V. ITS DEVICES

A. Types of Devices

This chapter of the Traffic Design Manual provides information on the design of many of the ITS (Intelligent Transportation Systems) Traffic Devices that are currently deployed in Delaware and designed by DelDOT's Traffic Section. ITS devices are connected to DelDOT's Integrated Transportation Management System (ITMS).

Sections V-B and V-C of this Manual outline the specific design elements required when preparing an ITS design per DelDOT standards. While the technology associated with many ITS devices is continually evolving, the design plan elements of most current ITS devices are similar and may also be applicable to future devices.

1. General

ITS Traffic Devices installed by the Department are used to help manage recurring congestion and minimize non-recurring congestion as part of the "Delaware Integrated Transportation Management Strategic Plan." These devices are used to increase safety, reduce delays, and improve operations by providing the necessary infrastructure to allow DelDOT to collect, monitor, and disseminate real-time, accurate traveler information. DelDOT may use this information to respond to changing travel conditions by modifying signal timing patterns, and deploying DelDOT staff, and may also provide this information to motorists, allowing the public to make informed decisions about route choice, mode choice, and the timing of their travel. Projects may include the installation or upgrade of communication infrastructure, or the installation or upgrade of monitoring and/or reporting devices. Projects may consist of a single device installation/upgrade, the installation/upgrade of multiple devices at a single location, or the installation/upgrade of multiple devices through a corridor-wide deployment as part of a CIP or Traffic-only project.

2. Communication Infrastructure

The ITMS Communication Infrastructure is the foundation of the data and communication system of DelDOT's Traffic Management Center (TMC). Without power and communication, the usefulness of an ITS device is severely limited. In Delaware, all ITS devices shall communicate with DelDOT's Transportation Management Center (TMC). The current ITMS system utilizes both hardwire and wireless connections. Typical hardwire connections are achieved using a single mode fiber optic cable, a twisted copper pair cable, or a T1 connection. Typical wireless connection is achieved via CDMA, 4.9GHz, or 900 MHz connections. Both hardwire and wireless systems provide connectivity between the TMC and the devices deployed in the field. Hardwire connections are typically underground pathways connecting to individual devices or linking multiple devices along a corridor back to a central hub location or directly to the TMC. There are several advantages and disadvantages of each type of connection.

Fiber optic cable (fiber) is commonly used by DelDOT. The primary benefit of fiber is its capacity to carry large amounts of data. Fiber optic cable is also less bulky than copper wire, avoids the monthly charges by the phone company associated with a T1 or CDMA connection, and may provide a more-reliable connection during critical events than wireless communication. However, it is not practical or cost-effective to install fiber in remote locations. Wireless communication may be the preferred method of connectivity with devices in locations where existing hardwire communication options are unavailable or where it would be cost-prohibitive to install the necessary infrastructure to connect the device(s) with existing communications lines. Wireless communication can also be used effectively during construction phasing as a temporary means of communication until proposed or existing infrastructure is installed or reconnected.

At junction points of major fiber pathways, the installation of a fiber mini-hub or a traditional hub building may be used. The purpose is to not only provide an access point to combine and increase the signal strength of the fiber optic cable, but to also allow for the ability to provide slack in an already overloaded corridor. Both full hub buildings and fiber mini-hubs require a power source.

See **Appendix T** for a sample plan for a fiber pathway.

3. System Detection

Real-time traffic monitoring devices allow the TMC to collect speed data and traffic volume data along highways and other key travel corridors within Delaware. These devices can also be deployed to monitor locations with recurring congestion and to assist in monitoring work zones. Real-time traffic monitoring provides the TMC with information necessary to appropriately adjust signal timing along affected routes and/or deploy necessary personnel or equipment to a site. Real-time traffic data is used in Delaware to inform motorists of current travel conditions via several different methods of communication, including CMS boards, websites, mobile device applications (DelDOT "app"), traveler advisory radio, and other information portals. Along major corridors, data received from real-time traffic monitoring devices can be the first alert to the TMC of severe congestion or the presence of a traffic-related incident.

