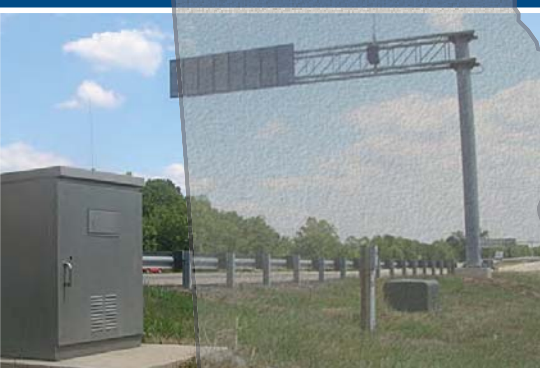
Delaware Department of Transportation

TRAFFIC DESIGN MANUAL

2015 EDITION



According to Title 17, Chapter 1, § 141 of the Delaware Code, Delaware Department of Transportation has jurisdiction and control of all state highways of the State of Delaware outside of the limits of incorporated cities and towns for the purpose of regulating traffic and for the use and operation of all vehicles thereover, and may adopt any and all rules and regulations respecting the use of such highways and the operation of all vehicles upon the same. Furthermore, according to Title 17, Chapter 1 § 134 of the Delaware Code, with respect to state highways within their corporate limits, incorporated cities and towns in the State may erect and maintain such traffic control signals as shall be authorized by proper ordinance of the city or town and by the Department.

This manual is the result of significant contribution and collaboration by many individuals, primarily those on DelDOT's Traffic Design Manual Committee. The lead consultant for this committee was RK&K Engineers, who provided project management, research and development for the manual. Jim Burnett, PE, PTOE was the consultant Project Manager and Mark Luszcz, PE, PTOE and Monroe Hite, PE were the DelDOT Project Managers. Individuals who contributed significantly to the preparation of this Manual include:

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List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities
ADT	Average Daily Traffic
APS	Accessible Pedestrian Signals
ATC	Advanced Traffic Controller
CADD	Computer-aided Design and Drafting
CCTV	Closed-Circuit Television
CDMA	Code Division Multiple Access
CFR	Code of Federal Regulations
CMF	Crash Modification Factors
CMS	Critical Movement Summation
Construction Group	DelDOT Traffic Systems Construction Group
DE MUTCD	Delaware Manual on Uniform Traffic Control Devices (*citations reflect 2011 edition*)
DelDOT	Delaware Department of Transportation
DelTRAC	DelDOT's Transportation Management Program
Design Group	DelDOT Traffic Systems Design Group
Designer	Developer, Consultant, or DelDOT Traffic Staff Preparing Plans
DMS	Dynamic Message Signs
FHWA	Federal Highway Administration
HAWK	High-Intensity Activated Crosswalk
HCM	Highway Capacity Manual
HDPE	High-Density Polyethylene
HIB	Hazard Identification Beacons
HSM	Highway Safety Manual
ICB	Intersection Control Beacons
ISD	Intersection Sight Distance
ITE	Institute of Transportation Engineers
ITMS	Integrated Transportation Management System
ITS	Intelligent Transportation Systems
LOS	Level of Service
Maintenance Group	DelDOT Traffic Systems Maintenance Group
MOE	Measure of Effectiveness
MOT	Maintenance of Traffic
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NTCIP	National Transportation Communications for ITS Protocol
OIT	DelDOT's Office of Information Technology
Operations Group	DelDOT Transportation Management Center, or TMC
PR	Public Relations
PROWAG	Draft Public Rights-of-Way Accessibility Guidelines
PS&E	Plans, Specifications and Estimates
PVC	Polyvinyl Chloride
RRFB	Rectangular Rapid Flash Beacons
RTMS	Remote Traffic Microwave Sensors
Safety Group	DelDOT Traffic Safety Group
Studies Group	DelDOT Traffic Studies Group
SSC	Signing, Striping, and Conduit
TIS	Traffic Impact Study
TMC	DelDOT Transportation Management Center
WTMC	Radio Frequency for Traveler Information

List of Common Reference Manuals

All signals and ITS traffic devices designed or modified in the State of Delaware should comply with the following policies, guidelines, and standards. Due to the design flexibility inherent with many of these references, the Delaware Traffic Design Manual has been developed to provide additional guidance regarding preferred design practices in Delaware.

- AASHTO - A Policy on Geometric Design of Highways and Streets
- AASHTO – Highway Safety Manual (HSM)
- AASHTO - Roadside Design Guide
- DelDOT - Lighting Design Guidelines
- DelDOT - Delaware Manual on Uniform Traffic Control Devices (DE MUTCD)
- DelDOT - Road Design Manual
- DelDOT - Delaware Standard Specification Book
- DelDOT - Subdivision Manual
- DelDOT – Standard Construction Details
- DelDOT - Work Zone Safety and Mobility Procedures and Guidelines
- DelDOT – Accessible Pedestrian Standards Facilities in the Public Right-of-Way
- FHWA - Manual on Uniform Traffic Control Devices (MUTCD)
- FHWA - Railroad-Highway Grade Crossing Handbook
- IEEE - National Electrical Safety Code (NESC)
- National Electrical Manufacturers Association (NEMA) - Codes and Standards
- NFPA - National Electrical Code (NEC)
- ITE - Manual of Traffic Engineering Studies
- TRB - Highway Capacity Manual (HCM)

Chapter I
INTRODUCTION

I. INTRODUCTION

The guidelines contained in this Traffic Design Manual have been written to define the standards and processes that should be followed in the preparation of design plans for all new or modified traffic system devices owned and/or maintained by the Delaware Department of Transportation (DelDOT). The manual also applies to all projects in which DelDOT is serving in an oversight role.

This introductory chapter outlines the purpose of the Manual and discusses the different types of traffic system devices. This chapter also compares the three primary project types that involve traffic system design, and includes some important maintenance of traffic considerations. Finally, this chapter defines the roles and responsibilities of various groups involved in the traffic system design process, both within DelDOT and throughout the state of Delaware.

A. Purpose

This Manual sets forth the latest design concepts and standard practices for engineers and technicians when preparing plans and specifications for traffic system design projects. This manual represents DelDOT's practices, techniques and procedures that will be applied in developing plans, special provisions, standards and specifications for any new or modified traffic system devices that will be installed or maintained by DelDOT. The manual also applies to all projects in which DelDOT is serving in an oversight role, regardless of ultimate ownership of the devices.

DelDOT's Traffic Section is responsible for the design, maintenance and operation of all traffic devices (including traffic signals) that are on the state system outside of municipalities, and in compliance with town agreements, many traffic devices on state maintained highways within municipalities. One of the primary objectives in developing this manual is to maintain uniformity and standardization in the use, design and operation of powered traffic system devices throughout Delaware, regardless of who develops the plans (i.e., in-house designers, consultants, etc.).

It should be noted that this manual does *not* address the design of signs, pavement markings or lighting, except when associated with powered traffic system devices. For information on the design of signs and pavement markings, refer to the Delaware Manual on Uniform Traffic Control Devices (DE MUTCD). For information on lighting design, refer to the DelDOT Lighting Design Guidelines. Note that all specific DE MUTCD citations in this Manual refer to the 2011 edition.

B. Traffic System Design Devices

The DelDOT Traffic Section is responsible for designing, reviewing and/or approving a variety of traffic systems devices that are used to monitor and control traffic throughout the State of Delaware. Safety, access and mobility are all considered during the design process. The most common type of traffic systems devices are traffic signals. Traffic signals may include standard intersection traffic control signals, hazard identification beacons (HIB), intersection control beacons (ICB), emergency vehicle signals, signals at moveable bridges, school signals, pedestrian signals, and temporary signals. The various traffic signal types are described in more detail in Chapter IV of this manual.

While traffic signals are the most common traffic device installed and maintained by DelDOT, the design of all other traffic systems devices follows a similar design process, which is outlined in this Manual. The design process for the following traffic devices is also governed by this manual: communications infrastructure, including underground conduit and some wireless networks; real-time traffic monitoring projects, including system loops and remote traffic microwave sensors (RTMS); closed-circuit television (CCTV) cameras; dynamic message sign (DMS) boards; roadway weather information stations (RWIS); and WTMC repeaters and auxiliary towers. These traffic devices are discussed further in Chapter V of this manual.

C. Project Types

There are four (4) primary project types in Delaware that result in the need for traffic system design elements. Each project type will require a slightly different design process. However, regardless of the project type, all traffic system equipment must be justified by the appropriate level of study and the resulting equipment must be designed to uniform standards.

The four project types are described below:

1. **Capital Projects** – This project type includes all traffic design elements associated with DelDOT capital projects. Capital projects are typically led by the Project Development, Bridge, or Transportation Solutions Sections of DelDOT. Examples of these projects include new roads, corridor improvement projects, sidewalk/multi-use path projects, or other capital improvement projects. The need for traffic control signals and/or other traffic system design elements is often based on projected traffic volumes developed during the DelDOT project development process. The DelDOT Traffic Section serves in a support role on these projects. Capital project traffic system elements may be designed by engineering consultants as part of an overall capital project assigned to a consultant. For consultant projects, the consultant typically develops the design, cost estimates, etc., and Traffic Systems Design Section staff serve as reviewers and coordinators. For capital projects designed in-house by DelDOT staff, a

DelDOT Traffic Systems Design staff member typically prepares the design plans for the traffic system elements. For in-house projects, the assigned Traffic System Design staff member is an important part of the project design team, and it is critical for the project designer to closely coordinate all relevant aspects of the project with the Traffic Section.

2. **Pavement & Rehabilitation Projects** – Typically these projects include traffic signal design work required to meet Americans with Disabilities Act (ADA) requirements on Pavement & Rehabilitation projects. Due to the limited staff and compressed time frames of these projects, the process followed is significantly different than for other capital projects. Although the Traffic Section is in a support role on these projects, they are the lead on determining the need for and designing pedestrian signal upgrades and associated curb ramp work related to ADA.

3. **Traffic Section Projects** – These projects are typically associated with traffic signals or other traffic system elements requested by legislative representatives, private citizens, fire companies, and/or recommendations by Traffic Section staff. These improvements can be a new design, an operational improvement identified as a result of an engineering study, or a safety or equipment improvement identified by DelDOT.

4. **Developer / Subdivision Projects** – These projects are typically associated with private developments including new subdivisions and new or modified commercial properties. The traffic system devices are often requested by the developer or required as part of the Traffic Impact Study or Traffic Operational Analysis approval process to facilitate movement to and from a new roadway or entrance.

D. Maintenance of Traffic Considerations

An important consideration on all DelDOT projects, including traffic system design projects, is the Maintenance of Traffic (MOT) requirements. In response to FHWA's Rule on Work Zone Safety and Mobility (23 CFR 630 Subpart J), DelDOT has developed a work zone safety and mobility policy that stresses DelDOT's commitment to maintaining optimum worker safety while having traffic traveling smoothly and safely through work areas at all times. The policy, outlined in DelDOT's 2007 document titled <u>Work Zone Safety and Mobility Procedures and Guidelines</u>, requires DelDOT to perform an evaluation of the broader safety and mobility impacts of work zones throughout project development, and also requires that a Transportation Management Plan (TMP) be prepared for "significant" projects.

For Capital Projects, Pavement & Rehabilitation Projects, and Developer / Subdivision Projects, the traffic systems design is typically only a portion of the overall design effort. These types of projects typically require either a Type A or Type B Transportation Management Plan (TMP) depending on the level of impacts. Therefore, the MOT plan is generally developed for the full construction. For these types of projects, the traffic systems designer must coordinate with the project designer and the DelDOT Safety Section to ensure that the work zone impacts associated with the construction of the traffic system devices are properly included in the MOT plans. This is particularly true when construction will occur at night or when pedestrian routes are interrupted. In all cases, the MOT needs should be addressed on the handoff form as well as in the cost estimate.

For Traffic Section Projects, it is the responsibility of the traffic systems designer to develop MOT plans and ensure compliance with the Work Zone Safety and Mobility (WZSM) Procedures and Guidelines. These types of projects are often considered non-significant in terms of the WZSM Guidelines and therefore, typically require only a Type A TMP. The traffic systems designer must also coordinate with the DelDOT Safety Section to ensure that the work zone impacts associated with the construction of the traffic system devices are properly included in the MOT plans and the TMP. This is particularly true when construction will occur at night or when pedestrian routes are interrupted. Refer to this document for additional details. The MOT requirements for each Traffic Section Project need to be estimated and explicitly documented, including required MOT set-ups, pedestrian MOT considerations, and allowable times for lane closures.

E. Roles and Responsibilities

Before discussing the detailed process that should be followed for a DelDOT traffic system design project, it is important to identify all the key stakeholders and personnel, as well as the responsibilities they have in the context of a traffic system design project. The following DelDOT Sections, companies, and organizations can each typically have a role in the planning, design, construction and operations of traffic system devices owned and maintained by DelDOT.

The **DelDOT Traffic Section** is the authority for the approval of all traffic system design projects in the State of Delaware in which the traffic devices will be owned and/or maintained by DelDOT. The Chief Traffic Engineer must approve and sign all traffic signal plans and timesheets. The DelDOT Traffic Section consists of several groups including the Traffic Studies Group, the Traffic Systems Design Group, the Traffic Construction Group, the Traffic Maintenance Group, the Traffic Safety Group, and the Transportation Management Center.

The **DelDOT Traffic Studies Group (commonly called "Studies")** performs and reviews traffic impact studies and traffic safety and operations studies. They have the responsibility of preparing traffic signal studies and signal justification/warrant analysis and subsequently initiating the signal design process for either new signal projects or modifications to the operations of existing signals.

The **DelDOT Traffic Systems Design Group (commonly called "Design" or "Traffic Design")** is responsible for the design, review, and recommendation for approval of all traffic system design projects to the Chief Traffic Engineer, including compiling the design, specifications and estimates; review and approval of "as-built" plans for traffic system devices; coordination and review of consultants' designs; the coordination with DelDOT Project Development Section and Planning Division; and coordination within the Traffic Section.

The **DelDOT Traffic Systems Construction Group (commonly called "Construction" or "Traffic Construction")** is responsible for the installation, construction coordination, inspection, and acceptance of all constructed statewide traffic system devices. Once a traffic project is awarded or handed off, Construction acts as a liaison for the Traffic Section, coordinating construction activity with the Contractor, the Districts, and utility companies through all phases of construction. They also monitor and coordinate all traffic system device construction activity statewide.

The **DelDOT Traffic Systems Maintenance Group (commonly called "Maintenance" or "Traffic Maintenance")** is responsible for the maintenance and upkeep of all existing DelDOT traffic system devices statewide. They also assist Construction and the TMC by performing minor signal upgrades, including upgrades to wiring, signal head replacement, knock-down repairs and some relatively minor upgrade projects (such as signal head modifications or installation of Accessible Pedestrian Signal (APS) equipment). They also provide assistance in construction and implementation of special traffic system devices.

The **DelDOT Traffic Safety Group (commonly called "Safety")**, for the purposes of this manual, is responsible for review and approval of maintenance of traffic (MOT) plans, work zone safety, monitoring of MOT during construction, and preparing / approving detour plans. Additionally, this group may recommend signal or other device installations or upgrades as part of the Highway Safety Improvement Program.

The **DelDOT Transportation Management Center (TMC, commonly called "Operations"),** is responsible for the operation of all traffic system devices that are owned and maintained by DelDOT. Signal timings, incident management, corridor-level roadway monitoring, and developing signal corridor timing plans and are among the many duties of this group. Some TMC staff focus on signal timings, systems monitoring, conveying information to the public, and running the day to day operations of the transportation system. Other TMC staff coordinate closely with the OIT communication group on maintaining and expanding the communications systems for traffic systems devices.

The DelDOT **Project Process Group** is comprised of representatives from the Design, Maintenance and Construction Groups, the TMC, and with occasional input from the Studies Group, Safety Group, OIT, capital project designers and/or private developers. This group's primary role is to review the design plans at various stages of the project and provide feedback to the traffic design engineer.

DelDOT's **Traffic Finance Group** is responsible for coordinating the financial obligations of the DelDOT Traffic Section with DelDOT's Finance Section.

DelDOT Contract Administration: This group has the responsibility of preparing final bid packages and advertising contracts for all contractors.

DelDOT's Office of Information Technology (OIT) is responsible for the integration of all DelDOT traffic system design devices into the statewide system.

DelDOT's Department of Technology and Information (DTI) is the state's central Information Technology (IT) organization, chartered to deliver core services to all state organizations and exercise governance over the technology direction and investments of the state. DTI provides innovative enterprise services enabling all organizations to effectively fulfill their missions.

The **Telecommunications Group** is comprised of representatives from the Maintenance and Construction Groups, the TMC and OIT, and occasionally from the Design Group. They are responsible for the integration of new and existing communications infrastructure, and providing input on the design elements related to telecommunication.

DelDOT's Planning Division has many responsibilities within the Department. For the purposes of this Manual, there are two primary groups within the Planning Division that may be involved in the Traffic Design process. The **Transportation Alternatives (TA) Section** is responsible for the design of smaller roadway/multi-modal improvement projects. The Design Group works with the TE Group to provide technical guidance, review and comment throughout the project design process. Along designated Byways, the particular requirements associated with the Byway should be coordinated with the Transportation Alternatives Section. The **Development Coordination Section** is responsible for the approval of new and/or upgraded access points along state roadways. The Studies Group works with this group to provide review and comment for Traffic Impact Studies and Traffic Operational Analyses submitted by developers. Additionally, the Design Group works with this group to provide review and comment of plans and design services when required.

DelDOT Project Development Sections is responsible for the design of Capital Projects within the state of Delaware. When a Capital Project includes traffic system design elements, the DelDOT Traffic Section will assist Project Development with review and/or design of all traffic related elements within the project.

DelDOT Bridge Section is also responsible for the design of Capital Projects within the state of Delaware. The Bridge Section is responsible for inspection of sign structures and high mast lights, the design of sign structures when upgrades are required, and any special design required for signal pole foundations.

DelDOT's Public Relations (PR) Section is responsible for public outreach for the Department. PR helps assist the DelDOT Traffic Section by informing the public of traffic related issues, including the construction of new devices, the modification of existing traffic patterns, or the disruption of traffic flow during construction projects.

Consultant: DelDOT or a private developer may request the services of an engineering consultant to prepare traffic system design plans. When a consultant renders services, it becomes the responsibility of the consultant to coordinate all data collection and design activities with the Design Group, Project Development, local governments and utility companies, through the Plans, Specifications and Estimates (PS&E) submission.

Power Company: The power company has the responsibility of providing electrical service to most new or modified traffic system devices. If the source of power is not obvious, or if conflicts are anticipated between existing aerial lines and proposed traffic equipment, coordination with the power company may be needed early in the design process. All traffic control signals should use hardwire power sources. Most ITS devices will also use hardwire power sources. If hardwire power is not readily available, some ITS devices may use solar power. However, the use of solar power requires prior approval from the DelDOT's Traffic Systems Design Group.

MISS UTILITY: MISS UTILITY is a private agency and is responsible for coordinating the location of underground utilities on state and local roads. Generally, the Maintenance & Construction Group and/ or the Design Group will contact MISS UTILITY to verify the locations of underground utilities during the design process and prior to construction of the project. DelDOT will also contact MISS UTILITY after a project is completed, identifying the location of all new or modified underground equipment.

Local Governments: Local governments include cities or towns that may have an operational/safety interest, financial interest or obligation, or other responsibilities for a traffic system design project. Coordination with local governments is necessary since local guidelines and ordinances may apply to traffic system design projects, especially signal projects, even if both intersecting roads are maintained by DelDOT. Local guidelines and ordinances may dictate streetscape elements and the overall appearance of traffic system equipment. Additionally, town agreements may specify which public entity is responsible for which traffic control devices. For traffic systems that will be owned by local governments, design and specification elements of this Manual may be modified to meet local standards/ preferences, as long as overall operational and safety parameters are met. For Traffic System Design Section-led projects within municipal limits, the following guidelines should be followed: 1) Notify the town of any/all projects. Depending on the scope, this could range from simple notification to a design review, to a consideration of different alternatives. This should be completed during design. 2) If the project impacts non-DelDOT equipment, a new town agreement is needed. 3) For any new installations within municipalities, a town agreement is needed whether the signal will be DelDOT or municipal owned.

F. Traffic Design Manual Updates

The information contained in this manual is current at the time of publishing. It is expected that the guidance contained in this document may be updated periodically. Interim guidance may be published by DelDOT and will be made available on DelDOT's website within the Design Resource Center (DRC). Proposed changes to this manual should be suggested using the Traffic Systems Design Directive form found in **Appendix A**, and must be approved by DelDOT's Chief Traffic Engineer.

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Chapter II

THE TRAFFIC DESIGN PROCESS

II. THE TRAFFIC DESIGN PROCESS

This chapter of the DelDOT Traffic Design Manual describes the recommended process for performing traffic design, from the initial request through installation of the device in the field.

A. Request

The traffic design process begins with a request to install or modify a traffic signal or other traffic device at an existing or proposed location. The request should include information regarding how the proposed traffic device would be expected to improve safety and/or operations at an intersection or along a corridor. The requests may come from a variety of sources, and in general, the source of the request determines which project type will be performed.

Requester	Typical Project Type
DelDOT Planning, Traffic, Project Development, Bridge Design	Project Type 1 – Capital Projects
DelDOT Pavement Management	Project Type 2 – Pave & Rehab Projects
Elected Officials, Citizen, Traffic Representative, Fire Companies	Project Type 3 – Traffic Section Projects
Developer	Project Type 4 – Developer / Subdivision Projects

B. Establish Need for Traffic System Design Elements

Once the request is received, the DelDOT Traffic Section must establish the need for the traffic device before the design process can begin. Need is typically established by conducting a study of current conditions and assessing the potential benefits of the traffic device. For example, to establish need for a new, modified, or removed traffic control signal, a signal study is required (see Chapter IV-A).

Approval from the Chief Traffic Engineer is required before a project involving a new traffic control signal or the removal of an existing traffic control signal can advance to the design stage. If it is determined that the traffic device is not needed, the findings should be documented and filed in the case history for future reference.

New Signal or Modification to an Existing Signal for Type 1 (Capital Projects), Type 2 (Pave & Rehab Projects) and Type 4 (Developer / Subdivision Projects):

DelDOT's Traffic Systems Design Group (Design) will coordinate a meeting with the DelDOT Project Process Group, including the Project Consultant (if not in-house design) and others with a specific interest in the project, at the time survey plans are submitted. The purpose of the meeting is to discuss the communications, facilities, and signal design. Data about the proposed or modified signals should be obtained and provided at the meeting. Agreement will be reached on recommendations for the changes, lane assignments and other elements such as the phasing, system detection, integration, etc. Upon concurrence by the Project Process Group that a new signal is justified, a signal resolution will be drafted for signature by the Chief Traffic Engineer. A signal agreement may also be required in which the Developer and DelDOT will agree on private funding requirements and/or right-of-way access (For additional information on signal agreements, see **Appendix B**). The project will subsequently be "handed off" to the Design Group or to a Consultant to begin the development of base plans.

New Signal or Modification to an Existing Signal for Type 3 (Traffic Section Projects):

DelDOT Traffic Engineering Studies Group (Studies) or Traffic Safety will conduct a traffic signal warrant or other traffic engineering study of the location, as outlined in Part III of this manual. If a new signal is justified or if modifications to an existing signal are being recommended, Studies will meet with the Chief Traffic Engineer to review the study. If approved by the Chief Traffic Engineer, a resolution will be drafted and signed, authorizing the new signal. Studies will then meet with the DelDOT Project Process Group. The Studies Group will provide copies of the study and other pertinent data for discussion. Agreements will be reached on the recommended change(s) and other required design elements. The project will be subsequently "handed off" to the Design Group so that they can begin the base plan preparation. Additionally, modifications to existing signals may be initiated by DelDOT's Design Group and/or Maintenance Group. These requests are typically associated with asset management projects.

C. Notify DelDOT Public Relations

Once the need for the new or modified traffic signal or other traffic systems device has been established, the group initiating the signal project should notify DelDOT Public Relations of the intent to commence design. Information that should be provided to Public Relations includes project location, scope, schedule, and the potential for MOT impacts. Continued coordination between the DelDOT Traffic Section and DelDOT Public Relations is important throughout the design process, particularly if there are any changes to the project scope or schedule. Prior to design completion, the Traffic Design Section should inform PR of the pending signal handoff and anticipated signal construction. During the construction phase, DelDOT's Signal Construction Group should keep PR informed of all lane closures, operational changes, and new activations.

D. Design Process Checklist

At this point in the traffic design process, the designer should begin preparing the design process checklist. The checklist is a working document that records the completed project tasks and follows the project from the beginning of design through handoff to Construction or Maintenance. A sample handoff form is provided with this Manual in **Appendix C**.

E. Plan Preparation

The next step in the traffic design process is plan preparation. Prior to beginning plan preparation, the Designer should obtain from the Department all existing data on record pertaining to the proposed location. A thorough on-site inventory / assessment should be conducted, at which time construction and operational constraints should be identified. If the project is located near an airport, port facility or an at-grade rail crossing, additional coordination with the appropriate agencies (Federal Aviation Administration (FAA), CSX, etc.) will likely be required. If an existing traffic signal is present, the designer should verify existing equipment and operation of the signal. If any field issues/irregularities are discovered, the designer should report them to the appropriate group or section in the Department. If utility, right of way, geometric, or other required information is indeterminable, a survey of the intersection may be required.

Base plans should be developed at 30-scale and include/identify existing and proposed roadway geometrics, utilities, right-of-way, and clear zone, as well as any physical features that could affect the design of the signal. All existing and proposed signal equipment should be shown, and the proposed phasing, lane use, intersection/system detection and system communication requirements should be shown and identified. Further details of base plan preparation are presented in Chapter III of this manual.

F. Design Review

Upon completion of the preliminary design, the Designer should again meet with DelDOT's Project Process Group to review the design plans. Following this review, the Designer will typically receive additional recommendations to modify the design. One or two more meetings (semi-final and final plan review) may be required with the Designer and DelDOT's Project Process Group to review design issues and address additional comments and recommendations.

Once all parties have reached a final agreement on the traffic design plan, the Designer will finalize the plan and sign the plan as recommended. For signal design projects, the Designer will then obtain the signature of the Signal System Manager and submit the signed plan(s) to the TMC Operation Manager for development of the final timing sheet. Once the signed timing sheet is obtained, the Designer should provide the Chief Traffic Engineer the final (signed) signal plan(s) and final timing sheet concurrently for signature. While some projects may not have a timing sheet ready for signature at this time, the process described previously is preferred. Next, DelDOT's Traffic Systems Design Group will provide a handoff form to Construction along with the signed signal plan(s), final timing sheet(s), traffic statement and any other project-specific information. For Type 3 projects (Traffic Section Projects), Traffic Construction controls the schedule. Therefore, priority should be designated as "ASAP," "High," or "Normal" on the handoff form, as appropriate. For other project types, priority should be designated as "Support" on the handoff form, and the Traffic schedule will follow the main project's schedule. The anticipated start date should also be noted on handoff form. A sample handoff form is provided in **Appendix C**.

G. Cost Estimate

During the design process the Designer should generate a cost estimate (i.e., a traffic statement) for the required work for the traffic device installation and/or modification. The cost estimate should include all items to be furnished and installed by the contractor and/or DelDOT to make the traffic device fully operational. The cost estimate should also include a contingency factor. The cost estimate should show the breakdown of cost contribution by any developers, local government and DelDOT, as determined by the project type.

H. Construction

Once the handoff form is provided by DelDOT's Traffic Systems Design Group and funding is verified, DelDOT Signal Construction will issue a Notice to Proceed to the selected Contractor to begin work on the project. The Contractor is responsible for coordinating all assigned construction activities with other projects administered by DelDOT Signal Construction. The Contractor is responsible for notifying MISS UTILITY prior to beginning construction. DelDOT Signal Construction will notify the Power Company at least 30 days in advance of a "turn-on" date.

Generally, a traffic signal project requires 30 - 40 calendar days to complete construction. For other types of projects such as signal enhancements and capital projects, the construction of signals is treated as an integral part of the total project and, therefore, may require a longer time to complete. The timetable to complete construction of other traffic systems devices varies by device type and scope of the project.

I. Activation

An important time of the traffic design process is the day the device is activated and put into service. For major projects, one representative of each DelDOT Section should attend the field activation. Typically, a new traffic control signal is operated on "flash" for a minimum of 72 hours prior to converting to stop and go operation. Similarly, portable changeable message signs (PCMS) are used to provide information to motorists about the pending signal activation approximately 1 week prior to signal activation. Prior to activation, the construction manager should notify DelDOT Public Relations regarding the "turn-on" date. Public Relations will then inform the public of any changes to traffic patterns in the area. Following activation, the project documents are handed off to Traffic Maintenance.

J. As-Built Plans

Once the project is constructed, completed, inspected and accepted by DelDOT Construction and Maintenance, the construction inspector will prepare an "as-built" plan. The "as-built" plan is a record of the final location and operations of the traffic signal equipment. The construction manager will submit the red lined "as-built" plan to the designated Traffic Systems design representative. The Designer will be responsible for updating the record drawings. If needed, new signatures will be obtained. Additional information on the preparation of "as-built" plans is included in Chapter III of this Manual.

Chapter III

PLAN PREPARATION

Chapter III
PLAN PREPARATION

III. PLAN PREPARATION

This Chapter of the DelDOT Traffic Design Manual discusses the general steps required for preparing plans for any traffic design project. It includes a discussion of the required contract documents, and outlines the process for developing preliminary, semi-final, and final design plans. Additional details regarding specific design elements are presented in Chapter IV (Traffic Signals) and Chapter V (ITS Devices).

A. Required Contract Documents

Traffic Design projects may be prepared in one of five formats:

1. Capital Project
2. Traffic-Only Signal Project (individual)
3. Traffic-Only System Improvement Project
4. ITS-Only Project (individual)
5. Developer / Subdivision Project

Capital Projects include the insertion of traffic devices into highway design and/or bridge projects prepared by DelDOT or consultants for formal advertisement. These types of projects, which require formal advertisement and construction of the entire project, must be coordinated closely with DelDOT's Project Manager and the Design Team.

Traffic-Only Signal Projects typically utilize the services of Statewide On-Call Contractors who have already been selected on a competitive bid basis and are readily available to begin work on new projects. Alternately, some small work tasks with low cost for installation or minor maintenance of material (small phasing change or head replacement) may instead be completed by Traffic Signal Maintenance Group or other DelDOT in-house forces.

Traffic-Only System Improvement Projects may require minor roadway geometric improvements together with the installation of new devices or modifications to existing traffic control equipment. Traffic-Only System Improvement Projects may be developed for a specific corridor or as part of a statewide implementation plan.

ITS-Only Projects typically utilize the services of Statewide On-Call Contractors or Integration Vendors who have already been selected on a competitive bid basis and are readily available to begin work on new projects. Alternatively, some small work tasks with low cost for installation or minor maintenance of material (device swaps, equipment upgrades) may instead be completed by Traffic Signal Maintenance Group or other DelDOT in-house forces.

Developer / Subdivision Projects historically represent traffic control signal designs that are prepared by DelDOT's Traffic Systems Design Group, as part of the permit approval plan set.

The signal documents are prepared and reviewed by DelDOT's Traffic Systems Design Group and the Sub-Division Section prior to approval by the Chief Traffic Engineer. Although DelDOT Traffic is responsible for preparing the signal plans, the Developer is responsible for obtaining the necessary right-of-way easements to construct the signal. The Developer is also responsible for providing DelDOT with digital files for preparation of design plans, and should continue to coordinate with DelDOT Traffic, updating any design files, as needed. Additionally, the Developer is responsible for designing all geometric elements of the signal design plans, including islands and curb ramps, as well as other associated traffic control devices (signs and pavement markings).

Table III-1 below identifies the PS&E requirements for each of the contract types from the previous page:

Table III-1
Requirements for Plans, Specifications and Engineer's Estimate

Contract Documents Required	Capital Projects	Traffic-Only Signal Projects	Traffic-Only System Improvement Projects	ITS-Only Projects	Developer / Subdivision Projects
Title Sheet	Yes(6)	No	Yes	No(5)	Yes
Signal Plan / ITS Device Plan (1)	Yes	Yes	Yes	Yes	Yes
Signing, Striping, and Conduit (SSC) Plan (1) (2)	Yes	No(4)	No(4)	No	Yes
Specifications	Yes	No(3)	No(3)	No(3)	Yes
Traffic Statement / Cost Estimate	Yes	Yes	Yes	Yes	Yes

NOTES:

(1) *Signing and marking are typically shown on the signal plan, but may be detailed separately.*

(2) *All Traffic Control devices should be integrated in to the State's ITMS Program. Communication plans may be required.*

(3) *Specifications will need to be written for non-standard items.*

(4) *While not required, a separate SSC plan may be needed for clarity.*

(5) *May be needed based on magnitude of project.*

(6) *An overall title sheet is required for the Capital Project. Typically, a separate title sheet for the traffic elements is not required.*

1. Title Sheet

A title sheet may be required for some traffic control projects that are part of a proposed system-wide upgrade or as part of a DelDOT Traffic project that is formally advertised. The title sheet shall identify the project location and limits of work on a location map. The title sheet shall also provide an index of the sheets contained in the plan set, and include signature blocks for, at minimum, the Chief Traffic Engineer, Systems Design Manager and Recommending Designer/Reviewer. When title sheets are used, a signature block may not be needed on each individual sheet (unless requested by the Traffic Systems Design Manager). Furthermore, the DelDOT or Federal-aid contract numbers (as applicable) and project location and project name shall be shown on the top center of the title sheet. The DelDOT Traffic Section has developed a standard title sheet format that is consistent with the general DelDOT title sheet. The standard traffic title sheet is included in this Manual in **Appendix D**.

2. Plan Sheet

The major objective of the design plan sheet is to graphically describe how the device is to be constructed and operated. This includes showing the existing and proposed geometrics, the location of all hardware and other pertinent information.

When preparing a traffic control device plan, the north arrow should be located in the upper right corner of the plan and should generally point up toward the top of the plan sheet. For signal plans, the major route should typically be oriented from left to right. However, for Capital and Developer Projects, the orientation should follow the roadway plan set conventions to maintain consistency within the plan set. Under the north arrow should be a note stating that the assumed direction of the major street is either east-west or north-south. The note - not the north arrow - will be used for numbering of the signal heads. Standard signal borders shall be used for signal plans. For other traffic control devices, a modified signal or standard state construction border may be used, depending on signature requirements. The Designer should check with the Systems Design Manager on border requirements. A typical signal design border includes a legend, signal phasing, signal head diagram, general signal notes, project title, location, permit number, contract number, county location, scale, addendum/revision block and signature block.

Generally, plan sheet layouts should be laid-out as follows: Project-specific notes should be shown in the top left corner of the plan. The conduit run schedule should be placed in the lower left corner. Notes pertaining to the conduit run schedule should be placed below the schedule. Any special MOT notes should be shown on the specific MOT plans or included in the construction hand-off package. MOT notes should not be shown on the traffic device plan sheet. Unless space limitations require an exception, all existing and proposed signs should be shown in the lower right portion of the plan. If needed, project-specific details should be shown where space allows or on a separate sheet. Fonts, symbols and title block and border should be used in accordance with DelDOT's CADD standards.

For new traffic control devices, the title block, whether placed on the title sheet or on the plan sheet, should include the Permit Number (if applicable) and contract number. For minor traffic control modifications, if required by the System Design Manager, the title block and the revision block should match the latest as-built plan and any previous revision. The revision block should include a brief description of the proposed revision and shall be initialed by the Designer. Larger-scale modifications, such as a phase change or pole relocation, will require the development of a new plan sheet, as directed by the Systems Design Manager.

Sample title sheets (**Appendix D**) and plan sheets (**Appendix E**), including ITS device sheets (**Appendix T** through **Appendix Y**), are provided in this Manual in the appendices.

3. Specifications

Standard Specifications, Special Provisions and Standard Construction Details for traffic projects have generally been established and standardized by DelDOT. Unless a unique or non-standard item is required, there should be no need to provide any additional specifications (i.e. special provisions). However, on a case-by-case basis, there may be a need to include an additional drawing or details for site-specific geometric and/or construction requirements. It should be noted, however, that non-standard specification usage should generally be avoided, to the extent possible.

On a case-by-case basis, there may be a need to include drawing details for site specific Temporary Traffic Control plans and/or Transportation Management Plans.

4. Traffic Statement (Cost Estimate)

The development of a Traffic Statement, or cost estimate, is required for all traffic design projects. Technically, a formal "Traffic Statement" is only required for Capital Projects. However, all projects require a cost estimate, and typically the same Traffic Statement form is used to prepare the cost estimate for all project types.

Traffic construction items, supplied and installed for all traffic control related items, are broken down into three different categories and vary by project type:

- Project Contractor Items (Capital and Developer/Subdivision projects only)
- Traffic Contractor Items (all)
- Traffic Supply Items (all)

Project Contractor Items (Capital and Developer/Subdivision Projects only)

Due to construction schedules and coordination issues, DelDOT has determined that some items will become the General Contractor responsibility for Capital Projects and Developer Projects. Typically, these items cover the supply and installation of underground facilities (conduit, junction wells, pole bases, cabinet bases, and loop detectors) and the removal of underground facilities by the project's main contractor. For Developer Projects, when off-site improvements are required, project versus Traffic Section contractor responsibilities should be defined during the design phase of the project.

Traffic Contractor Items (All)

These items cover supply and installation of items by the Traffic Section's Statewide Signal Contractor, as well as the installation of items furnished by DelDOT Traffic Signal Construction that are installed by Statewide Signal Contractor or by DelDOT's Traffic Signal Construction and/or Maintenance Groups. These items typically include the installation of all above-ground traffic control equipment and wiring. If the project is associated with a Developer/Subdivision Project, the underground equipment is typically the responsibility of the developer.

Traffic Supply Items (All)

These items account for all items supplied by the Traffic Section to the Statewide Signal Contractor for installation. These also cover the cost of integration of all equipment into DelDOT's Integrated Transportation Management System (ITMS).

The Traffic Statement shall show the unit and total cost of each item separately, as well as a combined total project cost. The Traffic Statement shall use item numbers and unit costs provided by Traffic for all Traffic Contractor and Supply items. For Project Contractor Items on Capital and Developer Projects, the unit cost should be estimated by the Capital/Developer Project Designer, and not by the Traffic Section.

B. Preparation of Design Plans

One of the most fundamental tasks in the traffic design process is the preparation of design plans. Traffic design plans provide the blueprint for all traffic elements installed in the field, and the information provided on the plans must be clear, thorough, and accurate. The preparation of design plans consists of the following activities:

- Collecting preliminary data. This involves researching the existing plan records and gathering items related to the study location, including as-built plans, right-of-way plats, highway design plans, utility design plans, and timesheets for existing signals.
- Developing base plans and performing a field survey verification, including verification of existing geometrics, signal timings, above and underground utilities and other roadway features.
- Preparing preliminary, semifinal, and final design plans and related documents, as necessary, for approval.
- Obtaining signatures and approvals of the final design plans to allow the design to move to the construction phase, activation, and ultimately the operational hand-off of the traffic device.

This chapter of the DelDOT Traffic Design Manual includes a discussion of each of the activities required during the design plan preparation process.

1. Collect Preliminary Data

The first step involved in the preparation of design plans is to collect preliminary data that is available for the study location. The Traffic Designer should begin by collecting all pertinent data that would help in the development of the base plan. This includes researching DelDOT records for as-built traffic plans, highway design plans, right-of-way plats, and utility plans. Gathering these items will help provide the Designer a history of the location and assist in the development of base plans. Some of this information may have already been gathered if the project is part of a Capital Project or Developer/Subdivision Project. It is the responsibility of the Traffic Designer to obtain and review these documents prior to any plan development.

For projects initiated by the Traffic Studies or Safety Sections or as part of a Traffic Impact Study agreement with a Developer, additional information related to the study location may also be available. The Designer should coordinate with the applicable Section, as appropriate, to obtain additional background information on the study intersection, such as traffic count data, existing signal timings (timesheet), and recommendations on the proposed lane arrangements and proposed signal operations. This information is often available in the Traffic Signal Study. Chapter IV-A of this Manual provides additional information regarding the data contained in a Traffic Signal Study.

2. Prepare Base Plans

After the Designer has collected all preliminary data, the next step in the process is the development of base plans. A base plan should contain all existing roadway geometrics, as well as the locations of any traffic control devices, signs, markings, lighting, and utilities. An itemized list of the typical base plan features is shown in **Table III-2**.

Table III-2 **Typical Traffic Base Plan Features**
Roadway Geometrics
• Alignment of intersecting streets • Right-of way lines (existing and proposed) • Widths and number of lanes • Physical features (curb and gutter, sidewalks, medians, shoulders, drainage structures, guardrail) • Street lighting • Corner radii • Utility locations including overhead height and underground • Roadway entrances within 150 feet of the intersection • Any existing sight-distance obstructions • Any railroads or emergency entrances in the vicinity • Building lines, fences, trees, shrubs
Traffic Control Features
• Lane usage and scaled dimensions • Parking restrictions • Location and message of existing signs • Locations and operation of existing traffic signal devices • Existing speed limits • Existing pavement markings • One-way streets • Bus stops and loading zones • Turn restrictions

On a case-by-case basis, a topographical survey may be needed to define geometric improvements such as intersection channelization. When required, a planimetric plan with spot elevations shall be provided as the basis of the base plan.

The Designer shall follow DelDOT's CADD Standards when preparing the base plan sheet. All standard items required in the development of the base plan, including the title block, cell library, seed files, fonts, line styles and borders, may be obtained from the Delaware Department of Transportation website (www.deldot.gov). All base plans shall be prepared utilizing the current version of MicroStation.

3. Perform Field Survey

Before proceeding too far along in the design process, it is important for the Designer to verify that the items contained on the base plan match existing field conditions. This is typically accomplished by performing a field survey. A field survey generally includes either a tape-and-wheel survey at an intersection or field verification of surveyed data. The limits of the survey are usually determined by the device type. For projects involving new or modified signals, the limits on each approach should be chosen to include the length of all existing and proposed turn lanes, all potential advance signing locations, and all possible locations for the placement of detectors. During this survey, the following information should be collected or verified:

- Number of lanes and lane widths for each approach
- Intersection skew
- Medians and type
- Roadway curvature
- Pavement markings
- Signing
- Signal Timing and Phasing
- Lighting
- Sidewalks and handicap ramps
- Guardrail
- Driveways and entrances
- Utilities, including proposed electrical feed
- Parking
- Buildings
- Trees and vegetation
- MISS UTILITY (Underground)

Preliminary device locations and potential power source should also be identified during the field survey. Overhead utility lines should be measured and documented with photographs. By measuring utility lines at the proposed device location in the field, the Designer can ensure that the locations do not conflict with overhead utility lines and other physical features. Documentation of these measurements can also help resolve future utility disputes, should the height or location of utility lines change prior to device installation. The Designer should tabulate the locations and clearances of all overhead utilities on the plans where a potential conflict could occur. For locations with existing traffic control signals, the Designer should check that the signal timing and phasing described on the timesheet matches both the plan sheet and the actual operations in the field. This requires that the cabinet be opened during the field survey, which must be performed or supervised by DelDOT Traffic staff.

4. Preliminary Design Plans

a. Development

Once the initial field survey is completed, the next step for the Designer is to prepare preliminary design plans. The preliminary design plans should identify the following design elements:

- Proposed device location
- Cabinet location
- Conduit and junction well (general layout)
- Power feed
- Signing and marking
- Integration considerations
- Communication pathway
- Utility clearances

For signal projects, the following additional design elements should also be included in the preliminary design plans:

- Configuration and pole type
- Signal head placement and display
- Pedestrian facilities

It should be noted that this list is not meant to be exhaustive. Depending on the specific needs of the project, additional design elements may be required to be included in the preliminary design plans, and should be identified at this stage of the process. Any design constraints or special project requirements should also be denoted in the preliminary design plans to help in the plan review process. For additional detail regarding preliminary design plan elements, refer to Chapter IV-C of this Manual.

b. Review

Once the proposed layout for the design elements listed in the previous section has been established, the preliminary design plan review can take place. The preliminary design plan review is the first in a series of reviews built into the traffic design process to allow the members of the Project Process Group to provide input on the design and ensure quality control.

As part of the preliminary design plan review, the Designer will meet with the Project Process Group to review the design and to receive comments on the preliminary design plans. If the proposed design is part of a Capital Project or Developer/Subdivision Project, the Designer should coordinate with the designated Traffic Systems Design representative to attend or verify a meeting with the Project Process Group. During the preliminary project process review additional recommendation and/or approval of preliminary design elements will be given at which time the design will move forward to the appropriate stage. Projects that are relatively small in scale with minimal impacts may forgo the preliminary plan submission upon approval by DelDOT's Traffic Systems Design Manager.

5. Semi-Final Design Plans

For Capital Projects and Developer/Subdivision Projects, the traffic design should follow the plan submission schedule outlined by the Project Manager. In many cases, this requires a semi-final plan submission. Traffic Section Projects generally skip the semi-final phase and proceed to preparation of final plans following preliminary plan review.

a. Development

If semi-final design plans are required, the Designer should address all comments received from the Project Process Group as part of the overall preliminary plan review before submitting semi-final design plans. Additionally, the semi-final plans should also be based on discussion with Traffic Safety and should include items such as pedestrian MOT and time restrictions. If conflicting comments are received, the Designer should work with the representatives who provided comments to determine an appropriate path forward to resolve the discrepancy.

The semi-final design plans should also include additional design elements that are typically not required until the final design stage. The more elements that the Designer can include in the semi-final design will result in a more-accurate initial traffic statement (engineer's estimate).

b. Initial Traffic Statement (Cost Estimate)

Once the Designer has addressed all comments and identified the additional design elements to be included in the semi-final design plans, the next step in the process is to prepare the initial traffic statement (see Chapter III-A). The traffic statement identifies the funding method to be used for the project and includes the engineer's estimate of anticipated project costs. Quantity takeoff should be performed following current DelDOT specifications (also see Chapter III-A). The Designer should verify that the correct unit costs are being applied and that the assumed contingency meets current DelDOT practices. The Designer should also coordinate with the Systems Design representative to determine which items will be considered the contractor's responsibility and which will be the responsibility of DelDOT's Construction Group (typically, the contractor is responsible for all underground work). This will affect the portion of the total cost for which DelDOT will be responsible.

c. Review

After the semi-final plans have been distributed, the Designer shall again coordinate with the DelDOT Systems Design representative and meet again with the Project Process Group. Following this meeting, additional recommendations may be provided or approval of semi-final design will be given and the design will move to final phase of design.

d. 90% Plan Submission

For some projects, the submission schedule developed by the Project Manager will require a "90%" submittal of plans for review, or there may be comments received during the semi-final plan review that necessitate a "90%" submittal. However, in most cases, the DelDOT Traffic Section prefers that the 90% plan submission should be avoided, if possible, because it can disrupt the project schedule. In most cases, issues can be addressed during other submittals.

6. Final (PS&E) Design Plans

For Traffic Section Projects, the preparation of final design plans typically follows the preliminary design review. For Capital Projects and Developer/Subdivision Projects, the preparation of final design plans typically follows the semi-final design review. The steps required for preparing final design plans, often referred to as plans, specifications, and estimates (PS&E), are presented in this chapter.

a. Development

During the final design plan stage, the Designer should address all comments received from the Project Process Group throughout the design process and finalize all remaining design elements. As with the preliminary plan review, if conflicting comments are received, the Designer should work with the representatives who provided comments to determine an appropriate path forward to resolve the discrepancy.

Once all comments have been addressed, the following remaining design elements should be identified for inclusion on the final design plans:

- NEMA phasing (for signal projects)
- Detectors (for signal projects)
- Finalize any required schedules (conduit run, mast arm, span, signing, etc.)
- Construction notes

Additional design elements that have been identified throughout the design process should also be included in the final design plans. Any design constraints or special project requirements should also be denoted in the final design plans to help in the construction process. For additional detail regarding final design plan elements, refer to Chapter IV-D of this Manual.

b. Final Traffic Statement (Cost Estimate)

Once the Designer has sufficiently addressed all comments and identified the additional final design elements to be included in the final design plans, the next step in the process is to prepare the final traffic statement. As discussed in Chapter III-B.5.b, the traffic statement identifies the funding method to be used for the project and includes the engineer's estimate of anticipated project costs. The final traffic statement should reflect all revisions made during the development of the Final Design plans, and include costs for every design element shown in the Final Design plans. An example of a Final Traffic Statement is provided in **Appendix F**.

c. Obtain Signatures

Following completion of the final design plans and final cost estimate, it is necessary for the Designer to obtain a series of signatures to get final approval of the plans. The following steps are required:

1. If the design plans are prepared by a Consultant (for a Developer/Subdivision Project, for example), the consultant should sign the plans as "recommended" and turn them in to DelDOT's Traffic Section for review. Following the review, the DelDOT Traffic Designer should also sign the plans as "recommended."

2. If the design plans are prepared in-house by DelDOT staff (for Traffic Section Projects and Capital Projects, for example), the Traffic Designer should sign the plans as "recommended."
3. Once the plans are signed as "recommended," they should be sent to DelDOT's Systems Design Manager for review. If acceptable, the Systems Design Manager approves and signs the plans.
4. For traffic control signal projects, plans signed by the Systems Design Manager shall be sent to the TMC manager to authorize the development of a Signal Timesheet.
5. In the final step in the process, the plans and approved Timesheet are sent to DelDOT's Chief Traffic Engineer for the final approval signature. In some cases, primarily for Capital Projects, the traffic design plans are signed by DelDOT's Chief Traffic Engineer while the Timesheets are being finalized. The signed version of the plan should be included in the PS&E record set.

d. Construction Hand-off

Once the Designer obtains the final signed version of the plan sheet(s), they are responsible for completing the design project check list and preparing the construction handoff package. A formal construction hand-off package is required for all Traffic Section Projects. For other project types, the construction hand-off typically occurs at PS&E. The hand-off package, provided in **Appendix C**, should contain the following items:

- Copy of signed plan(s)
- Traffic Statement
- Traffic Systems Design Handoff Form
- Funding Source
- Timesheet Status
- Any additional construction requirements (signing, marking, and/or lighting)
- Any special construction requirements
- Any special MOT requirements
- Any public relation notification requirements

Once all required documents and coordination has been completed, the Designer shall submit all related documents to DelDOT's Signal Construction Manager (or in some cases, Maintenance Manager), as well as any other sections within DelDOT that are required to perform work associated with the project.

