the Bluetooth system will be considered operational and the system will be accepted for use.

xx. MANUFACTURERS. The following manufactures are capable of providing software to meet the requirements of these specifications:

TRAFFAX  
P.O. Box 1176  
Riverdale, MD 20738-1176  
Tel.: (240)447-8612

TrafficCast  
2801 Coho Street, Suite 100  
Madison, WI 53713  
Tel.: (608)268-3946

Savari Networks  
2005 De La Cruz Boulevard  
Suite 131  
Santa Clara, CA 95050  
Tel.: (408)833-6369

Technologic Systems  
16610 East Laser Drive #10  
Fountain Hills, AZ 85268  
Tel.: (480)837-5200

Request for substitutions for the above shall be submitted to the Agency's Office of Contract Administration a minimum of ten (10) days in advance of the bid opening date. Substitutions for the above after award shall be approved by the Agency's Project Manager.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Bluetooth Observation System) to be measured for payment will be on a lump sum basis in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Bluetooth Observation System) will be paid for at the Contract lump sum price. Payment will be full compensation for performing the work specified, including preparing, submitting, and revising, if necessary, the Bluetooth Monitoring System Plan; furnishing, installing, operational and acceptance testing, relocating, operating, maintaining, monitoring, and removing the Bluetooth detector-based travel time reporting system; employing a System Manager; preparing and submitting daily and monthly reports as specified; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made as follows:

- (a) Thirty-five (35) percent of the Contract lump sum price will be paid when the Bluetooth Monitoring System Plan is approved and all required Bluetooth monitoring system components are delivered to the jobsite.
- (b) An additional twenty-five (25) percent of the Contract lump sum price will be paid upon Engineer's approval of the successful completion of the operational test.
- (c) An additional twenty (20) percent of the Contract lump sum price will be paid after 30 calendar days of full system operation.
- (d) The final twenty (20) percent of the Contract lump sum price will be paid after traffic has returned to normal non-construction flow, the Contractor's equipment has been removed from the project, and all data has been provided to the satisfaction of the Engineer.

When and as determined by the Engineer, five (5) percent of the Contract lump sum price will be deducted should the system malfunction for three (3) or more consecutive calendar days, or any total of five (5) calendar days in any one calendar month following approval of the operational test. This deduction will not reduce the total system payment to less than 75% of the overall Contract lump sum price bid for Special Provision (Bluetooth Observation System).

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
900.645 Special Provision (Bluetooth Observation System)	Lump Sum