The current techniques used by DelDOT to collect real-time traffic data are:

- System loops utilized along signalized corridors
- Real-time traffic monitoring stations (RTMS) along highways or major corridors where signal spacing cannot accurately provide real-time monitoring
- Automatic Traffic Recorder (ATR) stations that collect traffic volume data throughout the state.
- Bluetooth detection

System Loops

To collect real-time traffic data along signalized corridors, an inductive (6'x6') loop is placed downstream within each departure lane at a point where vehicles have reached free-flow speed. These loops are typically referred to as "system loops." The information collected by the system loops provides the TMC and the signal controller unit with current traffic volumes along the corridor and can be used to determine the appropriate signal-timing operation to be deployed in a traffic-responsive signal system based on current travel conditions. The data collected by system loops can also be used to supplement or replace manually-collected traffic data, typically turning movement counts or pneumatic tube counts.

US 13 at Llangollen Blvd, New Castle

In some cases, it may be necessary to place an additional loop on the departure side of a free right turn movement from the side street. The free right loop should only be placed where a full acceleration lane is present and at a position where traffic has reached free-flow speed, if possible.

Real-time Traffic Monitoring Stations (RTMS)

To collect real-time traffic data along highways and major unsignalized corridors, RTMS units are typically deployed. These devices collect information through the use of fixed low reference frequency and are capable of measuring traffic volume, vehicle classification, average speed, individual vehicle speeds, and volumes by lane. In order to collect travel time information, multiple units will be required at various points along the roadway segment. Using vehicle speed measured at each location and the distance between the units, reasonable assumptions can be made regarding average travel time and/or traffic delays along the corridor. Since accuracy and reliability is dependent on the number and placement of units, a minimum spacing of ½ mile is recommended. Bluetooth Monitoring Devices (see following page) can also be deployed in conjunction with RTMS units to improve data accuracy along major corridors.

I-95 SB at SR 273 On Ramp, Newark

When RTMS units are placed in the field, they are generally rigid mounted on their own breakaway pole. Mounting height and offset from roadway varies based on the number of lanes to be monitored and the manufacturer's design specifications. A cabinet should be installed at each unit location for controller and communication equipment. See **Appendix U** for a sample plan of an RTMS design.

Automatic Traffic Recorder (ATR) Stations

ATR stations are traffic volume counter stations permanently installed throughout Delaware covering all functional classifications of highways except local streets. ATR stations count the number of vehicles passing each location continuously, 24 hours per day, seven days per week, and transmit the recorded data back to DelDOT's Office of Information Technology (OIT) headquarters for electronic data processing. Some of the Department's ATR stations are also equipped with weigh-in-motion (WIM) equipment that records the weight of every vehicle passing over the station.

Bluetooth Monitoring Stations

Every Bluetooth-equipped (and enabled) device, including cellular phones, mobile GPS systems, wireless telephone headsets, in-vehicle navigation systems, laptop computers, and hands-free systems, emits an electronic signal containing a unique electronic address. These addresses, known as MAC addresses, can be detected within a few hundred feet of the device (source). Many transportation agencies, including DelDOT, are installing equipment to detect these signals that are being emitted from Bluetooth devices within vehicles as the vehicles pass by a Bluetooth monitoring station. By comparing data gathered at multiple stations, DelDOT can cost-effectively garner a variety of real-time travel information, including average travel times, average travel speeds, and travel patterns.

SR 1 at DelDOT TMC, Smyrna

The MAC addresses read by DelDOT's Bluetooth monitoring station do not contain any personal data or information that could be used to identify an individual. Additionally, users who have privacy concerns are also able to turn off the Bluetooth discovery function of their respective device(s) to prevent them from being detected.

4. CCTV Cameras

Closed Circuit Television (CCTV) is primarily used for monitoring current traffic conditions and verifying roadway incidents (crashes, disabled vehicles, and/or construction and maintenance activity). CCTV cameras also provide security surveillance of DelDOT roadway, bridge, and toll facilities, providing first-response information.