Once the construction hand off document is received, DelDOT's Construction Manager will place the project on the construction schedule. If the project is part of a Capital Project or Developer/Subdivision Project, the Traffic Construction Manager will place it on the schedule and coordinate with the appropriate construction inspection staff on the proposed construction schedule. If required, the procurement of any lead time items shall begin. Once construction begins, if any design changes are required, the Traffic Construction Manager will coordinate with the Designer and/or Construction Inspector to verify that a sound construction alternative is chosen. During the construction process, if minor construction changes occur, DelDOT's Traffic Construction Manager will provide DelDOT's Traffic Design Section with an as-built plan showing all plan adjustments or changes. Except on Capital Projects, the Traffic Design Section will be responsible for changing the record plans to reflect all construction changes.

Prior to completion of device construction, the Construction Manager should notify DelDOT's Public Relations office informing them of a pending new device activation and/or traffic operation change. Prior to completion of work in which a signal operational change and/or new traffic pattern is to occur, a message board should be installed on all approaches prior to implementation. For new signal activation, a message board should be installed on all approaches seven (7) days prior to implementation and a minimum 72-hour flash operation shall occur prior to full signal activation. For new signal projects and projects involving major phase changes to a signal, representatives from the following DelDOT Sections should be present at the field meeting to activate the device: Design, Construction, Maintenance, and the TMC. A representative from DelDOT's Traffic Studies Section should also visit the site within 24 hours of activation to verify that all traffic control devices are in-place and functioning properly.

Delaware Department of Transportation

TRAFFIC DESIGN MANUAL

2015 EDITION

Chapter IV

TRAFFIC SIGNALS

IV. TRAFFIC SIGNALS

A. Traffic Signal Justification Study

Prior to initiating the design for the installation, modification, or removal of a traffic signal, it is necessary to conduct an engineering study to establish need. The purpose of the study is to evaluate the applicability of a traffic control signal for a given location, evaluate less-restrictive intersection treatments, define the operational requirements for the intersection, and identify key features/ constraints which will influence the design of the selected treatment. This chapter of the Traffic Design Manual defines the required elements of a Traffic Signal Justification Study. A sample study is included as part of this Manual in **Appendix G**.

The process and requirements for a signal modification study may be reduced from that of a new signal study. However, at a minimum, data related to the existing signal should be collected, recent traffic count data should be used, and capacity analysis should be performed. Other studies and data may also be required for a signal modification project on a case-by-case basis depending on the scope of the project, the project budget, and the project schedule.

1. Study Initiation

A Traffic Signal Justification Study is often initiated by DelDOT's Traffic Studies Group following a request for signalization. The request may be from a citizen, elected official, or a developer, either due to a desire for signalization or as a requirement associated with approval of a traffic impact study (TIS). For proposed signals associated with Capital Projects, DelDOT's Project Development Group will typically coordinate with DelDOT's Studies Group to initiate the study. For proposed signals requested by a developer, the developer is responsible for preparing the study according to the guidelines in this Manual, pending review from the DelDOT Studies Group.

2. Traffic Data Collection

Once a Traffic Signal Justification Study has been initiated, the first step is to gather relevant traffic data. An accurate Traffic Signal Justification Study depends on the quality of the traffic data collected, and a thorough understanding of the existing conditions of the intersection. At a minimum, intersection turning movement counts must be collected or obtained, historical crash data should be obtained, a site visit should be conducted, and sight distances should be documented. Additionally, delay studies, queuing studies, spot speed studies, and gap studies may also be required, depending on the specific characteristics of the intersection.

An initial **Site Visit** should be conducted at the study location. The site visit should identify lane configurations, important roadway features, signing, lighting, utilities, pedestrian features, transit stops, adjacent signalized intersections, and information on the surrounding land uses. The site visit should also include written observations of traffic flow during peak and off-peak periods to gain a thorough understanding of the operational characteristics of the intersection and to identify potential safety hazards. Photographs and sketches of the intersection may be useful in documenting the findings of the site visit. During the site visit, **Intersection Sight Distance (ISD)** should be determined. Guidance on calculating intersection sight distance is provided in the AASHTO reference A Policy on Geometric Design of Highways and Streets.

For signal modification projects, existing signal timing and phasing data should also be collected during the site visit. To account for variability in cycle length and phase duration associated with actuated control, multiple signal cycles (typically between 5 and 10) should be observed in the field and compared to timing data obtained from the TMC.

Intersection Turning Movement Counts are a type of directional traffic count typically performed at roadway intersections. These counts quantify the volume of traffic for each movement through the intersection. These counts are typically conducted manually. Since data throughout the day is required to conduct a signal warrant analysis, 12- or 13-hour counts would be ideal. However, in most cases, an 8-hour count covering the morning, mid-day, and evening peak hours is acceptable. For long-term planning projects, counts collected during the AM and PM peak periods (a minimum of two hours of data during each peak period) may be sufficient, since off-peak trip generation is typically not performed. The volume of pedestrians and bicycles crossing each leg of the intersection should be collected during all intersection turning movement counts, even for locations without marked crosswalks. Counts should be conducted for signal modification projects, as well as new signal projects.

There are several other types of traffic volume counts which may also be useful in preparing a Traffic Signal Justification Study. **Total Volume Counts** tabulate the number of vehicles passing a single point along the roadway. These counts can either be bi-directional (total volume in both directions) or directional (total volume in one direction). These counts can be used to estimate Average Daily Traffic (ADT) volumes on each of the intersection approach legs, and they can also provide useful information regarding the variation in traffic throughout the day. **Classification Counts** identify the number and type of vehicles (passenger cars, buses, single-unit trucks, tractor-trailers) using the roadway network. Classification Counts should be conducted if truck traffic is cited as one of the key contributing factors for the need for signalization, or if trucks represent a significant portion of the traffic at any of the key movements at the intersection. Total Volume Counts and Classification Counts are typically conducted using automatic traffic count devices (typically consisting of pneumatic tubes stretched across the road) and are typically collected for a minimum of 24 to 48 hours.

It is advisable to check for any available traffic data before performing new counts. In general, traffic data should be 2 years old or newer when used in Traffic Signal Justification Studies. All project specific traffic data should be compared with information provided in DelDOT's Traffic Summary Report to verify the reasonableness of the data. Comparisons should be made with peak hour and/or daily traffic data, as appropriate.

Historical **Crash data** for the intersection for the most recent 3-year period available should be obtained. The crash data should be summarized and evaluated to identify crashes of types which are susceptible to correction by the installation of a traffic control signal or other alternative intersection treatment. Obtaining the individual police reports, in addition to the summary statistics, may provide a better understanding of crash trends.

There are several other types of traffic engineering studies that may be useful when preparing a Traffic Signal Justification Study depending on the site-specific characteristics of the study intersection. An **Intersection Delay Study** is used to quantify the amount of delay experienced by vehicles stopped at an intersection. A delay study can be used to calibrate intersection analysis software or to determine if an intersection approach meets specific signal warrant thresholds. While typically used to assess the delay of vehicles stopped on the minor street approaches to an intersection, Intersection Delay Studies can also be used to study the delay of left turns from a major street. A **Spot Speed Study** measures the travel speeds of vehicles at a specific location. A speed study may be used to determine 85^{th}-percentile speeds for application in signal warrant analyses, for setting speed limits, and for setting appropriate clearance intervals in signal timing plans. A **Gap Study** is used to measure the number and duration of available gaps in a traffic stream. A gap is the measurement of time between when the rear bumper of one vehicle and the front bumper of another vehicle pass a given location. Gap studies are useful for evaluating the need for a pedestrian signal and selecting appropriate left-turn phasing at a traffic control signal. Gap Studies may also be used to validate the assumptions used during the capacity analysis of the intersection. **Queuing Studies** are performed to determine the 95^{th} percentile length and duration of queues for an entire approach to an intersection, or within a specific lane. Any spillback into nearby intersections, access points, rail crossings should be noted.

Additional guidance on how to conduct these types of traffic engineering studies can be found in ITE's <u>Manual of Traffic Engineering Studies</u>.

3. Signal Warrant Analysis

A key component of a Traffic Signal Justification Study is a Traffic Signal Warrant Analysis. Chapter 4C of the Delaware Manual on Uniform Traffic Control Devices (DE MUTCD) identifies nine (9) warrants which should be evaluated to determine if the installation of a traffic control signal may be justified at a given location:

Warrant 1, Eight Hour Vehicular Volume: Intended for application at locations with a large volume of intersecting traffic, or where major street traffic volumes are so heavy that minor street traffic experiences excessive delay.

Warrant 2, Four Hour Vehicular Volume: Intended for application at locations with a high volume of intersecting traffic.

Warrant 3, Peak Hour: Intended for locations where minor street traffic suffers undue delay entering or crossing the major street during a minimum of one (1) hour during the day. The 2011 DE MUTCD specifies that: *The Peak Hour Warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, schools, or HOV facilities that attract or discharge large numbers of vehicles over a short time.*

Warrant 4, Pedestrian Volume: Intended for locations where the traffic volume on the major street is so heavy that pedestrians experience excessive delay crossing the major street.

Warrant 5, School Crossing: Intended for locations where the presence of school children crossing the road is the principal reason to consider installing a traffic control signal.

Warrant 6, Coordinated Signal System: Intended for locations at which the installation of a traffic control signal is necessary to maintain proper platooning of vehicles within a coordinated signal system.

Warrant 7, Crash Experience: Intended for locations where the severity and frequency of crashes are the principal reason to consider installing a traffic control signal.

Warrant 8, Roadway Network: Intended for locations where the installation of a traffic control signal might be justified to encourage concentration and organization of flow on a roadway network.

Warrant 9, Intersection Near a Grade Crossing: Intended for locations where the proximity to the intersection of a grade crossing is the principal reason to consider installing a signal.

a. Applicability

For analyses of existing conditions, at minimum, Warrants 1, 2, 3, and 7 should be examined. Actual traffic counts shall be used for determination of hours meeting a warrant's criteria. No average hourly volumes between two counted hours are acceptable for a final determination. For the analysis of future conditions or a projected opening-day for proposed developments, at minimum, Warrants 2 and 3 should be examined. Projected future traffic volumes may be calculated using land use and trip generation data.

Warrants 1 and 2 contain criteria based on the major-street speed. If the major-street speed is possibly applicable, a spot speed study should be completed if the posted speed limit is 35 mph or 40 mph.

Satisfaction of Warrant 3 alone is typically only considered justification for a signal in special cases (the unusual nature of which must be documented). However, it should be examined in all cases. Special cases that match Warrant 3 are:

1. **Office Complexes,**
2. **Manufacturing Plants,**
3. **Industrial Complexes,**
4. **Schools** (high schools that have significant numbers of student drivers and any school with a significant number of parent drivers in car pools), or
5. **High-Occupancy Vehicle (HOV) facilities that attract or discharge large numbers of vehicles over a short time.**

Signals installed based solely on Warrant 3 <u>must be operated under actuated control</u> to detect the presence of vehicles on the minor side-street approaches, particularly during off-peak hours.

Warrants 1, 2, and 7 may use the higher major-street left turn volume as the minor approach and the opposing major-street through volume as the major-street volume.

The *Guidance* in Section 4C.01 of the DE MUTCD should be followed. This section also explains the inclusion or exclusion of turn lanes when determining the number of approach lanes to an intersection in a warrant analysis (see Section 4C.01, paragraphs 08, 09 and 10). Generally, if the lane configuration is such that right-turning traffic experiences relatively low amounts of delay, either due to ample gaps in traffic on the major street, or relatively few occasions when they are blocked from proceeding by through or left-turning vehicles, they should not be included in the analysis. If right-turn volumes are included in the minor street approach volume, a supplemental right-turn volume analysis should be conducted based on the methodology, including Figure 2-11, provided in *NCHRP 457, Evaluating Intersection Improvements: An Engineering Study Guide.* That document provides a quantitative means of estimating the volume of right-turning traffic that would not benefit from the provision of a signal.

DelDOT will generally not operate signals on a part-time basis. All signals installed by DelDOT will be operational 24-hours per day, even at schools and churches.

It is important to note that the satisfaction of a traffic control signal warrant or warrants shall not in itself require the installation of a traffic control signal. There are alternatives to traffic control signals that could be implemented that modify the traffic operations and user needs that initially warranted consideration of a traffic control signal. Also, the location of the potential traffic control signal should be evaluated in relation to spacing with adjacent signals, where it falls in relation to an overall planning of future signal locations or access management plans, and what impacts a traffic control signal will have on traffic progression in a coordinated traffic control signal system.

b. Timetable

The timetable for implementation of a traffic control signal that meets warrants and has been approved by the Traffic Section typically differs for each of the different project types. For Capital Projects (project type 1), the implementation of the traffic control signal may occur concurrently with the construction of the major roadway improvement. Alternatively, the intersection may be designed for future signalization but initially be opened to traffic under some form of stop control. Both opening day and design year projections should be analyzed.

Pavement and Rehabilitation Projects (project type 2) are generally not associated with new traffic signals. For Traffic Section Projects (project type 3), the results of the signal warrant analyses are generally applicable to existing conditions. Therefore, design and construction of the traffic control signal can commence once the signal is approved by the Chief Engineer and funding is secured for Traffic Section Projects.

The timetable for implementation of a traffic control signal for Developer / Subdivision Projects (project type 4) is more complex, particularly for developments with a phased build-out. The Traffic Impact Studies prepared by the Developer typically evaluate traffic operations for existing conditions and a future build-out condition. Therefore, the signal warrant results often do not reflect near-term conditions, but rather operations at some future year, when the entire development is constructed and fully occupied.

DelDOT will not install a traffic control signal on an existing roadway based on presumed future conditions. If a developer is requesting that a traffic control signal be installed at the year of opening of the development or at an interim phase of development, a signal warrant analysis should be provided to DelDOT for the expected traffic conditions at the time of opening. Committed (background) development trips should not be included in the opening-day traffic projections unless solid evidence can be provided that the committed development is likely to be in full operation for the opening day time period.

If a location will not meet one or more of the DE MUTCD warrants until subsequent years after additional development occurs, a signal warrant analysis should be provided for the year in which the warrants are first met. In this case, there are several options that can be negotiated between DelDOT and the Developer for the treatment of the intersection before full signalization is justified. These options include 1) installing the signal and operating in flash mode until one of more of the warrants are satisfied, 2) installing only the underground utilities in the opening year to support the future installation of a signal, or 3) putting the signal design on hold until a future year. If a traffic signal is not justified when the facility opens to traffic, interim traffic movement restrictions may be required.

4. Safety Considerations Using the Highway Safety Manual

A Traffic Signal Justification Study should include an assessment of the safety implications of installing a new traffic signal, modifying an existing traffic signal, or removing an existing traffic signal. The Highway Safety Manual (HSM), published by AASHTO, offers a process for conducting quantitative safety analyses based on before and after studies at project sites. The HSM provides methodologies for predicting the expected average crash frequency for existing facilities, alternative designs at existing facilities, or proposed designs at future facilities. The HSM should be consulted to assist in performing the safety assessment.

DelDOT's preferred method for conducting the safety assessment is to use the "predictive method" from the HSM to estimate anticipated crash frequency. The predictive method (discussed in detail in Part C of the HSM) is an 18-step process involving three major components: 1) Safety Performance Functions, 2) Crash Modification Factors, and 3) Calibration Factors.

The Safety Performance Function (SPF) is a statistical regression model for estimating the average crash frequency for a facility type with specified base conditions. An SPF is a function of existing or forecasted traffic volumes and roadway characteristics.

Crash Modification Factor(s) (CMF) are used to account for a specific site condition(s) that differs from the SPF base conditions. When necessary, multiple CMFs may be applied to the SPF to account for all specific conditions at the site which vary from the SPF base conditions. However, the combined effect of multiple treatments could be overestimated if those treatments affect the same type of crash and the severity of those crashes. Therefore, engineering judgment must be used in order to determine the independence, or lack of independence, of the various CMFs.

The Calibration Factor (C) allows the SPFs to be adjusted to match local conditions. If calibration factors have not been developed, the Calibration Factor is assumed to be 1.0, meaning the site does not vary from the SPF base conditions. DelDOT is currently in the process of formulating local calibration factors. As such, DelDOT's Safety Programs Manager should be contacted prior to performing the safety assessment to obtain the appropriate calibration factor.

The predictive method produces a long-term expected crash frequency value that accounts for both predicted and observed crash frequencies of similar facilities, as shown in the following equation:

$$\mathbf{N_{predicted} = N_{SPFx} \times (CMF_{1x} \times CMF_{2x} \times CMF_{yx}) \times C_x}$$

Where:

	$N_{predicted}$	=	*predictive model estimate of crash frequency for a specific year on site type x*
	N_{SPF}	=	*predicted average crash frequency determine for base conditions with the Safety Performance Function representing site type x*
	CMF_x	=	*Crash Modification Factors specific to site type x*
	C_x	=	*Calibration Factor to adjust for local conditions for site type x*

The SPFs incorporated in the predicted average crash frequency value are limited to the base conditions for the facility types specified in **Table IV-1**. Two example calculations showing how the predictive method should be applied are provided with this Manual in **Appendix H**.

It is DelDOT's preference that a comparative analysis be performed using SPF's to compare the base (no improvements) scenario with the scenario that considers all proposed improvements. Additionally, the analyst should compare the SPF results with actual crash data, if available.

Table IV-1
Facility Types with Available Safety Performance Functions

HSM Chapter	Undivided Roadway Segments	Divided Roadway Segments	Intersections			
			Stop Control on Minor Leg(s)		Signalized	
			3-Leg	4-Leg	3-Leg	4-Leg
10 Rural Two-Lane, Two-Way Roads	✓		✓	✓		✓
11 Rural Multilane Highways	✓	✓	✓	✓		✓
12 Urban and Suburban Arterials	✓	✓	✓	✓	✓	✓

Source: AASHTO Highway Safety Manual, First Edition (2010), Table 1

The HSM should be referenced to obtain the latest version of this table.

The predictive method is only applicable, however, if an SPF is available for the particular base condition. In the absence of available SPF data, an alternative method can be used, in which a CMF is applied directly to the observed crash frequency data. Part D of the HSM provides a series of CMFs that can be used to determine the net change in crashes that would be expected following any intersection treatments or countermeasures. This is an acceptable method of estimation only when an SPF is unavailable for that particular base condition.

Chapter 14, Part D should be consulted for specific CMFs relevant to each potential intersection treatment involved a particular project. **Table IV-2**, excerpted from the HSM, provides crash modifications factors for converting a minor-road stop-controlled intersection to signal control, which is one of the most-common requests in Delaware. Additional examples of crash modification factors for other potential intersection modifications can be found in the HSM.

Table IV-2
Sample Crash Modification Factors

Treatment	Setting (Intersection Type)	Traffic Volume AADT (veh/day)	Crash Type (All Severities)	CMF	Std. Error
Install a Traffic Signal	Urban (Major Road Speed Limit at Least 40 mph; 4- Leg)	Unspecified	All types	0.95	0.9
			Right-angle	0.33	0.06
			Rear-end	2.43	0.4
	Rural (3-Leg and 4-Leg)	Major road 3,261 to 29,926; Minor road 101 to 10,300	All types	0.56	0.03
			Right-angle	0.23	0.02
			Left-turn	0.40	0.06
			Rear-end	1.58	0.2
Base Condition: Minor-road, stop-controlled intersection.					

Source: AASHTO Highway Safety Manual, First Edition (2010), Table 14-7

The HSM should be referenced to obtain the latest version of this table.

The crash modification factors and their associated standard error values can then be used to predict a range of expected crashes at a study intersection within the 95th percentile confidence interval, as shown in the following equation:

Expected Crashes with Treatment = [CFM ± (2 x SE)] x (N)

Where: *CMF = Crash Modification Factor*
SE = Standard Error Associated With CMF
N = Existing Crashes Per Year

The risk in applying the CMF method is it involves only the observed crash frequency for a site that could potentially be experiencing a particularly high or low crash frequency period. Application of CMFs to historical crash data involves regression-to-the-means bias, meaning a treatment is selected based on short-term trends observed in crash frequency, which could be overestimating or underestimating the safety implications of that treatment. The predictive method, on the other hand, allows for the correction of short-term crash data, and reduces the vulnerability of random variations in crash data.

The engineer should consult the DelDOT Safety Programs Manager for guidance on properly applying the methodologies contained in the HSM.

5. Alternative Intersection Treatments

As noted previously, satisfaction of one or more of the signal warrants from the DE MUTCD does not necessitate the installation of a traffic signal at a study location. This section of the Traffic Design Manual describes alternative intersection treatments that should be considered as part of the Traffic Signal Justification Study, especially if there are potential safety concerns with the installation of a traffic signal (see Chapter IV-A.4).

It is important to note that a traffic control signal is not always the most-desirable intersection treatment. Every time DelDOT installs a new traffic control signal, additional capital and maintenance costs are incurred. Additionally, the installation of a traffic control signal may result in unintended negative consequences, such as disruption to traffic flow, additional delay to motorists on the major street, or increases in certain types of crashes. Therefore, the Traffic Signal Justification Study should evaluate the feasibility of providing less-restrictive traffic control that could achieve similar capacity and safety benefits to those provided by a traffic control signal. Treatments that may be considered include:

- Roundabouts
- All-way stop control
- Channelized / restricted turn movements
- Geometric improvements, such as the addition of an exclusive turn lane
- Improved signing, striping, and/or lighting
- Consolidated property access, resulting in fewer, more widely-spaced intersections
- Other innovative intersection treatments

When considering alternative treatments, the Engineer should consult the HSM to determine the expected change in crash frequency caused by the intersection modification, if the required data is available.

6. Capacity Analysis

A Traffic Signal Justification Study should include an analysis of the intersection capacity under both existing conditions and proposed future conditions.

a. Evaluation Methodologies

The methodologies outlined in the appropriate version of the Highway Capacity Manual (HCM), as selected by DelDOT, should be used to conduct capacity analyses of the study intersection. The most-recent versions of the Highway Capacity Software and other simulation software packages that utilize the HCM methodology are typically considered acceptable tools for conducting capacity analyses. The use of a Microsimulation tool to supplement the HCM analysis may also be desirable for the analysis of closely-spaced intersections and intersections within a corridor having coordinated signal timings.

DelDOT also requires that all signalized intersections be evaluated using the Critical Movement Summation (CMS) methodology. Guidelines for conducting a CMS analysis are included with this manual in **Appendix I**.

b. Measures of Effectiveness

A Traffic Signal Justification Study should clearly document the projected change in operations at the study intersection due to the proposed improvements based on standard measures of effectiveness (MOE's).

Level of Service (LOS), as defined in the Highway Capacity Manual, is the standard measure of effectiveness to be used in evaluating proposed intersection improvements. For unsignalized and signalized intersections, LOS is based on the average delay per vehicle at the intersection.

Other MOE's may also be used to supplement LOS results, including 95th percentile queue lengths, volume-to-capacity ratios, and overall system delay. Additionally, the study should identify the potential for queue spillback into adjacent intersections or railroad crossings, or the potential blockage of nearby access points. Queue spillback from turn bays into the mainline should also be identified.

Operations should be analyzed for existing and future (opening-day, if applicable, and full build-out) conditions with and without a signal, and with any alternate form of intersection control. If the installation of a traffic control signal is recommended, a clear improvement in operations should be demonstrated and disadvantages of less-restrictive traffic control should be documented.

c. Signal Timing / Phasing

The Traffic Signal Justification Study should identify an appropriate preliminary timing and phasing plan for the proposed traffic control signal, which should also be used when conducting capacity analysis for the study. If the intersection is located within an existing signalized corridor, the existing signal cycle length should be used. The selected timing and phasing plan should use appropriate clearance intervals and consider the potential advantages and disadvantages of various phasing options, such as lead/lag phasing and split phasing. The timing plan should also consider coordination with adjacent signals (if needed), the anticipated type of left-turn treatment (permissive, exclusive-permissive, exclusive-only), and if pedestrian crosswalks and signals are included, the pedestrian walk and clearance timings. Refer to Chapter IV-E of this Manual for additional detail regarding signal timing and phasing.

7. Documentation of Results

The findings of the Traffic Signal Study should be documented in a brief report, as outlined below. A sample report can be found in **Appendix G**. If the Signal Study recommends the installation of a signal, a Signal Design / Modification Request Form (See **Appendix J**) should be initiated to advance the project to the design phase.

a. Report

The report summarizing the Traffic Signal Study should be thorough, yet concise, and include the following elements:

Problem Identification: The report should include a clear statement of the reason the Traffic Signal Justification Study was initiated, including the source of the request.

Summary of Existing Site Conditions: The report should briefly summarize the number of approach lanes for each leg of the intersection, the lane configuration at the intersection, the location and length of exclusive turn lanes (storage and taper length should be noted separately, a description of the horizontal and vertical geometry, roadside features, adjacent land use, and an inventory of existing traffic control devices, including signs and pavement markings. An Existing Conditions Diagram should be presented, along with photographs of the existing site conditions.

Previous Studies: DelDOT files should be reviewed to determine if the location was previously studied, or if signal agreements exist for the intersection. The findings of previous studies or agreements should be documented.

Anticipated Development: The report should summarize all known future development in the project area that would result in changes in traffic volumes at the intersection. This section is particularly important for studies pertaining to Developer / Subdivision Projects where the signal justification is based on projected traffic volumes.

Traffic Data: A brief summary of the existing traffic counts and future projected intersection traffic volumes (if applicable) should be included in the report, including an identification of the peak hours. Traffic data should be less than two (2) years old.

Crash Data: The report should summarize the key trends in the crash data obtained for the study, and include a crash diagram. At least three (3) years of data should be obtained from DelDOT's Safety Section. If necessary, individual police reports may be requested to establish a better understanding of the crash trends.

Observations: The report should include a brief discussion of significant items noted during field observations related to physical features and/or traffic operations.

Warrant Analyses: A statement identifying which of the eight (8) signal warrants from the DE MUTCD are satisfied at the study location should be included. A detailed summary of the signal warrant analyses should also be included as an attachment.

Operational Analyses: The report should include a summary of the existing intersection operations, identifying any capacity, delay, or queuing deficiencies. Proposed operations should also be summarized. For locations where signalization is recommended, the results should clearly demonstrate the expected improvements based on the critical measures of effectiveness. Additional information that may be summarized include the results of spot speed studies, delay studies, and gap studies.

Intersection Sight Distance: A comparison of the available intersection sight distance to the minimum values specified by AASHTO should be included.

Alternative/Short-Term Improvements: The report should identify any short-term improvements that could be implemented in lieu of signalization.

Recommendation: The report should include a recommendation for improvements based on the findings of the study.

Intended Signal Operations (Phasing / Timing): The report should include a description of the preliminary signal timing and phasing plan, including left-turn treatments. The final signal timing plan will be developed later in the design phase.

Intended Lane Configurations: The report should include a description of the intended intersection lane configuration, highlighting proposed changes from existing conditions.

Preliminary Design Considerations: A summary of issues identified during the site visit which may impact the design process should be outlined. Key issues may include utilities, intersection geometry (skew / lane alignment), physical constraints, pedestrian features, and system compatibility.

b. Signal Design Request Form

If a traffic control signal is recommended by the Traffic Signal Justification Study and is subsequently approved by the Chief Traffic Engineer, a Signal Design Request Form should be initiated and the signal recommendation section should be signed by the Chief Traffic Engineer. The signed Signal Design Request Form serves as a formal hand-off between the Studies Group and the Design Group to initiate the design phase. See **Appendix J** for DelDOT's Signal Design Request Form.

8. Signal Deactivation

A study is also required in cases where the deactivation of an existing traffic control signal is proposed. The requirements for this type of study are similar to those of a traditional Traffic Signal Justification Study. The study should clearly demonstrate the safety and operational benefits of deactivating the existing signal. Complete guidance on the procedure to be followed for signal deactivation is included with this manual in **Appendix K**.

B. Types of Signal Projects

This chapter of the Traffic Design Manual defines the nine types of traffic signals most-commonly used by DelDOT. Chapters IV-C and IV-D of this Manual outline the specific design elements required to prepare a traffic signal design per DelDOT standards.

1. Traffic Control Signal

A traffic control signal is defined as any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. Traffic is defined as pedestrians, bicyclists, vehicles, streetcars, and other conveyances either singularly or together while using any highway for purposes of travel. Traffic control signals are DelDOT's most-common type of signal project. Projects may include new signals at an existing or proposed intersection, or modifications to an existing signal.

All new signals installed in Delaware must be justified based on an engineering study. The required elements of the study are outlined in Chapter IV.A (Traffic Signal Justification Study) of this Manual. All new signals should operate as a full-time signal, 24 hours a day (signals will not be operated on a time or peak only basis). Whenever an existing part-time signal is encountered as part of a Capital Project, it should be re-designed to function as a full-time signal.

For additional information regarding traffic control signal design elements, refer to the DE MUTCD, Chapter 4D.

2. Hazard Identification Beacon (HIB)

A Hazard Identification Beacon (HIB) is a type of signal indication used to warn motorists of potentially hazardous conditions downstream. Beacons used for hazard identification should only be used as a supplement to other appropriate warning or regulatory signs and devices except STOP, DO NOT ENTER, WRONG WAY, and Speed Limit signs. Except for school speed limit signs, beacons should not be included within the border of the sign or device. The use of horizontally aligned beacons with School Speed Limit signs (S5-3-DE, R1-2 with S4-3 and S4-4) is no longer be permitted on state-maintained roadways in Delaware for new or retrofitted sign installations. Instead, if used with a new or retrofitted School Speed Limit sign assembly, the signal indications shall be vertically aligned, per Section 4L.04 of the DE MUTCD. The exception to this standard are School Speed Limit signs that are longer horizontally than vertically, which is typically the case for overhead installations. In these cases, horizontally aligned beacons are still considered acceptable and consistent with both Parts 4 and 7 of the Delaware MUTCD.

When used at intersections, beacons should not face conflicting vehicle movements. Warning beacons are yellow in color and should have a circular 12-inch diameter visible face. Two beacons aligned either horizontally or vertically and flashing alternately can be used for added emphasis. A system of four beacons, flashing alternately between top left/bottom right and top right/bottom left may also be used, typically mounted overhead.

Typical applications of Hazard Identification Beacons include alerting motorists of a traffic control signal ahead, warning vehicles of a sharp curve (horizontal or vertical), warning vehicles of inadequate sight distance for side streets or denoting the end of an expressway. HIBs should only be used when an engineering study shows a demonstrated need, because these types of traffic control devices can lose their effectiveness if overused.

3. Intersection Control Beacon (ICB)

Flashing beacons for intersection control may be used at locations where traffic volumes or physical conditions do not warrant traffic control signals, but crash history indicates a possible hazard. These beacons consist of one or more circular yellow or red lenses, typically with 12 inches of visible diameter. They should be used only at intersections to control two or more directions of travel. If multiple red beacons are used on a given approach, they must flash concurrently, because alternately flashing red beacons are reserved for rail crossings and pedestrian hybrid beacons. Application of intersection control beacons should be limited to the following:

- Yellow indication on one route (normally the major), red for the remaining approaches
- Red for all approaches, if a multi-way stop is justified

A stop sign should be used on any approach with a permanently flashing red beacon. Intersection control beacons are generally suspended over the roadway, but pedestal mounting is acceptable under appropriate conditions (refer to recommended mounting heights described previously under the heading “Hazard Identification Beacon”). When a pedestal mount is used, the pedestal should not be located in the roadway unless within the confines of a traffic or pedestrian island. Refer to the DE MUTCD, Section 4L.02, for additional information on the design of Intersection Control Beacons.

Intersection Control Beacons should only be used when an engineering study shows a demonstrated need for extra emphasis beyond the typical sign control, because these types of traffic control devices can lose their effectiveness if overused.

4. Emergency-Vehicle Signals and Hybrid Beacons

An emergency-vehicle traffic control signal is a special traffic control signal that assigns the right-of-way to an authorized emergency vehicle. An emergency-vehicle traffic control signal may be installed at a location that does not meet other traffic control signal warrants such as at an intersection or other location to permit direct access from a building housing the emergency vehicle.

Some fire and rescue signals currently in use in the State of Delaware do not conform to the current MUTCD standards. Non-compliant fire and rescue signals should be upgraded to meet the current standards if they fall within the limits of a Capital Project.

An alternative to installing a full traffic control signal for emergency-vehicles would be the installation of an emergency-vehicle hybrid beacon. An emergency-vehicle hybrid beacon may only be installed if the conditions justifying an emergency-vehicle traffic control signal are met. When new emergency-vehicle or emergency hybrid beacons are requested by emergency service agencies, funding for new installations is typically provided by community transportation funds as approved by area legislatures.

Refer to the DE MUTCD, Chapter 4G, for additional information on the design and operation of fire and rescue signals and hybrid beacons.

5. Railroad Crossing

Part 8 of the DE MUTCD provides a detailed description of all the design elements required for Railroad Crossings. Many of the design elements are the responsibility of the railroad company. However, when a traffic control signal is required, the design is performed by the DelDOT Traffic Section.

As noted in Section 8C.09 of the DE MUTCD, traffic control signals may be used instead of flashing-light signals to control road users at industrial highway rail grade crossings and other places where train movements are very slow, such as in switching operations. The appropriate provisions relating to typical traffic control signal design, installation, and operation shall be applicable where traffic control signals are used to control road users instead of flashing-light signals at highway-rail grade crossings. Traffic control signals shall not be used instead of flashing-light signals to control road users at a mainline highway-rail grade crossing.

Exempt railroad crossings require a standard traffic control signal, with green, yellow, and red indications to control traffic, in addition to the standard railroad crossing design elements.

If a highway-rail grade crossing is equipped with a flashing-light signal system and is located within 200 feet of an intersection or midblock location controlled by a traffic control signal, the traffic control signal should be interconnected, and the normal operation of the traffic signals controlling the intersection should be preempted to operate in a special control mode when trains are approaching, in accordance with Section 4D.27 of the DE MUTCD. The preemption sequence is extremely important to provide safe vehicular and pedestrian movements. Such preemption serves to ensure that the actions of these separate traffic control devices complement rather than conflict with each other.

If a highway-rail grade crossing is more than 200 feet from an intersection, but an engineering study indicates that queues may extend to the tracks, the Designer should consider implementation of one or more traffic control treatments, including signal pre-emption, signage ("Do Not Stop on Tracks"), or Hazard Identification Beacons, to warn motorists of the railroad crossing. For more information, refer to the *Railroad-Highway Grade Crossing Handbook* developed by FHWA.

6. Movable Bridges

Traffic control signals for movable bridges (often referred to as "draw bridges") are a special type of highway traffic signal installed to notify road users to stop because of a temporary road closure, rather than alternately giving the right-of-way to conflicting traffic movements. The signals are operated in coordination with the opening and closing of the movable bridge, and with the operation of movable bridge warning and resistance gates, or other devices and features used to warn, control, and stop traffic.

A movable bridge resistance gate provides a physical deterrent to road users when placed in the appropriate position. The movable bridge resistance gates are considered a design feature and not a traffic control device; requirements for them are contained in AASHTO's "Standard Specifications for Movable Highway Bridges." Refer to Section 4J.02 of the DE MUTCD for additional information on the design of traffic control at movable bridges.

7. Temporary Signal

A temporary signal is defined as a traffic control signal that is installed for a limited time period. Temporary signals may be designed and constructed for a specific location or they may be portable signals that can be easily transported and used at multiple locations. If non-portable temporary signals are used, they would typically be designed with wood poles if possible. All temporary signals should be justified by an engineering study, and typically should be designed to provide detection and communication, similar to permanent signals.

Common uses for temporary signals include providing traffic control for haul road access locations and for site access to a location where the permanent access is under construction.

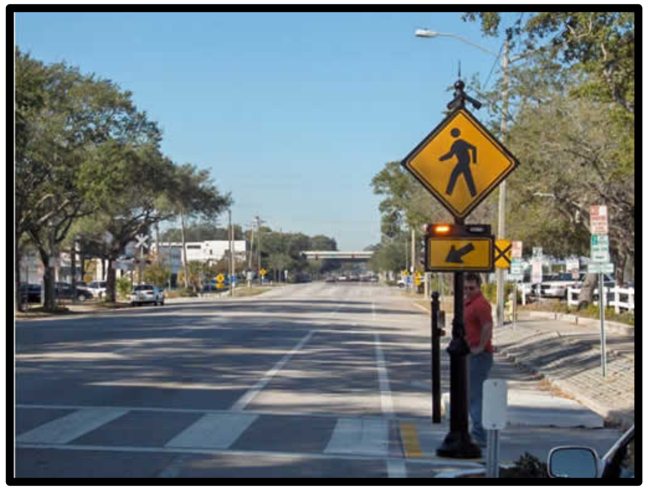
Temporary signals may also be used to provide temporary traffic control for two-way traffic using a single travel lane during construction, such as during bridge rehabilitation or replacement. Sight distance across or through the one-lane, two-way facility should be considered as well as the approach speed and sight distance approaching the facility when determining whether traffic control signals should be installed. A traffic control signal may be used if gaps in opposing traffic do not permit the flow of traffic through the one-lane section of roadway, even if the location does not meet the traditional nine MUTCD warrants for signalization. Temporary traffic control signals may be preferable to flaggers for long-term projects and other activities that would require flagging at night. Additional information regarding the design for temporary signals is provided in Sections 4D.32, 4H, and 6F.84 of the DE MUTCD.

8. Innovative Intersection Safety Treatments

Recently, FHWA has conducted research to identify new technologies and techniques to improve intersection safety. These innovative intersection safety treatments show promise for improving safety, but comprehensive effectiveness evaluations are not currently available.

Two examples of treatments currently under consideration (Rectangular Rapid Flash Beacons and High-Intensity Activated Crosswalks) and one example of a treatment that is no longer approved (Rapid Flash Diodes in Red Lights) are discussed on the following page. As other types of innovative intersection safety treatments are developed, they will be considered on a case-by-case basis for use in Delaware, including a review of current Federal guidance, and must be approved by the Chief Traffic Engineer.

a. <u>Rectangular Rapid Flash Beacons (RRFB)</u>



Rectangular Rapid Flash Beacons (RRFB) are user-actuated amber LEDs that supplement warning signs at unsignalized intersections or mid-block crosswalks. They can be activated by pedestrians manually by a push button or passively by a pedestrian detection system. RRFBs use an irregular flash pattern that is similar to emergency flashers on police vehicles, and they are a lower cost alternative to traffic signals and hybrid signals that are shown to increase driver yielding behavior at crosswalks significantly when supplementing standard pedestrian crossing warning signs and markings.

In July 2008, the MUTCD gave interim approval for the limited use of RRFBs. The interim approval allows for usage as a warning beacon to supplement standard pedestrian crossing warning signs and markings at either a pedestrian or school crossing; where the crosswalk approach is not controlled by a yield sign, stop sign, or traffic control signal; or at a crosswalk at a roundabout. In June 2012, FHWA modified the approved RRFP flash pattern. For additional information, refer to the FHWA Report FHWA-SA-09-009 dated May 2009.

b. <u>Pedestrian Hybrid Beacon (HAWK)</u>

SR 72 at Farm Lane, Newark

The pedestrian hybrid beacon uses traditional traffic and pedestrian signal heads but in a non-traditional configuration. It includes a sign instructing motorists to "stop on red" and a "pedestrian crossing" overhead sign. An example of a pedestrian hybrid beacon is shown to the right.

When not activated, the beacon is dark. The pedestrian hybrid beacon is activated by a pedestrian push button or passive pedestrian sensor, at which time the overhead beacon begins flashing yellow and then solid yellow, advising drivers to prepare to stop. The beacon then displays a solid red indication and shows pedestrians a "Walk" indication. Finally, an alternating flashing red signal indicates that motorists may proceed when safe, after coming to a full stop. During this alternating flashing red phase, the pedestrians are shown a flashing "Don't Walk" indication with a countdown indicating the time left to cross.

The need for pedestrian hybrid beacons should be considered on a basis of an engineering study that considers major street volumes, speeds, widths and gaps in conjunction with pedestrian volumes, walking speeds and delay. Refer to Section 4F.02 of the DE MUTCD (Pedestrian Hybrid Beacons) for additional information regarding the design of pedestrian hybrid beacons.

C. Preliminary Design Plan Elements

When developing preliminary signal design plans, there are numerous 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. Pole Design

a. Type

The type of signal supports used on a project is a major consideration in the design process. Some factors involved in the selection of an appropriate pole type include the location of overhead utilities, intersection geometrics, the proposed location of traffic signal heads, aesthetics, and local requirements. The three primary pole types are described below.

Strain Poles

Strain poles with span wires typically allow for more flexibility in the signal design by allowing for optimal signal head placement at wide intersections and during construction when signal heads may need to be shifted laterally. Strain poles also provide more options at locations with unusual geometrics. The size of the strain pole will vary in accordance with the span length. For span lengths less than 150 feet, a 28-foot steel strain pole should be used. A 32-foot steel pole should be used for span lengths of 150 feet or greater.

The Designer should always check span wire sag to ensure that the signal heads will hang properly between the maximum height for signal housing equipment (25.6 feet) and the minimum 15-foot clearance above the pavement (refer to Chapter IV-C.2.e of this Manual for additional information on the vertical placement of signal heads; a 16-foot minimum clearance is preferred in Delaware). Sag should be calculated at a minimum 3 percent, with 5 percent desired. **Figure IV-1** shows a sample calculation. The Designer should specify the pole mounting heights on the design plans. For suspended box designs, both the pole mounting height and the proposed bull ring mounting heights should be specified. Additionally, structural analysis may be required to ensure that proper sag is maintained for longer span lengths.

EXAMPLE: HOW TO CALCULATE & MEASURE SAG

Pole-to-Pole Distance: 200 ft
Pole Height: 32 ft
Span Attachment Height: 30 ft
Signal Head Height: 4 ft

5% Sag:
= Pole-to-Pole Distance x 0.05
= 200 ft x 0.05 = 10 ft

Distance Between Bottom of Head at Low Point & Pavement:
= Span Attachment Height - Sag - Signal Hed Height
= 30 ft - 10 ft - 4 ft = 16 ft

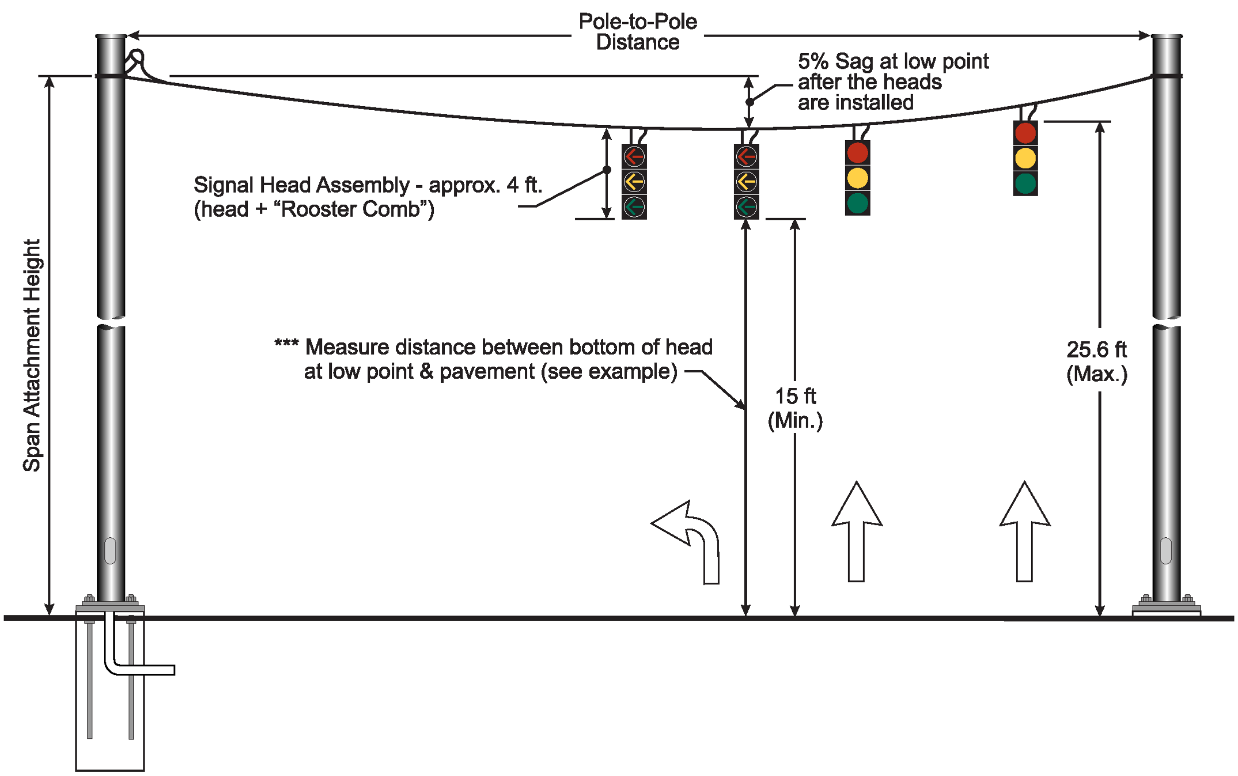


Figure IV-1. Sag Calculation

Mast Arms

Mast arm supports allow for a more-rigid (better) mounting for signs and signal heads and may be more aesthetically pleasing to the public. Mast arms can also minimize conflicts with overhead utilities because they have a lower conflict height and also can reduce the total number of poles required. However, there are some disadvantages to using mast arms, including increased cost. Intersections with unusual geometrics may also not be conducive to mast arm design.

Pedestal Poles

Pedestal poles for vehicular signal heads are typically implemented only for locations where other options are not possible. In some rare cases, pedestal poles may be the only option for mounting some or all of the intersection signals. Examples include: 1) intersections with buildings very close to the road; 2) historic areas, where pedestal poles are required for aesthetic reasons; 3) signals in the median of divided highways; and 4) locations where overhead utility conflicts preclude the use of mast arm or strain pole supports, and the use of pedestal poles is the only option to place signal heads in locations with good visibility. Approval from the Chief Traffic Engineer must be obtained before designing a signal using pedestal poles as the primary signal heads on any approach.

Pedestal poles are primarily used for mounting standard pedestrian signal heads and Hazard Identification Beacons (HIB's).

b. Configuration

After the signal support type is chosen, the next step in the signal design process is to determine an appropriate configuration. This chapter of the Traffic Design Manual describes each of the different configurations. The most-common layouts and pole choices used by DelDOT are listed below:

- "Box" Design (span wire or mast arm)
- "Suspended Box" Design (span wire only)
- "Diagonal" Design (span wire or mast arm)
- "Diagonal X" Design (span wire only)
- "Z"Design (span wire only)
- Twin Mast Arms (T-intersections only)
- Pedestal Pole Supports
- Wood Pole Supports (temporary only)

While there are many different alternative configurations that can be applied, **DelDOT's preference is to use a box design**, which allows the signal heads to be placed on the far side of the intersection. **Figure IV-2** on the following page shows an illustration of the preferred box design, as well as some of the other potential layouts for signal poles and signal heads.

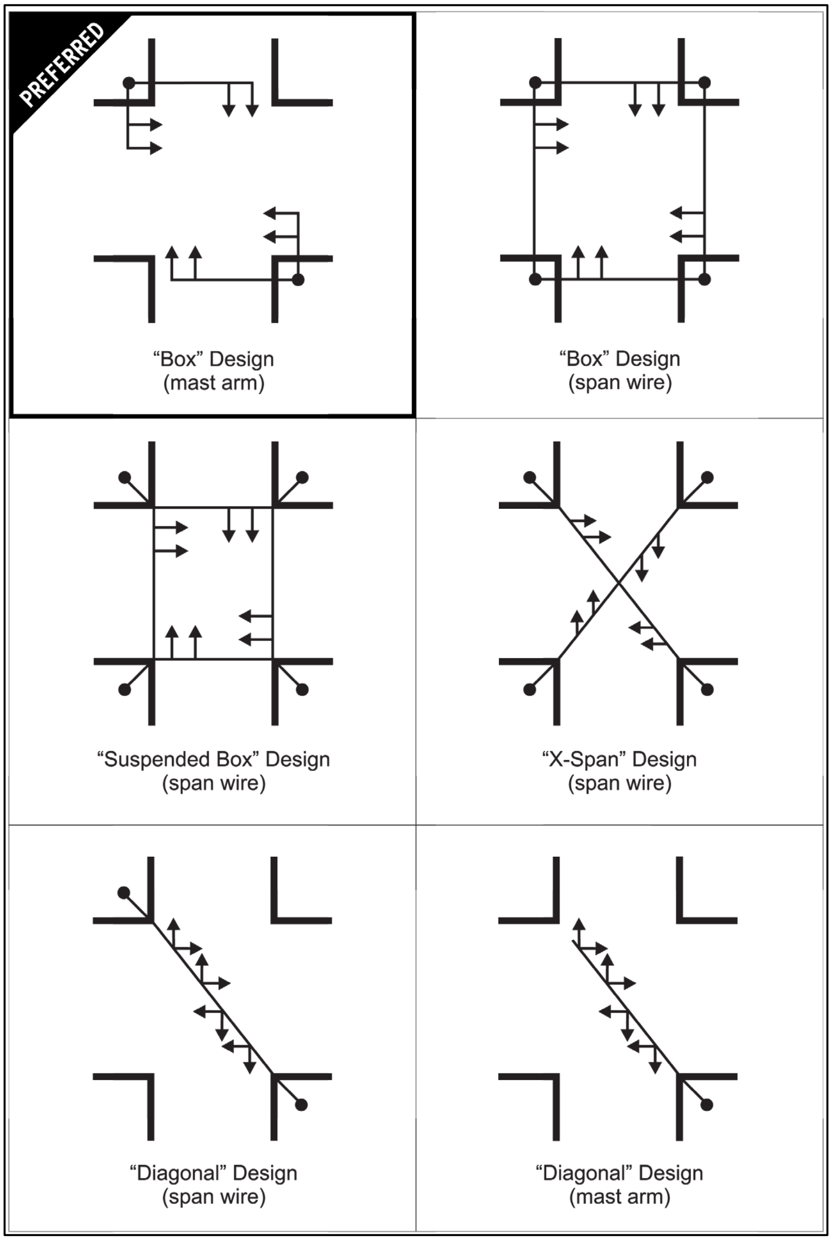


Figure IV-2. Typical Layouts of Signal Poles and Signal Heads

"Box" Design Configuration

The "box" configuration is DelDOT's preferred signal arrangement, and the "box" design should be used if the location allows. The "box" configuration provides excellent lateral placement of signal faces for maximum conspicuity and good signal head placement installation of overhead signs and provides convenient pole locations for supplemental signal faces and pedestrian faces/push buttons.

