MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
WIRELESS VEHICLE DETECTION SYSTEM (VDS)

a. Description. Furnish all labor, equipment, and material required to install, salvage or remove a VDS, complete with master interface board, access box, access point (AP) enclosure, repeater, contact closure (CC) card, detector rack mounting brackets, hardware, cable, connectors, grounding, sensors and epoxy, and any associated material required to complete the work. Storage and disposal of materials, when required, is also included in this item. Storage of salvaged equipment to be installed on the project must be contained in a protected and clean environment necessary to provide a complete and operating job.

b. Materials. Material must meet sections 918 and 921 of the Standard Specifications of Construction and this special provision.

1. General. The VDS must provide a system that detects and/or counts vehicles using battery powered magnetometers utilizing wireless communications to transmit detection information.

The VDS must consist of the master interface board, interface cards, access box, mounting rack and hardware; one wireless AP including NEMA 4X type enclosure with mounting bracket and hardware; one battery operated wireless Repeater (RP) with mounting bracket and hardwire, eight wireless flush mount Vehicle Sensor Nodes (VSN) including manufacturer recommended epoxy, and any associated cable, connectors and hardware necessary to complete the work.

The VDS must be capable of providing; vehicle counts per lane, lane occupancy, vehicle speed (when more than one VSN is installed per lane), and vehicle classification (when one or more VSN is installed per lane). The time intervals for the above measurements must be user selectable from 30 seconds to 24 hours.

Communication between the VSN, AP and RP must be wireless.

2. Vehicle Sensor Nodes (VSN). The VSN must consist of a magnetometer, microprocessor, wireless transmitter/receiver, battery and epoxy for placing the node into the pavement.

The VSN must be 1 inch high × 3 inches in diameter and be contained in a fully encapsulated housing to prevent moisture from degrading the components.

The VSN must operate at a temperature range from -37 degrees F to +176 degrees F (-38 degrees C to +80 degrees C) and operate from its battery for a minimum of 10 years under normal traffic conditions.

The VSN must detect a vehicle by measuring a change in the earth's magnetic field and transmit the detected information within 125 milliseconds (ms) of receiving the detected vehicle.

The VSN must be capable of being programmed with a unique identifying code. This code and detector information must be transmitted via a wireless radio communication method.

The VSN must automatically recalibrate in the event of a detector lock.

3. Access Point (AP). The AP must be the hub of the sensor network and be capable of communicating with up to 48 VSN's transmitting detection information to a centralized server over a cellular data connection, Ethernet or a serial link.

The AP must be capable of transmitting detection information to a 170, 2070 or NEMA type controller to provide real time detector information. The VSN must respond within 100 seconds when the AP is powered up.

The AP must operate from 48 volts direct current (VDC) at 3 watt power or via non-isolated external 10 to 15 VDC at 2 watt power and operate at a temperature range of -37 degrees F to +176 degrees F (-38 degrees C to +80 degrees C).

The AP must be capable of providing 1500 V isolation and 5 kV surge protection.

The AP electronics must be housed in a plastic enclosure no larger than 12 inches high × 8 inches wide × 4 inches deep and meet NEMA 4X and International Protection (IP)67 standards complete with mounting bracket and associated hardware.

4. Wireless Repeater (RP). The RP must be battery powered and housed in a plastic enclosure no larger than 5 inches high × 4 inches wide × 4 inches deep. Complete with mounting bracket and associated hardware.

The RP must extend the effective communication range of the VSN to the AP up to 1000 feet.

The RP must have an operational temperature range of -37 degrees F to +176 degrees F (-38 degrees C to +80 degrees C).

5. Wireless Communication. The VDS must operate in the unlicensed Industrial, Scientific and Medical (ISM) 2.4 Gigahertz (GHz) band. The AP and VSN must operate in any 1 of the 16 channels available in this band. Two way communication must be provided between the AP and VSN to ensure integrity over the RP interface.

The VSN must use Time Division Multiple Access (TDMA) protocol wherein each sensor is assigned a time slot during which it transmits and receives 1 or more data packets.

All system components must be synchronized to the same time reference sourced by the AP.

6. Wireless Contact Closure (CC) Card and Detector Rack. Comprised of a 4-channel CC card and detector rack, 1.5 A power supply, power cable for alternating current (AC) and direct current (DC) voltage input and a detector cable for the 4-channel detector card.

The CC must be capable of transmitting detection information to a NEMA type controller to provide real time detector information. The detector rack must support four CC cards and one power supply.

The CC must have four output channels comprising an optically isolated contact closure relay.

The CC card must have a single slot width of 7 inches × 4.5 inches × 1.1 inches.

The CC must have the capability of mapping up to15 VSNs to a single channel so that if any 1 VSN detects a vehicle, the contact closure relay for that channel will close.

The CC must have the capability of connecting to an expansion card to allow for additional sensor readings. The CC must accept up to 63 daisy chained expansion cards.

The CC must output a CC signal to a controller via 2 × 22 pin edge card connector and must receive an input from an AP via an Access Box using a 10/100 Base-T Ethernet port.

The 4-channel detector rack must be powered by 120 volts alternating current (VAC) power supply and must supply DC power to the CC. The CC must operate from 11 to 26 VDC and must consume no more than 5 Watts and operate at a temperature range of -40 degrees F to +176 degrees F (-40 degrees C to +80 degrees C).

The CC must have the capability of powering an AP using a Power over Ethernet (POE) cable. Specific pin assignments must be provided by the manufacturer.

7. Software. The VDS must be capable of accepting software and firmware upgrades. Software must be provided to configure the VSN, AP and RP units and also to store and retrieve the detection data. The VSN and RP must be reconfigurable by a user over the wireless communication interface.

8. Quality/Warranty. The Contractor will provide materials with a manufacturer's guarantee/warranty, transferable to the MDOT, that the supplied materials will be free from all defects in materials and workmanship for a specified period from the date of shipment. The Contractor will supply the Engineer with any guarantee/warranty documents from the manufacturer and a copy of the invoice showing date of shipment. A factory authorized representative must be available for assistance within 24 hours of notification during the warranty period.

c. Construction. The furnishing and installation of the VDS must be as indicated on the plans. The installation of the VDS, salvaged on the project, must be as indicated on the plans. The removal of the VDS includes all VSN, AP and RP units, associated enclosures, mounting brackets and hardware necessary to complete the work.

All work must comply with sections 819 and 820 of the Standard Specifications for Construction, the applicable "typical" construction details, and this special provision. Storage or disposal of the removed material is included and will not be paid for separately, and will be performed as directed by the Engineer and section 204 of the Standard Specifications for Construction.

The VSN must be installed in a 4 inch × 2-1/4 inch core drilled hole in the pavement surface and placed in the traffic lane as indicated on the plans or as directed by the Engineer. A two part

polyurea epoxy recommended by the manufacturer, or approved equal, must encapsulate the VSN.

The AP and RP must be installed within range of the sensors and as indicated on the plans or as directed by the Engineer.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following contract items (pay items):

Contact Items (Pay Items)	**Pay Unit**
Wireless Vehicle Sensor Node	Each
Wireless Access Point	Each
Wireless Contact Closure Card	Each
Wireless Detector Rack	Each