I-95 NB at SR 896, Newark

When placing a CCTV, the location should provide a clear line of sight of the roadway with minimal obstructions and provide as much upstream and downstream roadway coverage as possible. During the Initial Design Phase, a field visit with Traffic System Design, Traffic System Construction, and Traffic System Operations should be coordinated. During this field visit, a bucket truck or drone should be used to approximate the view of the proposed camera to ensure that the desired sightlines can be achieved. During or after the field visit, additional coordination with the local Maintenance District may also be necessary to identify possible conflicts. CCTV cameras typically have a view radius of 315 degrees with a 45-degree blind spot. The blind spot should be oriented to a location that is non-critical for viewing and should be depicted on the plan sheet. Care should be taken when CCTV cameras are placed in a residential or populated area to minimize impacts to the adjacent community by aligning the blind spot with residential areas, where possible. In these locations, additional shielding may be required to expand the blind spot, thereby reducing the view radius. Where feasible, CCTV cameras should also be located to provide a line of sight to view other nearby traffic control devices, such as CMS board messages or traffic signal heads. This allows for visual verification of device status to the TMC and can reduce the need for additional monitoring devices. Cameras located along a highway or major roadway corridor should provide as much continuous coverage as possible.

Cameras should be placed as high as possible over a roadway. They may be placed on their own pole, but consideration should be given to mounting cameras onto proposed and existing signal poles with a davit arm as a cost-effective solution, when possible. Where applicable the Designer should coordinate with nearby airports and FAA before placing tall camera poles (See Chapter 2 for more information). A low mounting height may also be necessary in constrained areas or to avoid community impacts. Typically, CCTV cameras should be installed with lowering devices to facilitate maintenance. See **Appendix V** for a sample plan of a CCTV camera design.

5. CMS Boards

Changeable Message Signs (CMS), also referred to as "dynamic message signs" or DMS, are used to provide motorists with current information on traffic conditions, crashes, incidents, hazardous roadway conditions, travel times, and construction and maintenance activities. CMS boards can be attached to permanent structures, or they can be portable units that are moved to different locations during construction activities or special events, as needed. All CMS message displays shall comply with the DE MUTCD.

SR 1 NB South of SR 30, Milford

Ideally, CMS boards should be located on a tangent roadway section with few roadside distractions to avoid driver hazards and provide maximum driver visibility. They should also be placed reasonably far enough away from downstream decision points to give motorists sufficient time to read and comprehend the sign message and take appropriate action. Permanent CMS boards should typically be placed on a butterfly overhead structure where feasible and conform to the sign spacing requirements outlined in the DE MUTCD. When determining the appropriate strategic placement of the CMS boards, consideration should be given to locations that allow drivers the ability to access alternative routes to circumvent potentially congested areas and avoid delays when a message is displayed. See **Appendix W** for a sample design plan for a permanently mounted CMS board.

6. Weather Stations

SR 1 at DelDOT TMC, Smyrna

Road Weather Information Systems (RWIS) provide the TMC, DelDOT maintenance personnel, and public and other agencies with real-time weather and pavement data. They assist in the decision-making process of deploying labor, equipment, and materials as cost-effectively as possible during a weather-related event.

RWIS units gather current air temperature, amount and type of precipitation, visibility, and wind speed. The RWIS units can also include roadway-embedded devices that provide information related to pavement temperatures, surface conditions, chemicals on the roadway, and the freezing point of the road surface.

RWIS stations are typically placed near bridges and overpasses or within other environmentally-sensitive areas. The main controller unit, wind sensor, and rain gauge are typically located on a pole near the base of a roadway structure, outside the clear zone, in an area accessible by maintenance crews. Roadway sensors are typically cored into the roadway surface within the travel lane(s) near the main controller unit. The roadway sensors may communicate with the controller via either a wireless sensor or a hardwired connection. See **Appendix X** for a sample plan of a weather station design.

Delaware has numerous rivers, dams, creeks, and intercoastal waterways that have the potential to flood, causing damage to roadways and surrounding infrastructure, thereby serving as a threat to public health and safety. DelDOT and the United States Geological Service (USGS) have begun an initiative to deploy numerous Hydrological Monitoring Sites statewide at critical flood locations. This equipment will be utilized by both parties to provide real-time flood management information during and after major storm events. Currently, the devices being deployed contain a rain gauge, water level sensors, a bubbler gauge, submerged pressure transducers, microwave depth sensors, and fluid velocity sensors.