However, for offset intersections and extremely wide intersections, the use of the standard "box" design may have disadvantages. At offset intersections, the standard "box" design can create a difficult angle for viewing the signal heads and can create very long span wire lengths. At very wide intersections, signal heads may be over 180 feet from the stop line, reducing visibility. These situations can typically be overcome by using the "suspended box" configuration and/or supplemental signal indications.

"Box" configurations can be designed using either mast arms or span wire. If span wire is used, 4 strain poles must be used. Mast arms allow for a more-rigid mount for signal equipment and signs and provide good lateral support. They also help reduce to number of poles and minimize conflicts with overhead utilities. **Mast arms are DelDOT's preferred pole choice.** However, size limitations (90-foot maximum length for single mast arms; 60-foot maximum length for twin mast arms), space limitations (clear zone), and cost must be taken into consideration. Strain poles are generally a lower-cost option, and they allow for more versatility in the placement of heads and also offer the ability to span wider intersections. For situations where an existing signal is being re-designed, typically from a "diagonal X" or "Z" configuration, the preferred "box" design may not be optimal due to the position of the existing strain poles. The resulting signal head placement and/or alignment may not be acceptable. Under these conditions, a "suspended box" may eliminate these constraints. It is the designer's responsibility to ensure that the appropriate pole is specified to accommodate all proposed and anticipated loadings.

Other Configurations

If the "box" design cannot be obtained, an alternate configuration may be used. For smaller intersections that have right-of-way, utility, or geometric constraints, a diagonal configuration may be a suitable alternative. Diagonal configurations can be achieved using a 2-pole span or single mast arm design. Diagonal configurations have a lower installation cost and limit the number of poles required. While the diagonal configuration will typically allow for adequate head placement, the designer should avoid configurations that may lead to signal head clutter in the middle of the intersection and/or poor visibility of indications from stop line. The diagonal configuration is typically not suitable for intersections requiring overhead signing.

For larger intersections, an X-span configuration may be an appropriate option for pole configuration. X-span configurations can provide adequate signal head placement. However, as with the diagonal configuration, signal head clutter and poor visibility from the stop line may occur depending on the number of signal heads and overhead signs required.

Hybrid designs or unique designs may be required in some cases for locations with atypical geometry or significant constraints.

c. Placement

1.) Clear Zone

When considering placement of poles, it is most desirable to have poles located outside of the clear zone. Signal poles may be placed closer to the edge of roadway if vertical curb is provided, if the horizontal clearance requirements in the DelDOT Road Design Manual are met. If a signal pole cannot be located outside of the clear zone or a sufficient distance from vertical curb due to geometric or other constraints, the signal pole shall be protected using guardrail or another acceptable form of barrier protection.

Refer to AASHTO's <u>Roadside Design Guide</u> for further information on clear zone requirements for pole placement.

Non-Breakaway Signal Support Location

<u>Requirements</u>

For safety reasons, all non-breakaway traffic signal supports should be located outside of the clear zone. Mast arm and span pole supports with a signal head over an open travel lane shall be considered non-break-away for the purposes of locating and protecting the support. This is most critical at locations with high-speed traffic, heavy turning movements, no parking lanes or shoulders, and for locations along the outside of a curve. In these cases, it is highly desirable to place the supports outside the designated roadway clear zone. Therefore, the following are acceptable distances:

Barrier Curb and Prevailing or 85th Percentile Speeds of 45 mph or Less:

- Minimum distance: 2 feet from face of curb to face of pole
- Desirable distance: 6 feet or more from face of curb to face of pole

Barrier Curb and Prevailing or 85th Percentile Speeds of Greater than 45 mph:

- Minimum distance: 2 feet from face of curb to face of pole, or 10 feet from edge of traveled roadway to face of pole (whichever is farther away from the traveled roadway)
- Desirable distance: as far from the roadway as practical within design requirements

NOTE: for new roadway projects where the 85th percentile speed is not available, the design speed should be used instead.

No Barrier Curb:

- Minimum distance: 2 feet from edge of shoulder to face of pole, or 10 feet from edge of traveled roadway to face of pole, or clear zone (whichever is farther away from the traveled roadway)

Table IV-3 and Table IV-4 on the following pages show the applicable clear zone distances based on design speed and average daily traffic (ADT), including horizontal curve adjustment factors. Refer to the AASHTO Roadside Design Guide for additional information.

For locations on the outside of a curve, the clear zone is calculated using the following equation:

$$\mathbf{CZ_C = (L_C)(K_{CZ})}$$

Where:	CZ_C	=	*Clear Zone on outside of curvature (ft)*
	L_C	=	*Clear zone on tangent section (ft)*
	K_{CZ}	=	*Curve correction adjustment factor*

Islands and Medians:
The installation of non-breakaway signal supports in islands and medians shall not be allowed unless the clear zone criteria can be met. Typically, this precludes the placement of signal poles in the median, except in situations where the median/island is very large.

2.) Utility Clearance

Utility clearance is the required distance between above and underground facilities. The ability to achieve proper utility clearance, including construction access, will be a major factor in selecting an appropriate signal configuration. The placement of signal equipment shall comply with current local utility companies and National Electrical Safety Code (NESC) clearance requirements. Typically, signal equipment 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. Additional coordination with the DelDOT Utility Coordinator or utility companies may be required for some projects.

Table IV-3
Clear Zone Distances (in feet from edge of traveled way)

Design Speed (MPH)	Design ADT	Backslopes			Foreslopes		
		1V:3H	1V:5H to 1V:4H	1V:6H or Flatter	1V:6H or Flatter	1V:5H to 1V:4H	1V:3H
40 or Less	Under 750	7 - 10	7 - 10	7 - 10	7 - 10	7 - 10	(2)
	750-1500	12 - 14	12 - 14	12 - 14	10 - 12	12 - 14	(2)
	1500-6000	14 - 16	14 - 16	14 - 16	12 - 14	14 - 16	(2)
	Over 6000	16 - 18	16 - 18	16 - 18	14 - 16	16 - 18	(2)
45 - 50	Under 750	8 - 10	8 - 10	10 - 12	10 - 12	12 - 14	(2)
	750-1500	10 - 12	12 - 14	14 - 16	14 - 16	16 - 20	(2)
	1500-6000	12 - 14	14 - 16	16 - 18	16 - 18	20 - 26	(2)
	Over 6000	14 - 16	18 - 20	20 - 22	20 - 22	24 - 28	(2)
55	Under 750	8 - 10	10 - 12	10 - 12	12 - 14	14 - 18	(2)
	750-1500	10 - 12	14 - 16	16 - 18	16 - 18	20 - 24	(2)
	1500-6000	14 - 16	16 - 18	20 - 22	20 - 22	24 - 30	(2)
	Over 6000	16 - 18	20 - 22	22 - 24	22 - 24	26 - 32 (1)	(2)
60	Under 750	10 - 12	12 - 14	14 - 16	16 - 18	20 - 24	(2)
	750-1500	12 - 14	16 - 18	20 - 22	20 - 24	26 - 32 (1)	(2)
	1500-6000	14 - 18	18 - 22	24 - 26	26 - 30	32 - 40 (1)	(2)
	Over 6000	20 - 22	24 - 26	26 - 28	30 - 32 (1)	36 - 44 (1)	(2)
65 - 70	Under 750	10 - 12	14 - 16	14 - 16	18 - 20	20 - 26	(2)
	750-1500	12 - 16	18 - 20	20 - 22	24 - 26	28 - 36 (1)	(2)
	1500-6000	16 - 20	22 - 24	26 - 28	28 - 32 (1)	34 - 42 (1)	(2)
	Over 6000	22 - 24	26 - 30	28 - 30	30 - 34 (1)	38 - 46 (1)	(2)

NOTES:

(1) Where a site-specific investigation indicates a high probability of continued accidents, or such occurrences are indicated by accident history, the designer may provide clear zones greater than indicated. Clear zones may be limited to 30 feet for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicate satisfactory performance.

(2) Because recovery is less likely on unshielded, traversable 1V:3H slopes, fixed objects should not be present near the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of the slope. Determination of the width of the recovery area at the toe of the slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and accident histories. Also, the distance between the edge of the travel lane and the beginning of the 1V:3H slope should influence the recovery area provided at the toe of the slope.

Source: AASHTO Roadside Design Guide, 4th Edition, Table 3.1

Designer should reference the source document to obtain the latest version of this table.

Table IV-4
Horizontal Curve Adjustment Factors, K_{cz}

Radius (feet)	Design Speed (MPH)						
	40	45	50	55	60	65	70
2860	1.1	1.1	1.1	1.2	1.2	1.2	1.3
2290	1.1	1.1	1.2	1.2	1.2	1.3	1.3
1910	1.1	1.2	1.2	1.2	1.3	1.3	1.4
1640	1.1	1.2	1.2	1.3	1.3	1.4	1.5
1430	1.2	1.2	1.3	1.3	1.4	1.4	
1270	1.2	1.2	1.3	1.3	1.4	1.5	
1150	1.2	1.2	1.3	1.4	1.5		
950	1.2	1.3	1.4	1.5	1.5		
820	1.3	1.3	1.4	1.5			
720	1.3	1.4	1.5				
640	1.3	1.4	1.5				
570	1.4	1.5					
380	1.5						

NOTE:
The clear-zone adjustment factor is applied to the outside of curves only. Curves flatter than 2860 feet do not require an adjusted clear zone.

Source: AASHTO Roadside Design Guide, Third Edition, Table 3.2

Designer should reference the source document to obtain the latest version of this table.

2. Signal Head Design

a. Number of Signal Heads

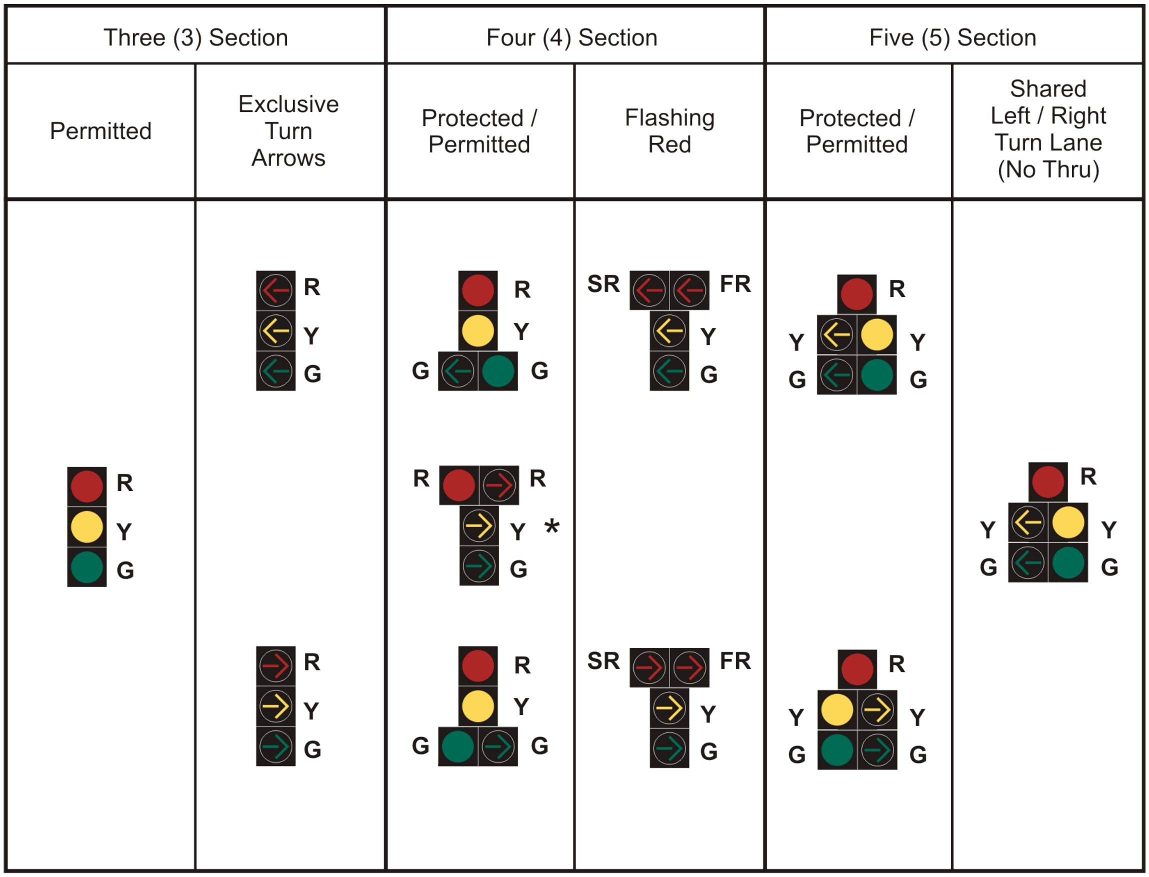
A minimum of two signal faces shall be provided for the through movement on each approach to an intersection. If a through movement does not exist on an approach, a minimum of two signal faces shall be provided for the turning movement that is considered the major movement. If there are more than two through lanes on an approach, one signal head per lane should be used.

b. Signal Head Configurations

There are several different signal head configurations that are used by DelDOT. The selection of the appropriate signal head configuration is dependent on the type of signal phasing and the corresponding lane configuration:

- For major and minor street through movements, standard three-section heads with circular indications should be used.
- When protected-permissive left-turn phasing is proposed, a five-section cluster head should be used in combination with a three-section head for the through lanes.
- When protected-only left-turn phasing is proposed, two three-section heads with arrow indications should be used for the turning movement.
- When a right-turn arrow phase is proposed, a five-section cluster head with right-turn arrows should be used in place of the right-hand, three-section head.
- When split-phasing is proposed, a four-section head should be used in place of the left-hand or right-hand three-section head to accommodate major movements through intersection.
- When flashing red arrow (FRA) phasing is proposed, two 4-section “Tee” heads shall be used for the left turning movement in combination with three-section heads for the through lanes

See **Figure IV-3** on the following page showing the typical signal head configurations. Other signal head configurations may also be allowed, if they are consistent with the DE MUTCD.



* Used in unusual situations where Right Turn on Red is allowed during some phases and not during others

Legend

→ Direction of travel
SR Steady red
FR Flashing red
SR/FR Steady red and flashing red
SY Steady yellow
FY Flashing yellow

Figure IV-3. Signal Head Displays

c. Signal Indication Size

For all traffic control signals in Delaware, 12-inch signal indications are the standard and shall be used, except under special circumstances, in which 8-inch signal indications may be permitted based on approval by DelDOT's Chief Traffic Engineer. Special circumstances include locations where required vertical clearance cannot otherwise be provided using standard 12-inch indications. Additionally, at an existing signalized location with 8-inch signal indications, the 8-inch indications may be used for remainder of their useful life, but they shall be replaced with 12-inch indications at the end of their useful life or as part of any signal modification.

d. Visibility

The signal designer should check the roadway curvature and profile when selecting the placement for traffic signal indications to ensure proper visibility on the approach. The geometry of the intersection, including vertical grades, horizontal curves, skewed approaches, and obstructions, shall be considered in determining the position of signal faces. Refer to Table 4D-2 in the DE MUTCD for a table showing the minimum visibility requirements. When minimum visibility cannot be met, refer to Section 4D.12 of the DE MUTCD for treatment options, including the appropriate use of "Signal Ahead" (W3-3) signs.

e. Signal Head Placement

The following guidelines should be followed when determining signal head placement:

- Where a signal face is meant to control a specific lane or lanes of approach, its position should be unmistakably in line with the path of the movement. Guidance related to the specific vertical and lateral placement of signal heads is provided on the following pages.
- Near side signals should be located as near as possible to the stop line.
- Required signal faces for any one approach must be mounted no less than 8 feet apart, measured horizontally between the centers of the face.
- Where possible, at least one and preferably both signal displays that control the major movement traffic should be located a minimum 40 feet and a maximum of 180 feet beyond the stop line.
- Where the nearest signal face is more than 180 feet beyond the stop line, supplemental signal indications shall be required.
- Where both signal faces required are post-mounted, they shall be on the far side of the intersection, one on the right and one on the left of the driver. This type of design shall only be considered with prior approval of the Chief Traffic Engineer.

1.) Vertical Placement

The bottom of the signal head housing (including any related attachments) of a vehicle signal face located over any portion of the highway that can be used by motor vehicles shall be at least 15 feet above the pavement (a minimum of 16-feet is preferred in Delaware). The top of the signal housing for a vehicle signal face located over a roadway shall not be more than 25.6 feet above the pavement. When the signal head is located between 40 feet and 53 feet from the stop line, the maximum mounting height to the top of the signal housing shall be as shown in **Figure IV-4** below.

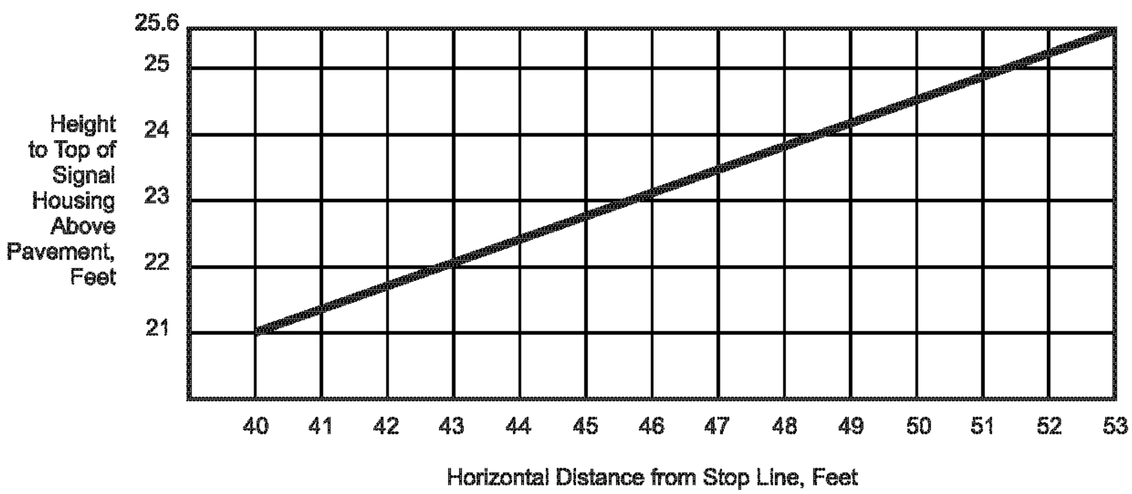


Figure IV-4. Maximum Mounting Height of Signal Housings

The bottom of the signal housing (including brackets) of a vehicular signal face that is vertically arranged and not located over a roadway:

- Shall be at least 8 feet, but not more than 19 feet, above the sidewalk or above the pavement grade at the center of the roadway, if there is no sidewalk.
- Shall be at least 4.5 feet, but not more than 19 feet above the median island grade of a center median island, if located on the near side of the intersection.

The bottom of the signal housing (including brackets) of a vehicular signal face that is horizontally arranged and not located over a roadway:

- Shall be at least 8 feet, but not more than 22 feet above the sidewalk or above the pavement grade at the center of the roadway, if there is no sidewalk.
- Shall be at least 4.5 feet, but not more than 22 feet, above the median island grade of a center median island, if located on the near side of the intersection.

For all span wire designs with backplates and/or signs, under-span tether wires shall be installed.

2.) Lateral Placement

The lateral placement of signal heads depends on the number of lanes on the approach as well as the signal phasing. Some typical configurations for the lateral placement of signal heads are shown in **Figures IV-5a through IV-5l** on the following pages:

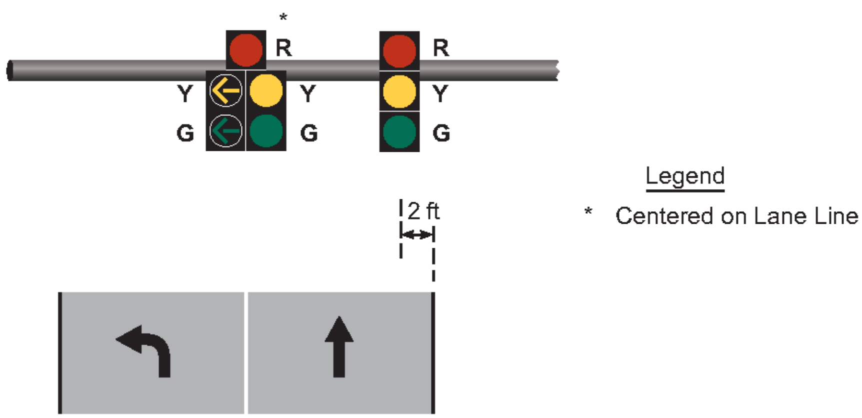


Figure IV-5a. One Through Lane with One Left-Turn Lane (Protected-Permissive Left-Turn Phasing)

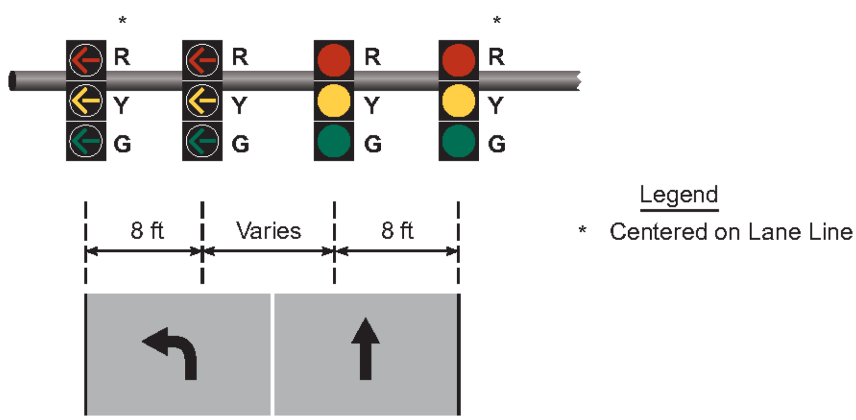


Figure IV-5b. One Through Lane with One Left-Turn Lane (Protected-Only Left-Turn Phasing)

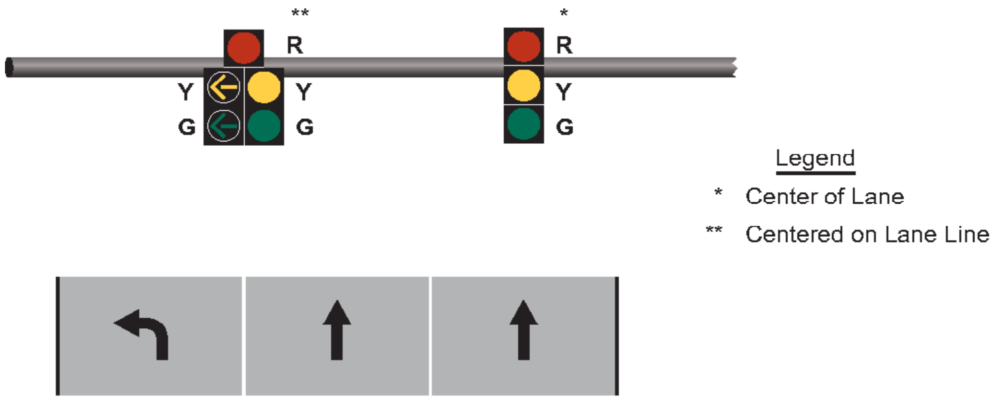


Figure IV-5c. Two Through Lanes with One Left-Turn Lane (Protected-Permissive Left-Turn Phasing)

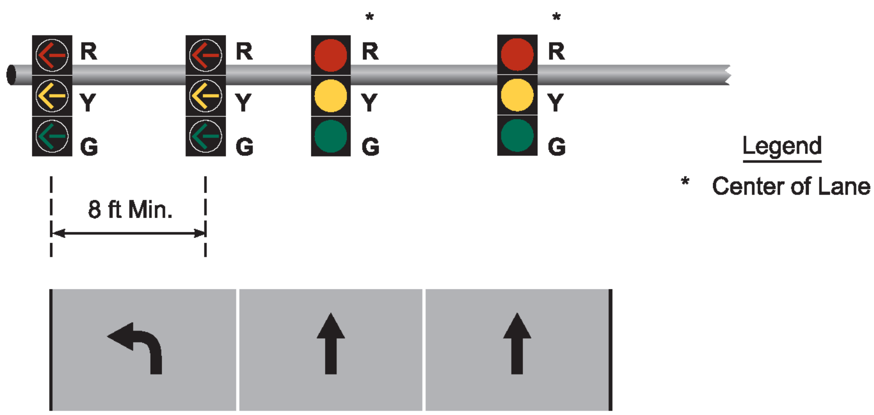


Figure IV-5d. Two Through Lanes with One Left-Turn Lane (Protected-Only Left-Turn Phasing)

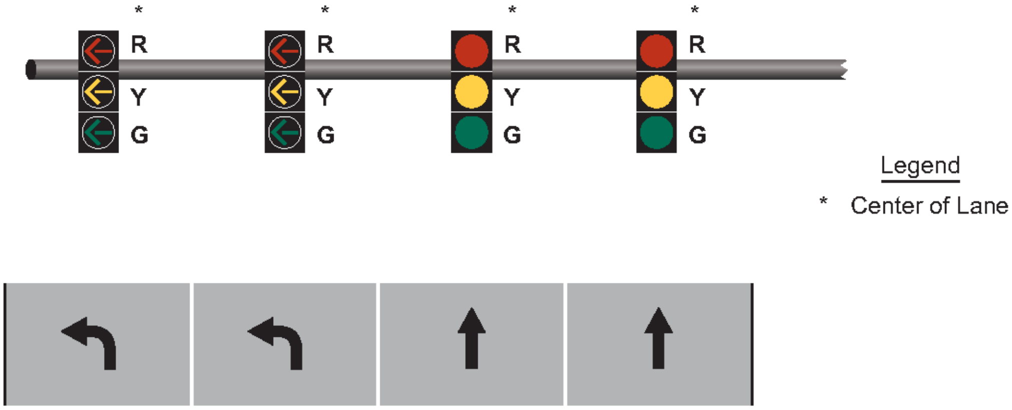


Figure IV-5e. Two Through Lanes with Two Left-Turn Lanes (Protected-Only Left-Turn Phasing)

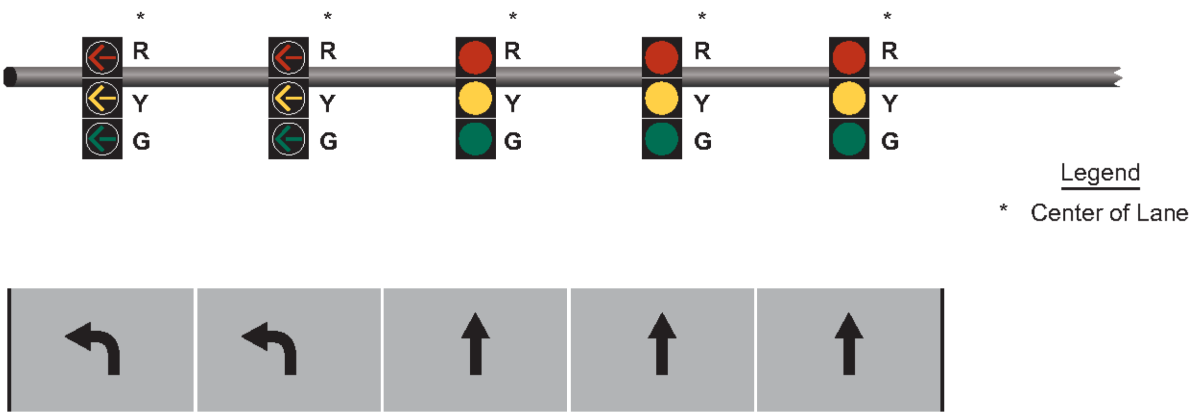


Figure IV-5f. Three Through Lanes with Two Left-Turn Lanes (Protected-Only Left-Turn Phasing)

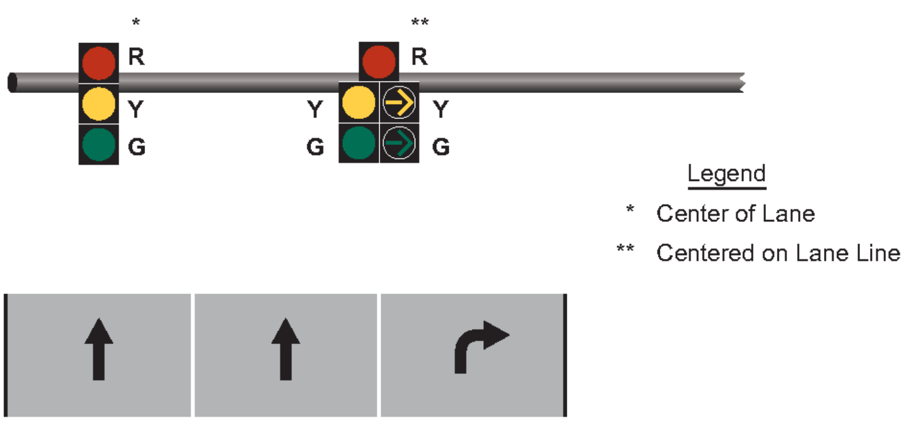


Figure IV-5g. Two Through Lanes with One Right-Turn Lane (Protected-Permissive Right-Turn Phasing)

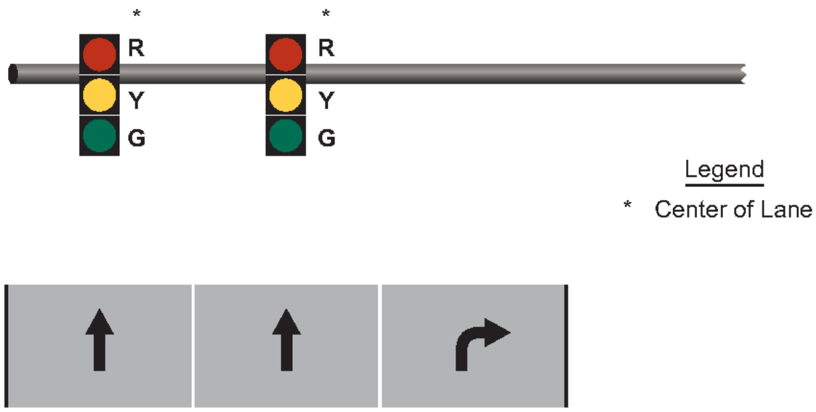


Figure IV-5h. Two Through Lanes With One Right-Turn Lane (Permissive Right-Turn Phasing)

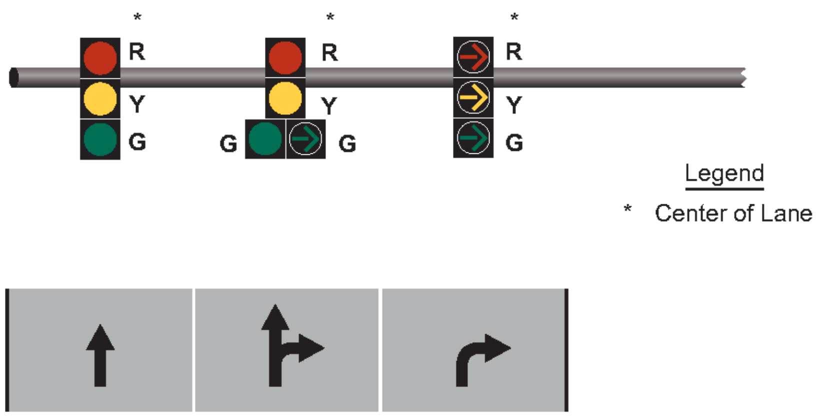


Figure IV-5i. One Through Lane, One Shared Through/Right Lane and One Right-Turn Lane (Protected-Permissive Right-Turn Phasing)

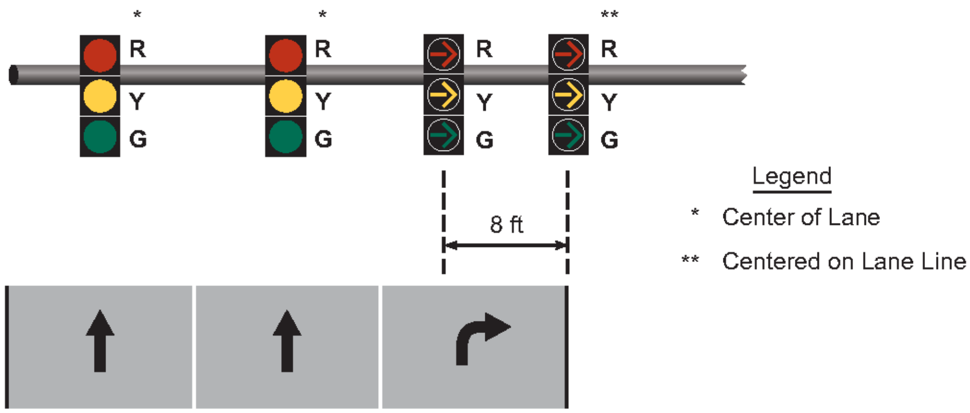


Figure IV-5j. Two Through Lanes With One Right-Turn Lane (Protected-Only Right-Turn Phasing)

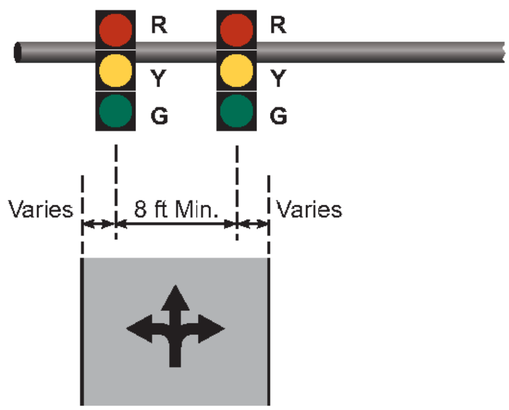


Figure IV-5k. One Shared Left/Through/Right Lane (Permissive Left-Turn Phasing)

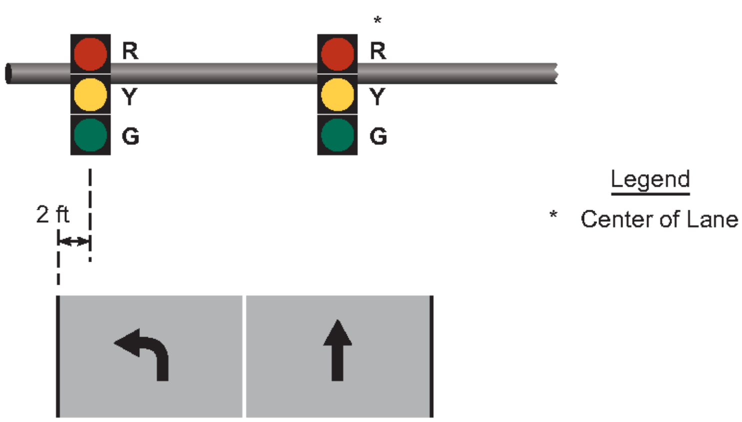


Figure IV-5l. One Left-Turn Lane With One Through Lane (Permissive Left-Turn Phasing)

Split Phasing

For a signalized intersection operating under split phasing, opposing approaches receive green indications separately without running concurrently. Typically this occurs on side streets with combination lanes and heavy turning movements. When split phasing is used, the signal head arrangements shown in **Figures IV-6a through IV-6f** below should be used. Refer to Chapter IV-E.3.d of this Manual for additional information regarding the appropriate use of split phasing.

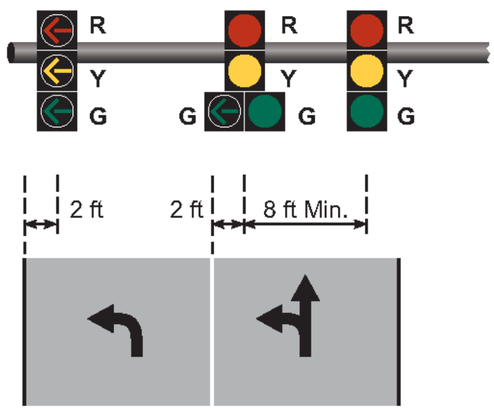


Figure IV-6a. One Left-Turn Lane with One Shared Left/Through Lane (Split Phasing)

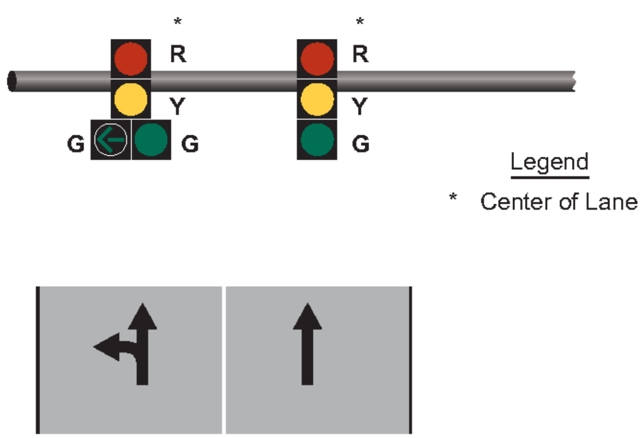


Figure IV-6b. One Through Lane with One Shared Through/Left Lane (Split Phasing)

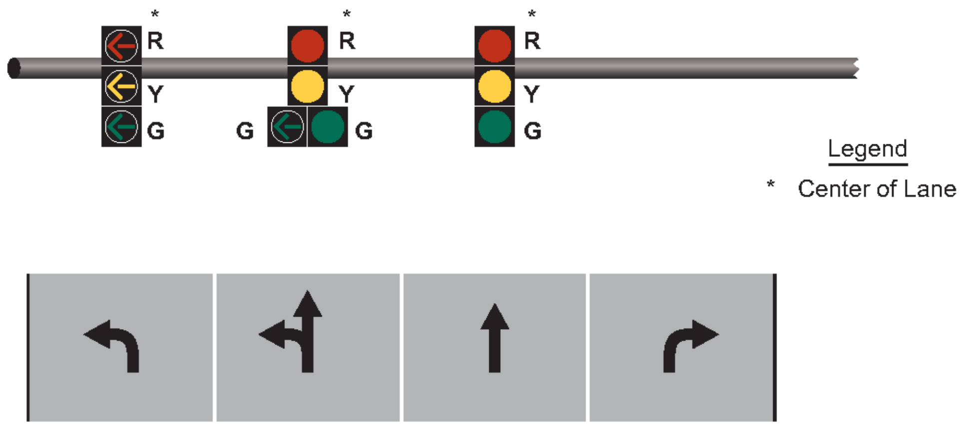


Figure IV-6c. One Left-Turn Lane, One Shared Left/Through Lane, One Through Lane and One Right-Turn Lane (Split Phasing)

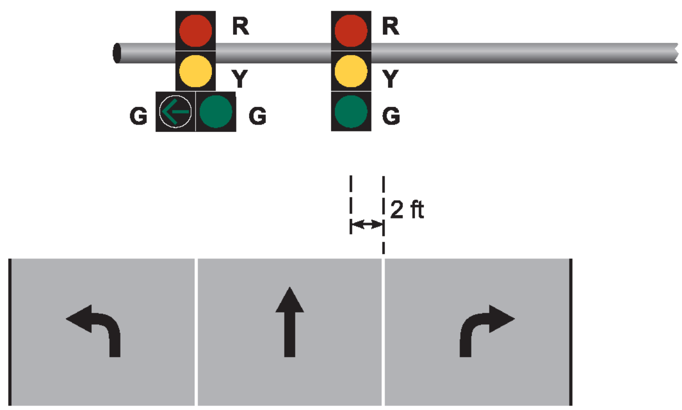


Figure IV-6d. One Left-Turn Lane, One Through Lane and One Right-Turn Lane (Split Phasing)

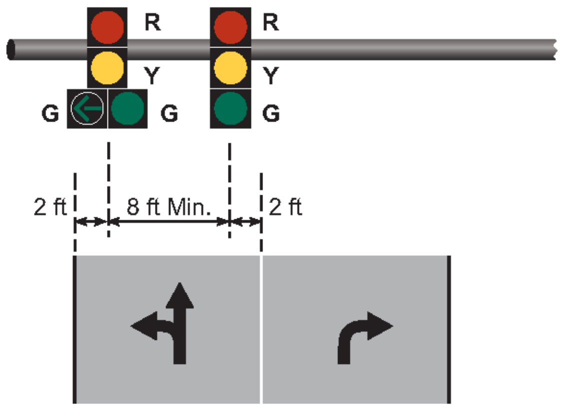


Figure IV-6e. One Shared Through/Left Lane and One Right-Turn Lane (Split Phasing)

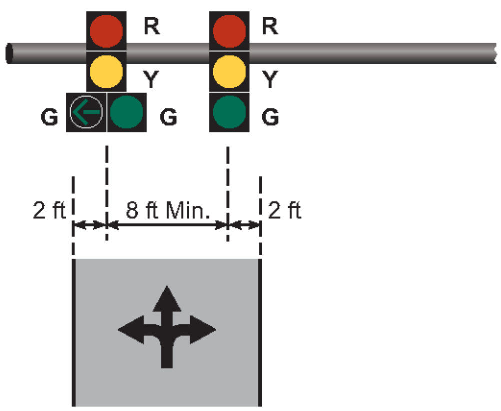


Figure IV-6f. One Shared Left/Through/Right Lane (Split Phasing)

<u>Near Side Signal Heads</u>

When used for left turns, near side signal heads should be located adjacent to the far-left lane of the approaching driver. When used for through movements, near side signal heads should be located adjacent to the far right lane.

f. Shielding of Signal Faces

The primary goal in the placement of signal head indications is to optimize the visibility for approaching drivers. Road users approaching a signalized intersection should have a clear sight-line to the signal face controlling their movement, and the signal heads should be placed to avoid driver confusion. However, in some cases, geometric constraints at the intersection may force multiple signal indications to be visible by drivers at the same time. In these cases, visors or backplates with a 2” reflective border can be used to enhance the visibility of the desired signal head, while obscuring the visibility of other heads.

Visors

A visor should be used on all signal faces to:

- Aid in directing the signal indication specifically to approaching traffic.
- Shade the signal lens from sun, sky, and other conditions which tend to make a lens look illuminated when it is not.
- Shield the lens from motorists on other approaches who might be confused if they were to see the lens.

There are three types of visors; cut-away, tunnel, and full circle. Cut-away visors should typically be used; however, the other types may be necessary in certain cases to further restrict the signal’s visibility.

Backplates

Backplates should only be used where an engineering study indicates their need to resolve a problem such as where sun glare, bright sky, and/or complex or confusing backgrounds indicate a need for enhanced signal face conspicuity. If used on span wire, a tether wire shall be used.

g. Optically Programmed Signal Heads

An optically programmed signal head is a signal head that contains optical units which project an indication that is selectively masked so as to be visible only within desired viewing boundaries. Optically directed lenses can provide an optical cut-off of the indication both vertically and horizontally, as needed.

Optically programmed signals were designed for applications where visibility of proper, non-conflicting signal indications is critical. The most-common uses are for closely spaced or sharply skewed intersections. When intersections are closely spaced, a motorist may see upstream signal indications and become confused as to which signals control the intersection he/she is approaching. When used, optically programmed signals should be programmed to ensure that adequate stopping sight distance is provided based on the 85th percentile speed of the road. At skewed intersections, optically programmed signal heads may be used so that approaching motorists will not see conflicting signal indications. Due to the high cost of these devices, they should only be used when absolutely necessary. If they are to be placed on a span wire installation, a bottom tether shall be used to provide a more stable mounting. The weight of the optically programmed signal heads should also be considered in the design. The desired optical zone of a programmable limiting traffic signal head should be depicted on the plan sheet.

3. Cabinet Placement

The signal cabinet is an aluminum enclosure that provides housing and protection for signal controller equipment from all forms of outdoor elements.

There are two types of mounting methods for signal cabinets, ground mounted and pole mounted. The Department's preferred method is a ground mounted cabinet which is installed on concrete base. The typical size cabinet base used by the Department is "Type P." Additional sizes may be used to address specific design needs but all alternate designs shall be pre-approved by the traffic design representative prior to their usage. Pole mounted cabinets are attached to either a mast arm or strain pole and are typically smaller in size and used in urban areas. Pole-mounted cabinets may only be used with advance approval from DelDOT's Traffic Systems Engineer.

Cabinets should be located as far off the travel edge as possible, outside of the clear zone, to provide protection from errant vehicles. Additional factors to consider when determining the location include:

- Safe access by maintenance personnel and maintenance vehicles
- Sufficient right-of-way to permit ready access
- Orientation of cabinet and door (which should be clearly shown on the plan sheet)
- Pedestrian access and ADA compliance (maintaining acceptable sidewalk width)
- Clear view of the intersection from the cabinet
- Ability to see two conflicting signal indications from cabinet location
- Convenience to power source
- Convenience to communication equipment
- Driver visibility (i.e., intersection sight distance across the corner)
- Drainage
- Proximity to low-lying areas and the need for a cabinet extension
- Door opens away from traffic

4. Pedestrian Considerations

a. Pedestrian Signal Guidelines

Pedestrian signals and crosswalks should typically be included with most signal design projects. A pedestrian signal shall be installed in conjunction with vehicular traffic signals under any of the following conditions:

- When a traffic control signal is installed under the pedestrian volume or school crossing warrant.
- When an exclusive interval or phase is provided or made available for pedestrian movement in one or more crosswalks with all conflicting vehicular movements being stopped for those crosswalks.
- At established school crossings at intersections signalized under any warrant.

Pedestrian signals may also be installed under any of the following conditions:

- When any volume of pedestrian activity requires use of a pedestrian clearance interval to minimize vehicle-pedestrian conflicts or to assist pedestrians in making a safe crossing.
- When multi-phase or split-phase timing would tend to confuse pedestrians guided only by vehicle signal indications and any volume of pedestrian activity is present.
- When pedestrians cross part of the street, to or from an island, during a particular interval where they should not be permitted to cross another part of that street during any part of the same interval.

The number of pedestrian crossings required is determined based on the surrounding land use and pedestrian patterns at the intersection, combined with consideration to avoiding crossing pedestrians across the heaviest vehicular movements, where possible. Typically, DelDOT will install crosswalks across both minor street approaches and one mainline approach. Two mainline crosswalks will be considered based on pedestrian desire lines and the impact to both pedestrian and vehicular traffic.

All new and retro-fit pedestrian signals shall include a countdown timer.

b. ADA Compliance

During the field survey, special consideration should be given to identify the potential impacts of the installation of new pedestrian signals and/or the modification of existing facility. All impacts should be identified on preliminary design plans and consideration should be given on how improvements will impact the construction sequence. All proposed crossings should be installed and all existing crossings should be retro-fitted to comply with current ADA standards. Placement of pedestrian poles and push buttons shall be placed within easy reach of pedestrians who are intending to cross and provide clear guidance on which push button is intended for each crossing by positioning the push button parallel with the path of travel. Push buttons should be placed in a reach range that complies with the “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” and the “Draft Public Rights-of-Way Accessibility Guidelines (PROWAG).” Push buttons shall be placed to allow for easy activation and conveniently located near each end of the crosswalk. For additional guidance on placement, see Section 4E.08 of the DE MUTCD.

Where feasible, the placement of ramps should take into consideration the installation of future accessible pedestrian signals (APS). APS devices provide non-visual pedestrian timing in a non-visual form either through audible tone, verbal message, and/or vibrating surfaces. For more information on APS, refer to Chapter 4 of the DE MUTCD. Requests for APS may be made to DelDOT using the application form provided in **Appendix L**. Requests for APS are addressed by DelDOT in a timely manner on a first-come-first-serve basis as funding allows.

5. Signal System Interconnection

During preliminary design, consideration should be given to how the proposed or existing signal could be integrated into the ITMS. All new signals shall be on system. Typically, retro-fit designs should also bring signals on system. This may be accommodated by tying into any existing fiber system or building a pathway to an adjacent system. However, consideration should be given that the proposed integration will not cause significant down time to the system. If an existing fiber system is not readily present or cost prohibits the linking to adjacent pathway, a wireless connection may be a viable option. This could be achieved by a CDMA or other wireless solution. For all integration into the DelDOT’s ITMS, the designer shall work with the TMC and the DelDOT Telecommunications Committee on integration solutions and cost.

6. Power Source

New electric service points should be verified early in the design process through coordination with the applicable power companies. For additional information, refer to the memorandum dated October 19, 2011 included with this Manual in **Appendix M**.