7. WTMC

DelDOT uses its designated AM radio frequency (1380 AM, WTMC-AM) to update travelers on roadway and transit conditions so they can make informed decisions regarding their travel patterns and avoid congestion. The main transmission tower is located near the City of Wilmington. Due to the limited signal strength of the current tower, the Department deploys numerous repeater sites strategically placed throughout the state. These sites allow for the expansion of the broadcast range of the WTMC. Each repeater site receives a weak or low-level signal and re-transmits the signal at a higher level so the signal can cover a broader area without degradation. See **Appendix Y** for a standard detail of a WTMC repeater site.

Sign Shop Rd, Dover

8. Variable Speed Limit Signs

I-495 NB North of I-95, Newark

Variable Speed Limit (VSL) signs allow the TMC to adjust the posted speed along a corridor based on a variety of factors, including adverse weather conditions, traffic congestion, construction/maintenance activities, or during incidents. The speed limit can be changed remotely from the TMC. Variable speed limit signs shall be placed in accordance with the DE MUTCD and follow the same standards required for static SPEED LIMIT (R2-1) signs. At the entrance to a roadway or corridor where variable speed limit signs are deployed, a NOTICE: CHANGEABLE SPEED LIMIT ZONE AHEAD (W3-5-DE) sign shall be posted in advance of the VSL signs, alerting motorists to changing posted speeds.

9. New Technology

DelDOT continuously seeks to improve its monitoring and data collection techniques and is constantly reviewing the latest state-of-the-art technologies as they are developed. DelDOT will review each new technology on a case-by-case basis and may choose to add new ITS devices to the Delaware ITMS program if they are deemed appropriate and effective. Designers should coordinate with the DelDOT Traffic Section for design guidance on new technologies not specifically addressed in this Manual.

B. Preliminary Design Plan Elements

When developing preliminary ITS device design plans, there are several elements and design factors that should be taken into consideration. The design elements presented in this chapter of the DelDOT Traffic Design Manual represent the minimum that should be incorporated into all preliminary design plans. Additional design elements may also be included at the discretion of the Designer, DelDOT, or other interested parties, based on project-specific needs.

1. Location

First and foremost, when selecting an appropriate location for ITS devices, consideration should be given to the type of information the device will be generating and transmitting back to the TMC, as well as the needs of the other interested parties that may utilize the information gathered from the device.

The device should be placed to allow for safe access by authorized personnel and adequate protection for maintenance crews. The location should also provide adequate accessibility for equipment required to maintain and/or repair the device. Devices should be located outside of the clear zone or be adequately protected by a guardrail, barrier, or breakaway device. Additionally, particularly within medians of high-speed roadways, care should be taken to place ITS devices in locations that have safe access for maintenance purposes.

All equipment should meet the same utility clearances required for traffic signals as outlined in Chapter IV-C of this Manual. Utility clearance is the required distance between overhead and underground utilities. The ability to achieve proper utility clearance is often a major factor in selecting an appropriate location. The placement of the device(s) should comply with current local utility companies and National Electrical Safety Code (NESC) clearance requirements. Typically, all devices should be at least 10 feet from all primary electric lines, 4 feet from all secondary electric lines, and 2 feet from cable and telephone lines. For underground facilities, a minimum of 2 feet should be maintained for all wet and dry facilities.

2. Power

ITS devices typically draw power from existing, nearby utilities. The Designer is responsible for identifying potential sources of power and leading coordination efforts with DelDOT forces and the utility company to finalize specific design details regarding the power connection. This effort to discuss viable options should occur during the preliminary design process. For additional information, refer to the DGM 1-27 dated April 07, 2020 included with this Manual in **Appendix M.** DelDOT's standard process for designing power feed should be followed with the power company's wire being brought to the device cabinet. Preferably, this should be an underground wire, but may be an overhead wire, if needed.

Due to the need to install ITS devices in remote locations, in areas where power is not readily available, or simply as a means to reduce long-term energy costs, some devices,based on power needs, may use solar power upon approval by the Traffic Systems Design Manager. Some devices, such as RTMS and Bluetooth devices, may have power needs that are low enough to rely completely on solar power. Other devices may still require connection to a hardwired power source in addition to solar power due to the critical nature of the information being gathered.

3. Communication

During preliminary design, the Designer is required to meet with DelDOT's Telecommunications Committee to discuss the communication requirements for the integration of the proposed device. Prior to meeting with the Telecommunications Committee, the Designer should have a draft idea of the communication needs of the project. All proposed devices should be shown and accounted for to provide an accurate scope of the project. Also, the Designer should have an idea of other significant projects in the area and/or long-range TMC communication plans. The Telecommunications Committee will provide the Designer with an integration strategy and will identify the required pathway and equipment needed to integrate the proposed devices into the ITMS system. The Telecommunications Committee will also provide the Designer with equipment and integration costs to be added to the traffic supply items listed in the traffic statement.

C. Final Design Plan Elements

Final design plans must include all elements necessary to fully construct all components of the ITS device. During the final design, the Designer must update and finalize all elements included in the preliminary design plans and must also include several more-detailed elements to the plan set. The design elements presented in this chapter of the DelDOT Traffic Design Manual should be incorporated into the final design plans.

1. Conduit Design

A conduit acts as a pathway for electrical and fiber-optic communication cables placed between junction wells, ITS devices, and the controller cabinet. The DelDOT Traffic Section uses Schedule 80 polyvinyl chloride conduit (PVC) or high-density polyethylene (HDPE) for ITMS and electrical pathways. For more information, refer to the chapter on conduit design for traffic signals of this manual (Chapter IV-D.1).

a. Sizes

For ITS devices, conduit sizes are typically selected based on the following:

- All proposed conduit shall be 4” Schedule 80 PVC when installed by trench or open cut
- All proposed conduit shall be 4” HDPE SDR - 13.5 when installed by bore. If hand bore is required conduit size may be reduced upon approval by a Traffic Systems Design Representative.

- All proposed electrical service shall be provided via a single 2" (or larger, as determined by maximum fill capacity) rigid conduit. Where conduit is installed underground for long distances, Schedule 80 PVC or HDPE may be deployed upon approval of the Traffic Systems Design representative.
- Where applicable proposed system loop detector lead-in conduit shall be 1 ½" rigid conduit. See standard construction detail T8 for additional guidance.
- All pole base conduits shall be as outlined in the section below. Once a tie-in to a junction well has occurred, the remainder of the pathway shall be as stated above. See standard construction detail T5 for additional guidance.

For pathway on structures, smaller conduit sizes may be used based on device deployment requirements. Additionally, galvanized conduit should be used for pathway exposed to the outside elements.

b. Installation Methods

There are four (4) typical methods for installing conduit:

- Trenched – Installation of conduit in grass or dirt
- Bored – Installation of conduit under roadway, pavement, or concrete surfaces
- Open Cut – Installation of conduit in roadway, pavement, or concrete surfaces where it cannot be bored
- Banded – Conduit may also be banded to poles and structures, where applicable

Boring is the preferred alternative to open cutting of roadway, pavement or concrete surfaces. Boring helps to minimize interruption to traffic and damage to surfaces/structures. The installation cost is typically also lower than open cutting. If boring is recommended for the conduits, the Designer must ensure that there will be sufficient room and right-of-way (approximately 10 feet in the direction of the conduit) to place machinery performing the boring operation. If boring beneath pavement or concrete surfaces is found to be infeasible, open cutting the pavement is generally an acceptable alternative installation method. Open cutting also provides the advantage of avoiding conflicts with underground utilities.

There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, for example, hand holes, junction wells, etc.

c. Conduit Fill Capacity

The National Electrical Code limits the portion of the conduit's cross-section that can be occupied by conductors. Like traffic signal conduits, the conduits for ITS devices should be limited to the following maximum allowable fill:

	Maximum Allowable Fill
• One Conductor	53%
• Two Conductors	31%
• Three or More Conductors	40%

However, for ITS device installations, the conduit fill should be limited to **26%** for new conduit and **35%** for existing conduit. This will facilitate installation through bends, installation of long runs, and potentially large numbers of conductors and help minimize installation damage. Cross-sectional areas of cables typically used for ITS installations are listed in **Table V-1** below.