D. Final Design Plan Elements

Final design plans must include all elements necessary to fully construct all components of the traffic signal. During 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 pathway for electrical and fiber-optic communication cables placed between junction wells, signal pole bases, and the controller cabinet. The DelDOT Traffic Section uses Schedule 80 polyvinyl chloride conduit (PVC) or high density polyethylene (HDPE) for all signal, electrical, and ITS pathways.

a. Sizes

DelDOT Traffic typically conduit sizes are selected based on the following:

- All proposed signal conduit shall be 4” Schedule 80 PVC when installed by trench or open cut
- All proposed signal conduit shall be 4” Schedule 80 HDPE when installed by bore. If hand bore is required conduit size may be reduced upon approval by a Traffic Systems Design representative.
- All proposed signal electrical service shall be provided by a single 2” (or larger, as determined by maximum fill capacity) rigid conduit.
- All proposed loop detector lead-in conduit shall be 1 1/2” rigid conduit.
- All pole base conduits shall be as outlined in the following section. Once a tie in to a junction well has occurred, the remainder of the pathway shall be as stated above.
- 4" Schedule 80 PVC or 4” Schedule 80 HDPE conduit shall be used for fiber-optic pathways.

For minor signal improvements, smaller conduit sizes may be used upon approval by a Traffic System Design representative. Additional galvanized conduit may be used but would require prior approval from DelDOT’s Traffic System Design representative.

b. Installation Methods

There are four (4) typical methods for installing signal 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 may be the only feasible option. Open cutting also provides the advantage of avoiding conflicts with underground utilities. If open cutting is proposed, the designer should coordinate with District Maintenance staff regarding the issue and any required patching design.

c. Conduit Fill Capacity

The National Electrical Code (NEC) limits the portion of the conduit's cross-section that can be occupied by conductors.

For traffic signal installations, the conduit fill should be limited to **26%** for new conduit and should be limited to **35%** for existing conduit. This will compensate for potentially large number of conductors, the length of run, and the number of bends. Cross-sectional areas of cables typically used for signal installations are listed in **Table IV-5**, while fill capacities used by DelDOT Traffic are shown in **Table IV-6**.

As an example, if an existing 2.5" conduit consists of four #14/9 cables and two #18/4 cables, the total area (1.29 sq. in.) would fall under the 35% allowable fill capacity of 1.72 sq. in., with 0.43 sq. in. still available.

Table IV-5
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	0.256
#14/16	0.389
6 Count Fiber	0.132
12 Count Fiber	0.132
24 Count Fiber	0.132
48 Count Fiber	0.132
144 Count Fiber	0.302

Table IV-6
Fill Capacities of Typical Conduit Sizes Used by DelDOT Traffic

Conduit Size	Allowable Fill Capacity	Area (Sq. In.)
1.5”	26%	0.46
	35%	0.62
2.0	26%	0.82
	35%	1.10
2.5	26%	1.28
	35%	1.72
4	26%	3.27
	35%	4.40

2. Junction Wells

Junction wells are pre-cast structures placed underground or within concrete barrier (junction boxes) with composite or steel frame and lid. 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

DelDOT Traffic uses fifteen (15) types of junction wells: precast concrete with steel frame and lid (types 1 through 5), precast polymer concrete (types 6 through 10) or precast concrete with composite frame and lid (types 11 through 15). The preferred junction well types used by DelDOT Traffic are listed below:

- Type 11 – 20"x 20": typically used for signal access points beyond the signal cabinet.
- Type 14 – 20"x 42½": typically used for a signal project as a tie-in point for entering the signal cabinet. Also used for pull points for the fiber optics pathway.
- Type 15 – 24"x 16": typically used for signal access points beyond the signal cabinet within narrow medians or constrained right-of-way locations.
- Type 7 – 36"x 60": typically used for the fiber optics pathway as splice points or device tie-in locations.

All new junction wells should be precast concrete with a composite frame and lid. Steel frame and lid junction wells may still be used where necessary due to field conditions. An example of when a steel frame lid may be appropriate is in median nose where vehicles may track over well causing damage to composite frame and lid. Under most design projects, the existing steel frame and lid junction wells should be retrofitted with new composite frames and lids. Upon approved usage by a Traffic System Design representative existing or proposed steel frame junction wells shall be bonded and grounded. Refer to standard construction detail T-2 for more guidance. For certain signal projects with a small scope of work and with the approval of a Traffic Systems Design representative, there may be no need to modify existing junction wells.

Additional junction well types may be used, but would require prior approval from the Traffic Systems Design Manager or Chief Traffic Engineer.

b. Location

Junction wells for signal design projects should be placed near each signal pole, loop detection splice point, change of direction, roadway crossing of pathway, traffic control device tie-in, and near the cabinet. The maximum spacing between junction wells for signal design projects is 250 feet. The maximum spacing between junction wells for ITS (fiber) pathway is 600 feet. Refer to Chapter V of this Manual for additional details regarding ITS design elements.

3. Detection

Signal detection provides the signal controller with information on the current traffic conditions at the intersection and on the approaches and departures to/from the intersection. Detection should be included in the design of all new and modified signals.

a. Function

The six (6) basic operational functions provided by detection are: 1) Presence, 2) Passage, 3) Sampling, 4) Emergency Vehicle Detection, 5) Pedestrian Detection, and 6) Bicycle Detection.

Presence detection provides the controller information on when a vehicle is present within the designated detection zone. These detectors are typically placed on side streets and left-turn bays prior to the stop line.

Passage detection provides the controller information on when a vehicle has passed through a detection zone. Passage detectors are located a calculated distance behind the stop bar, based on the speed of vehicles approaching the intersection and the grade.

Sampling detection provides the controller with presence and occupancy readings to help aid in determining which signal timing operation should be deployed based on the amount of traffic volume currently within the corridor. Sampling detectors are placed on the departure side of the intersection at a point where vehicles reach free flowing speeds. Sampling detectors should be strategically located to best serve the system, based on coordination with DelDOT Traffic.

Emergency Vehicle Detection alerts the controller of approaching emergency vehicles, which allows the signal to extend the current green time or to change the signal indications to allow for a green indication to be displayed to the emergency vehicle(s) on the required approach. Typically, all approaches should be designed with emergency vehicle detection.

Pedestrian Detection: is typically accomplished with push buttons located adjacent to a crosswalk that complies with the "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)." More detail on Pedestrian signal design is provided in Chapter IV-C of this Manual.

Bicycle Detection: is typically accomplished by using vehicle detectors in a designated bicycle lane. When present, bicycle detectors should be placed in bicycle lanes on side streets prior to the stop line. If bicycle lanes are not provided, detector settings should be adjusted to properly detect bicycles.

b. Design

While DelDOT Traffic currently utilizes multiple types of vehicle detection devices, **inductive loop detectors are preferred**. Inductive loop detectors are used for presence, passage, and sampling detection. The loops are formed by saw cutting the surface of the roadway, placing a No 14 AWG wire incased in flexible tubing detector wire into the saw cut, which is then sealed and run to the nearest junction well.

DelDOT Traffic typically utilizes two sizes of inductive loop detectors:

- <u>Type 1 Loop Detector</u> – Typically a 6-foot by 6-foot loop that can be used for both passage and sampling detection. When used as passage detection, the loop is placed in each of the through travel lanes in advance of the stop line to detect a vehicle approaching the intersection. The placement of the loop is determined by the approach roadway posted speed (refer to **Table IV-7** on the following page). When used as a sampling detector, the detector should be placed on the departure side of the intersection where traffic is expected to reach free flow conditions.
- <u>Type 2 Loop Detector</u> – Typically a 6-foot by 25-foot loop is used for presence detection. Type 2 detectors are generally placed at the stop line on minor street approaches and in left-turn lanes, to detect and/or extend green time for the movement being served. The leading edge of the detector is typically placed 12 inches behind the stop line, but placement may be adjusted to address field requirements.

Other types of detection utilized by DelDOT Traffic include Wireless and Non-Intrusive Detectors. Non-Intrusive detectors used by DelDOT currently include optical detection and video detection.

Table IV-7 **Detector Setbacks**	
Speed (MPH)	Detector Setback (feet)
25	90
30	125
35	160
40	200
45	250
50	300
55	350
60	410

NOTES:
Detector setback distances calculated using the following equations/assumptions:

Deceleration Rate, d = 12.0 feet per second^2
Reaction Time, r = 1.00 second
Detector Setback = Deceleration Distance + Reaction Distance

$$= \frac{v^2}{2d} + Vr$$

where V = speed (in feet per second)

Optical Detection is typically used for emergency vehicle detection. Optical detection consists of two primary components: an emitter installed in the emergency vehicle that produces a high-intensity light pulse, and a detector located on the signal. Upon activation, the detector sends a message to the control cabinet to begin a pre-programmed pre-emption sequence. Alternatively, emergency preemption can also be accomplished by the installation of a push button, typically installed within an emergency station. The push button activates an emergency vehicle signal via a hardwired connection.

Video Detection uses a video camera mounted to the signal pole to create a digitized detection zone. As vehicles pass through or wait in the zone, a detector call is recorded. For best results, a rigid mount is required on a mast arm or signal pole. Typically, one camera is required per approach. Wide approaches with multiple lanes may require more cameras.

Other detection systems are also available for use in special cases. One example is **Microwave Detection**, which may be used in special circumstances where the use of in-pavement sensors is not feasible or if non-metallic objects need to be detected.

4. Wiring

Electrical wiring is an integral component of a signal system. Well-designed electrical wiring systems assure proper signal operation and facilitate maintenance and expansion of the signal system. The amount and type of electrical wire required for each design is shown in the conduit run schedule on the plan sheet. This schedule shows the wire routing for all related signal equipment back to the controller. The following section of the report outlines DelDOT's preferred standard practices for wiring. The most common types and size cable used by the department are listed below in **Table IV-8**. For all new construction projects, the designer should update all wiring to comply with current DelDOT electrical standards. For minor retrofit projects, existing wiring may be retained if deemed adequate by a DelDOT Traffic Representative.

Table IV-8
Wiring Diagram Supplemental Information

Device	Cable Type	Size	Volt. (AC)
HIB	4-Conductor Electrical Cable	No. 14 AWG (2)	600
Pedestrian Signal Head and Push Button (1 way), Pedestrian Signal Head and Push Button (2 way)	5-Conductor Electrical Cable	No. 14 AWG (2)	600
1- & 2-Section Signal Heads, 3-Sect. Head w/Arrows & Jumper Wire (mast arm)	4-Conductor Electrical Cable (1)	No. 14 AWG (2)	600
4- and 5-Section Signal Heads (mast arm)	9-Conductor Electrical Cable (1)	No. 14 AWG (2)	600
Signal Heads (span wire)	16-Conductor Electric Cable	No. 14 AWG (2)	600
Loop Wire Lead-In Cable	1-Conductor (Aluminum shielded)	No. 14 AWG	600
Loop Detector Home-Run Cable	2-Conductor (Aluminum shielded)	No. 14 AWG	600
Opticom Detector	4-Conductor Detector Cable	No. 18 AWG	300
Grounding	Strand. Bare Cop. Gnd. Wire	No. 6 AWG (2)	----
Power Feed (disconnect to cabinet)	8-Conductor Electrical Cable	No. 8/ 2 UF w/G (2)	110/220
Electrical Service (transformer to disconnect)	1 – Conductor Electrical Cable	No. 8/ 2 UF w/G (2)	110/220

(1) – Consideration should be given to increasing number of conductors needed in mast arm installations for spare and future use.
(2) – For longer runs, heavier gauge cable may be required to reduce voltage drop.

a. Mast Arm Pole Cabling

The signal cables connecting the signal cabinet and each mast arm pole should be designed as follows:

- **Single Mast Arm with a Single Phase:** Use one (1) 9-conductor for the signal head, one (1) 5-conductor for each pedestrian indication and buttons, and one (1) 4-conductor for pre-emption devices.
- **Single or Dual Mast Arm with 2 to 3 Phases:** Use one (1) 16-conductor for the signal head, one (1) 5-conductor per each pedestrian indication(s) and push button(s), and one (1) 4- conductor for each pre-emption device installed.
- **Single or Dual Mast Arm with 4 Phases:** Use two (2) 16-conductors for signal head, one (1) 5-conductor for each pedestrian indication(s) and push button(s), and one (1) 4-conductor for each pre-emption device installed.

The above signal head cable configurations will serve as the "home run" between the controller and either the base of the mast arm pole or to a junction well located near the mast arm pole. At that point, the cable will be spliced with the individual cables that connect with each signal head:

- One (1) 9-conductor shall be run to each five (5)-section signal head
- One (1) 5-conductor shall be run to all signal heads with four (4) or fewer signal indications.

Pre-emption cable and pedestrian signal cable shall be as a single continuous run with no splice from each device installed back to the signal cabinet. Additional wiring configurations may be required for unusual signal designs including near-side and auxiliary signal heads. See **Appendix N** for additional wire cabling design considerations.

b. Span Wire Cabling

The signal cables connecting the signal cabinet and the primary strain pole in a span wire configuration should be designed with two (2) 16-conductor cables. One of these 16-conductor cables will be used to serve two approaches (one major street approach and one minor street approach) while the other 16-conductor cable will be used to serve the remaining approach(es). These two cables typically provide all the conductors necessary to serve all of the signal heads used for most span wire configurations.

Additionally, one (1) 5-conductor cable must be run between the signal cabinet and each pre-emption device. One (1) 5-conductor cable must also be run from the signal cabinet to each pedestrian indication per corner of the intersection requiring a pedestrian indication. This cable may either be run underground (preferred) or overhead, if necessary. Additional wiring configurations may be required for unusual signal designs including near-side and auxiliary signal heads. See **Appendix N** for additional wire cabling design considerations.

c. Pedestrian Signal

Pedestrian signals in Delaware require one (1) 5-conductor cable spliced in the base per each pedestrian indication(s) and push button(s).

d. Detector Wiring

For detector wiring, a single 2-conductor aluminum shield home-run cable is spliced into each loop detector and run from the junction well to the controller cabinet in a continuous run. No additional splices shall be permitted. All other detection methods should follow the recommended manufacturer requirements to maintain maximum output.

e. Overhead Cabling

Overhead cabling is used with span wire signal installations. Cables installed overhead shall be supported by span wires strung between signal poles. Attachment of signal cables to the span wire shall be by standard lashing methods with galvanized lashing wire. Attachment of cable to the span wire shall be by application of a minimum of five (5) wraps of plastic tape (black in color) at intervals of not more than 24 inches.

The vertical runs of cable to the overhead installation should be routed in conduits with a weather head or routed inside the steel pole. Drip loops shall be formed where the cable enters the weather head to prevent water from running down the cable into the conduit or pole.

In some cases, primarily for interconnection with other intersections or to provide power to the intersection, overhead cabling may also be used. Utility companies typically own existing poles that are located along roadways and joint usage of these poles can usually be arranged with the utility company. There are safety requirements to maintain certain clearances from other utility lines and attachment agreements may be required.

Cables installed overhead between existing poles shall be supported by messenger wires strung between poles. The messenger may be a separate wire used to support the cabling, or may be combined with an electrical cable in a common jacket. When combined, the cable has a figure 8 cross section profile and is therefore termed a "figure 8" cable.

f. Interconnect

Interconnect provides coordination between traffic signals allowing the ability to establish a time relationship between the signals. All signals should be interconnected through DelDOT's TMC. This allows the TMC to implement a standard clock, provides the ability to adjust timings, facilitates troubleshooting, and provides real-time traffic data. Coordination between adjacent signals has proven to be effective in improving the flow of vehicles and reducing vehicle delay and fuel consumption.

Coordination is accomplished through several different methods. Options include fiber-optic connection (for signals near existing or proposed fiber pathways), CDMA or commercial telephone connections (for remote locations or temporary connections), and 900 MHz wireless connection.

There are some basic principles to be followed when installing coordination interconnect cables:

- All cables shall be terminated inside of an enclosure (control cabinet, splice case, or computer building). This allows for easy termination on terminals and convenient testing points.
- Intermediate splices, other than at junction wells or cabinets, should be avoided.
- Interconnect cables should not be placed into the same conduit with cables that carry secondary line voltage or higher.

Consultation with the Telecommunications Group is required to finalize design.

g. Grounding

A single No 6 AWG ground wire shall run through all pathways between the cabinet and junction wells and the bases of all pole structures to ensure proper grounding of all wires.

h. Power Feed

DelDOT's traffic signals typically draw power from existing, nearby utilities. While the signal designer should identify potential sources of power, DelDOT Traffic Construction will coordinate directly with the utilities to finalize specific design details regarding the power connection. If the power source is not obvious, the designer should meet with representatives from DelDOT Construction and the power company to discuss viable options during design.

The standard signal service for DelDOT shall be as follows:

The power company's wire will be brought to the signal pole nearest to the traffic signal cabinet. Preferably, this should be overhead wire, but it may be underground in some cases. For a mast arm pole, the feed shall be underground.

A standard 40 amp fuse disconnect switch box should be mounted on the DelDOT pedestal pole to allow power to be turned "off" while working in the control cabinet. This will also protect the service line between the fuse and the cabinet. A larger amp fuse disconnect may be needed if multiple service requirements are present. If a metered service is required, a standard 200 amp meter socket shall be mounted on the pole, directly above the disconnect switch box. The service connections will be a 120/240-Volt, 60 Hz connection.

If multiple service requirements are needed, a distribution panel should be added to the signal pole to distribute the power to each device. The maximum amperage drawn by typical traffic devices is shown in **Table IV-9**.

Table IV-9
Signal Equipment Power Usage

	Max amperage
3-section 8" signal head; 9" pedestrian head (LED)	0.44 amps
3-section 12" signal head, 12" pedestrian head (LED)	0.55 amps
4-section, 8" signal head (LED)	0.30 amps
3-section, 12" signal head (LED)	0.31 amps
4-section, 12" signal head (LED)	0.37 amps
5-section, 12" signal head (LED)	0.48 amps
Loop detector amplifiers	0.30 amps
Controllers/Units	2.00 amps
Communication Device (i.e., fiber modem, CDMA, etc)	1.00 amps
Conflict Monitors	1.00 amps
Optically Programmed Signal Heads	1.25 amps

Therefore, a typical four-phase intersection with the following equipment will require the following amperes shown in **Table IV-10**:

Table IV-10
Example Signal Equipment Power Usage Calculation

Qty.	Material	Power (Amps)
6	12", 3-section signal heads @ 0.31 amps each	1.86 amps
2	12", 5-section signal heads @ 0.48 amps each	0.98 amps
12	Loop detector amplifiers @ 0.30 amps each	3.60 amps
1	Controller @ 2.00 amps each	2.00 amps
1	Conflict monitor @ 1.00 amp each	1.00 amps
	Total	9.42 amps

5. Phasing

Signal phasing assigns the right-of-way to one or more movements during a signal cycle. The phase numbering and sequencing are shown in a diagram in the upper right-hand corner of the signal plan sheet and shall follow the NEMA phasing conventions as adopted by DelDOT Traffic. For detailed information on phasing, refer to Section IV-E.3 of this Manual.

If the side street phasing is split, the side streets use Phases 3 and 4 only. If the side streets run concurrently, phase 4 and 8 shall be utilized. At a "T" intersection, the side street is typically Phase 4. In a box under the NEMA phasing diagram, the following note should be inserted:

1. Phases associated by a solid line will not operate concurrently.
2. Phases associated by a dashed line may operate concurrently.

On the plan sheet, the Designer should connect the phase circles by the appropriate type line.

NEMA PHASING

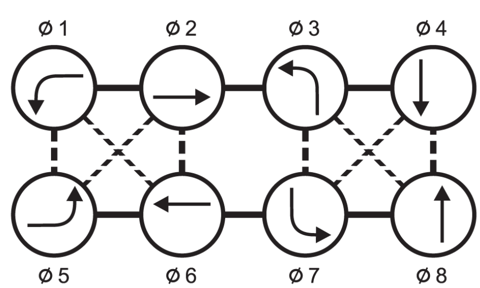


Figure IV-7. Standard NEMA Phasing Convention

The NEMA phasing diagram shown on the previous page in **Figure IV-7** corresponds with the following intersection movements shown below in **Figure IV-8**. Atypical phasing requires coordination between the designer and TMC.

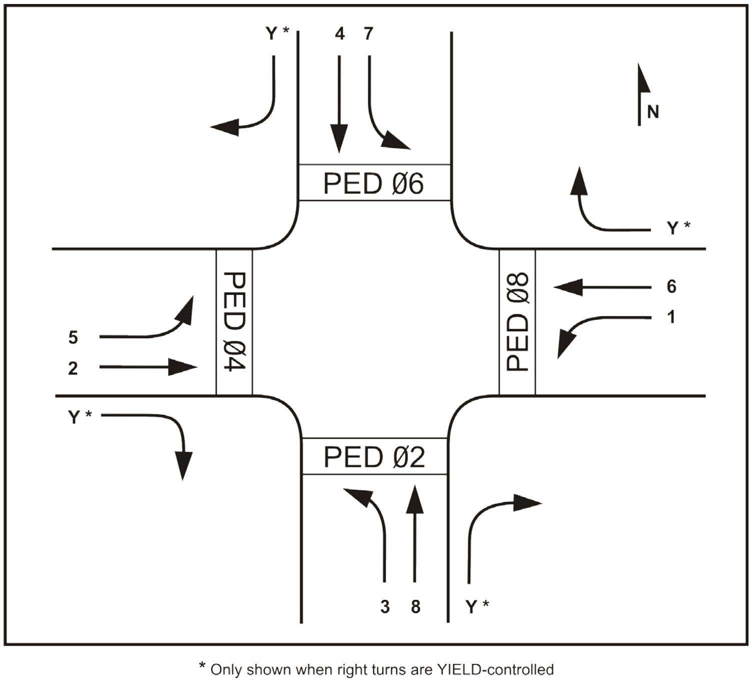


Figure IV-8. Typical Intersection Movements and Corresponding NEMA Phasing Convention

6. Control Cabinet

__Types__

For all signal projects, a 16-phase, fully actuated signal controller will be used. For all retrofits and/or signal modification projects, signal controllers should be upgraded. Controllers will typically be housed in a based-mounted cabinet except in situations where there is insufficient space, or other geometric or environmental constraints. In those cases, a pole mounted cabinet may be used. On the signal plan, the cabinet type shall be shown inside the cabinet symbol.

__Conduits__

All proposed signal cabinet bases shall have a minimum of four (4) conduits access points the typical layout shall be as followed. All new signal cabinet bases shall be connected directly to a type 14 junction well with a min of three (3) 4” Schedule 80 PVC conduits providing direct access. An additional 3” Schedule 80 PVC conduit shall be provided for direct access to the nearest signal pole into the cabinet base. If direct access from the nearest signal pole is unachievable an additional 4” Schedule 80 PVC conduit shall be installed from the type 14 junction well to the cabinet. There shall also be a single 2” (or larger, as determined by maximum fill capacity) Service rigid conduit providing direct access from the power source into the cabinet base.

Typical conduit designation should be as followed:

- Conduit 1: 120-volt cables (signal heads, remote services, etc.)
- Conduit 2: low voltage cables (detectors, opticom, etc.)
- Conduit 3: shall be for fiber optic applications.
- Conduit 4: shall be a dedicated spare.

7. Pole & Cabinet Base

Pole Base

DelDOT utilizes a Pole Base, Type 4A with drop-in anchors to support conventional, aluminum pedestrian signal (pedestal) poles. A Pole Base, Type 4B with breakaway couplings is used to support ornamental steel pedestrian signal (pedestal) poles.

For all designs with new traffic signal (i.e., strain and mast arm uprights), CCTV camera, and/or vehicle detector poles, the signal 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 signal designer should submit a soil boring request form (see **Appendix O**) to DelDOT's Geotechnical Engineer. At a conventional four-legged intersection, the initial soil boring request should generally consist of two borings on diagonal corners or all affected corners, at the discretion of DelDOT's Geotechnical Engineer. The anticipated project cost associated with soil borings is about $10,000 per intersection, which the signal designer should include in preliminary engineering estimates and developer funding requests.

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-11** on the following page.

Because Pole Base, Types 3B and 3C require 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.

Table IV-11
Pole Base Type Selection for Varying Soil Condition

	"Poor" Soil Conditions						*"Medium" Soil Conditions*					
	Case 1 Sand over sand	**Case 2** Sand over clay	**Case 3** Sand over rock	**Case 4** Clay over sand	**Case 5** Clay over clay	**Case 6** Clay over rock	**Case 7** Sand over sand	**Case 8** Sand over clay	**Case 9** Sand over rock	**Case 10** Clay over sand	**Case 11** Clay over clay	**Case 12** Clay over rock
40-ft mast arm	3A	3C	3	3B	*	3	3A	3A	3	3A	3A	3
60-ft mast arm	3B	3C	3	3C	*	3A	3A	3B	3	3A	3B	3
90-ft mast arm	3B	3C	3A	3C	*	3A	3A	3B	3	3A	3B	3
75-ft camera pole	3	3A	3	3A	3C	3	3	3	3	3	3	3
40-ft detector pole	3	3B	3	3B	3C	3	3	3	3	3	3	3
32-ft strain pole	3C	*	3A	3C	*	3B	3B	3C	3A	3B	3C	3A
37-ft stain pole	3C	*	3A	3C	*	3A	3B	3C	3A	3B	3C	3A

* Consultation with DelDOT's Geotechnical and Bridge Sections is required

These are general guidelines for selecting an appropriate pole base type. In some cases, it may be necessary to calculate the dead load for signal heads on mast arm or span wire before selecting the appropriate pole base. The signal designer should reference DelDOT's Standard Construction Details for sizes. Any modification to the construction detail must be pre-approved by the Chief Traffic Engineer prior to installation.

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 above) and the other being capped, unless otherwise required. Type 4 pole bases shall have one (1) 2.5" Schedule 80 PVC conduit elbow connecting to the nearest junction well. All new signal pole bases shall tie into a junction well (unless otherwise approved by a Traffic Systems Design representative or as noted above for direct connection to a cabinet base).

<u>Cabinet Base</u>

There are four common cabinet base types used by DelDOT Traffic.

- Cabinet Base Type P – Signal
- Cabinet Base Type F – Fiber
- Cabinet Base Type M – Intersection Lighting
- Cabinet Base Type R – Interchange Lighting

Refer to DelDOT's <u>Standard Construction Details</u> for additional information. Any modification to the construction detail must be pre-approved by the Chief Traffic Engineer prior to installation.

8. Signing

Signing improvements may be required in conjunction with a new or modified signal design project. All proposed signs shall be in accordance with the DE MUTCD for proper application and installation. Signs typically installed as part of a signal design include overhead street blades, a SIGNAL AHEAD (W3-3) sign with advance street name plaque (W16-8), or other lane use, regulatory and warning signs associated with signal operation, and pedestrian signs.

a. Overhead

All new and significantly retrofitted traffic control signals should include overhead street name signs (SNS). All SNS's on span wires and on mast arms should have the following characteristics:

- Be dual sided (except for one-way streets)
- Be hung below the span wire or mast arm
- Have a maximum width of 120 inches (10 feet)
- Have an initial upper case height of 8" and lower case height of 6", Highway Gothic D lettering
- Have 17' maximum clearance from roadway surface to bottom of sign
- Be installed only when the angle of the mast arm or span wire is less than 30 degrees measured perpendicular to the direction of travel

Additionally:

- Overhead SNS may incorporate a route shield when the roadway meets the conditions set out in the DE MUTCD Section 2D.43 paragraph 02.

- The designer should avoid overhead SNS with two lines of lettering if it all possible.
- Single line overhead SNS should not be tethered
- Two line overhead SNS with back plates may be tethered
- Regulatory signs mounted on mast arms should be rigid mounted to the mast arm (not hanging)
- Span mounted signs will not be tethered unless special circumstances dictate so, such as size

The combination of possible geometric intersection designs and signal designs make it impractical to develop a specific policy that will show exactly where every sign should be located. For additional guidance refer to DelDOT's guidance memo on Overhead Street Signs Mounted on Traffic Signals in **Appendix P**.

b. Ground Mounted

An advance SIGNAL AHEAD (W3-3) sign with advanced street name plaque (W16-8) shall be installed for all approaches. For a new signal, a NEW (W3-7a-DE) plate shall be installed and remain in place for 90 days. Additionally if an operational change is occurring, a NEW TRAFFIC PATTERN (W3-8a-DE) sign should be installed and remain in place for 90 days. Any additional required signs shall be displayed in accordance with the DE MUTCD.

Signs to be removed shall be clearly depicted in the plan sheet. For a stop-controlled intersection being converted to a signal, the "STOP" R1-1 shall be removed concurrently with the signal becoming operational.

9. Pavement Markings

A signal plan may require the installation or modification of existing pavement markings. All markings shall be designed in accordance of the DE MUTCD and may include crosswalks, stop lines, message/arrow markings, lane lines, channelizing and auxiliary lines, and edge lines. All new pavement markings shall be designed and detailed to a point where they can be transitioned into the existing markings. Marking shall be labeled and quantified on the plans in accordance with DelDOT CADD standards. Quantities should be rounded up to the next 10-foot increment for estimating purposes. Removal of existing markings that conflict with new markings shall also be shown on the plans and quantified.

10. Maintenance of Traffic

The Traffic Designer needs to consider the required maintenance of traffic (MOT) setups that will be required to construct the project. Typical MOT requirements can be found in Chapter 6 of the DE MUTCD. If the signal project is part of a larger project, the Designer should coordinate with the project team developing the Transportation Management Plan (TMP).

The cost estimates prepared for the project should include all MOT items. Time restrictions for any required lane closures should be coordinated between the Designer and the Safety Section prior to handing the project off to construction. If night work is required, this should be noted in the handoff form and the appropriate MOT items should be included. 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. The Designer must also account for pedestrian access during construction. Pedestrian MOT should be determined prior to project handoff to Construction.

11. Time Sheet

The Traffic Designer should prepare and submit a draft time sheet with the final plan set. The TMC is then responsible for finalizing the time sheet and obtaining the necessary signatures. Refer to Chapter IV-E of this Manual for additional information related to preparing the time sheet.

The following information should be submitted to the TMC along with the Draft Timesheet:

1. A full sized signal plan
2. Photographs documenting the posted speed limits on all approaches
3. Crosswalk distances*
4. Approach grades

**Note: Crosswalk distances can be shown in plan view on the signal plan or in a separate document that details either or both of those plan elements.*

One copy of the latest version of the time sheet should be placed in the signal cabinet. Other copies should also be retained by the TMC and the District office.

12. Supplemental Equipment

In most cases, the design elements outlined above comprise all elements required for a complete signal design. However, in special circumstances, supplemental equipment may be required (such as HIBs, cameras, etc.) All supplemental equipment included in the final traffic signal design plans should be approved by the Traffic Systems Design Engineer before being included in the plans.

Separate ITS devices, such as cameras or antennas, may also be included in a signal design project. The design of these elements is covered later in this Manual in Chapter V.

13. Traffic Statement

DelDOT Traffic is responsible for developing the engineer's estimate for stand-alone Traffic Section Projects and/or Developer / Subdivision Projects. For In-House Capital Projects, DelDOT Traffic will develop the Traffic Statement. For Consultant-led Capital Projects, DelDOT Traffic will provide review and comment of the consultant-developed Traffic Statement. The Traffic Statement gathers an overall cost for all signal, signing, ITS, and lighting work to be completed as part of the project by either the on-call traffic and/or general contractor work. Each discipline is broken down into the following breakout sections:

Project Contractor Items – These are items associated with Capital Projects (i.e., bid items) or Developer / Subdivision Projects only. These are items or tasks the general contractor would perform as part of his required work. These items are typically underground infrastructure for signal and ITS projects associated with the overall contract. The estimate should include the installation and/or removal of roadway signing associated with the project, and furnishing, installation and testing of roadway and highway lighting systems.

Traffic Contractor Items – As part of Capital Projects or Developer / Subdivision Projects, these items would cover the cost for furnishing and installation of traffic related equipment by the traffic on-call contractor. This cost would be associated with all the wiring, connection and integration required for signal and ITS work required under the scope of the project.

As part of Traffic Section Projects, these items would cover the cost for furnishing and installation of traffic-related equipment, along with the cost to complete all underground work for signal and ITS projects. Also included would be the installation and/or removal of roadway signs associated with the project and the installation of all roadway lighting systems.

Traffic Supply Items – These are items to be supplied by DelDOT Traffic for all types of projects.

Unit Cost - The cost for contractor items is determined as part of the overall bid of the contract. For the engineers estimated item cost, the designer shall determine the unit cost based on the latest DelDOT price index or historical data. Traffic contractor and supply item costs are based on agreed upon on-call contractor prices.

Quantity Take-off - Many items are directly measured or counted as an actual number, such as junction wells, pole bases, poles, signal indications, cabinets, controllers and devices. For other items, the following are the standard practices for quantity take-off:

Conduit – Use the total measured point-to-point in plan view. If additional footage is needed due to grade or elevation change, it should be denoted on the plan in the conduit run schedule.

Cable – Use the total measured quantity from all required underground pathway and pole height, mast arm length and span wire distance to the underground pathway plus 10% to account for the excess required in junction wells, pole foundations, slack, connections at the cabinet, and splices points.

Signs – Cost for each sign shall be provided, using the latest cost breakdown for signing.

Test Pit Excavation – Use one cubic yard for every two pole foundations.

Pavement Markings – Measure the actual quantity rounding to the next 10 foot increment for quantities under 150 feet or to the next 50 foot increment for quantities greater the 150 feet.

E. Signal Timing & Phasing

This chapter of the Traffic Design Manual discusses fundamental concepts and techniques involved in calculating the initial timing for various types of signal control. The focus of this chapter is on timing parameters related to design issues (phasing, loop placement, etc.) and basic signal timing considerations (yellow clearance interval, all-red, etc.) This chapter is not intended to address detailed timing practices, philosophy, etc.

In the past, signal timing was generally considered an operational responsibility rather than a part of the design activities. However, developing a recommended initial signal timing plan is an important design responsibility. Before a new signal can be activated for operation, a basic timing program must be established. Additionally, signal timing assumptions establish design details such as the number, type, and position of signal heads. Once a signal is constructed, signal timings should be reviewed for adequacy and updated as necessary to meet current demands.

The timing strategies that may be applied are a function of the type and capacity of the controller and the operational (traffic) requirements of the intersection. Pre-timed and actuated controllers are timed differently because of the inherent differences in operational philosophy and functional characteristics. Timing strategies also differ for isolated intersections, intersections along an arterial, and intersections within a system network.

The timing parameters for new or improved signalized intersections are frequently based on timing settings that have proved effective for similar types of intersections, traffic conditions, and equipment. These timing settings are implemented and traffic flow is observed after the signal is activated. If, after the traffic has stabilized, excessive stops or delays occur, the timing is adjusted accordingly, and the rationale documented.

1. General

The functional objective of signal timing is to alternate the right of way among the various traffic and pedestrian movements in such a way as to:

- Provide for the orderly movement of traffic
- Minimize average delay to vehicles and pedestrians
- Reduce the potential for crash-producing conflicts
- Maximize the capacity of each intersection approach
- Maximize bandwidth on signalized arterials

Unfortunately, these desirable attributes are generally not compatible. For example, using as few phases as possible and the shortest practical cycle length may maximize approach capacity and minimize delay, while using multiple phases and longer cycles may reduce the number of conflict points and therefore improve safety. Accordingly, it is necessary to exercise engineering judgment to achieve the best possible compromise among these objectives.

2. Timing Parameters

This section of the Traffic Design Manual describes the calculations required to determine appropriate values for various timing parameters, including cycle length, phase length, yellow change interval, and clearance (all-red) time. Before these calculations are presented, the following definitions of common terms related to signal timing are presented:

- **Cycle:** One complete sequence of signal indications (phases).
- **Phase:** That part of a signal cycle allocated to any combination of one or more traffic movements simultaneously receiving the right of way during one or more intervals.
- **Interval:** A discrete portion of the signal cycle during which the signal indications remain unchanged.
- **Offset:** The time difference (in seconds or in percent of the cycle length) between the start of the green indication at one intersection as related to the start of the green indication at another intersection or from the system time base (for signals on system).
- **Split:** The percentage of a cycle length allocated to each of the various phases in a signal sequence.

a. Cycle Length

The time required to complete a prescribed sequence of phases is known as the cycle length. For isolated, actuated intersections, cycle length varies from cycle to cycle based on traffic demand and signal timing parameters. For coordinated intersections, a background cycle length is used to achieve consistent operation between consecutive intersections. DelDOT typically uses a cycle length of 60 to 180 seconds. A shorter cycle length is typically used at low-volume rural intersections while a longer cycle length is typically used at intersections with heavy volumes on multiple approaches.

Selecting a cycle length is an iterative process that is initially performed during the second step of the critical movement summation (CMS) analysis (see **Appendix J**). CMS analysis focuses on “raw” intersection capacity, that is, the ability for an intersection to serve demand for given lane configurations and signal phasing. This analysis is a fundamental tool for calculating green times and evaluating signal phasing schemes because it identifies movements that are "critical" to the signal operations. Specifically, the results provide a baseline for determining signal timing parameters such as splits and cycle length.

According to ITE's *Traffic Signal Timing Manual*, "The amount of time in an hour is fixed, as is the fact that two vehicles (or a vehicle and a pedestrian) cannot safely occupy the same space at the same time. Critical movement analysis identifies the set of movements that cannot time concurrently and require the most time to serve demand." Additionally, CMS analysis incorporates the following basic assumptions for intersection geometrics and traffic flow:

- Lane widths and grades on the intersection approaches are "typical." No adjustments are made for specific widths or grades.
- Adjustments are not made for the specific composition of traffic. The proportion of trucks, motorcycles, bicycles, and buses do not affect analysis results.
- Pedestrians do not conflict with turning vehicles.
- Right-turning and left-turning vehicles discharge through the intersection at the same rate as through vehicles.
- Traffic does not equally distribute amongst multiple lanes on an approach.

Additional information regarding DelDOT's specific CMS procedures and guidelines can be found in **Appendix P** of the *DelDOT Standards and Regulations for Subdivision Streets and State Highway Access*.

b. Vehicle Clearance Interval

The vehicle clearance interval (or "change period") consists of a **yellow change interval** and a **red clearance interval** ("all-red time"). The function of the vehicle clearance interval is to warn traffic of an impending change in the right of way assignment and then provide time to safely allow conflicting movements to proceed. The engineer must take care not to use excessively long change intervals because of the loss in efficiency and capacity at the intersection. Similarly, if the clearance interval is too short, collisions may increase. The following two sections discuss the typical DelDOT methodology for calculating the yellow change interval and the red clearance interval. It should be noted that clearance intervals may be adjusted based on field conditions, crash problems, or if observed speeds along a corridor are found to differ from the vehicle speeds assumed in the calculations.

c. Yellow Change Interval

The yellow change interval is the interval following a steady green or flashing red arrow interval during which a steady yellow signal is displayed. The purpose of the yellow change interval is to warn traffic of an impending change in the right-of-way assignment. The DE MUTCD states that "the duration of the yellow change interval shall be determined using engineering practices." The Institute of Transportation Engineers (ITE) recommended method for calculating the yellow change interval is:

$$\boldsymbol{YCI = t + \frac{V}{2(a + Gg)}}$$

where:	YCI	=	yellow change interval (s)
	t	=	perception-reaction time (s)
	V	=	approach speed, (ft/s)
	a	=	deceleration rate (ft/s^2)
	G	=	gravitational acceleration (ft/s^2)
	g	=	approach grade (ft/ft)

Discussion of each of these variables is presented below:

Perception-Reaction Time (t)

A study of driver perception-reaction time was performed and incorporated into recommendations presented in *NCHRP Report 731*: "Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections." The results of the study showed that the average reaction time was 1.0 seconds and the 85th-percentile reaction time was 1.33 seconds, and recommends the use of 1.0 seconds. DelDOT has adopted a value of 1.2 seconds for all yellow change interval calculations, which is greater than the NCHRP Report 731 recommendation, but less than the 85th percentile.

Approach Speed (V)

The 85th-percentile approach speed is suggested as the conservative basis from which the yellow interval should be calculated. Because conducting speed studies at all signals is cumbersome, an accurate approximation of the 85th-percentile speed is required. *NCHRP Report 731* recommends using the posted speed limit on the approach to the signal plus a constant value of 7 mph. DelDOT has adopted this recommendation, which was determined through extensive field data collection for the report.

Deceleration Rate (a)

For stopping sight distance and other roadway calculations, DelDOT has adopted the AASHTO Green Book methodology for calculating deceleration rate, which recommends

11.2 ft/sec^2 as the comfortable deceleration rate. AASHTO Green Book noted studies that show most drivers decelerate at a rate greater than 14.8 ft/s^2 and 90 percent of all drivers decelerate at rates greater than 11.2 ft/s^2. These decelerations are within the driver's capability to stay within his or her lane and maintain steering control during the braking maneuver on wet surfaces. Studies conducted for *NCHRP Report 731* also found that this recommended value falls within the mean and 85th-percentile deceleration rates of actual drivers.

Gravitational Acceleration (G)

Acceleration due to gravity is a constant value of 32.2 ft/s^2.

Approach Grade (g)

Maximum approach downgrade *within the stopping sight distance* should be measured and included in the yellow change interval calculation. Any upgrade should not be included in the calculation. The stopping sight distance can be determined from **Table IV-12** below, taken from the Table 3-1 of the AASHTO Green Book.

Table IV-12
AASHTO Design Stopping Sight Distance

Posted Speed Limit (mph)	Stopping Sight Distance (ft)
25	155
30	200
35	250
40	305
45	360
50	425
55	495

Source: AASHTO – Geometric Design of Highways and Streets, 2004, page 112

Accounting for the recommended constants and converting the approach speed (V) in ft/s to posted speed limit (S) in mph yields the following equation:

$$\boldsymbol{YCI = 1.4 + \frac{1.47(S+7)}{22.4 + 64.4g}}$$

where:

YCI = yellow change interval (s)
S = posted speed limit (mph)
g = maximum approach downgrade (ft/ft)

Significant Figures and Rounding

When calculating the yellow change interval, the result is reported to two significant figures. The value implemented in the controller is rounded up to the next whole second. For example, if running the equation yields a calculation of 4.0488 – report to two significant figures (4.0), and no rounding is needed. If the equation yields a calculation of 4.0529 – report to two significant figures (4.1), and round up to the next whole second (5.0).

Left Turns and Split Phasing

Yellow change intervals for non-permissive left-turn movements should match the adjacent through movement on the same approach.

Other Requirements

Yellow change intervals for main-street movement pairs (phases 1, 2, 5, 6 as shown in **Figures IV-7 and IV-8**) should match in each direction. Side street movements may have different yellow change intervals. For example, if phase 2 required yellow is 4.0 seconds and phase 6 required yellow is 5.0 seconds, field-implemented yellow intervals should be 5.0 seconds for both phases 2 and 6 (typical main-street through movement phase numbers). If phase 4 required yellow is 3.0 seconds and phase 8 required yellow is 4.0 seconds, field-implemented yellow intervals can be 3.0 seconds for phase 4 and 4.0 seconds for phase 8. The maximum yellow change interval is 6.0 seconds.

d. Red Clearance Interval (All-Red)

The red clearance interval is the interval that follows that steady yellow interval during which a steady red signal is displayed to potentially conflicting traffic movements at an intersection. The purpose of the red clearance interval is to provide additional time before conflicting traffic movements are released. The DE MUTCD states that "when used, the duration of the red clearance interval shall be determined using engineering practices." The method selected by DelDOT for timing red clearance intervals at signalized intersections is the one described in the *ITE Journal* article "A Rational Method for Setting All-Red Clearance Intervals" (Fitch, et. Al; February 2011). The proposed method calculates how long a vehicle legally entering the intersection at the end of the yellow change interval takes to clear the farthest conflict point with a conflicting vehicle legally entering the intersection at the beginning of the next green interval. The calculation can be summarized as follows:

$$RCI = t_c - t_{min}$$

where: RCI = red clearance interval (s)
t_c = maximum clearance time (s)
t_{min} = minimum conflicting time (s)

To complete the calculation, a "worst-case" conflict point must be identified for each movement. A conflict point is any point where the clearing vehicle's path is crossed by the path of a conflicting movement. The "worst-case" conflict point, therefore, is the farthest conflict point from the stop bar along the driving path of the clearing vehicle. **Figure IV-9** below depicts the "worst-case" conflict points for the through and left-turn movements at an example intersection.

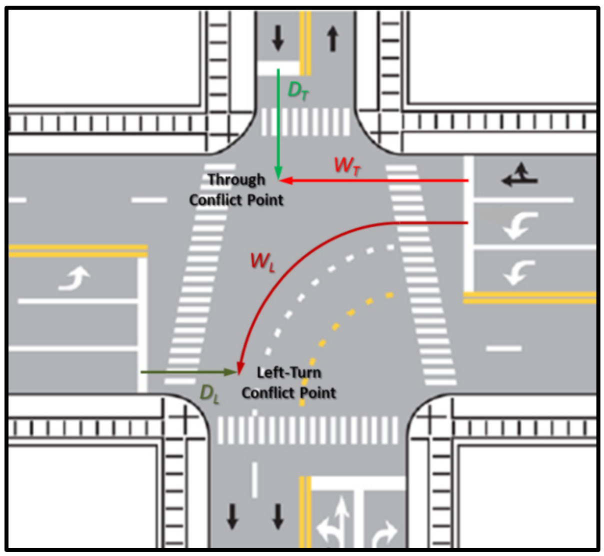


Figure IV-9. Intersection Conflict Points

Maximum Clearance Time (t_c)

A reasonable expectation for a signal timing policy is to account for drivers who enter the intersection on the last instant of the yellow indication, because such behavior is both legal and commonly observed. The "worst-case" scenario is therefore presented by a vehicle entering the intersection on the last moment of yellow change and traveling at the low end of the speed distribution, because a slow vehicle will occupy the intersection longer than a faster one. The 10th-percentile speed is recommended. The 10th-percentile speed can be estimated by subtracting a differential speed value from the 85th-percentile speed, which is estimated as the posted speed limit plus 7 mph (see yellow change interval calculation) per *NCHRP Report 731*. The *ITE Journal* recommends subtracting 10 mph from the 85th-percentile speed for speeds 45 MPH and below and subtracting 15 mph for speeds above 45 mph, with a floor of 30 mph. **Table IV-13** below summarizes the estimated 10th-percentile speeds for each posted speed limit.

Table IV-13
10th Percentile Speed Estimate

Posted Speed Limit (mph)	10th Percentile Speed (mph)
25	25
30	30
35	32
40	32
45	37
50	42
55	47

Based on this estimate, the maximum clearance time is:

$$t_c = \frac{W}{1.47 \times S_{10}}$$

where:
t_c = maximum clearance time (s)
W = clearing width, stop line to conflict point (ft)
S_{10} = 10th percentile speed (mph)

This time represents the latest time, following the end of the clearing phase's yellow, that a vehicle on that phase could be reasonably expected to occupy the conflict point.

Minimum Conflicting Time (t_{min})

A reasonable expectation for drivers seeing a red indication change to green is that they will simply accelerate into the intersection if no traffic is obviously in conflict. The critical "worst-case" combination scenario is observed when a vehicle approaches an intersection without coming to a complete stop as a red indication changes to green. If no other vehicle is stopped at the intersection as an impediment, then a realistic expectation is that the driver of this vehicle should be decelerating at a rate that would allow a stop at the stop bar for the red (because the driver cannot know when a green indication will be displayed) but, upon seeing the green, will accelerate at a comfortable rate. This vehicle will exhibit a "rolling start" and will cross paths with traffic clearing the intersection sooner in time than if it had started from a complete stop at the intersection stop bar. While deceleration and acceleration rates can vary greatly, *ITE Journal* (Fitch, et. al) made a conservative assumption of -10 ft/s^2 deceleration and

15 ft/s^2 acceleration, which has been adopted by DelDOT. The minimum conflicting time calculation thus simplifies to:

$$t_{min} = 0.283\sqrt{D}$$

where: t_{min} = minimum conflicting time (s)
D = conflicting distance, stop line to conflict point (ft)

This time represents the minimum amount of time, following a new green light, for a driver to accelerate (at 15 ft/s^2) to a conflict point D feet beyond the stop bar, assuming that the driver had been decelerating at a rate (-10 ft/sec^2) that would have resulted in a safe stop at the stop bar.

Left Turns and Split Phasing

Red clearance intervals for non-permissive left-turn movements shall be calculated in the same manner as each through movement – determining a worst-case conflict point and measuring the two conflicting distances (*W* and *D*). The only change is the estimated 10th-percentile speed (S_{10}) used in the equation to calculate t_c is 15 mph as suggested in the *ITE Journal* article.

Minimum Red Clearance Interval

Due to a long historical precedent in Delaware of using 2.0 second all-red clearance intervals, and driver expectation of this standard value, DelDOT recommends a minimum red clearance interval of 2.0 seconds for all signalized movements.

Significant Figures and Rounding

When calculating the red clearance interval, the result is reported to two significant figures. The value implemented in the controller is rounded up to the next whole second. For example, if running the equation yields a calculation of 2.0497 – report to two significant figures (2.0), and no rounding is needed. If the equation yields a calculation of 2.0513 – report to two significant figures (2.1), and round up to the next whole second (3.0).

Other Requirements

Red clearance intervals for main-street movement pairs (phases 1, 2, 5, 6 as shown in **Figures IV-7 and IV-8**) shall match in each direction. Side street movements may have different red clearance intervals. For example, if phase 2 required all-red is 2.0 seconds and phase 6 required all-red is 3.0 seconds, field-implemented all-red intervals shall be 3.0 seconds for both phases 2 and 6 (typical main-street through movement phase numbers). If phase 4 required all-red is 2.0 seconds and phase 8 required all-red is 3.0 seconds, field-implemented all-red intervals can be 2.0 seconds for phase 4 and 3.0 seconds for phase 8.