Table V-1
Cross-Sectional Areas of Electrical and Fiber Optic Cables

No. of Conductors/Wire Size	Area (Sq. In.)
#8/2 UFWG Strand. Bare Copper Ground. Wire	0.250
#18/4	0.049
#14/1	0.049
#14/2	0.091
#14/4	0.119
#14/5	0.139
#14/9	0.297
#14/16	0.389
#6 AWG Stranded Copper	0.051
6 Count Fiber	0.132
24 Count Fiber	0.132
48 Count Fiber	0.132
144 Count Fiber	0.302
CAT	0.102

2. Junction Wells

Junction wells are pre-cast structures placed underground or within concrete barriers (junction boxes) with composite or steel frames and lids. They act as a point of access to reach cable, to provide a change of direction for a conduit run, or to provide a cable splice location.

a. Types & Sizes

ITS devices typically use three (3) types of junction wells; precast concrete with steel frame and lid (Type 1 and 4), and precast polymer concrete (Type 7). Additional junction well types may be used but would require prior approval from the Traffic Systems Design Engineer or Chief of Traffic Engineering. Sizes of the preferred junction well types used by ITS devices are as follows (see DelDOT's Standard Construction Detail T-1 for additional information):

- Type 1 – 20"x 20": typically used for connecting multiple devices to a power source or connecting power sources with the device cabinet.
- Type 4 – 20"x 42½": typically used for pull points for the fiber optics pathway. Also used as a tie-in point for entering the device cabinet.
- Type 7 – 36"x 60": typically used for pull and/or splice points for fiber optics pathway and/or device tie-in locations.

b. Location

For a communication pathway, the maximum spacing between Type 4 junction wells for ITMS (fiber) pathway shall not exceed 600 feet with every fourth well (maximum 2,400 feet) being a Type 7 junction well. For all underground splice locations, a Type 7 junction well shall be installed. A Type 4 junction well shall be placed at all ITS device tie-in points and at the cabinet location. A Type 4 well should also be placed near each pole, change of direction, and roadway crossing of the pathway. The maximum spacing between junction wells for power supply for ITS devices is 300 feet. Refer to Chapter IV-D.2 of this Manual for additional details regarding junction well design elements.

3. Wiring

For ITS devices, the required wiring is specific to the type of device being deployed and is typically provided by the device vendor. Refer to the vendor cut sheet and/or specification for specific information and wiring requirements. For the integration of devices into the ITMS system, the fiber group will determine the type and count of fiber to be utilized. Refer to Chapter IV-D.4 of this Manual for additional details regarding wiring design elements.

4. Control Cabinet

a. Types

For all ITS devices, the unit's controller should be housed in a base-mounted cabinet Type P & F (see DelDOT's Standard Construction Detail T-4 for dimensions and additional support information), except in special circumstances where there is insufficient space, or other geometric or environmental constraints are present. In those cases, a pole-mounted NEMA-rated Size 4 cabinet, typically referenced as K Cabinet, may be used once approved by The Chief Traffic Engineer. On the ITS device plan sheet, the cabinet type shall be shown inside the cabinet symbol. The cabinet should be equipped with a fan to provide adequate cooling of the controller unit.

b. Location

Like control cabinets for traffic signals, ITS control cabinets should be placed to allow for clear visibility of the devices. Cabinets should be located outside of the clear zone or a minimum of 2 feet beyond vertical curb and as far off the travel edge as possible, to provide protection from errant vehicles. Additional factors to consider when selecting the location include:

- Safe access by maintenance personnel and maintenance vehicles
- Sufficient right-of-way to permit ready access
- Should be traffic facing
- Clear view of the device from the cabinet
- Convenience to power source
- Convenience to communication equipment
- Areas prone to flooding
- Driver visibility

c. Cabinet Base and Conduits

All proposed ITS device cabinet bases Type P (see DelDOT's Standard Construction Detail T-4-2 for dimensions and additional support information) shall have a minimum of 4 conduit access points. The typical layout shall be as follows:

- All new cabinet bases shall be connected directly to a type 4 junction well with a minimum of four (4) 4" Schedule 80 PVC conduits providing direct access.
- There shall also be a single 2" (or larger, as determined by maximum fill capacity) rigid Service conduit providing direct access or via type 1 junction well from the power source into the cabinet base.