3. Phasing

The DE MUTCD defines a signal phase as the right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of traffic movements. Signal phasing is the sequence of individual signal phases or combinations of signal phases within a cycle that define the order in which various pedestrian and vehicular movements are assigned the right of way. This section of the DelDOT Traffic Design Manual includes descriptions of the different possible phasing options and provides general guidance on selecting appropriate phasing. Refer to the DE MUTCD for additional rules for determining controller phasing, selecting allowable signal indication combinations for displays on an approach to a traffic control signal, and determining the order in which signal indications can be displayed.

a. NEMA Phasing

Signal phasing at most intersections in Delaware should use the standard National Electrical Manufacturers Association (NEMA) ring-and-barrier structure. This structure organizes phases to prohibit conflicting movements (e.g., eastbound and southbound through movements) from operating concurrently while allowing nonconflicting movements (e.g., northbound and southbound through movements) to operate together. In the phasing diagram, phases associated with dashed lines are compatible and may operate concurrently. Phases associated with solid lines are conflicting and will not operate concurrently.

If the side street phasing is split, the side streets use Phases 3 and 4 only. If the side streets run concurrently, phase 4 and 8 shall be utilized. At a "T" intersection, the side street is typically Phase 4.

The NEMA phasing diagram was presented earlier in this Manual as **Figure IV-7** in Chapter IV-D.5.

While the standard NEMA ring-and-barrier structure allows most of the signal phasing patterns in use in the State of Delaware to be achieved, there are some special cases where an alternative structure may be used, such as for five-leg intersections and some lead-lag operations.

b. Selecting Appropriate Phasing

The simplest form of phasing is a two-phase sequence in which NEMA Phases 2 and 6 run concurrently to allocate the right of way to the main street followed by NEMA Phases 4 and 8 running concurrently to transfer the right of way to the cross street. In this two-phase sequence, the major cross (through) movements are separated, but the left-turn movements must yield to opposing traffic, turning only when there is an adequate gap in traffic.

In determining the number of phases required at an intersection, the goals of safety and capacity may conflict. For example, in many situations, protected left-turn phases are safer for left-turning vehicles than protected-permitted left turns. However, the added phases may result in longer cycle lengths, reduced progression in systems, and increased delay and percent of vehicles stopped. These factors adversely impact traffic performance, capacity, and fuel consumption, and may tend to reduce safety for all traffic.

The following **general rules for acceptable intersection phasing** should be followed:

- The Main Street through movement should be phase 2 for North or East, and phase 6 for South or West.
- The Main Street left-turn movement should be phase 5 for North or East, and phase 1 for South or West.
- Side Street through movements should be phase 4 and phase 8.
- Side Street left-turn movements should be phase 3 and phase 7.
- For Split Phasing, the lower volume cross street approach should be phase 3 and the higher volume cross street approach should be phase 4.

c. Left Turn Treatment

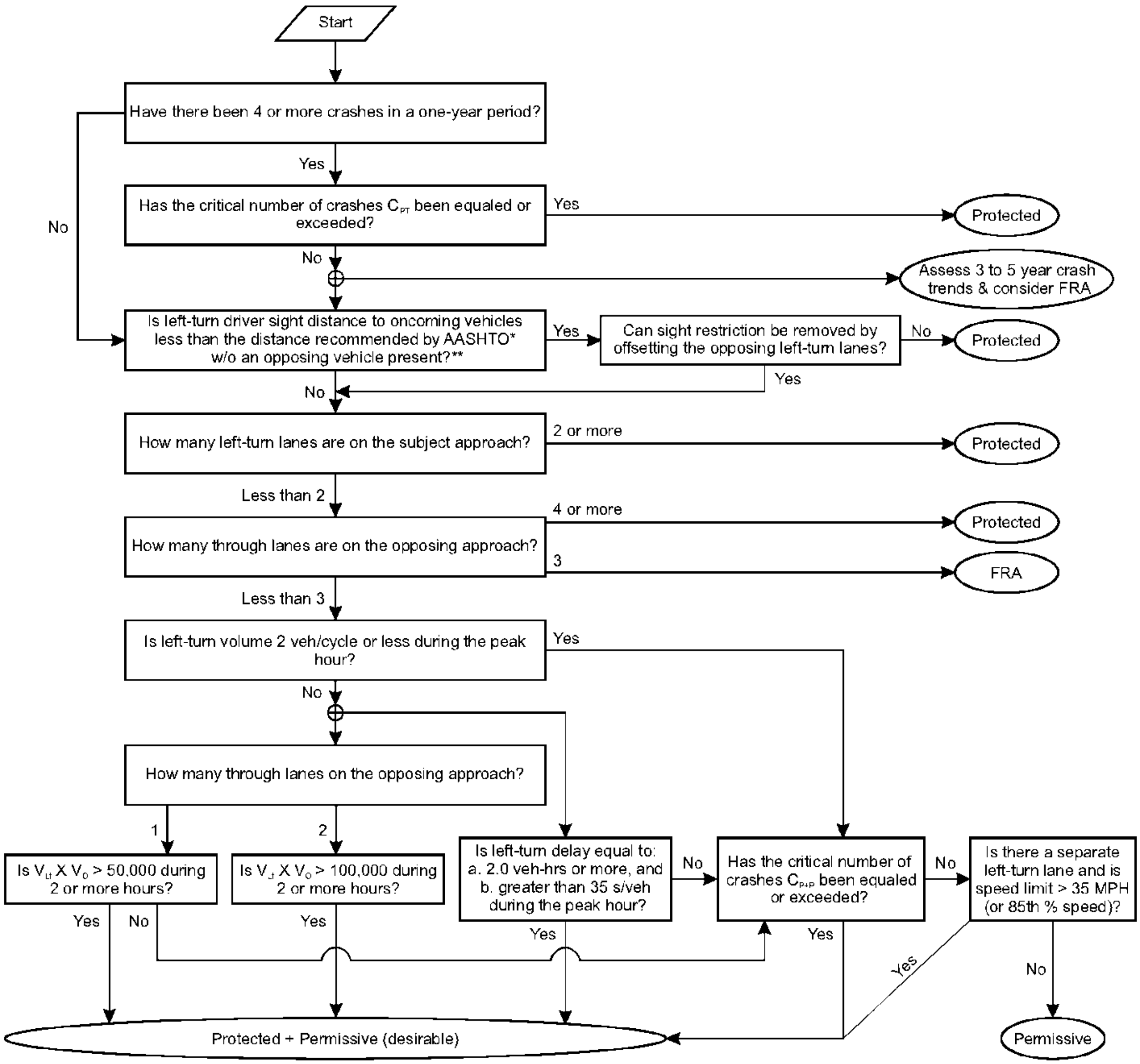
An important consideration in developing an appropriate signal phasing plan is determining the left-turn phase type at the intersection. The most basic form of control for a four-legged intersection is "permissive only" control, which allows drivers to make left turns after yielding to conflicting traffic or pedestrians, and provides no special protected interval for left turns. However, for most high-volume intersections, "permissive-only" left-turn phasing is generally not practical for the major street movements. Therefore, some type of "exclusive" (protected) control is typically provided once volumes or number of crashes at the intersection exceed minimum levels. The various types of left turn treatments and the guidelines for selecting them are presented in the following section.

1.) Separate Left-Turn Lanes

Before considering the implementation of an exclusive left-turn phase, the designer should first consider the benefits of providing a separate left-turn lane while maintaining "permissive only" phasing. In most cases, intersections considered for signalization in Delaware should have at least two lanes on each approach, including separate left-turn lanes on the mainline. The lane configuration for the side street approaches can vary, but typically at least two lanes should be provided.

2.) Left-Turn Phasing

The type of left-turn phasing operation chosen for a signalized intersection is one of the most critical traffic signal design and operational issues considered. There is typically a trade-off between safety and efficiency in this decision. **Figure IV-10**, which DelDOT adapted from FHWA's Signal Timing Manual, provides guidelines for determining the appropriate left turn treatment. The list on the pages following **Figure IV-10**, in generic terms, is in order of least delay/least restrictive to most delay/most restrictive for left-turning traffic. Historically, DelDOT has rarely, if ever, converted from a "more restrictive" to a "less restrictive" option, even with numerous public requests or complaints. Note that for any traffic movement with any type of signal operation, drivers are required to cautiously enter the intersection, and must yield to other vehicles and pedestrians who are lawfully within the intersection.



*AASHTO, <u>A Policy on Geometric Design of Highways and Streets</u>, 2011 (or current). Chapter 9, 9.5.3 Intersection Control, Case F - Left Turn From the Major Road. Calculated based on Equation 9-1 and Table 9-13, adjusted for number of lanes, as needed.

**If left-turn driver sight distance is temporarily obstructed by an opposing left-turning vehicle and consequently temporarily less than AASHTO recommendations, consideration should be given to the obstruction's frequency and the potential for and severity of crashes (e.g., consider opposing left turn phasing, opposing through speeds and volumes).

<u>Variables:</u>
V_{LT} = left-turn volume on the subject approach, veh/h
V_O = through plus right-turn volume on the appoach opposing the subject left-turn movement, veh/h

<u>Source:</u>
Adapted from FHWA's <u>Signal Timing Manual</u>

Number of Left-turn Movements on Subject Road	Period During Which Crashes are Considered (years)	Critical Left-Turn-Related Crash Count: When Considering Protected-only, C_{pt} (crashes/period)	Critical Left-Turn-Related Crash Count: When Considering Prot.+Perm., C_{p+p} (crashes/period)
One	1	6	4
One	2	11	6
One	3	14	7
Both	1	11	6
Both	2	18	9
Both	3	26	13

Figure IV-10. Guidelines for Determining Left-Turn Lane Signal Phasing Treatment

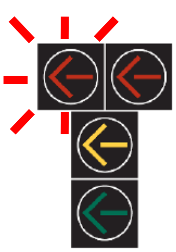
Permissive

This type of operation never provides a separate left-turn arrow. Drivers turn left on a green ball, when they can find a gap in opposing traffic. This type of operation is often used on relatively low volume side streets, and sometimes in urban areas with relatively low speeds and low left-turning volumes. Specifically, permissive left-turn phasing for DelDOT's signals should only be used when there is a single left turn lane that is opposed by one (1) or two (2) through lanes. Permissive left-turn phasing should also only be implemented if the sight distance to oncoming traffic is longer than the minimum distances recommended by AASHTO (see **Figure IV-10**). As left-turning volumes increase, permitted phasing operation becomes potentially less safe and less efficient than other options noted below. **Figure IV-10** provides specific volume and crash thresholds above which permissive-only phasing should not be used.

Protected-Permissive

This type of operation is typically implemented in Delaware with the "doghouse" signal head. Normally a left-turn green arrow is displayed first (protected part of phase), followed by a yellow left-turn arrow, and finally a green ball (permitted part of phase). It is generally viewed that this type of operation is more efficient (less delay) than protected-only, but also potentially less safe, because a driver has to make a decision about selecting an adequate gap in opposing traffic. Protected-Permissive phasing for DelDOT's signals should only be used when there is a single left turn lane that is opposed by one (1) or two (2) through lanes. Protected-permissive left-turn phasing should also only be implemented if the sight distance to oncoming traffic is longer than the minimum distances recommended by AASHTO (see **Figure IV-10**). **Figure IV-10** provides specific volume and crash thresholds, one or more of which should be met to implement protected-permissive phasing.

Special Protected-Permitted (Flashing Red Arrow)



Protected-permitted operation with a flashing red arrow has been implemented at some signalized intersections in Delaware. Normally, a left-turn green arrow is displayed first (the protected phase), followed by a yellow arrow, then a red ball or red arrow, and finally a flashing red arrow (the permitted phase). Legally, drivers are required to completely stop and then proceed during the flashing red arrow interval. DelDOT can adjust the amount of time of the solid red arrow/ball based on the conditions at the intersection. This type of left-turn operation generally falls somewhere between protected-permissive and protected-only phasing with respect to both efficiency and safety. Flashing red arrow phasing for DelDOT's signals should only be considered where permissive or protected-permissive phasing has resulted in four (4) or more crashes in a one-year period but the critical number of crashes shown in **Figure IV-10** has not been equaled or exceeded. Alternately, flashing red arrows may also be considered for single left-turn lanes that are opposed by 3 lanes if the sight distance to oncoming traffic is longer than the minimum distances recommended by AASHTO. For additional information on flashing red arrows in Delaware, refer to Chapter IV-E.3.c.5 of this Manual.

Protected-Only

This type of operation presents the driver with a green arrow, then a yellow arrow, and finally a red arrow. The driver does not need to make a decision about gaps. It is generally agreed that this type of operation is safer than protected-permitted, but is also less efficient (more delay). Naming this type of operation the “safest” is not an absolute statement. Although the chances of left-turning crashes is significantly reduced, the potential for rear-end crashes is increased, particularly if traffic backs up beyond the turn lane(s) on a regular basis. This type of left-turn operation is often implemented on divided highways with both heavy left-turning and opposing through traffic, used whenever there are dual left-turn lanes, and often implemented where there are a significant number of left-turn crashes. Opposing vehicle speeds, sight distance restrictions, and motorist expectancy are additional criteria that should be taken into consideration when evaluating the need for protected-only operations, according to the guidelines presented in **Figure IV-10**.

Split Phasing

This is a form of protected-only operation where all movements on an approach get green, yellow, and red indications at the same time with no opposing traffic. This type of operation is occasionally used on side streets with shared left/through lanes and relatively heavy left-turn volumes. Depending on the number/type of lanes and traffic volumes, this type of operation may be relatively safe and efficient for side street movements, but often requires additional time which must be taken away from main street movements. For more information, refer to Chapter IV-E.3.d of this Manual.

3.) Lead / Lag Lefts

There are two primary alternatives for the timing of a protected-only left-turn phase in a cycle sequence. When the protected-only left-turn phase precedes the through movement in the same direction, it is called “lead” left. When the protected-only left-turn phase follows the through movement in the same direction, it is called “lag” left. While used on an infrequent basis in Delaware, lag lefts can be combined with a lead left in the opposing direction. This sequence is commonly called “lead-lag” phase sequencing. While these difference left turn sequences have advantages and disadvantages, the most common practice in Delaware is to provide lead left-turn phases on all approaches.

In a small number of situations, a lag left-turn phase may be beneficial. These include:

- Where both opposing left-turn lanes are protected-only and there are left turn storage bay issues, particularly where the left-turn lane may be frequently blocked by queues in the through lanes.
- Where both opposing left-turn lanes are protected-only and a lag left turn benefits bandwidth
- Where there are no left turn lanes and a relatively even number of left turns in both directions.

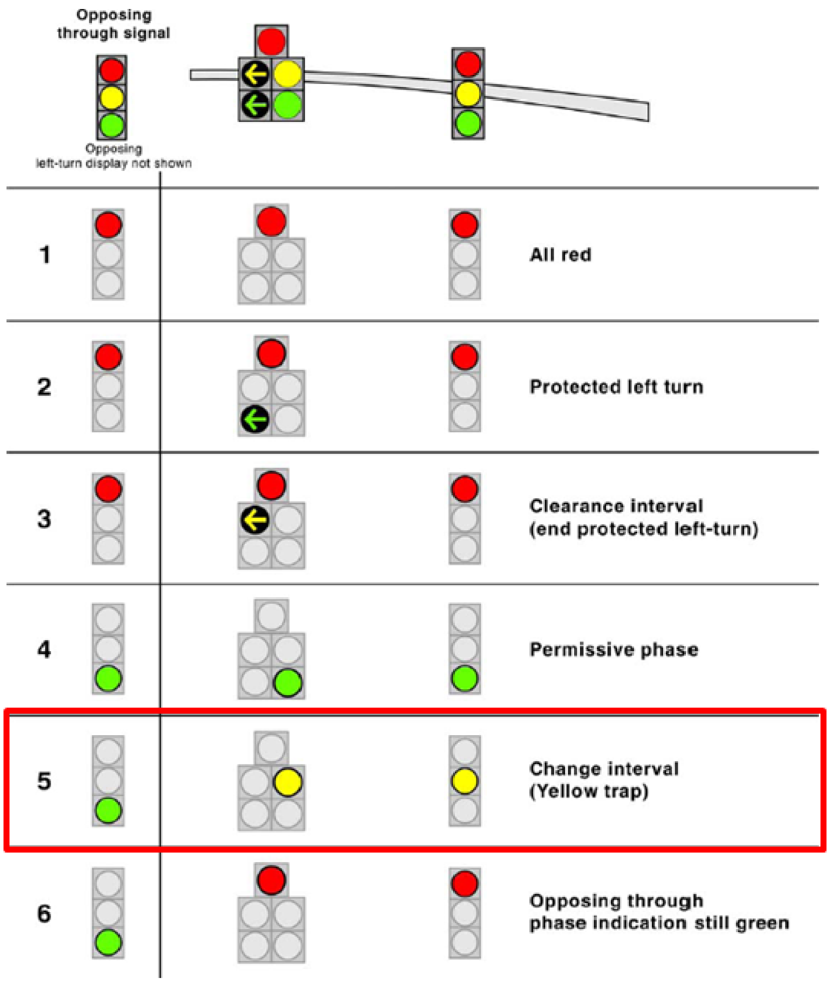
While lag left turn phasing may improve operations, care should be taken to avoid the “left-turn trap”, as discussed in the following section.

4.) Yellow (Left-Turn) Trap

The combination of a permissive left-turn phase and an opposing lag phase can lead to a situation commonly referred to as the “yellow trap.” As shown in **Figure IV-11** on the following page.

If this scenario is permitted, a left-turning vehicle, present at the end of the through phase (i.e., still awaiting a gap when the “yellow ball” is displayed), may incorrectly presume that the opposing through phase also is ending. When the signal turns red, the left-turning vehicle may get “trapped” in the intersection or attempt to complete the turn into oncoming traffic.

To mitigate the yellow trap phenomenon either created by a preset signal sequence (e.g., lead/lag protected/permissive left-turn phasing) or by unique cycle-by-cycle traffic characteristics, such as low side-street demand or emergency vehicle preemption, DelDOT has developed yellow trap guidelines for over 20 scenarios (see **Appendix Q**). Based on these guidelines, DelDOT’s most common yellow trap countermeasure is to program a protected/permissive controller with a special sequence to omit left-turn calls during the adjacent through phase; however, there are also warning sign options per Sections 2C.48 and 4D.05 of the DE MUTCD.



Source: FHWA's Signalized Intersection Guide

Figure IV-11. Yellow Trap with Protected/Permissive Left-Turn Phasing

5.) Flashing Red Arrow

DelDOT is one of the few agencies in the country that utilizes a flashing red arrow. Although this phasing operation is somewhat unusual, it has proven to be both relatively safe and efficient at many locations. In 2008, DelDOT formally reviewed the safety and operational characteristics of all flashing red arrow intersections in Delaware. Some locations have been modified to protected-only operations due to moderate crash issues or concerns about intersection sight distances. An updated evaluation of all locations has been conducted twice since 2008, and will be conducted again in 2014. New flashing red arrow locations have not been installed in Delaware for at least 10 years. This was due to a concern that federal guidelines would eliminate this type of operation as an option. Recent federal guidelines still allow the flashing red arrow operation, although the exact manner in which it is required to operate has changed. For additional information regarding signal indications for permissive mode left turns, including flashing red arrows, refer to Section 4D.18 of the DE MUTCD.

Given the relatively successful use of flashing red arrows in Delaware, DelDOT intends to ensure that all existing locations will remain compliant with revised federal guidelines and may install them at additional intersections after careful consideration. It is anticipated that most future flashing red arrow installations will be at a locations that were operating with protected-permitted left-turn phasing, but experienced a moderate crash problem. Rather than applying the traditional solution of converting to protected-only operations, DelDOT may first consider the use of flashing red arrows. The Designer should review the guidelines for determining left turn lane signal phasing treatments (see **Figure IV-10**) and subsequently check with the Chief Traffic Engineer before initiating any designs that include use of flashing red arrows. For additional discussion regarding the use of flashing red arrow compared to other left-turn phasing treatments, refer to Chapter IV-E.3.c.2 of this Manual.

6.) Flashing Yellow Arrow

Flashing yellow arrow is not currently used in Delaware as a left turn treatment.

7.) Other

Refer to the current version of the DE MUTCD, Section 4D.17, for guidance on additional acceptable left-turn treatments that could be considered.

d. Split Phasing

Split phasing consists of having two opposing approaches to run consecutively rather than concurrently (i.e., all movements originating from the west followed by all movements originating from the east). **Split phasing should be used infrequently, because a more-efficient conventional phasing plan can usually be found.** However, the following conditions could indicate that split phasing might be an appropriate design choice:

- There is a need to accommodate multiple turn lanes on an approach, but sufficient width is not available to provide separate lanes. Therefore, a shared through/left lane is required. An operational analysis should be performed to ensure this option is superior compared to a single turn lane option under various phasing scenarios.

- The left-turn lane volumes on two opposing approaches are approximately equal to the through traffic lane volumes on the same approach but the total approach volumes are significantly different on the two approaches. Under these somewhat unusual conditions, split phasing may prove to be more efficient than conventional phasing.
- A pair of opposing approaches is physically offset such that the opposing left turns could not proceed simultaneously or a permissive left turn could not be expected to yield to the opposing through movement.
- The angle of the intersection is such that the paths of opposing left turns would not be forgiving of errant behavior by turning motorists.
- The safety experience indicates an unusual number of crashes (usually sideswipes or head-on collisions) involving opposing left turns. This may be a result of unusual geometric conditions that impede visibility of opposing traffic.
- A pair of opposing approaches each has only a single lane available to accommodate all movements and the left turns are heavy enough to require a protected phase.
- One of the two opposing approaches has heavy demand and the other has minimal demand. Under this condition, the signal phase for the minimal approach would be skipped frequently and the heavy approach would function essentially as the stem of a "T" intersection. For this condition, it is important that the signal be designed with actuation on the minor volume approach and the controller be programmed to skip the phase entirely if no vehicles are present.

For additional discussion regarding the use of split phasing compared to other left-turn phasing treatments, refer to Chapter IV-E.3.c.2 of this Manual.

4. Types of Control

Traffic control signals operate in either pre-timed or actuated mode. Pre-timed signals operate with fixed cycle lengths and green splits. Actuated signals vary the amount of green time allocated to each phase based on traffic demand. Either type may be used in uncoordinated (isolated) or coordinated operation (see Chapter IV-E.5 of this Manual). There is no universal "best" method of determining the optimum type of control for a given local intersection. Each type of control has its unique advantages and disadvantages.

- Pre-timed controls may feature multiple timing plans, with different cycle, split, and offset values for different periods of the day. The timing plans are generally established based on historic and/or anticipated traffic demand, and the signal splits and cycle lengths do not change as a result of real-time traffic flow. When used in a system, adjacent intersections operate on the same signal cycle and have fixed controller offsets. Because pre-timed control does not recognize or accommodate short-term fluctuations in traffic demand, it can cause excessive delay to vehicles and pedestrians where there exists a high degree of variability in the traffic flows. DelDOT rarely installs or operates signals with pre-timed control. Rather, pre-timed control is typically applied in urban grid networks, and/or in locations where grid coordination is desired.

- Actuated control provides variable lengths of green timing for phases. The time for each movement depends on the characteristics of the intersection and timing parameters. Actuated control does not rely on a fixed cycle length unless the intersection is in a coordinated system or under adaptive control. This type of control assigns the right of way on the basis of actual traffic conditions (demand) within given limitations.

1) **Fully-actuated** ("system free") control requires detectors for all phases, with each phase timed according to preset timing parameters.

   In a full-actuated application, the controller unit operates on continuously variable cycle lengths. All phase the number of vehicles detected on the various controlled approaches determines green times. Full-actuated operation is generally used when the intersection operates independently and where demands on all approaches vary throughout the day.

2) **Actuated-coordinated** control requires detectors on the minor-street approach and main street left lanes, and is especially effective in systems and at intersections where the major street has a relatively uniform flow and the minor street has low volumes with random peaks.

   The non-actuated phase is the phase that is coordinated with adjacent intersections, whereas actuated phases are allowed to respond to detected demand.

   The actuated-coordinated control application, one phase (usually the major street) operates in the non-actuated mode. Vehicular and/or pedestrian detection is required on the phase(s) that is actuated. This type of operation is often used where the controller is incorporated into a coordinated system. The non-actuated phase is the phase that is coordinated with adjacent intersections, whereas actuated phases are allowed to respond to detected demand.

a. Selection Considerations

From a signal timing perspective, selecting the best type of control for a location requires full knowledge of local conditions, but, in general, can be based on:

- Variations in peak and average hourly traffic volumes on the major approaches.
- Variations in morning and afternoon hourly volumes.
- Percentage of volumes on the minor approaches.
- Usage by large vehicles, pedestrians, and bicycles.

1.) Volume Characteristics

The volume of vehicle traffic on the minor approaches will frequently indicate the type of control needed. For example, if traffic on the minor approach arrives at the intersection in low volumes and/or with random arrival patterns at a steady rate for most hours of the day, but the mainline volume is typically more uniform, semi-actuated pre-timed control usually operates effectively.

In general practice, the rule of thumb is: for predictable traffic, use semi-actuated; for unpredictable traffic, use fully actuated control. Another form of this general rule can be stated in terms of the warrant satisfied. The minimum vehicular warrant (Warrant 1) requires a steady volume for 8 hours on the minor approach, thus suggesting semi-actuated control. Interruption of continuous traffic (Warrant 2) usually involves the sporadic arrival of traffic on the minor approaches, thus indicating fully actuated control.

2.) Other Characteristics

In addition to the volume consideration discussed above, other factors may exert an influence on this determination. Specifically, if the intersection is part of a traffic control system, the type of control selected must be compatible with the system. Maintenance capabilities may also influence the selection in that the more advanced control hardware requires a much higher level of maintenance expertise.

b. Elements of Control

1.) Pre-timed Control

There are several fundamental aspects of developing timing settings for signal control. The essential elements include:

- Number of timing plans
- Phase change intervals (yellow change plus all-red clearance)

- Pedestrian timing requirements (including decision whether or not to use pedestrian indications)
- Cycle length calculations
- Split calculations
- Flashing operation

To function effectively, signal operations must take into account a number of local intersection variables and hardware characteristics. It is difficult to set forth-comprehensive guidelines to fit all possible situations. In many situations, it is desirable to monitor the initial operations and adjust the timing settings to reflect the unique character of the intersection and traffic flow. The following discussion is intended to provide a conventional approach to establishing initial timing settings and reasonable ranges of values for the various parameters.

"Time-of-Day" Signal Timing Plans

A timing plan may be defined as a unique combination of cycle length (commonly ranging from 60 to 180 seconds), split, and, in system operations, offset. Most controllers today have the capability of numerous timing plans. Timing plans may differ by phase length, cycle length offset, phase arrangement, or any combination thereof.

Traffic demand at the intersection is the critical determinant of the number of timing plans required. For example, for a two-phase intersection that is heavily loaded on one phase during the morning peak, heavily loaded on the opposite phase during the evening peak, and lightly loaded on both phases during the remainder of the day, it is obvious that three plans would be required. Traffic demand patterns typical of a majority of locations may be categorized as:

- A.M. peak period
- Average day (midday) period
- P.M. peak period
- Night (low-flow) period
- Weekend or special function periods

DelDOT's time-of-day patterns (i.e., "coordination data") are typically programmed in the TMC's signal system database and operate based on a time-based coordination (TBC) schedule. Each individual signal pattern should be generated using CMS analysis and the time-based data should be developed using hourly and diurnal traffic volume data, which is typically available via Traffic's signal system detection or Planning's automatic traffic recorders.

The most common method for implementing signal timing patterns is through time-of-day and day-of-week schedules, which change timing patterns at specific, predetermined time periods (e.g., AM, mid-day, and PM peak periods). When traffic conditions vary significantly within these time periods, or when traffic is inconsistent on a day-to-day basis, time-of-day schedules are not as effective in reducing delays and queues. Traffic responsive operation is an alternative to time-of-day control, which uses vehicle detection to monitor real-time traffic conditions – volume (or headways) and density (or spacing) – to select a timing pattern that is best suited for the current traffic conditions.

Traffic responsive systems use system detectors to monitor and control the signal system. The system detectors are capable of categorizing data based on the following functions:

- Congestion level – cycle length selection
- Major versus minor-street demand – split selection
- Arterial travel direction (inbound, outbound) – offset selection

Real-time traffic data is collected by system detectors, analyzed, and then compared to predefined data profiles for timing patterns with unique cycle lengths, splits, and offsets. When a profile match is identified, the corresponding timing pattern is implemented.

Because traffic responsive systems are only capable of selecting timing parameters not modifying them, this type of operation still requires transportation professionals to determine timing patterns and develop a "library" that is best suited for varying traffic conditions.

There is a transition period along a signal system when timing plans change, and coordination is temporarily interrupted as the cycle length and/or offsets are adjusted. Therefore, the "sensitivity" of a traffic responsive system should be considered when developing a selection matrix to avoid frequently changing timing plans.

2.) Basic Timing Parameters

Minimum Green Interval

The minimum green interval is the shortest time a called phase can receive a green indication. For main-street through phases, DelDOT typically utilizes a 10-second or 15-second minimum green time. For all other phases, a 5-second minimum green interval is often used.

Passage Time

The green time for an actuated phase can be extended via the passage interval (or extension/gap). For left-turn phases, DelDOT has generally standardized on 3-second passage times. Split side-street phases and all through phases typically utilize a 4-second passage interval.

Maximum Green Interval

The maximum green interval is the longest time a called phase can receive a green indication. For main-street through phases, DelDOT typically operates with a 60-second maximum green time. For side-street through or split phases, DelDOT typically defaults to a 30-second maximum green time and a 20-second maximum green interval is often used for left-turn phases. It should be noted that the maximum green interval may get overridden by system data when the signal operates as part of a coordinated system.

c. Controllers

DelDOT has standardized with NEMA-structured, dual-ring controllers that must be compatible with the current signal system at DelDOT's TMC.

Dual-ring controller unit: A controller unit containing two interlocking rings that are arranged to time in a preferred sequence and to allow concurrent timing of both rings, subject to the restraint of the barrier (compatibility line). The phases within the two timing rings shall be numbered as illustrated in **Figure IV-12**. It should be noted that DelDOT's typical signal controllers allow additional phases to be added, if needed, for special circumstances.

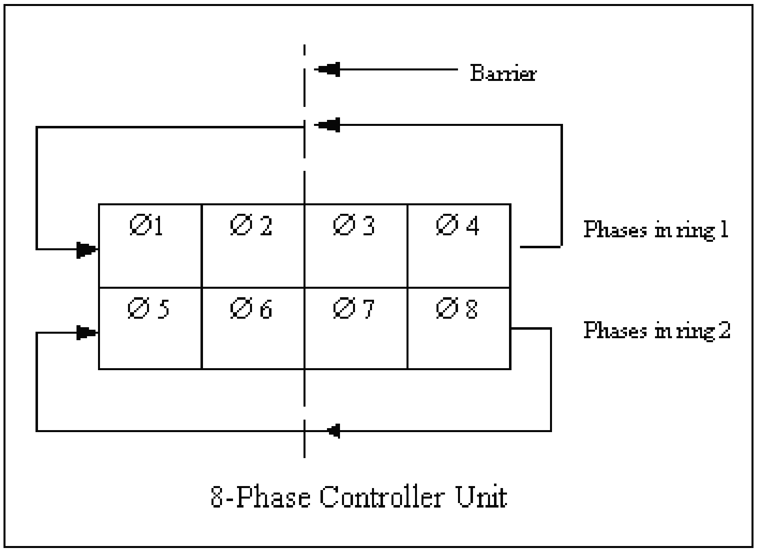


Figure IV-12. Sequence of Phases for Dual-Ring 8-Phase Controller Unit

Barrier (compatibility line): The Barrier is a reference point in the preferred sequence of a dual-ring controller unit at which both rings are interlocked. Current NEMA equipment has more than two barrier capability with two barriers as the NEMA standard. Two reference points or barriers assure that there will be no concurrent selection and timing of conflicting phases for traffic movement in different rings, as illustrated in Figure IV-12. Both rings cross the barrier simultaneously to select and time phases on the other side.

Dual entry: A mode of operation (in a dual-ring controller unit) in which one phase in each ring must be in service. If a call does not exist in a ring when it crosses the barrier, a phase is selected in that ring to be activated by the controller unit in a predetermined manner. For example, referring to **Figure IV-12**, in the absence of calls on Phases 7 and 8, Phase 2 and Phase 6 terminate to service a call on Phase 3. Programming determines whether Phase 7 or Phase 8 will be selected and timed concurrent with Phase 3. DelDOT's current best practice is to operate Phases 2, 4, 6, and 8 with dual entry at "8-phase" (concurrent) intersections.

5. System Compatibility

a. Uncoordinated Signals

This is a form of signal control in which an individual signalized intersection has neither control relationships between intersections nor any data flow between intersections. The individual isolated intersection may have local actuated control or Time of Day/Day of Week changes based on historical traffic flows. This category has also been called isolated signal control and totally isolated systems.

b. Coordinated Signals

The potential benefits to be derived from coordinated operation of two or more signalized intersections are directly related to the platoon arrival characteristics at the downstream intersection. If approaching vehicles arrive at the stop bar as a well-defined compact platoon, coordinated operation can provide a significant reduction in stops and delays. The DE MUTCD suggests that signals spaced less than 1/2 mile apart should be coordinated because the cohesion of the platoon can be maintained for this distance.

The question of whether or not to coordinate a series of intersections is a complex decision. The prime objective is to assemble those intersections requiring similar timing strategies (i.e., cycle lengths and traffic flow patterns) into groups of reasonable size. The factors that need to be considered include:

- **Geographic relationship:** Distance between intersections; natural and artificial boundaries such as rivers and controlled-access facilities should be considered. Generally, signals within ½ mile of one another along a major route should be coordinated.
- **Storage:** The storage length between intersections is a very critical factor in the decision to interconnect traffic control signals. Closely spaced intersections should always be coordinated unless an engineering study recommends otherwise. In cases where queues extend from one intersection to another, signal coordination should be provided.
- **Volume levels:** The larger the mainline volume, the greater the need for coordination between signals.
- **Traffic flow characteristics:** If traffic arrivals are uniform throughout the cycle, the red portion of the cycle would produce the same stops and delays regardless of its position. On the contrary, platooned arrival enhances the benefits of coordination. When systems operating on different cycle lengths are adjacent to or intersect each other, changes to provide a uniform cycle length appropriate for both systems should be considered, so that the systems can be unified, at least for certain portions of the day. Half-cycles or double cycles should also be considered for some locations if that facilitates coordination.
- **Permissive Left Turns and Safety:** Drivers may have difficulty making permissive turning maneuvers at signalized intersections (e.g., permissive left turns, right turn on red after stop) because of lack of gaps in through traffic. This can contribute to both operational and safety problems. Left-turning vehicles waiting to turn can block through traffic, even if a left-turn lane is provided. This can lead to rear-end crashes between turning and through vehicles. Collisions may also

occur when left-turning drivers become impatient and accept a gap that is smaller than needed to complete a safe maneuver. Such collisions could be minimized if longer gaps were made available.

One method of providing longer gaps is to coordinate adjacent traffic control signals to promote platooning of vehicles. Signal progression can help improve driver expectancy of changes in right-of-way assignment due to signal changes. Increased platooning of vehicles can create more defined gaps of increased length for permissive vehicle movements at intersections and can result in improved intersection operation. Increased platooning of vehicles may also result in a decrease in rear-end crashes. Effective coordination of signals should reduce the required number of stops for the higher priority movements (presumably the major street through movement).

Table IV-14 below summarizes the issues associated with providing signal coordination.

Table IV-14
Summary of Issues for Providing Signal Coordination

Characteristic	Potential benefits	Potential Liabilities
Safety	Fewer rear-end and left-turn collisions.	May promote higher speeds
Operations	Improves traffic flow.	Usually longer cycle lengths.
Multimodal	May reduce pedestrian-vehicle conflicts.	May result in longer pedestrian delays due to longer cycle lengths.
Physical	No physical needs.	None identified.
Socioeconomic	Reduces fuel consumption, noise, and air pollution	None identified.
Enforcement, Education, and Maintenance	May result in less need for speed enforcement.	Signal timing plans need periodic updating.

Apart from its operational benefits, signal coordination is known to reduce vehicle conflicts along corridors where traffic control signals are coordinated. Largely, it reduces the number of rear-end conflicts, as vehicles tend to move more in unison from intersection to intersection. Studies have proven the effectiveness of signal coordination in improving safety. The ITE *Traffic Safety Toolbox: a primer on Traffic Safety* cites two studies of coordinated signals with intersection crash frequencies that dropped by 25 and 38 percent. Selected findings of safety benefits associated with signal coordination are shown in **Table IV-15** on the following page.

Table IV-15
Safety Benefits Associated With Signal Coordination or Progression

Treatment	Finding
Signal Coordination	• 3 to 18% estimated reduction in all collisions along corridor • 14 to 43% estimated reduction in rear-end collisions along corridor
Provide Signal Progression	• 10 to 20% estimated reduction in all collisions along corridor

Once the decision is made to coordinate a series of intersections, there are a variety of ways to interconnect the controllers, using different forms of communication infrastructure. Coordination interconnection is typically accomplished using either fiber optic communication cables or telephone type cables with multiple conductors (6 pair, 12 pair, 18 pair, 25 pair).

There are some basic principles to be followed when installing coordination interconnect cables.

i. All cables shall be terminated inside of an enclosure (control cabinet or computer building). This allows for easy termination on terminals and convenient testing points.
ii. Intermediate splices should be avoided.
iii. Do not place interconnect cables into the same conduit with cables that carry secondary line voltage or higher.

Grouping the signals to be coordinated is a very important aspect of design of a progressive system. Factors that should be considered include geographic barriers, volume-to-capacity ratios, and characteristics of traffic flow (random versus platoon arrivals).

c. Signal Pre-Emption / Priority

Section 4D.27 of the DE MUTCD discusses signal preemption, standards for the phases during preemption, and priorities for different vehicle types that might have preemption capabilities. A specific vehicle often targeted for signal preemption in Delaware is the emergency vehicle. Signal preemption allows emergency vehicles to disrupt a normal signal cycle to proceed through the intersection more quickly and under safer conditions. The preemption systems can extend the green on an emergency vehicle's approach or replace the phases and timing for the whole cycle. While several types of emergency vehicle detection technologies are available, the most commonly used preemption systems in Delaware consist of an emitter mounted on an emergency vehicle that sends an infrared pulse toward a detector mounted at the traffic signal, which is wired into the signal controller. Signal preemption detectors should be designed and installed on all approaches of DelDOT owned and maintained signals.

Sections 4D.27 and 8C.09 of the DE MUTCD include requirements and recommendations associated with traffic control signals located in the vicinity of grade crossings and, subsequently, railroad preemption. Because railroad preemption may cause excessive vehicular delays and/or abnormal traffic control signal operations for extended periods of time, the decision to install railroad preemption should not be made without consideration of other safety and operational alternatives. If an engineering study determines that railroad preemption is an appropriate countermeasure for a specific location, then the right-of-way transfer time, queue clearance time, and maximum preemption time should be based on the TxDOT's *Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings* (see **Appendix R**).

Where traffic signals at movable bridges are interconnected with signals at adjacent intersections, the traffic signals at the adjacent intersections should be preempted by the operation of the movable bridge. See Sections 4J.03 and 4D.27 of the DE MUTCD for additional guidance.

6. Pedestrians

a. Signal Guidelines

According to Section 4E.03 of the DE MUTCD, pedestrian signal heads **must** be used in conjunction with vehicular traffic control signals under any of the following conditions:

- If a traffic control signal is justified by an engineering study and meets either Warrant 4 - Pedestrian Volume, or Warrant 5 - School Crossing (see DE MUTCD, Sections 4C.05 and 4C.06).
- If an exclusive signal phase is provided or made available for pedestrian movements in one or more directions, with all conflicting vehicular movements being stopped.
- At an established school crossing at any signalized location.
- Where engineering judgment determines that multiphase signal indications (as with split-phase timing) would tend to confuse or cause conflicts with pedestrians using a crosswalk guided only by vehicular signal indications.

Pedestrian signals **should** be used under the following conditions:

- If it is necessary to assist pedestrians in making a reasonably safe crossing or if engineering judgment determines that pedestrian signal heads are justified to minimize vehicle-pedestrian conflicts.
- If pedestrians are permitted to cross a portion of a street, such as to or from a median of sufficient width for pedestrians to wait, during a particular interval but are not permitted to cross the remainder of the street during any part of the same interval.
- If no vehicular signal indications are visible to pedestrians, or if the vehicular signal indications that are visible to pedestrians starting or continuing a crossing provide insufficient guidance for them to decide when it is reasonably safe to cross, such as on one-way streets, at t-intersections, or at multiphase signal operations.

Pedestrian signals **may** also be installed under any of the following conditions:

- When pedestrians cross part of the street, to or from an island, during a particular interval where they should not be permitted to cross another part of that street during any part of the same interval.

The DE MUTCD provides specific guidance on the type and size of pedestrian signal indications (Section 4E.04). As noted in the DE MUTCD, all new pedestrian signals should use the UPRAISED HAND (symbolizing DON'T WALK) and WALKING PERSON (symbolizing WALK) indications.

b. Timing Requirements

Pedestrian movements across signalized intersections are typically accommodated by one of the following options:

- Pedestrians cross the street with the parallel vehicular green indication (no pedestrian signal display). While this type of pedestrian accommodation may still be present at some older signals in Delaware, it should not be used for new signals or signal upgrades.
- Pedestrian movements are controlled by a concurrent, separate pedestrian signal display. This is DelDOT's preferred method of accommodating pedestrians at signals.
- Pedestrians move on an exclusive phase while all vehicular traffic is stopped.
- A leading pedestrian interval to give the pedestrian(s) the opportunity to enter the roadway before traffic begins to move.

The essential factor in any of these options is to provide adequate time for the pedestrian to enter the intersection (walk interval) and to safely cross the street (pedestrian clearance interval). In cases where there are no separate pedestrian displays and the pedestrian moves concurrently with vehicular traffic on the parallel street, the time allocated to vehicular traffic must consider the time required for pedestrians to react to the vehicular green indication and move across the street.

When separate pedestrian displays (WALK, DON'T WALK) are used, the minimum WALK interval preferred by DelDOT is 7 seconds. This allows the pedestrian ample opportunity to leave the curb before the pedestrian clearance interval commences. Various research studies have indicated that when there are fewer than 10 pedestrians per cycle, a WALK interval as short as 4 seconds may be used.

1.) Walking Speeds

Pedestrian walking speeds generally range between 2.5 ft/s and 6.0 ft/s. The DE MUTCD uses a walk speed of 3.5 ft/s for determining crossing clearance times. There are, however, various categories within the general population that walk at a slower rate. For example, very young children, the elderly, and the handicapped walk at a slower rate. Research on pedestrian characteristics verifies that 15% of all pedestrians walk at or below 3.5 ft/s. In general, to accommodate users who require additional time to cross the roadway, especially in lower speed areas where there are concentrations of children and or elderly persons, a walking speed of less than 3.5 ft/s should be considered.

A general rule of thumb indicates that pedestrians at crossings are willing to wait only 30 seconds, at which point they will begin to look for opportunities to cross, regardless of the walk indication and the crossing location (reference 7, Chapter 18 of *HCM 2000).* Shorter cycle lengths benefit pedestrians, particularly where pedestrians often need to cross two streets at a time to travel in a diagonal direction, as well as drivers, who experience generally shorter delays.

2.) Minimum Clearance Times

Pedestrian timing requirements include a WALK interval and a flashing DON'T WALK interval. The WALK interval gives pedestrians adequate time to perceive the WALK indication and depart the curb before the clearance interval (flashing DON'T WALK) begins.

The DE MUTCD mandates that a pedestrian clearance interval always be provided and displayed long enough to allow the pedestrian who left the curb or shoulder during the WALK indication to travel from the curb or shoulder to the far curb or to a median of sufficient width for pedestrians to wait. Generally, the flashing DON'T WALK should be terminated and a steady DON'T WALK displayed at the onset of the yellow vehicular change interval. The minimum clearance interval is calculated by dividing the crossing distance (curb to curb) by the "normal" walking speed of 3.5 ft/s, as shown in the top equation of **Figure IV-13**.

Additionally, the sum of the walk interval and clearance time should allow a pedestrian walking at 3.0 ft/s to travel from the pedestrian detector to the far face of the curb. The equation to calculate this time is shown at the bottom of **Figure IV-13**. For additional information, refer to Section 4E.06 of the DE MUTCD.

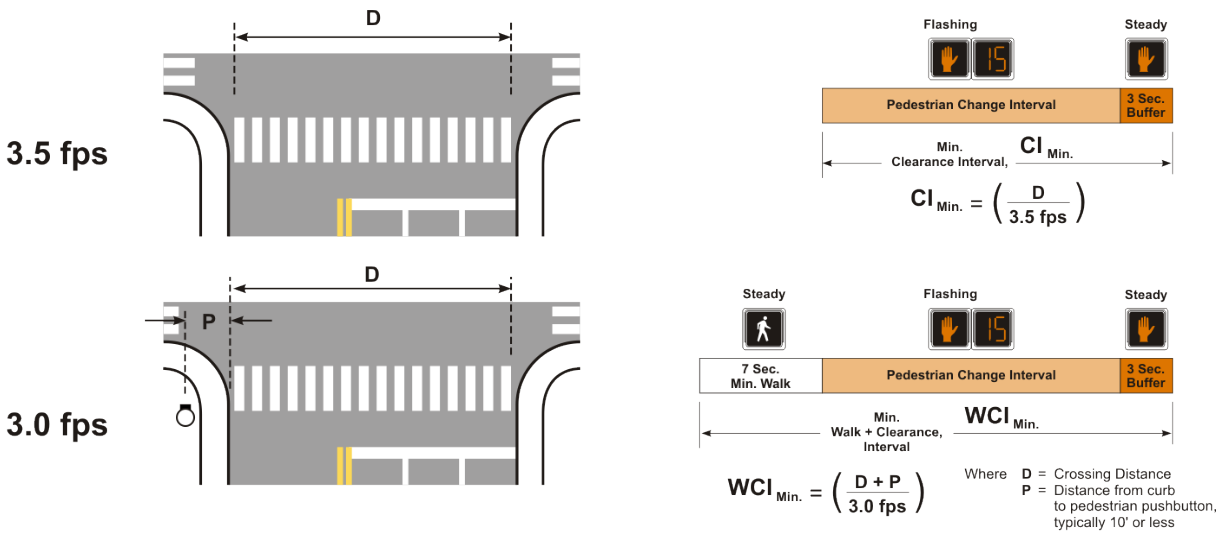


Figure IV-13. Clearance Interval Time Calculations

The recommended practice is for the pedestrian clearance time to be accommodated completely within the flashing DON'T WALK time.

During the transition to preemption, the WALK interval may be shortened or omitted.

c. Rest in Walk

When in a coordinated system, pedestrian phases operating concurrently with the major street through phases are typically programmed to "rest" in the corresponding walk interval. This operation allows the pedestrian walk interval to be extended to reduce the frequency of "jaywalking;" however, it adversely affects preemption transition times because shortening the pedestrian clearance interval is prohibited in Delaware.

d. Accessible Pedestrian Signals (APS)

Some signalized intersections have factors that may make them difficult for pedestrians who have visual disabilities to cross safely and effectively. As noted in the DE MUTCD (section 4E.09), these factors include:

- Increasingly quiet cars.
- Right turn on red (which masks the sound of the beginning of the through phase).
- Continuous right-turn movements.
- Complex signal operations (e.g., protected-permissive phasing, lead-lag phasing or atypical phasing sequences).
- Roundabouts.
- Wide streets.

To address these challenges, accessible pedestrian signals have been developed to provide information to the pedestrian in a nonvisual format, such as audible tones, verbal messages, and/or vibrating surfaces. Detail on these treatments can be found in the DE MUTCD and in several references sponsored by the U.S. Access Board and the National Cooperative Highway Research Program (NCHRP).

The latest version of the Draft Public Rights-of-Way Accessibility Guidelines (*Draft PROWAG*), published in July 2011, requires pushbutton-integrated APS that provide an audible and vibrotactile indication of the WALK signal. While the guidelines have not been finalized as standards, these draft guidelines should be considered best practice at this time (Federal Highway Administration memo on public rights-of-way, January 2006).

When used, accessible pedestrian signals should have an audible tone(s) during the WALK interval.

DelDOT will install APS upon request at a signalized intersection. Request forms are available online at DelDOT's webpage (www.deldot.org). To access the form, click on "Community Programs and Services" in the "Information" column on the left side of the homepage, and then select "Request An Audible Pedestrian Traffic Signal."

e. Countdown Pedestrian Signals

All new and reconstructed traffic signals in Delaware will incorporate countdown pedestrian signals. See **Appendix S** for specific DelDOT timing guidelines. Current thinking suggests that redundancy in information to pedestrians benefits all pedestrians.

Countdown signals display the number of seconds remaining before the end of the DON'T WALK interval. Countdown displays shall not be used during the WALK interval, nor during the yellow change interval. The WALKING person symbol and flashing and steady UPRAISED HAND symbol still appear at the appropriate intervals, unless federally approved. The countdown signals do not change the way a signal operates; they only provide additional information to the pedestrian.

If the pedestrian change interval is interrupted or shortened as part of a transition into a pre-emption sequence, the countdown display should be discontinued and go dark immediately.

f. Alternative Pedestrian Phasing Options

Three options beyond standard pedestrian signal phasing are:

- The leading pedestrian interval.
- The lagging pedestrian interval.
- The exclusive pedestrian phase.

A leading pedestrian interval entails retiming the signal splits so that the pedestrian WALK signal begins a few seconds before the vehicular green. As the vehicle signal is still red, this allows pedestrians to establish their presence in the crosswalk before the turning vehicles, thereby enhancing the pedestrian right-of-way.

A lagging pedestrian interval entails retiming the signal splits so that the pedestrian WALK signal begins a few seconds after the vehicular green for turning movement. The 2001 ITE guide, *Alternative Treatments for At-Grade Pedestrian Crossings*, indicates that this treatment is applicable at locations where there is a high one-way to one-way turning movement and works best where there is a dedicated right-turn lane. This benefits right-turning vehicles over pedestrians by giving the right turners a head start before the parallel crosswalk becomes blocked by a heavy and continuous flow of pedestrians.

An exclusive pedestrian signal phase allows pedestrians to cross in all directions at an intersection at the same time, including diagonally. It is sometimes called a "pedestrian scramble" phase. Vehicle signals are red on all approaches of the intersection during the exclusive pedestrian signal phase. The objective of this treatment is to reduce vehicle turning conflicts, decrease walking distance, and make intersections more pedestrian-friendly. However, exclusive pedestrian phases generally have a significant impact on intersection capacity and should be considered only in exceptional circumstances. The

2001 ITE guide refers to research that indicates that leading pedestrian phases were more effective treatments than exclusive pedestrian phases.

Leading pedestrian phasing may be considered where:

- There is moderate to heavy pedestrian traffic.
- A high number of conflicts/collisions occur between turning vehicles and crossing pedestrians.

Lagging pedestrian phasing may be considered where:

- There is moderate to heavy pedestrian traffic.
- There is right-turn channelization that is heavily used by vehicles.
- A high number of conflicts/collisions occur between right-turning vehicles and crossing pedestrians.

Exclusive pedestrian phasing (scramble) may be considered where:

- There is very heavy pedestrian traffic on all or most approaches.
- Delay for vehicular turning traffic is excessive due to the heavy pedestrian traffic.
- There are a large number of vehicle-pedestrian conflicts involving all movements.

Note that for any of the three treatments, the use of accessible pedestrian signals is recommended to give people with visual disabilities information of the walk phase in the absence of predictable surging traffic.

In rare circumstances, a 4-section T-shaped signal head with a solid red right turn arrow can be used in locations where right turns may be prohibited during certain phases per Sections 4D.22 of the DE MUTCD.

Delaware Department of Transportation

TRAFFIC DESIGN MANUAL

2015 EDITION

Chapter V

ITS DEVICES

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), and were formerly referred to as "DelTRAC" devices within DelDOT.

Chapters 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 information. DelDOT may use this information to respond to changing travel conditions by modifying signal timing patterns, 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 or multi-mode fiber optic cable, a twisted copper pair cable, or a T1 connection. Typical wireless connection is achieved via CDMA, 4.9GHz, 700MHz 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. Additionally, DelDOT is currently investigating implementation of a 4.9 GHz wireless network, which may become a part of the ITMS communications infrastructure and could provide a more-reliable wireless connection during critical events.

At junction points of major fiber pathway, the installation of fiber mini-hub or 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 communications, 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

US 13 at Llangollen Blvd, New Castle

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. 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 function classifications of highways except local streets. Equipped with loop detectors, 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.

SR 1 at DelDOT TMC, Smyrna

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 hand-free systems, emit an electronic signal containing a unique electronic address. These addresses, known as a MAC address, 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 is able to cost-effectively garner a variety of real-time travel information, including average travel times, average travel speeds, and travel patterns.

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 of 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 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 existing poles with a davit arm as a cost-effective solution, when possible. 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 or VMS, 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 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, 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 intercostal 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 Geologic 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 rage of the WTMC. Each repeater site receives a weak or low-level signal and re-transmits the signal at a higher level, so that 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

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 motorist to changing posted speeds.

I-495 NB North of I-95, Newark

9. New Technology

DelDOT continuously seeks to improve their 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, with 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 guardrail, barrier, or a 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. While the Designer is responsible for identifying potential sources of power, DelDOT Traffic Construction will coordinate directly with the utilities to finalize specific design details regarding the power connection. If the power source is not obvious, the Designer should meet with representatives from DelDOT Traffic Construction and the power company to discuss viable options during preliminary design. 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 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, the Department is currently experimenting with the ability to use solar power. Some devices, such as VSL signs, 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. Where existing power sources are greater than 2,000 feet away, solar power may be recommended. If solar power is recommended, the Designer is required to get approval of the Traffic Systems Design Engineer prior to its use.

3. Communication

Early in the design process, the Designer is required to meet with DelDOT's Telecommunications Committee to discuss the integration requirements of the proposed device. Prior to meeting with the Telecommunications Committee, the Designer should have a draft idea of the communication needs the project will use. All proposed devices should be shown and accounted for to provide an accurate scope of 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 an equipment and integration cost 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 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 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 chatper of this manual on conduit design for traffic signals (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" Schedule 80 HDPE 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 by a single 2" (or larger, as determined by maximum fill capacity) Schedule 80 PVC
- All proposed system loop detector lead-in conduit shall be 1" flexible non-metallic liquid tight conduit.
- 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.

For pathway on structures, smaller conduit sizes may be used based on device deployment requirements. Additional 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.

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 should be limited to **35%** for existing conduit. This will compensate for potentially large number of conductors, the length of run, and the number of bends. Cross-sectional areas of cables typically used for ITS installations are listed in and **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
#14/9	0.256
#14/16	0.389
6 Count Fiber	0.132
12 Count Fiber	0.132
24 Count Fiber	0.132
48 Count Fiber	0.132
144 Count Fiber	0.302

2. Junction Wells

Junction wells are pre-cast structures placed underground or within concrete barrier (junction boxes) with composite or steel frame and lid. 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), precast polymer concrete (Type 7), or precast concrete with composite frame and lid (types 11 and 15). Additional junction well types may be used, but would require prior approval from the Traffic Systems Design Manager or Chief Traffic Engineer. The preferred junction well types used by ITS devices are as follows:

- Type 11 – 20"x 20": typically used for connecting multiple devices to a power source or connecting power sources with the device cabinet.
- Type 14 – 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.

All new junction wells should be precast concrete with a composite frame and lid, or precast polymer concrete. Steel frame and lid junction wells may still be used where necessary due to field conditions. An example of when a steel frame lid may be appropriate is in median nose where vehicles may track over the well causing damage to composite frame and lid. Only steel frame and lid junction wells supplying power will require bonding and grounding, and such designs will require approval by a Traffic System Design Representative.

b. Location

For communication pathway, a maximum spacing between Type 4 and 14 junction wells for ITMS (fiber) pathway shall not exceed 600 feet with every fourth well (max 2,400') being a Type 7 junction well. For all underground splice locations, a Type 7 junction well shall be installed. A Type 4 or 14 junction well shall be placed at all ITS device tie-in points and at the cabinet location. A Type 4 or 14 junction well should also be placed near each pole, change of direction, and roadway crossing of pathway. The maximum spacing between junction wells for power supply for ITS devices is 250 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 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), except in special circumstances where there is insufficient space, or other geometric or environmental constraints are present. In those cases, a pole-mounted cabinet (Type K) 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 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 to 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
- Driver visibility

c. Cabinet Base and Conduits

All proposed ITS device cabinet bases (Type P) 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 14 junction well with a minimum of three (3) 4" Schedule 80 PVC conduits providing direct access.

- An additional 3” Schedule 80 PVC conduit shall be provided for direct access to the nearest device pole into the cabinet base.
- If direct access from the nearest device pole is unachievable, an additional 4” Schedule 80 PVC conduit shall be installed from the type 14 junction well to the cabinet.
- There shall also be a single 2” (or larger, as determined by maximum fill capacity) Service rigid conduit providing direct access from the power source into the cabinet base.

Fiber minihub cabinet bases (Type F) 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) Service rigid conduit providing direct access from the power source into the cabinet base.

Refer to DelDOT’s Standard Construction Details for additional information. Any modification to the 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 device. The poles are typically 75 feet tall, but can range from 50 to 75 feet in height depending on need and site constraints.
- RTMS devices are typically 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 structures. Refer to AASHTO standards for overhead sign structure design requirements.
- RWIS devices are typically 40 foot breakaway pole.

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

b. Bases / Foundations

For all designs with CCTV camera, and/or vehicle detector poles, the signal 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 signal designer should submit a soil boring request form (see **Appendix O**) to DelDOT's Geotechnical 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-11** in Chapter 4D.

Because Pole Base, Types 3B and 3C require 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.

These are general guidelines for selecting an appropriate pole base type. In some cases, it may be necessary to calculate the dead load for signal heads on mast arm or span wire before selecting the appropriate pole base. The signal designer should reference DelDOT's Standard Construction Details for sizes. Any modification to the construction detail must be pre-approved by the Chief Traffic Engineer prior to installation.

For all other device foundations, the designer shall design the foundation to meet current ASHTO standards.

c. Conduits

Type 1, 2, 2A, 2B, 3, 3A and 3B 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 or, as previously noted, for direct connection to a cabinet base).

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

Refer to DelDOT's Standard Construction Details for additional information. Any modification to the construction detail must be pre-approved by the Chief Traffic Engineer prior to installation.

Appendices

APPENDIX A

DelDOT Traffic Systems Design Directive

Traffic Systems Design Directive

169 Brick Store Landing Road, Smyrna, DE

Number (Year - #) ______________

Requestor Name: ________________________________

Date Submitted: ________________________________

Applicable Chapter / Section / Page / Figure in current manual: ________________________________

Requires modification to Traffic Design Manual?
☐ Yes
■ No

Description of Current Practice: ____

____

____

____

Recommended Change: ____

____

____

____

Date Received: ___________________________ Received By: ___________________________

Based upon the conditions presented, it is recommended that this be approved as an updated Traffic Systems Design Practice and included as a revision to the Traffic Design Manual (if applicable).

Recommended By: ____ Date: ______________
Requestor

Recommended By: ____ Date: ______________
Design / Construction / Safety / Studies Manager

Approved By: ____ Date: ______________
(Signature)

Status / Date Completed: ____

APPENDIX B

Memo – Signal Agreements (March 30, 2012)

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

SHAILEN P. BHATT
SECRETARY

MEMORANDUM

TO: Traffic Studies, Design and Administrative Staff

FROM Donald Weber

DATE: March 30, 2012

SUBJECT: Signal Agreements

As many of you are aware, we have been working on changes to the signal agreement process including updates to language as well as the process used in getting signal agreements approved. The modified language is based on coordination between DelDOT's Traffic, Legal, Engineering Support, Planning and Real Estate Sections. The modified language includes some additional legal protection to DelDOT, as well as ensures that the agreements are in conformance with all applicable state and federal laws related to real estate acquisition. There are three types of basic signal agreements:

- **Type A – Off-Site Developer Agreement.** This agreement is typically used when a developer is required to contribute to the cost of a new or upgraded traffic signal or ITS device that is not located directly on the development's property.
- **Type B – On-Site Developer Agreement.** This agreement is typically used when a developer is required to contribute to the cost of a new or upgraded traffic signal or ITS device that is located on or directly adjacent to the development's property.
- **Type C – Right of Entry Agreement.** There is no cost component of this agreement. It simply allows DelDOT right of entry onto the property to install, operate and maintain

TEAM DelDOT

signal and ITS devices. Property owners must willingly enter into this agreement without compensation. If the property owner would like to receive compensation, then this agreement is not applicable and the full DelDOT right of way process must be followed, or the design must be redone to avoid the property impact. These agreements require a graphical representation of the area of the property in question (see attached for an example).

Each of the basic agreements are attached. Agreement language should not be modified. In the event there is need to consider modifications based on some unique condition, a draft of the modifications will need to be sent to the Chief Engineer through the Traffic Studies or Systems Design Manager, and the Assistant Director for Traffic. Prior to issuing the memorandum, the Department's assigned Deputy Attorney General should review the proposed modifications and "approve as to form."

Note that this memorandum does not address agreements that will be required for the Traffic Signal Revolving Fund. The Traffic Signal Revolving Fund basic agreement and process is currently being finalized and will be covered in a separate memorandum.
Additional tracking mechanisms are being introduced to the signal agreement process as well. Please follow the process noted below:

1. Upon notification of the need for an agreement, and receipt of property owner information, fill out the appropriate basic agreement and forward to Traffic's Administrative Specialist III. Two original copies are required. Please provide the project name and/or number when applicable.
2. Traffic's Administrative Specialist III will log the agreement and send to Department's assigned Deputy Attorney General for his signature.
3. Department's assigned Deputy Attorney General will return to Traffic's Administrative Specialist III, who will then log the agreement and return to the Studies or Systems Design staff member who initiated it.
4. Mail or hand-deliver the agreements to the developer/property owner.
5. When the agreements are returned, deliver to Traffic's Administrative Specialist III who will log them and send them to the Chief Engineer for signature.
6. The Chief Engineer will sign with the Director of Technology & Support Services attesting.
7. Finance takes one of the two original agreements.
8. The remaining original agreement will be returned to Traffic's Administrative Specialist III who will log it. At this point, the agreements are officially executed. A developer's requirement to enter into an agreement is now satisfied, and DelDOT and its contractors are allowed access onto property as noted in the agreement.

9. Traffic's Administrative Specialist III will transfer the executed agreement to Traffic's Administrative Specialist II, who once a month will record all agreements in each of the three respective counties (as necessary).
10. Upon recordation, the County will return the recorded agreements to Traffic's Administrative Specialist III, who will log them for the final time and distribute copies to the initiating staff member, the developer/property owner, and Department's assigned Deputy Attorney General.

Enclosure/attachments
cc: Natalie Barnhart
Fritz Schranck
Rob McCleary
Bill Brockenbrough

APPENDIX C

Traffic Systems Design Handoff Form

Traffic Systems Design Handoff Form

DelDOT

169 Brick Store Landing Road, Smyrna, DE

Project Name: ____________________

Contract/Project No.: ____________________ **Maximo No.:** ____________________

Designer Name: ____________________ **Date:** ____________________

Handoff To:
- ☐ Traffic Construction
- ☐ Traffic Maintenance
- ☐ Power Company ____________________
- ☐ Other: ____________________

Project Type:
- ☐ Capital
- ☐ Pavement Markings
- ☐ Power Company Lighting
- ☐ Traffic
- ☐ Signing
- ☐ Developer
- ☐ Pave & Rehab
- ☐ OIT
- ☐ Other: ____________________

Permit Number(s): ____________________

Description: ____________________

Project Justification: ____________________

Funding Approval: ☐ Yes ☐ No

Funding Notes: ____________________

Priority:
- ☐ ASAP
- ☐ High
- ☐ Normal
- ☐ Support

Expected Start: ____________________

Communication/ ITS Needs: (i.e., fiber, CDMA, etc.) ____________________

Special MOT Notes: (Time Restrictions, Ped MOT, etc.) ____________________

Overhead Signing: ☐ Yes ☐ No

Timesheet Status: ☐ Complete ☐ Pending ☐ Not Required

Public Relations: DelDOT PR lead: ____________________
- ☐ PCMS
- ☐ Press Release
- ☐ None
- ☐ Other: ____________________

Version: ☐ Original ☐ Revision Number: ____________________

Comments: (e.g. special order items, decorative poles, APS, etc.) ____________________

File Location: ____________________

Attachments:

Plans: ☐ Attached ☐ File Location: ____________________

Estimates: ☐ Attached ☐ File Location: ____________________

Other: ☐ ____________________

Form Date: 09/30/2014

Traffic Systems Design Handoff Form

169 Brick Store Landing Road, Smyrna, DE

Handoff Email Distribution List

Signal Construction
- Mark Luszcz
- Denny Hehman
- Mel Peters
- Mike Havel
- Jack Hardy
- Frank Motley
- Will Newcomb

Signal Maintenance
- Jim Bunting
- Rob Kern (NCCo only)
- Dan Schmeusser (Kent and Sussex only)

Design
- Monroe Hite III
- Max Saintil
- Mike Fleming

Finance
- Amanda Davis

Safety
- Adam Weiser
- Jerry Nagyiski
- Wayne Hamilton (NCCo North only)
- Marvin Pedigo (NCCo Canal only)
- Rich Ross (Kent only)
- Dan Thompson (Sussex only)

TMC/Operations
- Gene Donaldson
- Jim Clacher
- Silvana Croope

Public Relations
- Louise Holt

M & O
- Geri C. Smith++++

Architectural Accessibility Board
- Dan Muterspaw

Bridge Design
- Jason Hastings*
- Jason Arndt*
- Nathan Draper*

*	*for all projects with mast arms, or poles >60' high*

Signing
- Bob Hutson
- Connie Bainton
- Rick Tracy
- Lori Hutson
- Lee Benningfield (NCCo only)
- Tim Weishaupt (Kent only)
- Denise Coulbourne (Sussex only)

North District
- Bill Thatcher#
- Shelly Bailey#
- Gerard Mulderrig##

Central & South District
- Jason McCluskey#
- Alastair Probert#

#	*for lighting projects only*
##	*for all lighting projects statewide*

OIT+
- Dave Gray+
- Rob Longhurst+
- Denise Ksiazek++
- Ron Galbreath+++
- Jason Rashid

Utilities
- Eric Cimo++

+	*only when project has ITMS communications involvement*
++	*only when project has fiber involvement*
+++	*only when project requires ITMS data circuit coordination with Verizon*
++++	*only when project involves CTF funds*

Rail
- Bob Perrine

Traffic Studies
- Tom Meyer^
- Initiating Staff Member ^

^	*only for projects initiated by Traffic Studies*

General Note:
Power company lighting projects only need to be handed off to the Power Company, Design, Finance, and North District.

APPENDIX D

Standard Traffic Title Sheet

THE STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION

U.S. CUSTOMARY UNITS

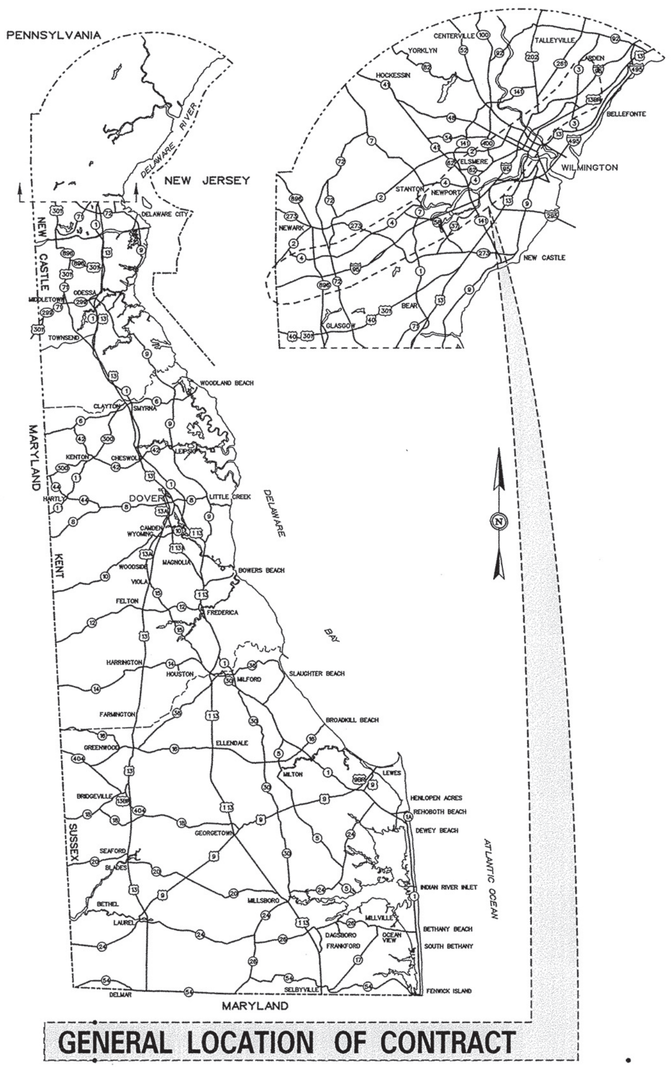
FINAL PLANS

CONSTRUCTION PLANS FOR:

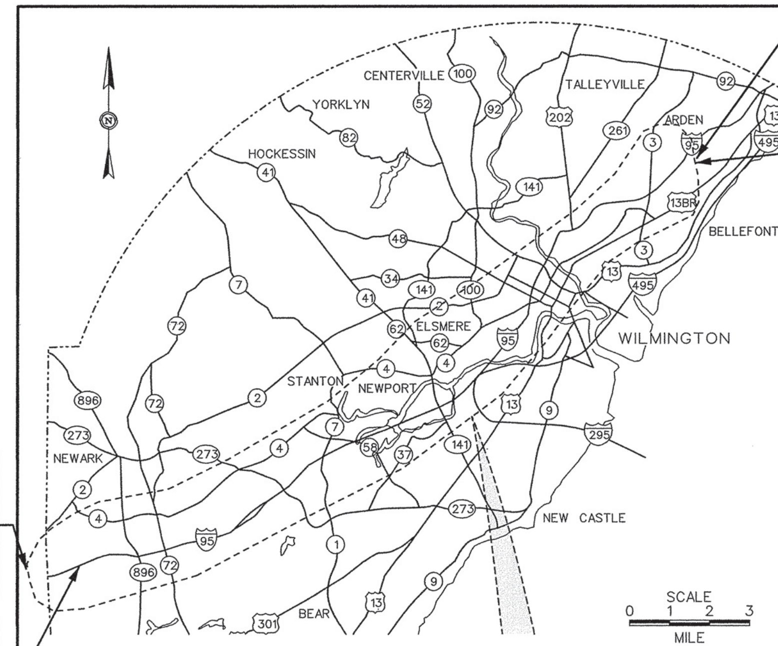
I-95 WTMC 1380AM
TRAVEL ADVISORY RADIO
SIGN INSTALLATIONS

CONSTRUCTION CONTRACT NUMBER: T201304701
FEDERAL AID PROJECT NUMBER: 1516

COUNTY: NEW CASTLE   M.R. #: 84



GENERAL LOCATION OF CONTRACT



LIMIT OF CONSTRUCTION
CONTRACT T201304701
I-95

END
CONTRACT T201304701
I-95

LIMIT OF CONSTRUCTION
CONTRACT T201304701
I-95

BEGIN
CONTRACT T201304701
I-95

LOCATION MAP

DESIGN DESIGNATION

FUNCTIONAL CLASS: FREEWAY		D.H.V. PROJECTED: 12,400	YEAR: 2030
TYPE OF CONSTRUCTION: SIGN INSTALLATION		DESIGN SPEED: 70 M.P.H.	
A.A.D.T. CURRENT: 78,500	YEAR: 2011	TRUCKS: 15 %	
A.A.D.T. PROJECTED: 117,500	YEAR: 2050	DIRECTION OF DISTRIBUTION: 50 %	

COUNTY	M.R. NO.	FEDERAL AID PROJECT NUMBER	SHEET NUMBER	TOTAL SHEETS
NEW CASTLE			1	20

INDEX OF SHEETS

TOTAL SHEETS: 20

APPROVED DESIGN EXCEPTIONS

DESIGN PARAMETER	REQUIRED	PROVIDED	DATE

ADDENDA & REVISIONS

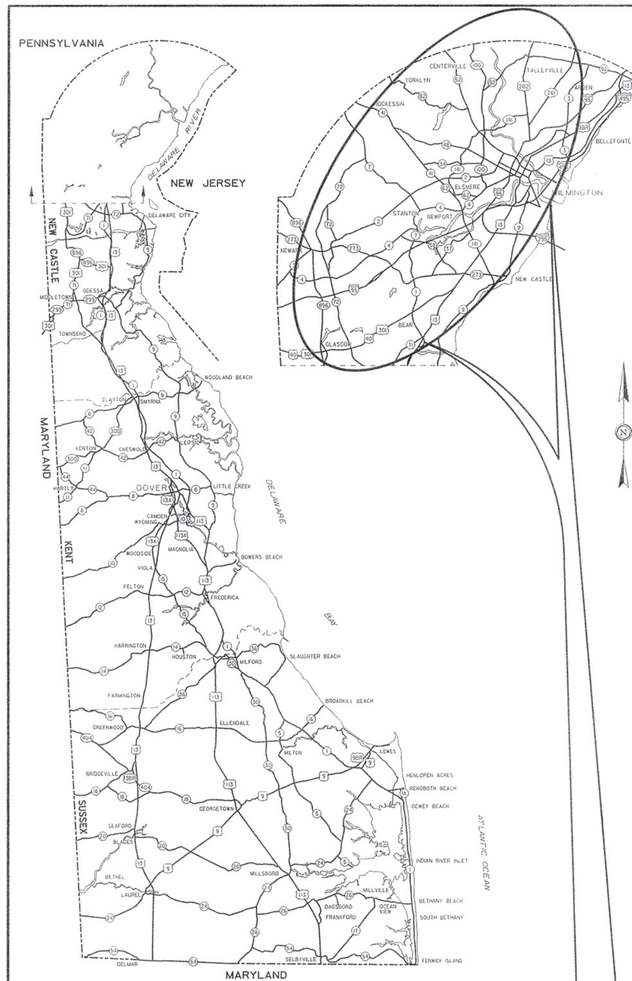
DESCRIPTION	NAME & DATE

ASSOCIATED CONTRACTS

CONTRACT NO.	CONTRACT NAME

DATE: 11-26-12 RECOMMENDED	DATE: RECOMMENDED	DATE: 11/30/2012 RECOMMENDED	DATE: 11/30/12 APPROVED TRAFFIC ENGINEER	DATE: 11/30/12 APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER

LAST REVISED: 8/7/2008
H:\60181684-DELDOT WILM\000_CAD\006_CIVIL\ITMS-SHEETS\SS_01-COVERSHT.DGN



GENERAL LOCATION OF CONTRACT

THE STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION

U.S. CUSTOMARY UNITS

FINAL PLANS

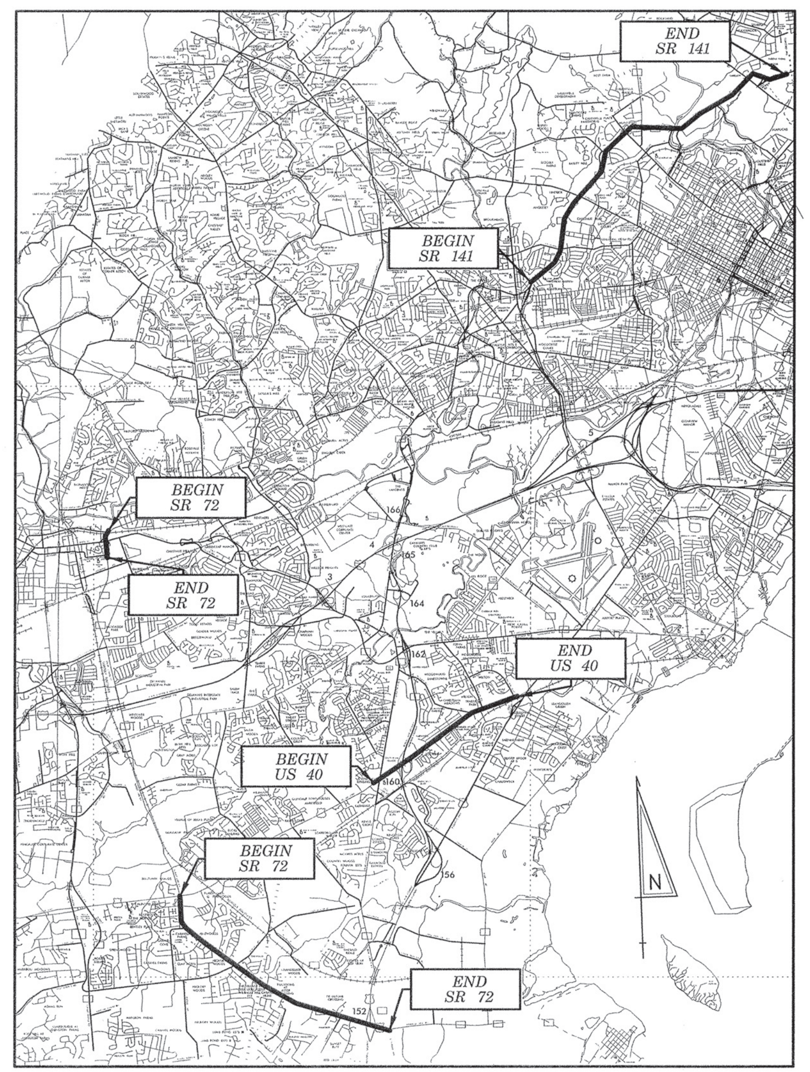
CONSTRUCTION PLANS FOR:

NEW CASTLE COUNTY
SYSTEM LOOP DETECTION PHASE II

CONTRACT NUMBER: T201204701

FEDERAL AID PROJECT NUMBER:

COUNTY: NEW CASTLE



LOCATION MAP

DESIGN DESIGNATION

FUNCTIONAL CLASS:		D.H.V. PROJECTED:	YEAR:
TYPE OF CONSTRUCTION:		DESIGN SPEED: 60 M.P.H.	
A.A.D.T. CURRENT:	YEAR:	TRUCKS:	
A.A.D.T. PROJECTED:	YEAR:	DIRECTION OF DISTRIBUTION:	

INDEX OF SHEETS

TOTAL SHEETS: 20

APPROVED DESIGN EXCEPTIONS

DESIGN PARAMETER	REQUIRED	PROVIDED	DATE

ADDENDA & REVISIONS

DESCRIPTION	NAME & DATE

ASSOCIATED CONTRACTS

CONTRACT NO.	CONTRACT NAME

DATE: 9.24.13 RECOMMENDED	DATE: RECOMMENDED	DATE: RECOMMENDED	Norman C. Hoke III DATE: 9/24/13 APPROVED TRAFFIC ENGINEER	DATE: 9/25/13 APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER

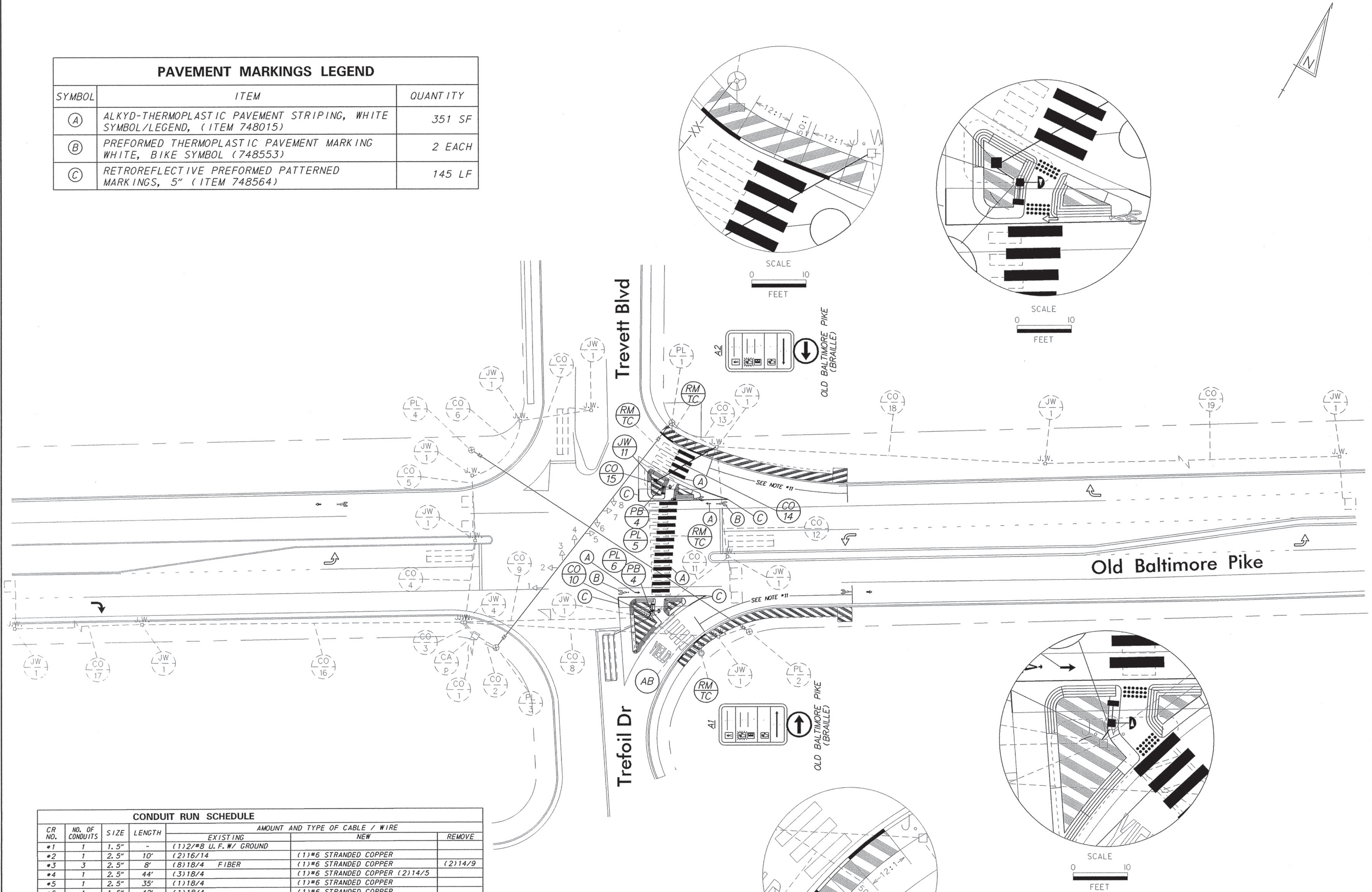
11/18/2011 12:17:46 PM
\\RKKM\V2010\2010\10028_DELDOT_ITS\TASK 2 - I-495 SPEED DETECTION SITES\CADD\PLANS\T101_TITLE.DGN

APPENDIX E

Sample Traffic Control Signal Plan Sheets

PAVEMENT MARKINGS LEGEND

SYMBOL	ITEM	QUANTITY
A	ALKYD-THERMOPLASTIC PAVEMENT STRIPING, WHITE SYMBOL/LEGEND, (ITEM 748015)	351 SF
B	PREFORMED THERMOPLASTIC PAVEMENT MARKING WHITE, BIKE SYMBOL (748553)	2 EACH
C	RETROREFLECTIVE PREFORMED PATTERNED MARKINGS, 5" (ITEM 748564)	145 LF



CONDUIT RUN SCHEDULE

CR NO.	NO. OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE / WIRE: EXISTING	NEW	REMOVE
*1	1	1.5"	-	(1)2/#8 U.F.W/ GROUND		
*2	1	2.5"	10'	(2)16/14	(1)#6 STRANDED COPPER	
*3	3	2.5"	8'	(8)18/4 FIBER	(1)#6 STRANDED COPPER	(2)14/9
*4	1	2.5"	44'	(3)18/4	(1)#6 STRANDED COPPER (2)14/5	
*5	1	2.5"	35'	(1)18/4	(1)#6 STRANDED COPPER	
*6	1	1.5"	42'	(1)18/4	(1)#6 STRANDED COPPER	
*7	1	2.5"	41'	(1)18/4	(1)#6 STRANDED COPPER	
*8	1	2.5"	139'	FIBER	(1)#6 STRANDED COPPER	
*9	1	2.5"	100'	(4)18/4	(1)#6 STRANDED COPPER (2)14/5	(2)14/9
10	1	2.5"	3'		(1)#6 STRANDED COPPER (1)14/5	
*11	1	2.5"	54'	(3)18/4	(1)#6 STRANDED COPPER (1)14/5	(1)14/9
*12	1	2.5"	60'		(1)#6 STRANDED COPPER (1)14/5	(1)14/9
*13	1	2.5"	26'		(1)#6 STRANDED COPPER	(1)14/9
14	1	4"	38'		(1)#6 STRANDED COPPER (1)14/5	
15	1	2.5"	5'		(1)#6 STRANDED COPPER (1)14/5	
*16	1	1.5"	175'	(1)18/4	(1)#6 STRANDED COPPER	
*17	1	1.5"	190'	(1)18/4	(1)#6 STRANDED COPPER	
*18	1	1.5"	180'	(1)18/4	(1)#6 STRANDED COPPER	
*19	1	1.5"	185'	(1)18/4	(1)#6 STRANDED COPPER	

* DENOTES EXISTING

ADDITIONAL SIGNAL NOTES

7. THE PROPOSED POLE BASE TYPE 4 AND PEDESTAL POLE FOR PEDESTRIAN SIGNAL SHALL BE CONSTRUCTED IMMEDIATELY ADJACENT TO THE LANDING AREA OF THE CURB RAMP OR SIDEWALK IN ACCORDANCE WITH CURRENT ADA BEST PRACTICES. THE PEDESTRIAN PUSH BUTTON SHALL BE INSTALLED AT HEIGHT OF 42 INCHES ABOVE THE LANDING AREA/SIDEWALK, AND SHALL BE LOCATED SUCH THAT MAXIMUM REACH IS 10 INCHES.

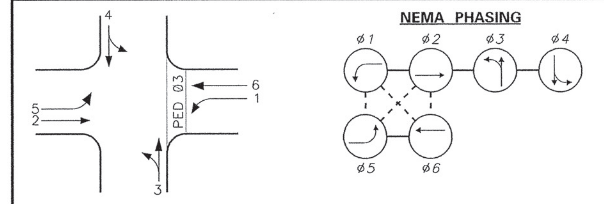
8. ALL PEDESTRIAN SIGNAL HEADS SHALL BE COUNTDOWN.

9. REMOVE EXISTING CROSSWALK AND RE-STRIPE AS PROPOSED.

10. THE CONTRACTOR SHALL INSTALL A TUBULAR MARKER (FLEXI-POST) ON ALL THREE (3) CORNERS OF THE CHANNELIZING ISLAND, AS SHOWN. EACH TUBULAR MARKER SHALL BE RETROREFLECTORIZED IN ACCORDANCE WITH THE SECTION 6F.60 OF THE DELDOT MUTCD.

11. COORDINATE WITH VINCENT DAMIANI (302-576-6094) OF DTC BEFORE CONSTRUCTION BEGINS. HE WILL TRY TO HAVE HIS CONTRACTOR REPLACING THE SIDEWALKS AND INSTALLING THE BUS PAD AT THE SAME TIME OF TRAFFIC'S CONSTRUCTION.

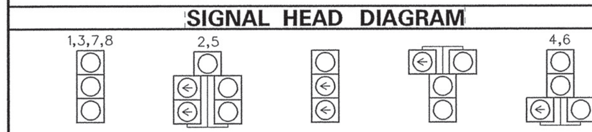
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

AB	ABANDON	OH / #	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA / X	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)	OH / #	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA / X	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	PB / X	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO / #	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PB / X	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO / #	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PL / X	EXISTING POLE IDENTIFIER (# OF POLE)
JW / X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PL / X	PROPOSED POLE IDENTIFIER (# OF POLE)
JW / X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	RM / C	REMOVE BY CONTRACTOR
MA / XX	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)	RM / O	REMOVE BY OTHERS
MA / XX	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)	RM / TC	REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		P
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. LOOP DETECTORS:
TYPE #1 - 6' x 6' - TO BE INSTALLED ON MAIN STREET THROUGH MOVEMENTS.
TYPE #2 - 6' x 25' - TO BE INSTALLED ON MAIN STREET LEFT TURN MOVEMENTS.
TYPE #2 - 6' x 25' - TO BE INSTALLED ON SIDE STREET THROUGH AND LEFT TURN MOVEMENTS.

2. CO #1 IS NOT DRAWN TO SCALE, NOR IS THE DIRECTION NECESSARILY CORRECT.

3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.

4. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.

5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.

6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ____________ DATE: ________

RECOMMENDED ____________ DATE: ________

RECOMMENDED Mark [signature] DATE: 2/21/14

APPROVED TRAFFIC ENGINEER [signature] DATE: 2/21/14

APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 2/25/14

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE 0 30 60 90 FEET

CONTRACT	PERMIT NO.	N528
T201101001	DESIGNED BY: MG	
COUNTY		
NC	CHECKED BY: MH	

SIGNAL PLAN
OLD BALTIMORE PIKE & TREVETT BLVD

SHEET NO. X
TOTAL SHTS. X

SIGNING LEGEND

1	REMOVE EXISTING SIGN
2	EXISTING SIGN TO REMAIN
3	PLACE NEW SIGN
4	RENEW EXISTING SIGN
5	REPOSITION EXISTING SIGN

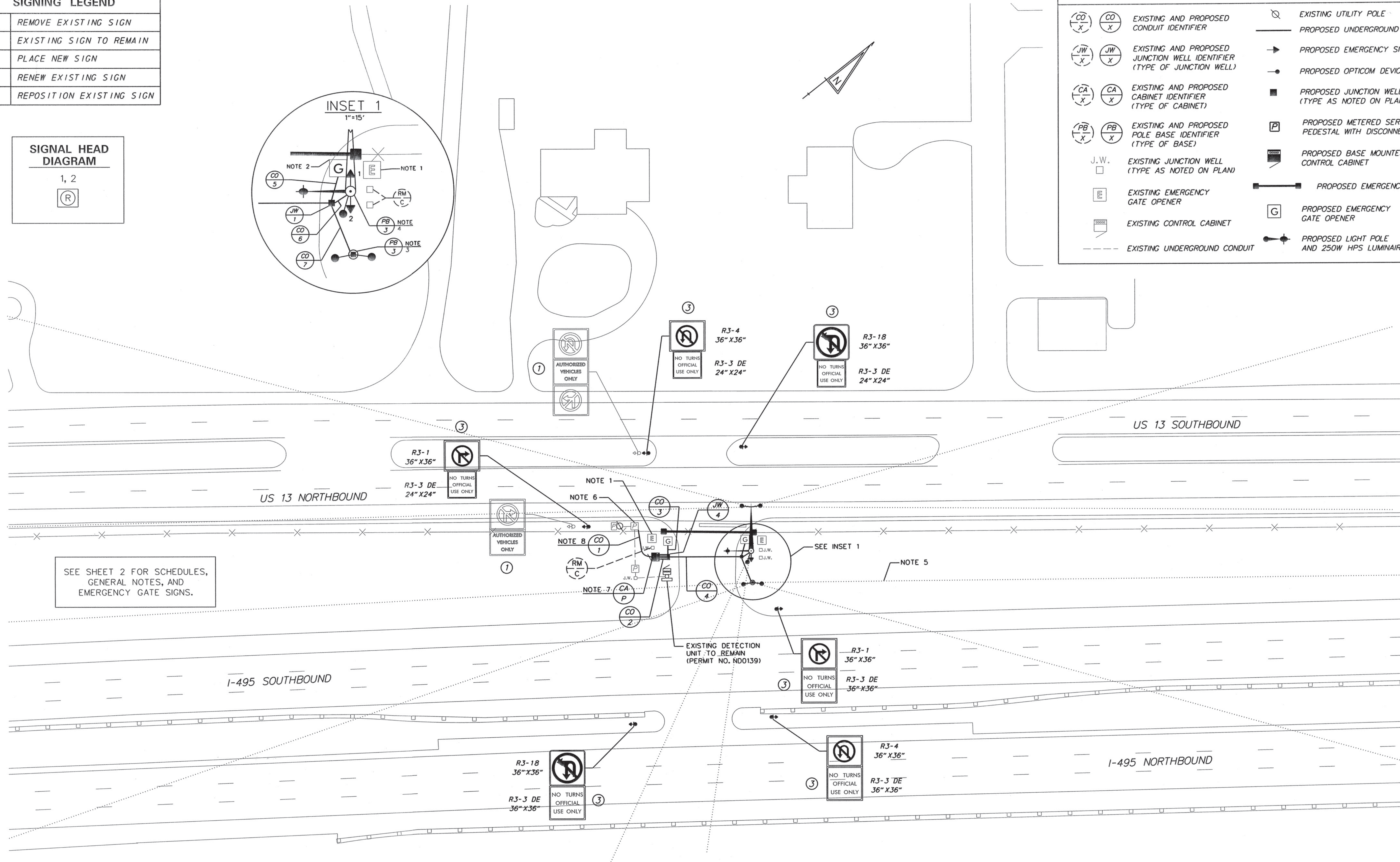
SIGNAL HEAD DIAGRAM

1, 2

R

LEGEND

CO/X	EXISTING AND PROPOSED CONDUIT IDENTIFIER
JW/X	EXISTING AND PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
CA/X	EXISTING AND PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
PB/X	EXISTING AND PROPOSED POLE BASE IDENTIFIER (TYPE OF BASE)
J.W.	EXISTING JUNCTION WELL (TYPE AS NOTED ON PLAN)
E	EXISTING EMERGENCY GATE OPENER
	EXISTING CONTROL CABINET
- - -	EXISTING UNDERGROUND CONDUIT
	EXISTING UTILITY POLE
——	PROPOSED UNDERGROUND CONDUIT
	PROPOSED EMERGENCY SIGNAL HEAD
	PROPOSED OPTICOM DEVICE
	PROPOSED JUNCTION WELL (TYPE AS NOTED ON PLAN)
P	PROPOSED METERED SERVICE PEDESTAL WITH DISCONNECT SWITCH
	PROPOSED BASE MOUNTED CONTROL CABINET
	PROPOSED EMERGENCY GATE
G	PROPOSED EMERGENCY GATE OPENER
	PROPOSED LIGHT POLE AND 250W HPS LUMINAIRE



SEE SHEET 2 FOR SCHEDULES, GENERAL NOTES, AND EMERGENCY GATE SIGNS.

RECOMMENDED ______ DATE: 8.8.12	RECOMMENDED ______ DATE: ______	RECOMMENDED ______ DATE: 8/8/12	APPROVED TRAFFIC ENGINEER ______ DATE: 8/8/12	APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ______ DATE: 8/8/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

SCALE 0 30 60 90 FEET

EMERGENCY GATE INSTALLATION PROJECT

CONTRACT T201304701
COUNTY NEW CASTLE

GATE NO. N783
DESIGNED BY: SM
CHECKED BY: JCR

SOUTHERN GATE

SHEET NO. 1
TOTAL SHTS. 2

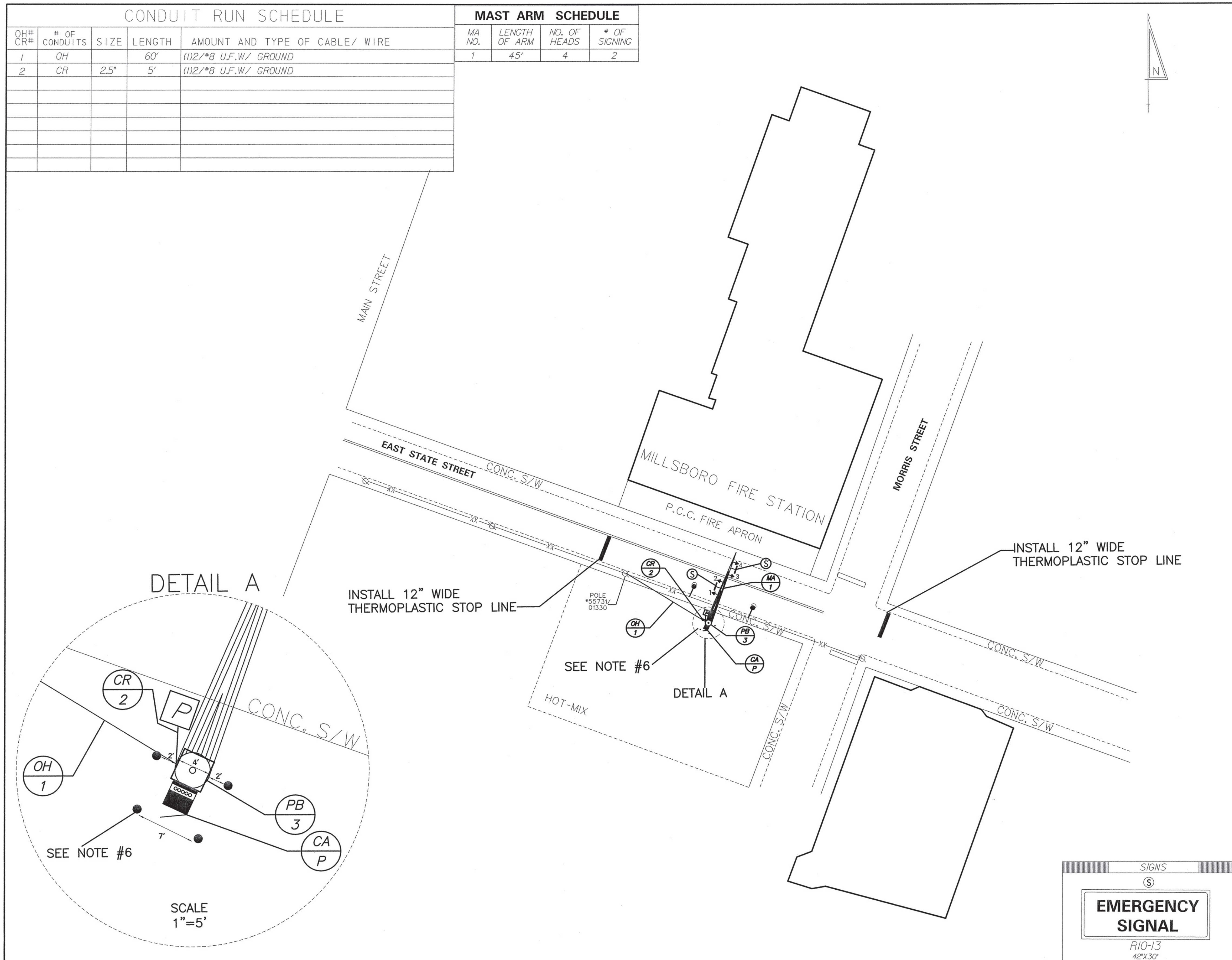
7/27/2012 10:45:02 AM
\\RKKNV2010\2010\10028_DELDOT_ITS\TASK 3 - CAPITAL PROGRAM REVIEW\EMERGENCY GATES\CADD\CP03_SOUTHGATE.DGN

CONDUIT RUN SCHEDULE

OH# CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
1	OH		60'	(1)2/#8 U.F.W/ GROUND
2	CR	2.5"	5'	(1)2/#8 U.F.W/ GROUND

MAST ARM SCHEDULE

MA NO.	LENGTH OF ARM	NO. OF HEADS	# OF SIGNING
1	45'	4	2



SIGNAL PHASING

1. IN NON PREEMPT MODE SIGNALS 1 AND 2 SHALL DISPLAY DARK. WHEN PREEMPTED A FLASHING YELLOW IS DISPLAYED FOLLOWED BY A STEADY YELLOW DURING THE CHANGE INTERVAL. THEN TWO FLASHING RED INDICATIONS DISPLAY UNTIL THE PREEMPTION IS OVER.