Fiber Minihub cabinet bases Type F (see DelDOT's Standard Construction Detail T-4-1 for dimensions and additional support information) shall have a minimum of 6 conduit access points. The typical layout shall be as follows:

- All new cabinet bases shall be connected directly to a Type 7 junction well with six (6) 4" Schedule 80 PVC conduits providing direct access.
- There shall also be a single 2" (or larger, as determined by maximum fill capacity) rigid Service conduit providing direct access or via type 1 junction well from the power source into the cabinet base.

Any modification to the standard construction detail must be pre-approved by the Chief Traffic Engineer prior to installation.

5. Pole / Structure

a. Types

The types of poles/structures used to mount ITS devices vary by the device type, as follows:

- CCTV cameras are typically standalone pole-mounted devices. The poles are typically 75 feet tall but can range from 50 to 75 feet in height depending on need and site constraints. CCTV cameras can also be mounted on signal strain poles or signal mast arms using a mounting adapter.
- RTMS devices are typically mounted on a 40-foot breakaway pole. Device mounting height is based on roadway offset and device manufacturer recommendations.
- CMS boards are typically mounted on an overhead sign structure or cantilever sign structure. Refer to DelDOT's Bridge Design Manual. For additional resources, refer to the AASHTO LRFD Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
- RWIS devices and hydrology beacon poles are typically 40-foot breakaway pole.

For other ITS devices, refer to the specification or manufacturer recommendations for mounting requirements.

b. Pole Bases

For all designs with CCTV cameras, and/or vehicle detector poles, the designer should first consult DelDOT's Geotechnical Engineer to determine if soil information is readily available for the project location. If historical soil data is unavailable, the designer should submit a soil boring request form (see **Appendix O**). For Traffic-Only projects, all soil boring requests should go through the Traffic Systems Design Manager to DelDOT's Materials & Research Manager and Geotechnical Engineer. For all other projects, except Developer projects, requests should be coordinated with the Project Manager and Group Engineer. Following the soil analysis, DelDOT's Geotechnical Engineer will recommend one of twelve soil condition "cases" for each pole base location for the signal designer to utilize as shown in **Table IV-5** in Chapter 4D. For unique or other foundation requirements, the designer shall refer to AASHTO LRFD Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

Because Pole Base, Type 3C requires specialized foundation drilling equipment and unique mobilization, DelDOT's Traffic Construction Section should be consulted in advance of the project handoff to advise of project-specific cost estimate and constructability constraints.

c. Conduits

Type 3, 3A, 3B, and 3C pole bases shall have two (2) 3" Schedule 80 PVC conduit elbows with one providing a connection from the pole base to the nearest junction well (or cabinet; see previous sections) and the other being capped unless otherwise required. All new ITS device pole bases shall tie into a junction well unless otherwise approved by a Traffic Systems Design Representative.

For any devices requiring a non-standard foundation design, the designer should accommodate the necessary number of conduits required by the manufacturer, or as requested by the Department.

6. Maintenance of Traffic

The Traffic Designer shall determine the required maintenance of traffic (MOT) setups that will be required to construct ITMS systems. Typical MOT requirements can be found in Chapter 6 of the DE MUTCD utilizing typical case applications. Coordination with the Traffic Safety section shall occur during the design process to determine allowable work hours, pedestrian access, and any additional MOT project requirements. If the project is part of a capital project, pavement rehabilitation project, or developer project, the Designer should coordinate with the project team developing the Transportation Management Plan (TMP).

The cost estimates prepared for Traffic lead projects should include all MOT items. Time restrictions, night work requirement, and pedestrian access should be denoted on the plan in the handoff form. For capital projects, pavement rehabilitation projects, and developer projects, the time restrictions set for the main contractor will also typically apply to the Traffic contractor.

7. Traffic Statement

DelDOT Traffic System Design is responsible for developing the engineer's estimate for stand-alone ITMS Projects including coordination with DelDOT Telecommunication committee on communication cost. For In-House Capital Projects, DelDOT Traffic System Design Staff will ensure all needed items are included in the Traffic Statement. For Consultant-led Capital Projects, and/or Developer / Subdivision Projects DelDOT Traffic System Design Staff will assist in the coordination of obtaining Telecommunication communication cost and in the review and comment on the consultant-developed Traffic Statement.