SIGNAL HEAD DIAGRAM

1,2,3,4

FLASHING RED BALL (R) (R) FLASHING RED BALL

(Y) FLASHING/STEADY YELLOW BALL

LEGEND

AB — ABANDON	OH * — EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA X — EXISTING CABINET IDENTIFIER (TYPE OF CABINET)	OH * — PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA X — PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	PB X — EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO * — EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PB X — PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO * — PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PL X — EXISTING POLE IDENTIFIER (# OF POLE)
JW X — EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PL X — PROPOSED POLE IDENTIFIER (# OF POLE)
JW X — PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	RM C — REMOVE BY CONTRACTOR
MA XX — EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)	RM O — REMOVE BY OTHERS
MA XX — PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)	RM TC — REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		P
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. ALL SIGNAL POLES WILL BE MAST ARMS
2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
3. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
4. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
6. INSTALL "BOLLARDS" AROUND SIGNAL POLE.
7. NEW OPTICOMS ARE TO BE INSTALLED ON THE TOP OF THE PROPOSED PED POLES.

RECOMMENDED Myk Fleming DATE: 11/10/11 | RECOMMENDED ________ DATE: ________ | RECOMMENDED [signature] DATE: 6/4/12 | APPROVED TRAFFIC ENGINEER [signature] DATE: 6/4/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 6/4/12

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUM / REVISIONS	SCALE 0 30 60 90 FEET	MILLSBORO FIRE STATION	CONTRACT T201204308	PERMIT NO. S333	FIRE SIGNAL PLAN EAST STATE STREET (IRON BRANCH ROAD)
				COUNTY SC	DESIGNED BY: MYK	SHEET NO. 1
					CHECKED BY: DLH	TOTAL SHTS. 1

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CONDUIT/OVERHEAD RUN SCHEDULE					
CR# OH#	# OF WIRES	SIZE	# OF CON	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
1	4	2.5"	2	10'	(2)9/*14,(1)2/*8 U.F.W/ GROUND,(1)4/*14
2	4	2.5"	2	50'	(2)9/*14,(1)2/*8 U.F.W/ GROUND,(1)4/*14
3	1	2"	1	10'	(1)4/*14
4	3	2.5"	2	50'	(2)9/*14 (1)2/*8 U.F.W./GROUND
5	3	2.5"	2	45'	(2)9/*14 (1)2/*8 U.F.W./GROUND
6	2	2.5"	1	60'	(2)9/*14
7	2	2.5"	1	20'	(2)9/*14
8	1	2.5"	1	75'	(1)2/*8 U.F.W./GROUND
1A	2			45'	(2)9/*14
2B	2			75'	(1)4/*14

*\DENOTES DOUBLE CONDUIT RUN

SIGNING LEGEND	
①	REMOVE EXISTING SIGN
②	EXISTING SIGN TO REMAIN
③	PLACE NEW SIGN
④	RENEW EXISTING SIGN
⑤	REPOSITION EXISTING SIGN

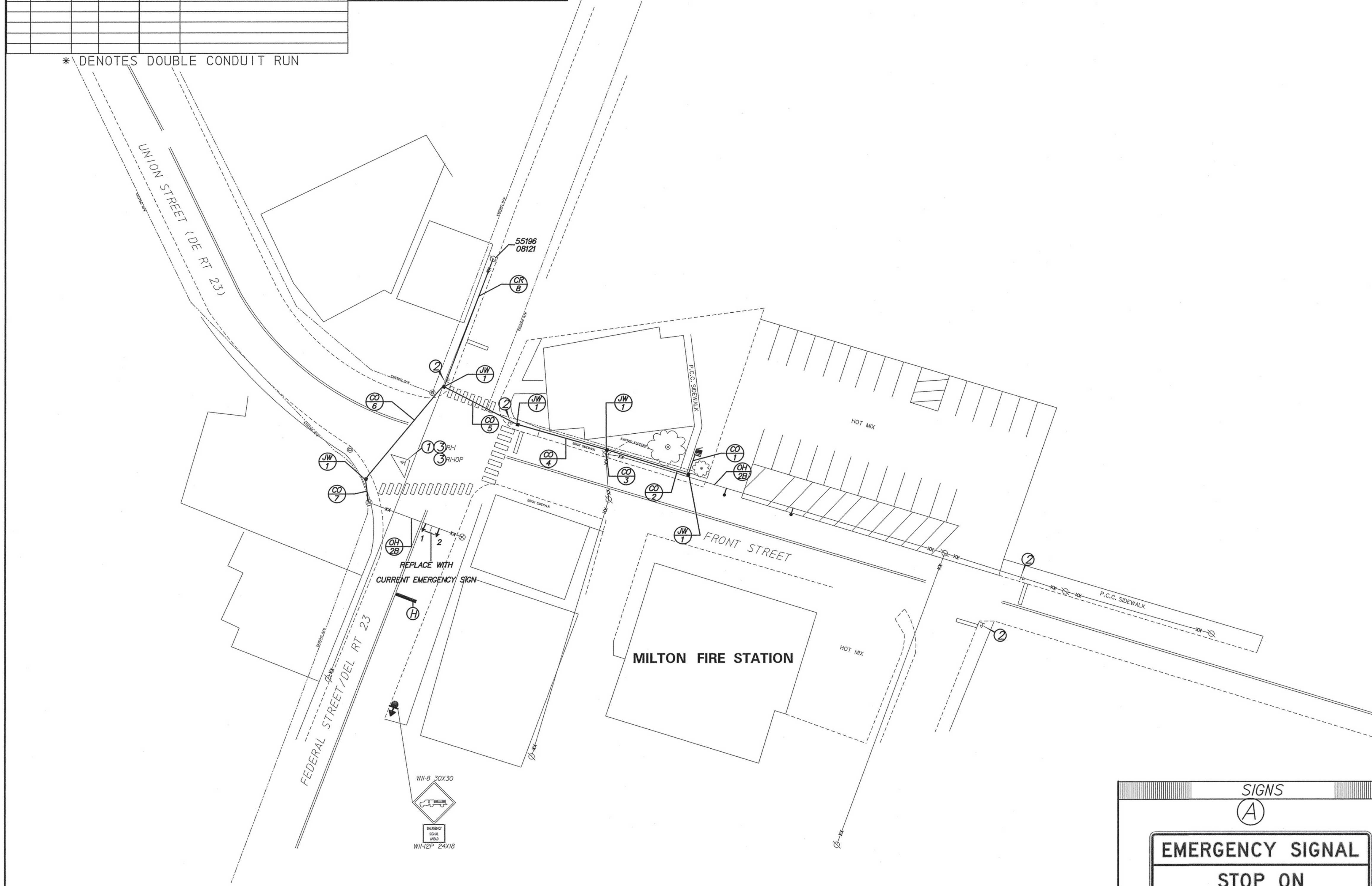
EXCEPT RIGHT TURN

R1-10P

STOP

R1-1

PAVEMENT MARKINGS LEGEND		
SYMBOL	ITEM	QUANTITY
(H)	24" SOLID WHITE ALKYD THERMOPLASTIC PAVEMENT STRIPING (ITEM 748015)	60 SF



SIGNAL PHASING

1. IN NON PREEMPT MODE SIGNALS 1 AND 2 SHALL DISPLAY DARK. WHEN PREEMPTED A FLASHING YELLOW IS DISPLAYED FOLLOWED BY A STEADY YELLOW DURING THE CHANGE INTERVAL. THEN TWO FLASHING RED INDICATIONS DISPLAY UNTIL THE PREEMPTION IS OVER.

SIGNAL HEAD DIAGRAM

1,2

FLASHING RED BALL (R) (R) FLASHING RED BALL

(Y) FLASHING/STEADY YELLOW BALL

LEGEND

PROPOSED SIGNAL CABINET	REMOVE BY CONTRACTOR
EXISTING SIGNAL CABINET	REMOVE BY OTHERS
PROPOSED SIGNAL POLE BASE	ABANDON
EXISTING SIGNAL POLE BASE	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PROPOSED PEDESTRIAN POLE BASE	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
EXISTING PEDESTRIAN POLE BASE	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
PROPOSED WOOD POLE	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
EXISTING UTILITY POLE	PROPOSED CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)
PROPOSED JUNCTION WELL	EXISTING CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)
J.W. EXISTING JUNCTION WELL	PROPOSED OVERHEAD RUN IDENTIFIER (* OF OVERHEAD RUN)
PROPOSED SIGNAL HEAD	EXISTING OVERHEAD RUN IDENTIFIER (* OF OVERHEAD RUN)
EXISTING SIGNAL HEAD	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
PROPOSED PEDESTRIAN SIGNAL HEAD	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
EXISTING PEDESTRIAN SIGNAL HEAD	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED PEDESTRIAN PUSHBUTTON	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
EXISTING PEDESTRIAN PUSHBUTTON	PROPOSED SPAN WIRE
PROPOSED VIDEO DETECTION	XX EXISTING SPAN WIRE
EXISTING VIDEO DETECTION	RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED MICROWAVE DETECTION	PROPOSED SPAN INSULATOR
EXISTING MICROWAVE DETECTION	EXISTING SPAN INSULATOR
OVERHEAD SIGNING	P SERVICE PEDESTAL
PROPOSED OPTICOM RECEIVER	
EXISTING OPTICOM RECEIVER	
PROPOSED MAST ARM	
EXISTING MAST ARM	
PROPOSED LUMINAIRE	
EXISTING LUMINAIRE	
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)	
EXISTING LOOP DETECTOR (TYPE 1 OR 2)	

GENERAL SIGNAL NOTES

1. ALL SIGNAL POLES WILL BE XX FEET, EXCEPT WHERE SHOWN.
2. CO *1 IS NOT DRAWN TO SCALE, NOR IS THE DIRECTION NECESSARILY CORRECT.
3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
4. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS.SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

SIGNS

(A)

EMERGENCY SIGNAL

STOP ON FLASHING RED

R10-14a

36X24

RECOMMENDED [signature] DATE: 5/03/12 | RECOMMENDED ____________ DATE: ______ | RECOMMENDED [signature] DATE: 5/3/12 | APPROVED TRAFFIC ENGINEER [signature] DATE: 5/3/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 5/3/12

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUM / REVISIONS	SCALE 0 30 60 90 FEET	MILTON FIRE STATION FIRE SIGNAL DESIGN	CONTRACT T201209404	PERMIT NO. S197P	SIGNAL PLAN	SHEET NO. 1
				COUNTY SUSSEX	DESIGNED BY: MYK	MILTON FIRE STATION	TOTAL SHTS. 1
					CHECKED BY: ML		

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NOTES:

7. THE CONTRACTOR SHALL INSTALL A FULL-DEPTH HOT-MIX PATCH FLUSH WITH THE ADJOINING PAVEMENT.

8. THE CONTRACTOR SHALL SPLICE THE LEAD-IN CABLES FOR THE PROPOSED LOOP DETECTORS TO THE EXISTING 4/*18 'HOME RUN' CABLE.

9. DELDOT TRAFFIC/TMC SHALL MODIFY THE SIGNAL PHASING SO THAT PHASES 1 AND 5 ARE PROTECTED ONLY.

10. THE CONTRACTOR SHALL INSTALL BACK GUYS, IN ACCORDANCE WITH ITEM 746501, ON THE EXISTING SIGNAL POLES PRIOR TO INSTALLING THE PROPOSED SPAN WIRES. THE BACK GUYS SHALL BE REMOVED, IN ACCORDANCE WITH ITEM 746710, WHEN THE EXISTING SPAN WIRES ARE REMOVED FROM THE EXISTING SIGNAL POLES.

11. THE CONTRACTOR SHALL ATTACH THE PROPOSED SPAN WIRES USING A GALVANIZED STEEL BULL RING. THE BULL RING SHALL HAVE A 4-INCH INSIDE DIAMETER AND BE FABRICATED FROM STEEL CONFORMING TO A668, QUENCHED AND TEMPERED. THE BAR DIAMETER SHALL NOT BE LESS THAN 7/8 INCHES. THE WELDLESS RINGS SHALL MEET FEDERAL SPECIFICATION RR-C271B TYPE VI. THE RINGS SHALL BE HOT DIP GALVANIZED IN ACCORDANCE WITH A153 SPECIFICATIONS. TWO GALVANIZED 3-BOLT GUY CLAMPS AND A SERVICE SLEEVE SHALL BE INSTALLED FOR EACH SPAN WIRE ATTACHMENT IN ACCORDANCE WITH STANDARD NO. T-12 (2005).

12. THE CONTRACTOR SHALL REMOVE THE EXISTING SPAN WIRE, SIGNAL HEADS, OPTICOM RECEIVERS, AND ELECTRICAL CABLES.

13. THE CONTRACTOR SHALL INSTALL THE PROPOSED SPAN WIRES, (2) 16/*14 HEAD CABLES, (4) 4/*18 OPTICOM CABLES, SIGNAL HEADS, OPTICOM RECEIVERS, AND OVERHEAD SIGNS, AS SHOWN.

14. THE CONTRACTOR SHALL INSTALL A DAVIT ARM CCTV CAMERA ON THE PROPOSED SIGNAL POLE, AS SHOWN.

15. DELDOT OIT SHALL COORDINATE THE SPLICING AND INSTALLATION OF ALL FIBER OPTIC CABLE AND INNERDUCT.

SPAN WIRE SCHEDULE

SPAN	LENGTH	SPAN MOUNT HEIGHT	5% DROP	BULL RING HEIGHT	5% SAG	SPAN LOW POINT
NORTHEAST	72 FT	29.1 FT	3.6 FT	25.5 FT	-	-
SOUTHEAST	100 FT	30.5 FT	5.0 FT	25.5 FT	-	-
NORTHWEST	48 FT	27.9 FT	2.4 FT	25.5 FT	-	-
SOUTHWEST	52 FT	28.1 FT	2.6 FT	25.5 FT	-	-
NORTH	110 FT	-	-	25.5 FT	5.5 FT	20.0 FT
SOUTH	110 FT	-	-	25.5 FT	5.5 FT	20.0 FT
EAST	72 FT	-	-	25.5 FT	3.6 FT	21.9 FT
WEST	72 FT	-	-	25.5 FT	3.6 FT	21.9 FT

* FIELD ADJUSTMENTS AS REQUIRED
** EXISTING NORTHEAST & SOUTHWEST SIGNAL POLES ARE 32 FEET
*** PROPOSED NORTHWEST & SOUTHEAST SIGNAL POLES ARE 32 FEET
**** NE CORNER - NEUTRAL @ 26'-10", PROPOSED SPAN @ 26'-8"
***** SE CORNER - NEUTRAL @ 31'-4", PROPOSED SPAN @ 26'-8"

CONDUIT RUN SCHEDULE

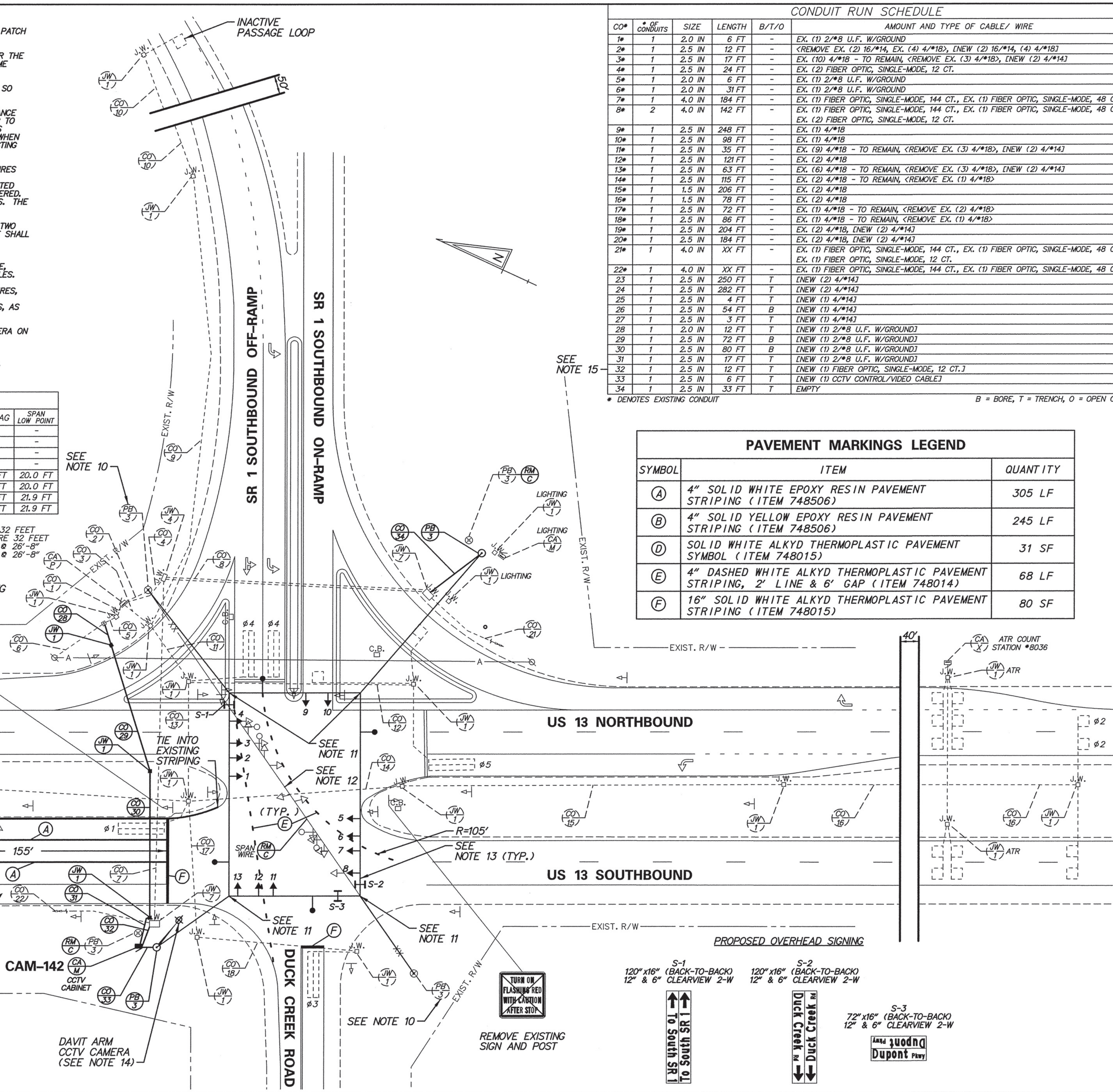
CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1*	1	2.0 IN	6 FT	-	EX. (1) 2/*8 U.F. W/GROUND
2*	1	2.5 IN	12 FT	-	<REMOVE EX. (2) 16/*14, EX. (4) 4/*18>, [NEW (2) 16/*14, (4) 4/*18]
3*	1	2.5 IN	17 FT	-	EX. (10) 4/*18 - TO REMAIN, <REMOVE EX. (3) 4/*18>, [NEW (2) 4/*14]
4*	1	2.5 IN	24 FT	-	EX. (2) FIBER OPTIC, SINGLE-MODE, 12 CT.
5*	1	2.0 IN	6 FT	-	EX. (1) 2/*8 U.F. W/GROUND
6*	1	2.0 IN	31 FT	-	EX. (1) 2/*8 U.F. W/GROUND
7*	1	4.0 IN	184 FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT.
8*	2	4.0 IN	142 FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT., EX. (2) FIBER OPTIC, SINGLE-MODE, 12 CT.
9*	1	2.5 IN	248 FT	-	EX. (1) 4/*18
10*	1	2.5 IN	98 FT	-	EX. (1) 4/*18
11*	1	2.5 IN	35 FT	-	EX. (9) 4/*18 - TO REMAIN, <REMOVE EX. (3) 4/*18>, [NEW (2) 4/*14]
12*	1	2.5 IN	121 FT	-	EX. (2) 4/*18
13*	1	2.5 IN	63 FT	-	EX. (6) 4/*18 - TO REMAIN, <REMOVE EX. (3) 4/*18>, [NEW (2) 4/*14]
14*	1	2.5 IN	115 FT	-	EX. (2) 4/*18 - TO REMAIN, <REMOVE EX. (1) 4/*18>
15*	1	1.5 IN	206 FT	-	EX. (2) 4/*18
16*	1	1.5 IN	78 FT	-	EX. (2) 4/*18
17*	1	2.5 IN	72 FT	-	EX. (1) 4/*18 - TO REMAIN, <REMOVE EX. (2) 4/*18>
18*	1	2.5 IN	86 FT	-	EX. (1) 4/*18 - TO REMAIN, <REMOVE EX. (1) 4/*18>
19*	1	2.5 IN	204 FT	-	EX. (2) 4/*18, [NEW (2) 4/*14]
20*	1	2.5 IN	184 FT	-	EX. (2) 4/*18, [NEW (2) 4/*14]
21*	1	4.0 IN	XX FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 12 CT.
22*	1	4.0 IN	XX FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT.
23	1	2.5 IN	250 FT	T	[NEW (2) 4/*14]
24	1	2.5 IN	282 FT	T	[NEW (2) 4/*14]
25	1	2.5 IN	4 FT	T	[NEW (1) 4/*14]
26	1	2.5 IN	54 FT	B	[NEW (1) 4/*14]
27	1	2.5 IN	3 FT	T	[NEW (1) 4/*14]
28	1	2.0 IN	12 FT	T	[NEW (1) 2/*8 U.F. W/GROUND]
29	1	2.5 IN	72 FT	B	[NEW (1) 2/*8 U.F. W/GROUND]
30	1	2.5 IN	80 FT	B	[NEW (1) 2/*8 U.F. W/GROUND]
31	1	2.5 IN	17 FT	T	[NEW (1) 2/*8 U.F. W/GROUND]
32	1	2.5 IN	12 FT	T	[NEW (1) FIBER OPTIC, SINGLE-MODE, 12 CT.]
33	1	2.5 IN	6 FT	T	[NEW (1) CCTV CONTROL/VIDEO CABLE]
34	1	2.5 IN	33 FT	T	EMPTY

* DENOTES EXISTING CONDUIT

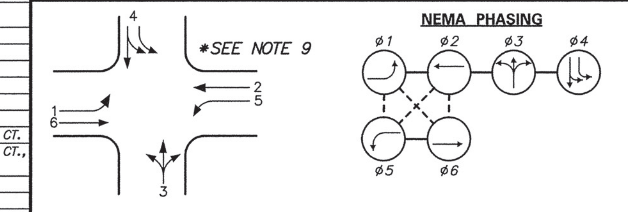
B = BORE, T = TRENCH, O = OPEN CUT

PAVEMENT MARKINGS LEGEND

SYMBOL	ITEM	QUANTITY
A	4" SOLID WHITE EPOXY RESIN PAVEMENT STRIPING (ITEM 748506)	305 LF
B	4" SOLID YELLOW EPOXY RESIN PAVEMENT STRIPING (ITEM 748506)	245 LF
D	SOLID WHITE ALKYD THERMOPLASTIC PAVEMENT SYMBOL (ITEM 748015)	31 SF
E	4" DASHED WHITE ALKYD THERMOPLASTIC PAVEMENT STRIPING, 2' LINE & 6' GAP (ITEM 748014)	68 LF
F	16" SOLID WHITE ALKYD THERMOPLASTIC PAVEMENT STRIPING (ITEM 748015)	80 SF



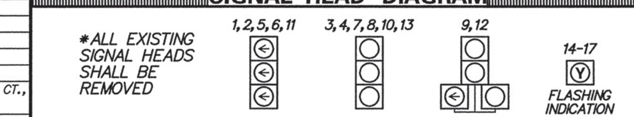
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

PROPOSED SIGNAL CABINET
EXISTING SIGNAL CABINET
PROPOSED SIGNAL POLE BASE
EXISTING SIGNAL POLE BASE
PROPOSED PEDESTRIAN POLE BASE
EXISTING PEDESTRIAN POLE BASE
PROPOSED WOOD POLE
EXISTING UTILITY POLE
PROPOSED JUNCTION WELL
EXISTING JUNCTION WELL
PROPOSED SIGNAL HEAD
EXISTING SIGNAL HEAD
PROPOSED PEDESTRIAN SIGNAL HEAD
EXISTING PEDESTRIAN SIGNAL HEAD
PROPOSED PEDESTRIAN PUSHBUTTON
EXISTING PEDESTRIAN PUSHBUTTON
PROPOSED VIDEO DETECTION
EXISTING VIDEO DETECTION
PROPOSED MICROWAVE DETECTION
EXISTING MICROWAVE DETECTION
OVERHEAD SIGNING
PROPOSED OPTICOM RECEIVER
EXISTING OPTICOM RECEIVER
PROPOSED MAST ARM
EXISTING MAST ARM
PROPOSED LUMINAIRE
EXISTING LUMINAIRE
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
EXISTING LOOP DETECTOR (TYPE 1 OR 2)
REMOVE BY CONTRACTOR
REMOVE BY OTHERS
ABANDON
PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED SPAN WIRE
EXISTING SPAN WIRE
RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED SPAN INSULATOR
EXISTING SPAN INSULATOR
SERVICE PEDESTAL
PROPOSED DAVIT ARM CCTV CAMERA

GENERAL SIGNAL NOTES

1. EXISTING LOOP DETECTORS (TO REMAIN):
   TYPE #1 - 6' x 6' - NORTHBOUND US 13 THROUGH MOVEMENTS AND SR 1 SB OFF-RAMP (INACTIVE)
   TYPE #2 - 6' x 25' - DUCK CREEK ROAD ALL MOVEMENTS, SR 1 SB OFF-RAMP LEFT-TURN AND THROUGH MOVEMENTS, AND US 13 LEFT-TURN MOVEMENTS
   SYSTEM - 6' x 6' - SR 1 SB ON-RAMP AND US 13 RECEIVING LANES

   PROPOSED LOOP DETECTORS:
   TYPE #1 - 6' x 6' - TO BE INSTALLED IN SOUTHBOUND US 13 THROUGH MOVEMENTS
2. ALL EXISTING AND PROPOSED SIGNAL POLES ARE 32 FEET.
3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
4. POLE BASES ARE TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ______ DATE: ______
RECOMMENDED ______ DATE: ______
RECOMMENDED ______ DATE: 2/16/10
APPROVED TRAFFIC ENGINEER ______ DATE: 2/17/10
APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ______ DATE: 2/17/10

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

1 CONVERTED NB & SB US 13 LEFT-TURN PHASES TO PROTECTED ONLY AND INSTALLED SUSPENDED BOX SPAN, SIGNAL AHEAD HBS ALONG SB US 13, & DELTRAC CCTV. D.W.C. (WR&A) 12-09 (CONTRACT # 30-004-01)

SCALE 0 30 60 90 FEET

HEP 2009, TRANSPARENCY REPORT, SITE 5

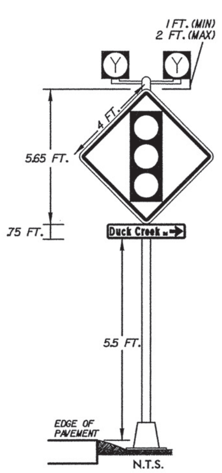
CONTRACT	30-004-01	PERMIT NO.	N-561
COUNTY	NEW CASTLE	DESIGNED BY: D.W.C. (WR&A)	CHECKED BY: M.J.B. (WR&A)

SIGNAL PLAN
US 13 @ DUCK CREEK ROAD / SR 1 SB RAMPS

SHEET NO. 1
TOTAL SHTS. 2

pw:\31627-010\CADD\SG01_US 13 @ Duck Creek.dgn
2/11/2010 6:24:43 PM

HIB ASSEMBLY



1. HAZARD IDENTIFICATION BEACON (HIB) ASSEMBLY SHALL CONSIST OF A PAIR OF ALTERNATELY FLASHING BEACONS AND A SIGNAL AHEAD SIGN (W3-3, 48" x 48") WITH AN ADVANCE STREET NAME PLAQUE SIGN (W16-8, 48" x 9") MOUNTED ON A PEDESTAL POLE.
2. THE BEACONS SHALL BE 12-INCH YELLOW L.E.D. ONE-SECTION TRAFFIC SIGNAL HEADS.
3. THE BEACONS SHALL OPERATE 24 HOURS A DAY, 7 DAYS A WEEK.
4. THE FLASHING RATE SHALL NOT BE LESS THAN 50 NOR MORE THAN 60 TIMES PER MINUTE.
5. THE ILLUMINATED PERIOD OF EACH FLASH SHALL NOT BE LESS THAN 1/2 NOR MORE THAN 2/3 OF THE FLASH CYCLE.
6. SIGNFIX (OR SIMILAR) SHALL BE INSTALLED ON THE BACK OF THE PROPOSED SIGNS FOR MOUNTING SUPPORT.
7. TO INSTALL THE PROPOSED SIGNS AND BEACONS AT THE REQUIRED MOUNTING HEIGHTS, 4-INCH RIGID ALUMINUM CONDUIT SHALL BE THREADED TO THE TOP OF THE PEDESTAL POLE.
8. THE PEDESTAL POLE SHALL BE SPUN ALUMINUM, SCHEDULE 80.

CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1*	1	2.0 IN	6 FT	-	EX. (1) 2/#8 U.F. W/GROUND
2*	1	2.5 IN	12 FT	-	<REMOVE EX. (2) 16/#14, EX. (4) 4/#18>, [NEW (2) 16/#14, (4) 4/#18]
3*	1	2.5 IN	17 FT	-	EX. (10) 4/#18 - TO REMAIN, <REMOVE EX. (3) 4/#18>, [NEW (2) 4/#14]
4*	1	2.5 IN	24 FT	-	EX. (2) FIBER OPTIC, SINGLE-MODE, 12 CT.
5*	1	2.0 IN	6 FT	-	EX. (1) 2/#8 U.F. W/GROUND
6*	1	2.0 IN	31 FT	-	EX. (1) 2/#8 U.F. W/GROUND
7*	1	4.0 IN	184 FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT.
8*	2	4.0 IN	142 FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT., EX. (2) FIBER OPTIC, SINGLE-MODE, 12 CT.
9*	1	2.5 IN	248 FT	-	EX. (1) 4/#18
10*	1	2.5 IN	98 FT	-	EX. (1) 4/#18
11*	1	2.5 IN	35 FT	-	EX. (9) 4/#18 - TO REMAIN, <REMOVE EX. (3) 4/#18>, [NEW (2) 4/#14]
12*	1	2.5 IN	121 FT	-	EX. (2) 4/#18
13*	1	2.5 IN	63 FT	-	EX. (6) 4/#18 - TO REMAIN, <REMOVE EX. (3) 4/#18>, [NEW (2) 4/#14]
14*	1	2.5 IN	115 FT	-	EX. (2) 4/#18 - TO REMAIN, <REMOVE EX. (1) 4/#18>
15*	1	1.5 IN	206 FT	-	EX. (2) 4/#18
16*	1	1.5 IN	78 FT	-	EX. (2) 4/#18
17*	1	2.5 IN	72 FT	-	EX. (1) 4/#18 - TO REMAIN, <REMOVE EX. (2) 4/#18>
18*	1	2.5 IN	86 FT	-	EX. (1) 4/#18 - TO REMAIN, <REMOVE EX. (1) 4/#18>
19*	1	2.5 IN	204 FT	-	EX. (2) 4/#18, [NEW (2) 4/#14]
20*	1	2.5 IN	184 FT	-	EX. (2) 4/#18, [NEW (2) 4/#14]
21*	1	4.0 IN	XX FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 12 CT.
22*	1	4.0 IN	XX FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 144 CT., EX. (1) FIBER OPTIC, SINGLE-MODE, 48 CT.
23	1	2.5 IN	250 FT	T	[NEW (2) 4/#14]
24	1	2.5 IN	282 FT	T	[NEW (2) 4/#14]
25	1	2.5 IN	4 FT	T	[NEW (1) 4/#14]
26	1	2.5 IN	54 FT	B	[NEW (1) 4/#14]
27	1	2.5 IN	3 FT	T	[NEW (1) 4/#14]
28	1	2.0 IN	12 FT	T	[NEW (1) 2/#8 U.F. W/GROUND]
29	1	2.5 IN	72 FT	B	[NEW (1) 2/#8 U.F. W/GROUND]
30	1	2.5 IN	80 FT	B	[NEW (1) 2/#8 U.F. W/GROUND]
31	1	2.5 IN	17 FT	T	[NEW (1) 2/#8 U.F. W/GROUND]
32	1	2.5 IN	12 FT	T	[NEW (1) FIBER OPTIC, SINGLE-MODE, 12 CT.]
33	1	2.5 IN	6 FT	T	[NEW (1) CCTV CONTROL/VIDEO CABLE]
34	1	2.5 IN	33 FT	T	EMPTY

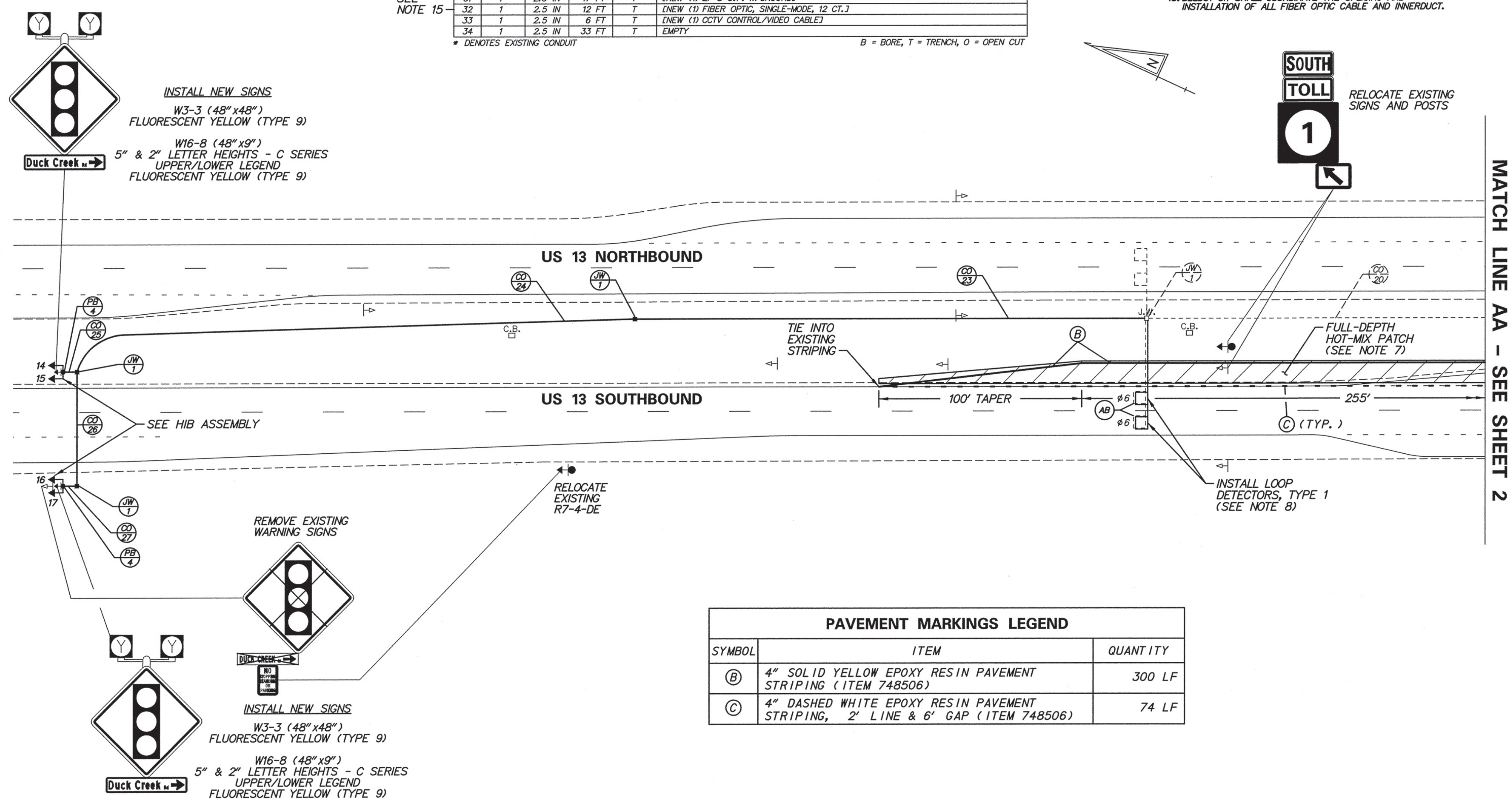
SEE NOTE 15 (CO 32)

* DENOTES EXISTING CONDUIT

B = BORE, T = TRENCH, O = OPEN CUT

NOTES:

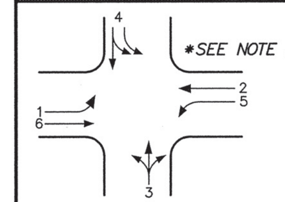
7. THE CONTRACTOR SHALL INSTALL A FULL-DEPTH HOT-MIX PATCH FLUSH WITH THE ADJOINING PAVEMENT.
8. THE CONTRACTOR SHALL SPLICE THE LEAD-IN CABLES FOR THE PROPOSED LOOP DETECTORS TO THE EXISTING 4/#18 'HOME RUN' CABLE.
9. DELDOT TRAFFIC/TMC SHALL MODIFY THE SIGNAL PHASING SO THAT PHASES 1 AND 5 ARE PROTECTED ONLY.
10. THE CONTRACTOR SHALL INSTALL BACK GUYS, IN ACCORDANCE WITH ITEM 746501, ON THE EXISTING SIGNAL POLES PRIOR TO INSTALLING THE PROPOSED SPAN WIRES. THE BACK GUYS SHALL BE REMOVED, IN ACCORDANCE WITH ITEM 746710, WHEN THE EXISTING SPAN WIRES ARE REMOVED FROM THE EXISTING SIGNAL POLES.
11. THE CONTRACTOR SHALL ATTACH THE PROPOSED SPAN WIRES USING A GALVANIZED STEEL BULL RING. THE BULL RING SHALL HAVE A 4-INCH INSIDE DIAMETER AND BE FABRICATED FROM STEEL CONFORMING TO A668, QUENCHED AND TEMPERED. THE BAR DIAMETER SHALL NOT BE LESS THAN 7/8 INCHES. THE WELDLESS RINGS SHALL MEET FEDERAL SPECIFICATION RR-C271B TYPE VI. THE RINGS SHALL BE HOT DIP GALVANIZED IN ACCORDANCE WITH A153 SPECIFICATIONS. TWO GALVANIZED 3-BOLT GUY CLAMPS AND A SERVICE SLEEVE SHALL BE INSTALLED FOR EACH SPAN WIRE ATTACHMENT IN ACCORDANCE WITH STANDARD NO. T-12 (2005).
12. THE CONTRACTOR SHALL REMOVE THE EXISTING SPAN WIRE, SIGNAL HEADS, OPTICOM RECEIVERS, AND ELECTRICAL CABLES.
13. THE CONTRACTOR SHALL INSTALL THE PROPOSED SPAN WIRES, (2) 16/#14 HEAD CABLES, (4) 4/#18 OPTICOM CABLES, SIGNAL HEADS, OPTICOM RECEIVERS, AND OVERHEAD SIGNS, AS SHOWN.
14. THE CONTRACTOR SHALL INSTALL A DAVIT ARM CCTV CAMERA ON THE PROPOSED SIGNAL POLE, AS SHOWN.
15. DELDOT OIT SHALL COORDINATE THE SPLICING AND INSTALLATION OF ALL FIBER OPTIC CABLE AND INNERDUCT.



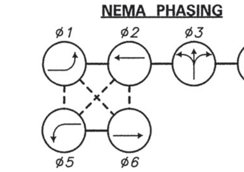
PAVEMENT MARKINGS LEGEND

SYMBOL	ITEM	QUANTITY
B	4" SOLID YELLOW EPOXY RESIN PAVEMENT STRIPING (ITEM 748506)	300 LF
C	4" DASHED WHITE EPOXY RESIN PAVEMENT STRIPING, 2' LINE & 6' GAP (ITEM 748506)	74 LF

SIGNAL PHASING



NEMA PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM

*ALL EXISTING SIGNAL HEADS SHALL BE REMOVED

1,2,5,6,11 | 3,4,7,8,10,13 | 9,12 | 14-17 FLASHING INDICATION

LEGEND

PROPOSED SIGNAL CABINET	REMOVE BY CONTRACTOR
EXISTING SIGNAL CABINET	REMOVE BY OTHERS
PROPOSED SIGNAL POLE BASE	ABANDON
EXISTING SIGNAL POLE BASE	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PROPOSED PEDESTRIAN POLE BASE	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
EXISTING PEDESTRIAN POLE BASE	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
PROPOSED WOOD POLE	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
EXISTING UTILITY POLE	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
PROPOSED JUNCTION WELL	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
EXISTING JUNCTION WELL	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
PROPOSED SIGNAL HEAD	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
EXISTING SIGNAL HEAD	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
PROPOSED PEDESTRIAN SIGNAL HEAD	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
EXISTING PEDESTRIAN SIGNAL HEAD	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED PEDESTRIAN PUSHBUTTON	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
EXISTING PEDESTRIAN PUSHBUTTON	PROPOSED SPAN WIRE
PROPOSED VIDEO DETECTION	EXISTING SPAN WIRE
EXISTING VIDEO DETECTION	RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED MICROWAVE DETECTION	PROPOSED SPAN INSULATOR
EXISTING MICROWAVE DETECTION	EXISTING SPAN INSULATOR
OVERHEAD SIGNING	SERVICE PEDESTAL
PROPOSED OPTICOM RECEIVER	PROPOSED DAVIT ARM CCTV CAMERA
EXISTING OPTICOM RECEIVER	
PROPOSED MAST ARM	
EXISTING MAST ARM	
PROPOSED LUMINAIRE	
EXISTING LUMINAIRE	
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)	
EXISTING LOOP DETECTOR (TYPE 1 OR 2)	

GENERAL SIGNAL NOTES

1. EXISTING LOOP DETECTORS (TO REMAIN):
   TYPE #1 - 6' x 6' - NORTHBOUND US 13 THROUGH MOVEMENTS AND SR 1 SB OFF-RAMP (INACTIVE)
   TYPE #2 - 6' x 25' - DUCK CREEK ROAD ALL MOVEMENTS, SR 1 SB OFF-RAMP LEFT-TURN AND THROUGH MOVEMENTS, AND US 13 LEFT-TURN MOVEMENTS
   SYSTEM - 6' x 6' - SR 1 SB ON-RAMP AND US 13 RECEIVING LANES

   PROPOSED LOOP DETECTORS:
   TYPE #1 - 6' x 6' - TO BE INSTALLED IN SOUTHBOUND US 13 THROUGH MOVEMENTS
2. ALL EXISTING AND PROPOSED SIGNAL POLES ARE 32 FEET.
3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
4. POLE BASES ARE TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ______ DATE: ______ | RECOMMENDED ______ DATE: ______ | RECOMMENDED [signature] DATE: 2/16/10 | APPROVED TRAFFIC ENGINEER [signature] DATE: 2/17/10 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 2/17/10

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

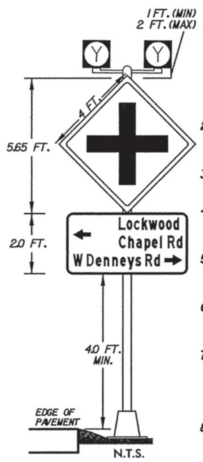
1 CONVERTED NB & SB US 13 LEFT-TURN PHASES TO PROTECTED ONLY AND INSTALLED SUSPENDED BOX SPAN, SIGNAL AHEAD HIBS ALONG SB US 13, & DELTRAC CCTV
D.W.C. (WR&A) 12-09 (CONTRACT # 30-004-01)

SCALE 0 30 60 90 FEET

HEP 2009, TRANSPARENCY REPORT, SITE 5

CONTRACT	PERMIT NO.	N-561	SIGNAL PLAN	SHEET NO.
30-004-01	DESIGNED BY: D.W.C. (WR&A)		US 13 @ DUCK CREEK ROAD / SR 1 SB RAMPS	2
COUNTY				TOTAL SHTS.
NEW CASTLE	CHECKED BY: M.J.B. (WR&A)			2

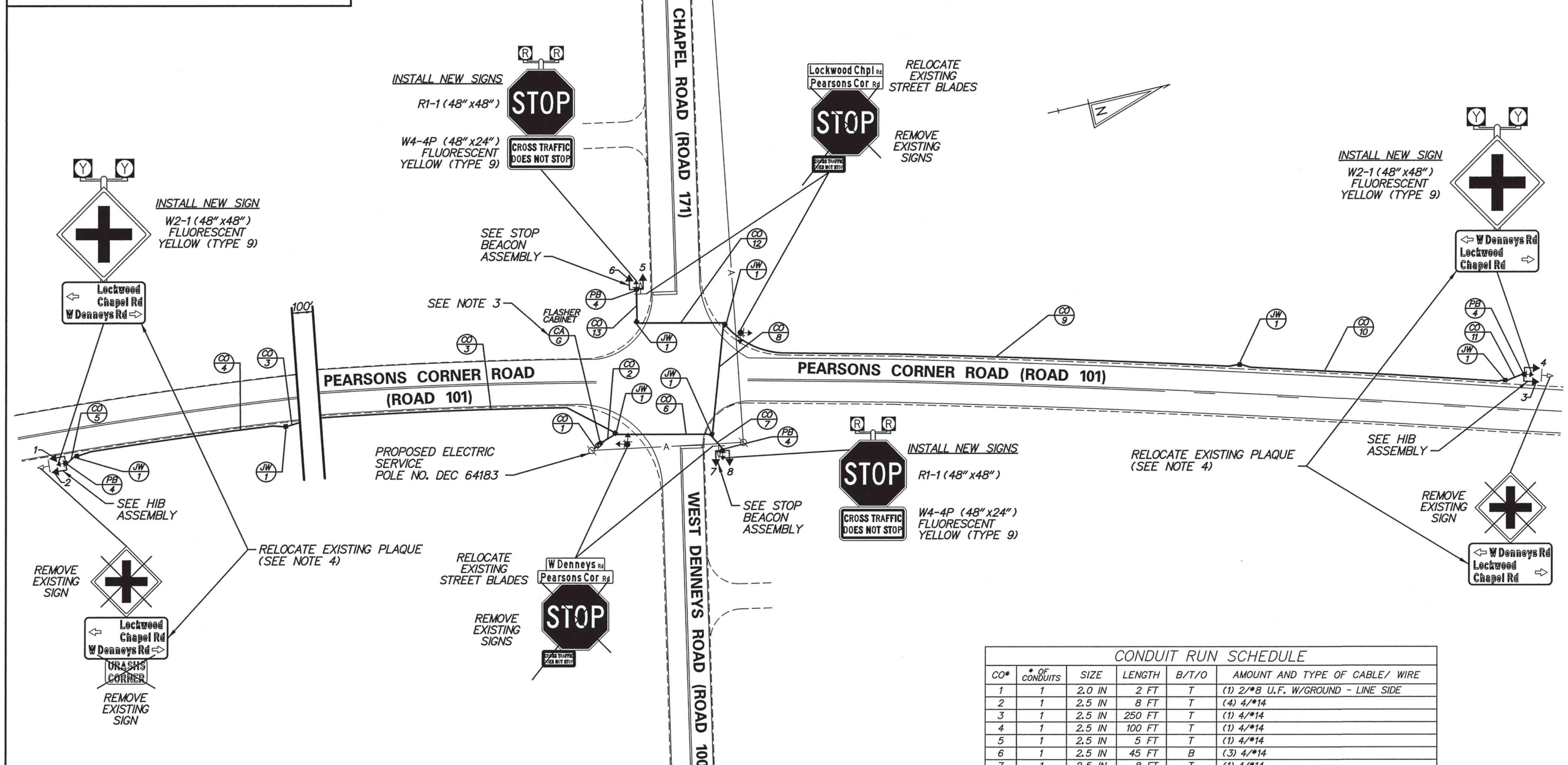
HIB ASSEMBLY



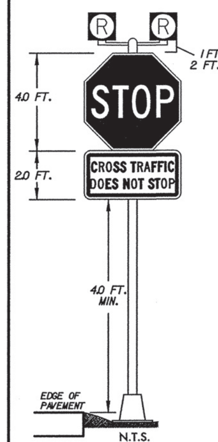
1. HAZARD IDENTIFICATION BEACON (HIB) ASSEMBLY SHALL CONSIST OF A PAIR OF ALTERNATELY FLASHING BEACONS AND A CROSS ROAD WARNING SIGN (W2-1, 48" x 48") WITH AN ADVANCE STREET NAME PLAQUE (W16-8aP, 36" x 24") MOUNTED ON A PEDESTAL POLE.
2. THE BEACONS SHALL BE 12-INCH YELLOW L.E.D. ONE-SECTION TRAFFIC SIGNAL HEADS.
3. THE BEACONS SHALL OPERATE 24 HOURS A DAY, 7 DAYS A WEEK.
4. THE FLASHING RATE SHALL NOT BE LESS THAN 50 NOR MORE THAN 60 TIMES PER MINUTE.
5. THE ILLUMINATED PERIOD OF EACH FLASH SHALL NOT BE LESS THAN 1/2 NOR MORE THAN 2/3 OF THE FLASH CYCLE.
6. SIGNFIX (OR SIMILAR) SHALL BE INSTALLED ON THE BACK OF THE PROPOSED SIGNS FOR MOUNTING SUPPORT.
7. TO INSTALL THE PROPOSED SIGNS AND BEACONS AT THE REQUIRED MOUNTING HEIGHTS, 4-INCH RIGID ALUMINUM CONDUIT SHALL BE THREADED TO THE TOP OF THE PEDESTAL POLE.
8. THE PEDESTAL POLE SHALL BE SPUN ALUMINUM, SCHEDULE 80.

NOTES:

3. THE PROPOSED FLASHER CABINET SHALL BE INSTALLED ON THE PROPOSED METERED SERVICE PEDESTAL.
4. DELDOT'S SIGNING SECTION SHALL REMOVE THE EXISTING W16-8aP PLAQUE AND INSTALL SIGNFIX (OR SIMILAR) TO THE BACK OF THE EXISTING PLAQUE. DELDOT'S TRAFFIC CONTRACTOR SHALL INSTALL THE PLAQUE TO THE PROPOSED HIB ASSEMBLY.



STOP BEACON ASSEMBLY



1. STOP BEACON ASSEMBLY SHALL CONSIST OF A PAIR OF SIMULTANEOUSLY FLASHING BEACONS AND A STOP SIGN (R1-1, 48" x 48") WITH A CROSS TRAFFIC DOES NOT STOP PLAQUE (W4-4P, 48" x 24") MOUNTED ON A PEDESTAL POLE.
2. THE BEACONS SHALL BE 12-INCH RED L.E.D. ONE-SECTION TRAFFIC SIGNAL HEADS.
3. THE BEACONS SHALL OPERATE 24 HOURS A DAY, 7 DAYS A WEEK.
4. THE FLASHING RATE SHALL NOT BE LESS THAN 50 NOR MORE THAN 60 TIMES PER MINUTE.
5. THE ILLUMINATED PERIOD OF EACH FLASH SHALL NOT BE LESS THAN 1/2 NOR MORE THAN 2/3 OF THE FLASH CYCLE.
6. SIGNFIX (OR SIMILAR) SHALL BE INSTALLED ON THE BACK OF THE PROPOSED SIGNS FOR MOUNTING SUPPORT.
7. TO INSTALL THE PROPOSED SIGNS AND BEACONS AT THE REQUIRED MOUNTING HEIGHTS, 4-INCH RIGID ALUMINUM CONDUIT SHALL BE THREADED TO THE TOP OF THE PEDESTAL POLE.
8. THE PEDESTAL POLE SHALL BE SPUN ALUMINUM, SCHEDULE 80.

SIGNAL PHASING

SIGNAL HEAD DIAGRAM

1-4 Y ALTERNATELY FLASHING INDICATION

5-8 R SIMULTANEOUSLY FLASHING INDICATION

LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM/C REMOVE BY CONTRACTOR
- RM/O REMOVE BY OTHERS
- AB ABANDON
- PB/X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB/X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW/X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW/X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA/XX PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA/XX EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA/X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA/X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P SERVICE PEDESTAL

GENERAL SIGNAL NOTES

1. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
2. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1	1	2.0 IN	2 FT	T	(1) 2/#8 U.F. W/GROUND - LINE SIDE
2	1	2.5 IN	8 FT	T	(4) 4/#14
3	1	2.5 IN	250 FT	T	(1) 4/#14
4	1	2.5 IN	100 FT	T	(1) 4/#14
5	1	2.5 IN	5 FT	T	(1) 4/#14
6	1	2.5 IN	45 FT	B	(3) 4/#14
7	1	2.5 IN	8 FT	T	(1) 4/#14
8	1	2.5 IN	51 FT	B	(2) 4/#14
9	1	2.5 IN	250 FT	T	(1) 4/#14
10	1	2.5 IN	126 FT	T	(1) 4/#14
11	1	2.5 IN	8 FT	T	(1) 4/#14
12	1	2.5 IN	41 FT	B	(1) 4/#14
13	1	2.5 IN	14 FT	T	(1) 4/#14

B = BORE, T = TRENCH, O = OPEN CUT

RECOMMENDED ______ DATE: ______ RECOMMENDED ______ DATE: ______ RECOMMENDED [signature] DATE: 2/22/11 APPROVED TRAFFIC ENGINEER [signature] DATE: 2/22/11 APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 2/22/11

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE 0 30 60 90 FEET

2009 HEP, SITE I

CONTRACT	PERMIT NO.	K296
T201000401	DESIGNED BY: D.W.C. (WR&A)	
COUNTY		
KENT	CHECKED BY: M.J.B. (WR&A)	

HAZARD IDENTIFICATION BEACON PLAN
PEARSONS CORNER ROAD (ROAD 101) @ LOCKWOOD CHAPEL ROAD (ROAD 171)/ WEST DENNEYS ROAD (ROAD 100)

SHEET NO. 1 TOTAL SHTS. 1

N:\3827-007\CADD\S01_Pearsons Corner.dgn 2/19/2011 8:14:27 AM

ADDITIONAL GENERAL SIGNAL NOTES

8. INSTALL TEMPORARY SPAN WIRE TO CONNECT PROPOSED MAST ARMS. ROUTE THE SIGNAL CABLE AERIALLY THROUGH THE PROPOSED SPAN WIRE TO ACTIVATE SIGNAL HEADS #5-#8.

9. THE LOAD BEARING JUNCTION WELL IS A SPECIAL PROVISION JUNCTION WELL AND WILL BE FABRICATED BASED ON THE DETAIL AND SPECIAL PROVISION SPECIFICATION. THE JUNCTION WELL WILL BE UNDER TRAFFIC AT THIS LOCATION. AT THE END OF ROAD CONSTRUCTION THIS LOCATION WILL BE PART OF CURBED MEDIAN.

10. THE PROPOSED SIGNAL POLES, MAST ARM, AND CONTROLLER CABINET SHALL BE CONSTRUCTED AT THE BEGINNING OF THIS PHASE.

11. CONDUIT RUN #5 AND #8 SHALL BE INSTALLED DURING THIS PHASE.

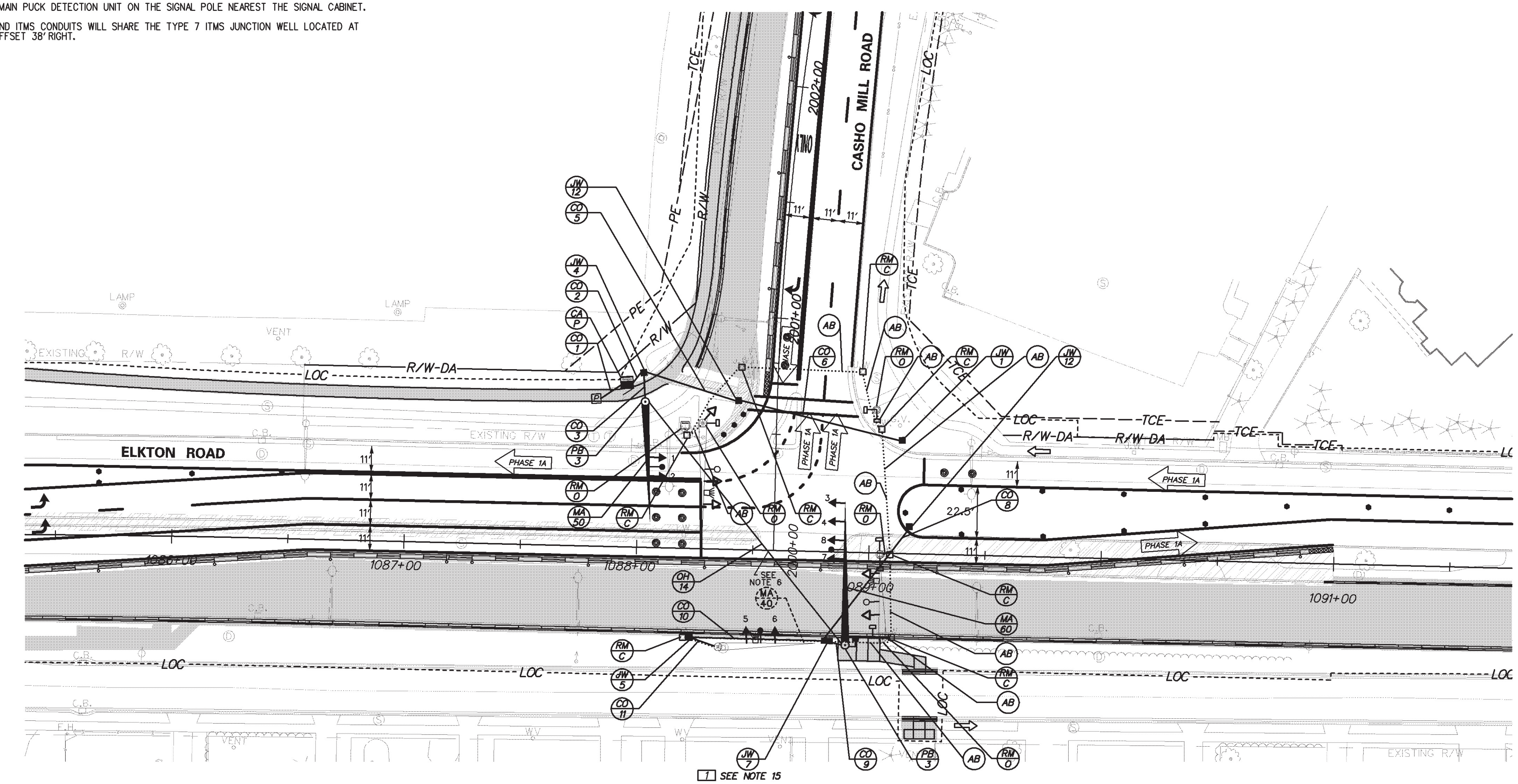
12. WHEN A PEDESTRIAN CROSSING IS PROHIBITED FOR ANY MOVEMENT, THE CORRESPONDING PEDESTRIAN SIGNAL HEAD SHALL BE BAGGED.

13. REMOVE THE VIDEO DETECTION SYSTEM FROM THE MAST ARMS.

14. INSTALL THE MAIN PUCK DETECTION UNIT ON THE SIGNAL POLE NEAREST THE SIGNAL CABINET.

1 15. THE SIGNAL AND ITMS CONDUITS WILL SHARE THE TYPE 7 ITMS JUNCTION WELL LOCATED AT STATION 1088+83 OFFSET 38' RIGHT.

PHASE 1A



CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
1	1	2"	10'	(1)2/#8 U.F. W/GROUND
2	3	2.5"	5'	(3)16/#14, (3)4/#18, (1)9/#14
3	1	2.5"	9'	(3)16/#14, (3)4/#18, (1)9/#14
5	1	2.5"	39'	EMPTY
6	1	2.5"	70'	EMPTY
8	1	2.5"	60'	EMPTY
9	1	2.5"	2'	(1)16/#14, (1) 9/#14, (1)4/#18
10	1	2.5"	62'	(1)16/#14, (1)4/#18
11	1	2.5"	12'	(1)16/#14, (1)4/#18
OH14			133'	(2)16/#14, (1)9/#14, (2) 4/#18

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

POLE SCHEDULE

NO.		STATION	OFFSET
1	50' MAST ARM POLE W/ TYPE 3 BASE	1088+02	63' L
2	60' MAST ARM POLE W/ TYPE 3 BASE	1088+91	40' R
2 *3	40' MAST ARM POLE W/ TYPE 3 BASE	1088+36	42' R

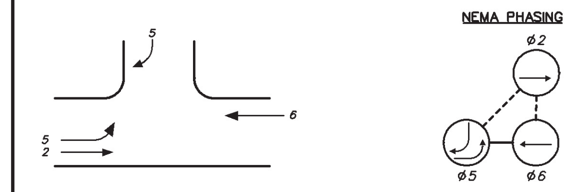
* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

JUNCTION WELL AND CABINET SCHEDULE

NO.	STATION	OFFSET
J1	1088+01 ℄ SR 2	75' L
J3	1088+42 ℄ SR 2	64' L
J4	1089+13 ℄ SR 2	49' L
2 J5	1089+17 ℄ SR 2	12' L
1 J6	1088+83 ℄ SR 2	38' R
J7	1088+22 ℄ SR 2	39' R
2 CA	1087+95 ℄ SR 2	71' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

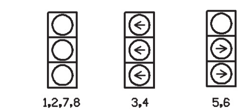
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM C — REMOVE BY CONTRACTOR
- RM O — REMOVE BY OTHERS
- AB — ABANDON
- PB X — PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB X — EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW X — PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW X — EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO # — PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO # — EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH # — PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH # — EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA XX — PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA XX — EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA X — PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA X — EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- XX — EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P — SERVICE PEDESTAL
- PUCK DETECTION SYSTEM

GENERAL SIGNAL NOTES

1. INSTALL TEMPORARY MAGNETIC IN STREET (PUCK) DETECTION SYSTEM IN EACH LANE AT A DISTANCE OF 8 FEET AND 20 FEET FROM THE STOP BAR.

2. ALL SIGNAL POLES WILL BE 21 FEET, EXCEPT WHERE SHOWN.

3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.

4. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.

5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.

6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

7. ALL SIGNAL HEADS SHALL BE CONTROLLED BY THE PROPOSED CONTROLLER CABINET DURING THIS PHASE. THE NEW SIGNAL LAYOUT SHALL BE ACTIVATED BEFORE THE REMOVAL OF THE EXISTING CONTROLLER CABINET AND SIGNAL SETUP.

RECOMMENDED *Mir Wahed* DATE: 1/20/10 | RECOMMENDED ____ DATE: ____ | RECOMMENDED ____ DATE: ____ | APPROVED TRAFFIC ENGINEER ____ DATE: ____ | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ____ DATE: ____

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS
1 REVISED SHEET - MAW 12/3/2010
2 REVISED SHEET - MAW 05/4/2011

SCALE 0 30 60 90 FEET

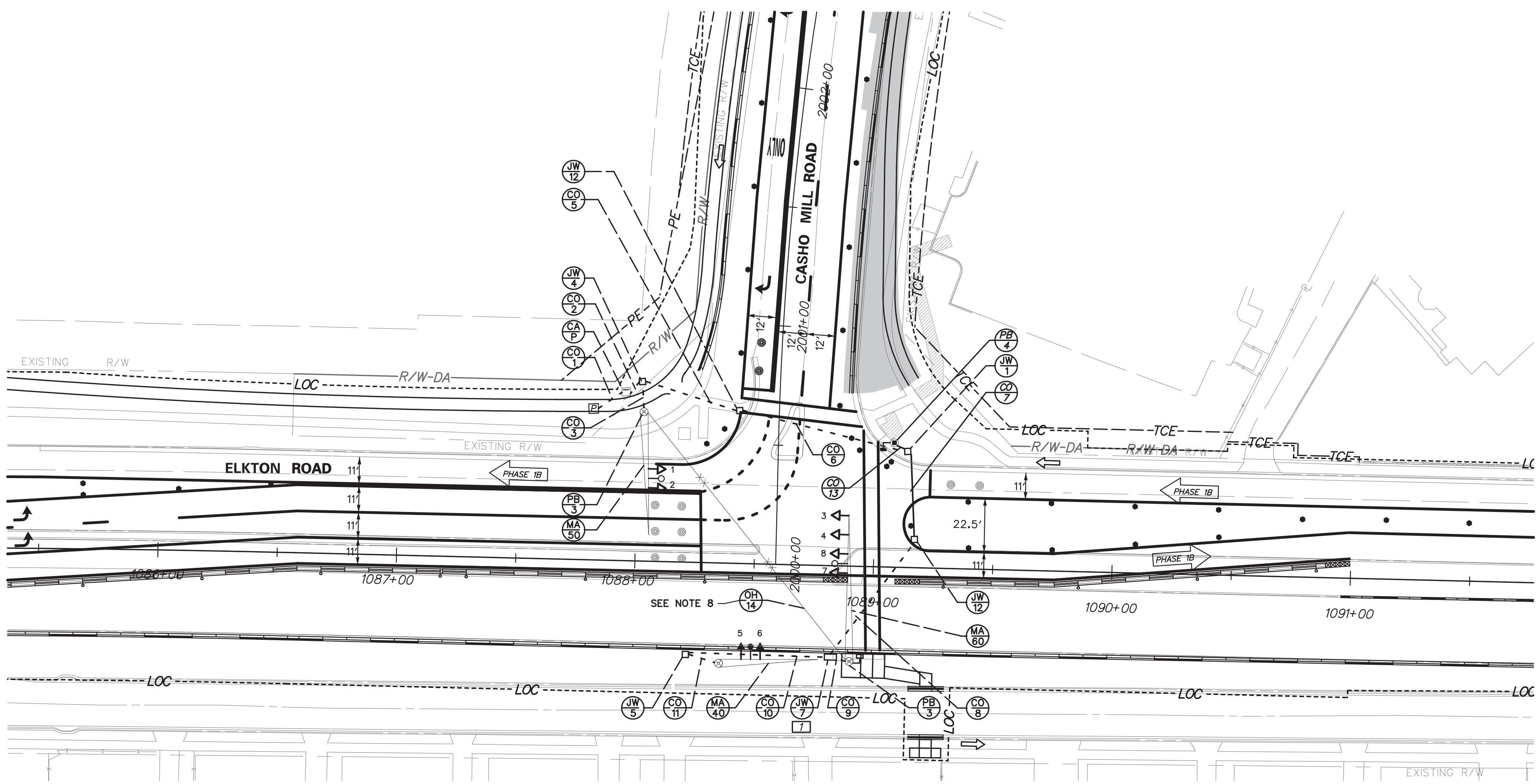
ELKTON ROAD, CASHO MILL ROAD TO DELAWARE AVENUE

CONTRACT	24-044-01
COUNTY	NEW CASTLE
PERMIT NO.	N 639
DESIGNED BY:	JDS
CHECKED BY:	MAW

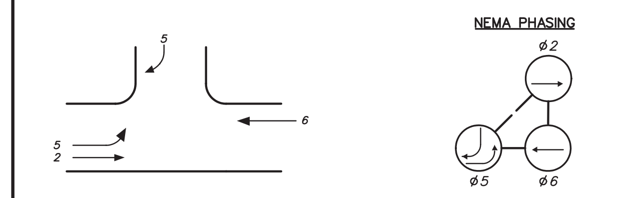
SIGNALIZATION PLAN
ELKTON RD @ CASHO MILL RD

SUBMISSION STATUS: PS&E
DATE PLOTTED: 5/11/2011
JMT FILE LOCATION: Q:\NDE\020626_000Elkton_RD\020_CashoMillRd-DelAve\CADD\SG06_1B.dgn

PHASE 1B



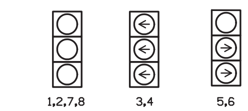
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM C — REMOVE BY CONTRACTOR
- RM O — REMOVE BY OTHERS
- AB — ABANDON
- PB X — PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB X — EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW X — PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW X — EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO • — PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO • — EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH • — PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH • — EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA XX — PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA XX — EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA X — PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA X — EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- XX — EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P — SERVICE PEDESTAL
- PUCK DETECTION SYSTEM

CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
*1	1	2"	10'	(1)2/#8 U.F. W/GROUND
*2	3 [1]	2.5"	5'	(3)16/#14, (3)4/#18, (2)9/#14 [1]
*3	1	2.5"	9'	(3)16/#14, (3)4/#18, (1)9/#14
*5	1	2.5"	39'	(1)9/#14 [1]
*6	1	2.5"	70'	(1)9/14 [1]
7	1	2.5"	35'	EMPTY
*8	1	2.5"	60'	EMPTY
*9	1	2.5"	2'	(1)16/#14, (1) 9/#14, (1)4/#18
*10	1	2.5"	62'	(1)16/#14, (1)4/#18
*11	1	2.5"	12'	(1)16/#14, (1)4/#18
13	1	2.5"	5'	(1)9/#14 [1]
*OH14			133'	(2)16/#14, (1)9/#14, (2) 4/#18

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

POLE SCHEDULE

	NO.	TYPE	STATION	OFFSET
	*1	50' MAST ARM POLE W/ TYPE 3 BASE	1088+02	63' L
	*2	60' MAST ARM POLE W/ TYPE 3 BASE	1088+91	40' R
[2]	*3	40' MAST ARM POLE W/ TYPE 3 BASE	1088+36	42' R
	5	PEDESTRIAN POLE W/ TYPE 4 BASE	1089+08	52' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

JUNCTION WELL AND CABINET SCHEDULE

	NO.	STATION	OFFSET
	*J1	1088+01 ℄ SR 2	75' L
	*J3	1088+42 ℄ SR 2	64' L
	*J4	1089+13 ℄ SR 2	49' L
[2]	*J5	1089+17 ℄ SR 2	12' L
[1]	*J6	1088+83 ℄ SR 2	38' R
	*J7	1088+22 ℄ SR 2	38' R
[2]	*CA	1087+95 ℄ SR 2	71' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

GENERAL SIGNAL NOTES

1. ALL SIGNAL POLES WILL BE 21 FEET, EXCEPT WHERE SHOWN.
2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
3. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
4. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
6. INSTALL THE PEDESTRIAN POLE AT STA. 1089+08L AT THE BEGINNING OF THIS PHASE.
7. WHEN A PEDESTRIAN CROSSING IS PROHIBITED FOR ANY MOVEMENT, THE CORRESPONDING PEDESTRIAN SIGNAL HEAD SHALL BE BAGGED.
8. REMOVE THE SPAN WIRE AT THE END OF THIS PHASE.

RECOMMENDED *Mir Wahed* DATE: 1/20/10 | RECOMMENDED ________ DATE: ________ | RECOMMENDED ________ DATE: ________ | APPROVED TRAFFIC ENGINEER ________ DATE: ________ | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ________ DATE: ________

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS
[1] REVISED SHEET - MAW 12/3/2010
[2] REVISED SHEET - MAW 05/4/2011

SCALE: 0 30 60 90 FEET

ELKTON ROAD, CASHO MILL ROAD TO DELAWARE AVENUE

CONTRACT	PERMIT NO.	N 639	SIGNALIZATION PLAN	SHEET NO.
24-044-01	DESIGNED BY: JDS			345
COUNTY			ELKTON RD @ CASHO MILL RD	TOTAL SHTS.
NEW CASTLE	CHECKED BY: MAW			384

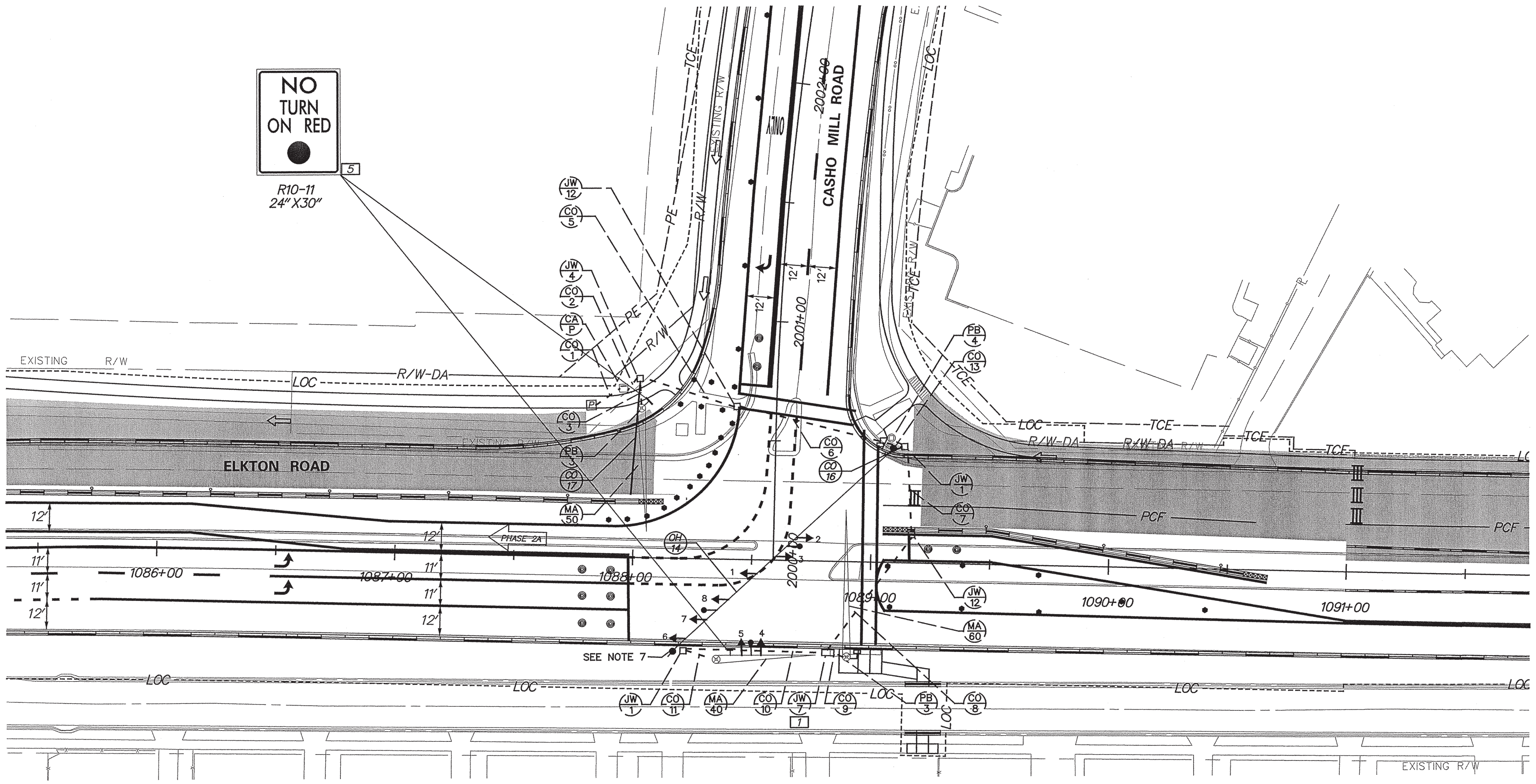
ADDITIONAL GENERAL SIGNAL NOTES

7. INSTALL TEMPORARY SPAN WIRE TO CONNECT TEMPORARY WOOD POLES. RELOCATE THE ELKTON ROAD SIGNAL HEADS ON THE SPAN WIRE PRIOR TO START OF PHASE 2A. ACTIVATE THE SIGNAL THROUGH TEMPORARY CONDUIT #15.

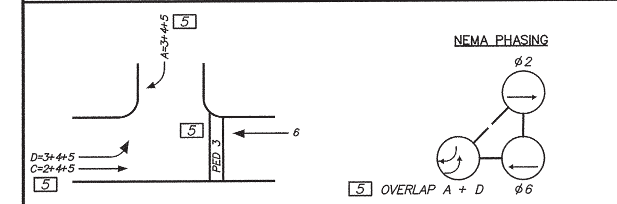
[1] 8. INSTALL THE PEDESTRIAN POLE WITH SIGNAL AT STA 1088+98, OFFSET 63'L DURING PHASE 2B WEEKEND WORK. BAG PEDESTRIAN SIGNAL HEAD UNTIL PHASE 2C.

9. THE CONDUIT RUN #17 WILL BE INSTALLED THROUGH OPEN TRENCH DURING THIS CONSTRUCTION PHASE. THE REMAINING PORTION OF CR#17 WILL BE INSTALLED DURING PHASE 2C.

PHASE 2A & PHASE 2B



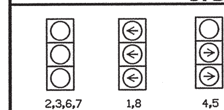
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM/C REMOVE BY CONTRACTOR
- RM/O REMOVE BY OTHERS
- AB ABANDON
- PB/X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB/X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW/X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW/X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO/# PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO/# EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH/# PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH/# EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA/XX PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA/XX EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA/X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA/X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- XX EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P SERVICE PEDESTAL
- PUCK DETECTION SYSTEM

GENERAL SIGNAL NOTES

1. ALL SIGNAL POLES WILL BE 21 FEET, EXCEPT WHERE SHOWN.

2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.

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5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

6. INSTALL 40 FEET TEMPORARY WOOD POLES AT STA 1089+15, OFFSET 52'L AND AT STA 1088+23, OFFSET 38'R.

CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
*1	1	2"	11'	(1)2/#8 U. F. W/GROUND
*2	3 [1]	2.5"	5'	(3)16/#14, (2)9/#14, (3)4/#18 [1]
*3	1	2.5"	9'	EMPTY
*5	1	2.5"	39'	(3)16/#14, (2) 9/#14, (3)4/#18 [1]
*6	1	2.5"	70'	(3)16/#14, (2) 9/#14, (3)4/#18 [1]
*7	1	2.5"	35'	(1)16/#14, (1) 9/#14, (1)4/#18
*8	1	2.5"	60'	(1)16/#14, (1) 9/#14, (1)4/#18
*9	1	2.5"	14'	(1) 9/#14
*10	1	2.5"	44'	(1)16/#14, (1)4/#18
*11	1	2.5"	20'	(1)16/#14, (1)4/#18
*13	1	2.5"	5'	(1)9/#14
OH14			150'	(2)16/#14, (2)4/#18
16	1	2.5"	5'	(2)16/#14, (2)4/#18
17	1	2.5"	47'	EMPTY [1]

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

POLE SCHEDULE

	NO.	TYPE	STATION	OFFSET
	*1	50' MAST ARM POLE W/ TYPE 3 BASE	1088+02	63' L
	*2	60' MAST ARM POLE W/ TYPE 3 BASE	1088+91	40' R
[2]	*3	40' MAST ARM POLE W/ TYPE 3 BASE	1088+36	42' R
	*5	PEDESTRIAN POLE W/ TYPE 4 BASE	1089+08	52' L
	6	40' TEMPORARY WOOD POLE	1089+15	52' L
	7	40' TEMPORARY WOOD POLE	1088+23	38' R

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

JUNCTION WELL AND CABINET SCHEDULE

	NO.	STATION	OFFSET
	*J1	1088+01 ℄ SR 2	75' L
	*J3	1088+42 ℄ SR 2	64' L
	*J4	1089+13 ℄ SR 2	49' L
[2]	*J5	1089+17 ℄ SR 2	12' L
[1]	*J6	1088+83 ℄ SR 2	38' R
[2]	*J7	1088+22 ℄ SR 2	38' R
[2]	*CA	1087+95 C SR 2	71' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

RECOMMENDED Mi Wahed DATE: 1/20/10

RECOMMENDED ______ DATE: ______

RECOMMENDED ______ DATE: ______

APPROVED TRAFFIC ENGINEER [signature] DATE: 1/17/12

APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 1/18/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

[1] REVISED SHEET - MAW 12/3/2010
[2] REVISED SHEET - MAW 05/4/2011
[5] REVISED SHEET - MAW 01/13/2012

SCALE 0 30 60 90 FEET

ELKTON ROAD, CASHO MILL ROAD TO DELAWARE AVENUE

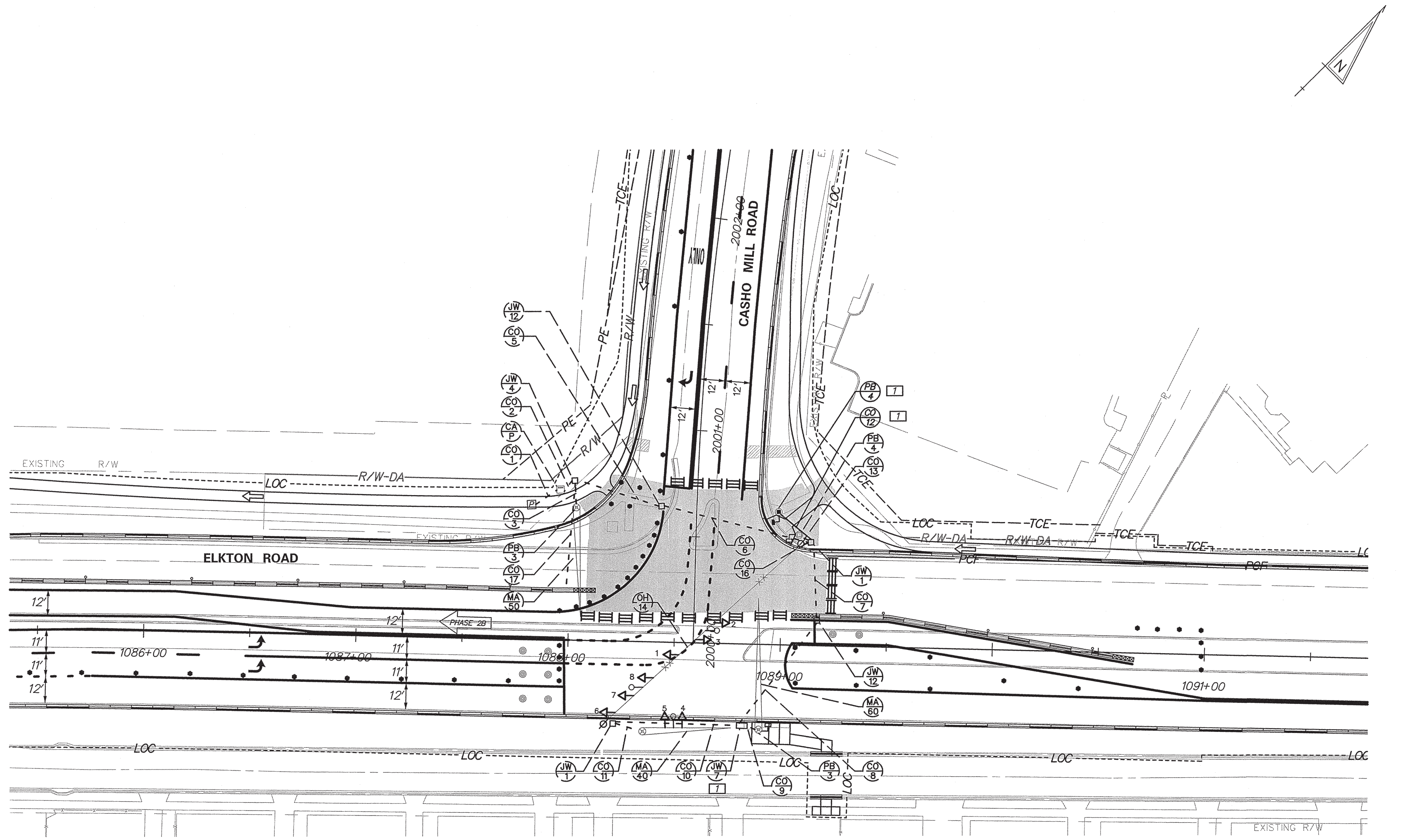
CONTRACT 24-044-01
COUNTY NEW CASTLE
PERMIT NO. N 639
DESIGNED BY: JDS
CHECKED BY: MAW

SIGNALIZATION PLAN
ELKTON RD @ CASHO MILL RD

SHEET NO. 346
TOTAL SHTS. 384

SUBMISSION STATUS: PS&E
DATE PLOTTED: 1/13/2012
JMT FILE LOCATION: Q:\NDE\020626_000Elkton_RD\020_CashoMillRd-DelAve\CADD\SG06_2A&2B.dgn

PHASE 2B WEEKEND



CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
*1	1	2"	11'	(1)2/#8 U.F. W/GROUND
*2	3 [1]	2.5"	5'	(3)16/#14, (3)9/#14, (3)4/#18 [1]
*3	1	2.5"	9'	EMPTY
*5	1	2.5"	39'	(3)16/#14, (3) 9/#14, (3)4/#18
*6	1	2.5"	70'	(3)16/#14, (3) 9/#14, (3)4/#18
*7	1	2.5"	35'	(1)16/#14, (1) 9/#14, (1)4/#18
*8	1	2.5"	60'	(1)16/#14, (1) 9/#14, (1)4/#18
*9	1	2.5"	14'	(1) 9/#14
*10	1	2.5"	44'	(1)16/#14, (1)4/#18
*11	1	2.5"	20'	(1)16/#14, (1)4/#18
12	1	2.5"	18'	(1)9/#14
*13	1	2.5"	5'	(1)9/#14
*OH14			150'	(2)16/#14, (2)4/#18
*16	1	2.5"	5'	(2)16/#14, (2)4/#18
*17	1	2.5"	47'	EMPTY [1]

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

POLE SCHEDULE

	NO.	TYPE	STATION	OFFSET
	*1	50' MAST ARM POLE W/ TYPE 3 BASE	1088+02	63' L
	*2	60' MAST ARM POLE W/ TYPE 3 BASE	1088+91	40' R
[2]	*3	40' MAST ARM POLE W/ TYPE 3 BASE	1088+36	42' R
	4	PEDESTRIAN POLE W/ TYPE 4 BASE	1088+98	63' L
	*5	PEDESTRIAN POLE W/ TYPE 4 BASE	1089+08	52' L
	*6	40' TEMPORARY WOOD POLE	1089+15	52' L
	*7	40' TEMPORARY WOOD POLE	1088+23	38' R

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

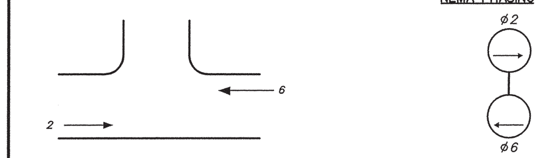
JUNCTION WELL AND CABINET SCHEDULE

	NO.	STATION	OFFSET
	*J1	1088+07 ℄ SR 2	62' L
	*J3	1088+42 ℄ SR 2	64' L
	*J4	1089+13 ℄ SR 2	49' L
[2]	*J5	1089+17 ℄ SR 2	12' L
[1]	*J6	1088+83 ℄ SR 2	38' R
[2]	*J7	1088+22 ℄ SR 2	38' R
[2]	*CA	1087+95 C SR 2	71' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

SIGNAL PHASING

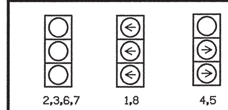
NEMA PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM/C REMOVE BY CONTRACTOR
- RM/O REMOVE BY OTHERS
- AB ABANDON
- PB/X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB/X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW/X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW/X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA/XX PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA/XX EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA/X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA/X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- XX EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P SERVICE PEDESTAL
- PUCK DETECTION SYSTEM

GENERAL SIGNAL NOTES

1. ALL SIGNAL POLES WILL BE 21 FEET, EXCEPT WHERE SHOWN.

2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.

3. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.

4. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.

5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

6. BAG TRAFFIC SIGNAL HEADS #1, #4, #5 AND #8 DURING THIS PHASE.

7. WHEN A PEDESTRIAN CROSSING IS PROHIBITED FOR ANY MOVEMENT, THE CORRESPONDING PEDESTRIAN SIGNAL HEAD SHALL BE BAGGED.

RECOMMENDED *Mir Wahed* DATE: 1/20/10 | RECOMMENDED ______ DATE: ______ | RECOMMENDED ______ DATE: ______ | APPROVED TRAFFIC ENGINEER *[signature]* DATE: 1/24/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER *[signature]* DATE: 1/27/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS
[1] REVISED SHEET - MAW 12/3/2010
[2] REVISED SHEET - MAW 05/4/2011

SCALE 0 30 60 90 FEET

ELKTON ROAD, CASHO MILL ROAD TO DELAWARE AVENUE

CONTRACT 24-044-01
COUNTY NEW CASTLE
PERMIT NO. N 639
DESIGNED BY: JDS
CHECKED BY: MAW

SIGNALIZATION PLAN
ELKTON RD @ CASHO MILL RD

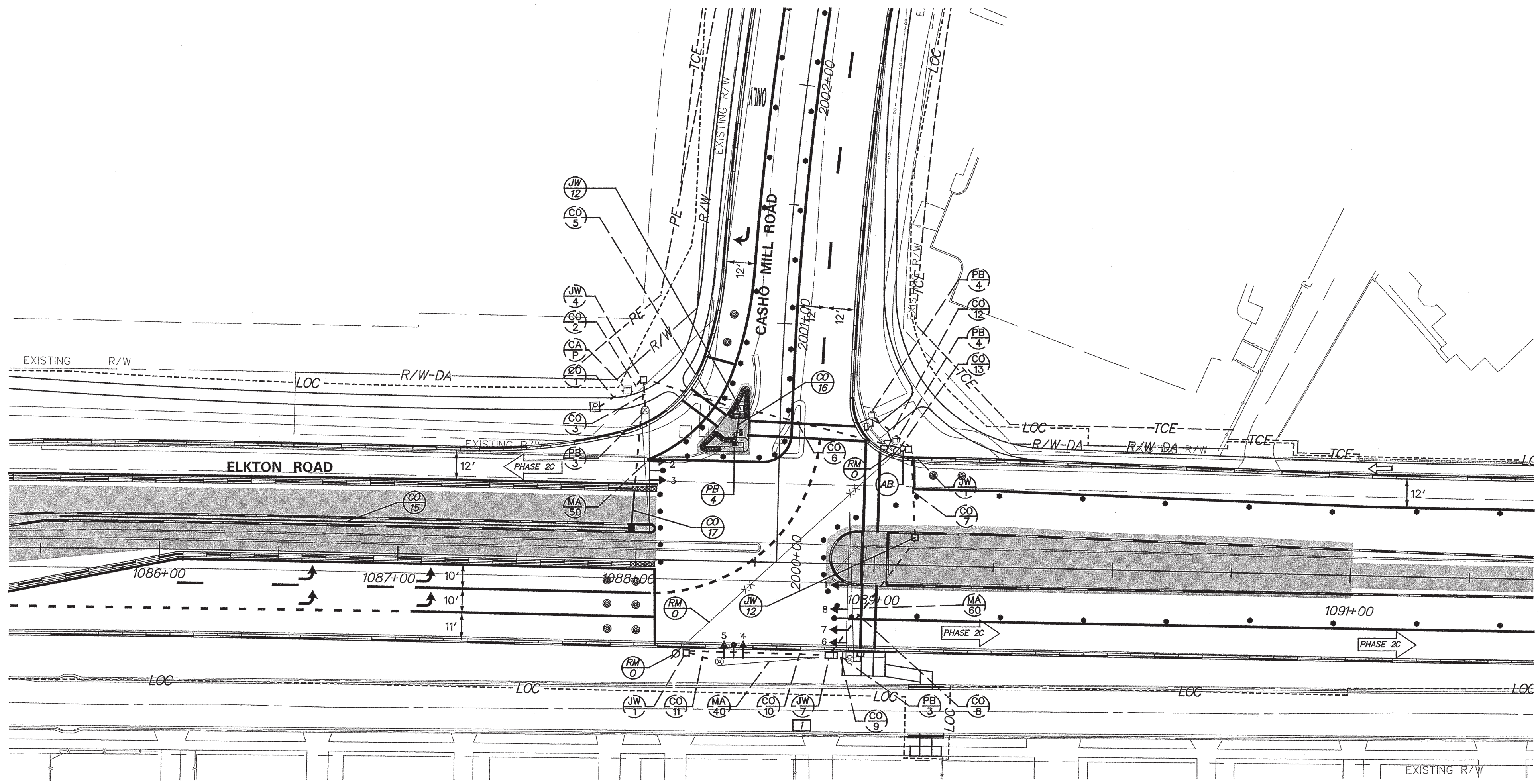
SHEET NO. 347
TOTAL SHTS. 384

SUBMISSION STATUS: PS&E
DATE PLOTTED: 12/15/2011
JMT FILE LOCATION: Q:\NDE\020626_000Elkton_RD\020_CashoMillRd-DelAve\CADD\SG06_2B Weekend.dgn

ADDITIONAL GENERAL SIGNAL NOTES

9. REMOVE THE TEMPORARY STRAIN POLES AND THE SPAN WIRE (OH14) DURING THIS PHASE.
10. BAG TRAFFIC SIGNAL HEADS #4 AND #5 DURING THIS PHASE.

PHASE 2C



CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
*1	1	2"	11'	(1)2/#8 U. F. W/GROUND
*2	3 [1]	2.5"	5'	(3)16/#14, (3)4/#18, (4)9/#14
*3	1	2.5"	9'	(1)16/#14, (1)4/#18
*5	1	2.5"	39'	(2)16/#14, (4) 9/#14, (2)4/#18
*6	1	2.5"	70'	(2)16/#14, (3) 9/#14, (2)4/#18
*7	1	2.5"	35'	(2)16/#14, (1) 9/#14, (2)4/#18
*8	1	2.5"	60'	(2)16/#14, (1) 9/#14, (2)4/#18
*9	1	2.5"	14'	(1)16/#14, (1) 9/#14, (1)4/#18
*10	1	2.5"	44'	(1)16/#14, (1)4/#18
*11	1	2.5"	20'	(1)16/#14, (1)4/#18
*12	1	2.5"	18'	(1)9/#14
*13	1	2.5"	3'	(1)9/#14
15	1	2.5"	241'	EMPTY [1]
16	1	2.5"	15'	(1)9/#14
17	1	2.5"	62'	EMPTY [1]

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

POLE SCHEDULE

	NO.	TYPE	STATION	OFFSET
	*1	50' MAST ARM POLE W/ TYPE 3 BASE	1088+02	63' L
	*2	60' MAST ARM POLE W/ TYPE 3 BASE	1088+91	40' R
[2]	*3	40' MAST ARM POLE W/ TYPE 3 BASE	1088+36	42' R
	*4	PEDESTRIAN POLE W/ TYPE 4 BASE	1088+98	63' L
	*5	PEDESTRIAN POLE W/ TYPE 4 BASE	1089+08	52' L
[2]	6	PEDESTRIAN POLE W/ TYPE 4 BASE	1088+40	49' L

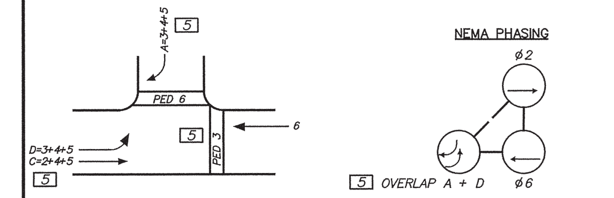
* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

JUNCTION WELL AND CABINET SCHEDULE

	NO.	STATION	OFFSET
	*J1	1088+07 ℄ SR 2	62' L
	*J3	1088+42 ℄ SR 2	64' L
	*J4	1089+13 ℄ SR 2	49' L
[2]	*J5	1089+17 ℄ SR 2	12' L
[1]	*J6	1088+83 ℄ SR 2	38' R
[2]	*J7	1088+22 ℄ SR 2	38' R
[2]	*CA	1087+95 ℄ SR 2	71' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

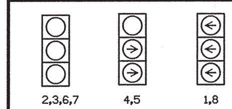
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM C — REMOVE BY CONTRACTOR
- RM O — REMOVE BY OTHERS
- AB — ABANDON
- PB X — PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB X — EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW X — PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW X — EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO — PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO — EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH — PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH — EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA XX — PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA XX — EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA X — PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA X — EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- —XX— EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P — SERVICE PEDESTAL
- PUCK DETECTION SYSTEM

GENERAL SIGNAL NOTES

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2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
3. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
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6. REMOVE 28 FEET TEMPORARY WOOD POLES AT STA 1089+15, OFFSET 52'L AND AT STA 1088+23, OFFSET 38'R AND ABANDON THE CONDUIT RUN CONNECTED TO THESE POLES.
7. REMOVE THE TEMPORARY PEDESTRIAN SIGNAL AND POLE LOCATED AT STA 1088+14, OFFSET 68'L AND THE TEMPORARY SPAN WIRE POLES. ABANDON THE CONDUIT RUN CONNECTED TO THESE POLES.
8. WHEN A PEDESTRIAN CROSSING IS PROHIBITED FOR ANY MOVEMENT, THE CORRESPONDING PEDESTRIAN SIGNAL HEAD SHALL BE BAGGED.

RECOMMENDED Mi Wahed DATE: 1/20/10 | RECOMMENDED ____ DATE: ____ | RECOMMENDED ____ DATE: ____ | APPROVED TRAFFIC ENGINEER [signature] DATE: 1/17/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 1/18/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS
[1] REVISED SHEET - MAW 12/3/2010
[2] REVISED SHEET - MAW 05/4/2011
[3] REVISED SHEET - MAW 01/13/2012

SCALE 0 30 60 90 FEET

ELKTON ROAD, CASHO MILL ROAD TO DELAWARE AVENUE

CONTRACT 24-044-01 | COUNTY NEW CASTLE | PERMIT NO. N 639 | DESIGNED BY: JDS | CHECKED BY: MAW

SIGNALIZATION PLAN
ELKTON RD @ CASHO MILL RD

SHEET NO. 348 | TOTAL SHTS. 384

SUBMISSION STATUS: PS&E
DATE PLOTTED: 1/13/2012
JMT FILE LOCATION: Q:\NDE\020626_000Elkton_RD\020_CashoMillRd-DelAve\CADD\SG06_2C.dgn

ADDITIONAL GENERAL SIGNAL NOTES

8. THE LOAD BEARING JUNCTION WELL IS A SPECIAL PROVISION JUNCTION WELL AND WILL BE FABRICATED BASED ON THE DETAIL AND SPECIAL PROVISION SPECIFICATION. THE JUNCTION WELL WILL BE UNDER TRAFFIC DURING CONSTRUCTION. AT THE END OF ROAD CONSTRUCTION THIS LOCATION WILL BE PART OF THE CURB MEDIAN.

9. ALL MAGNETIC DETECTION SYSTEMS SHALL BE REMOVED PRIOR TO INSTALLATION OF PAVEMENT LOOPS.

10. ALL LOOP DETECTORS SHALL BE INSTALLED AFTER THE APPLICATION OF TYPE C PAVING.

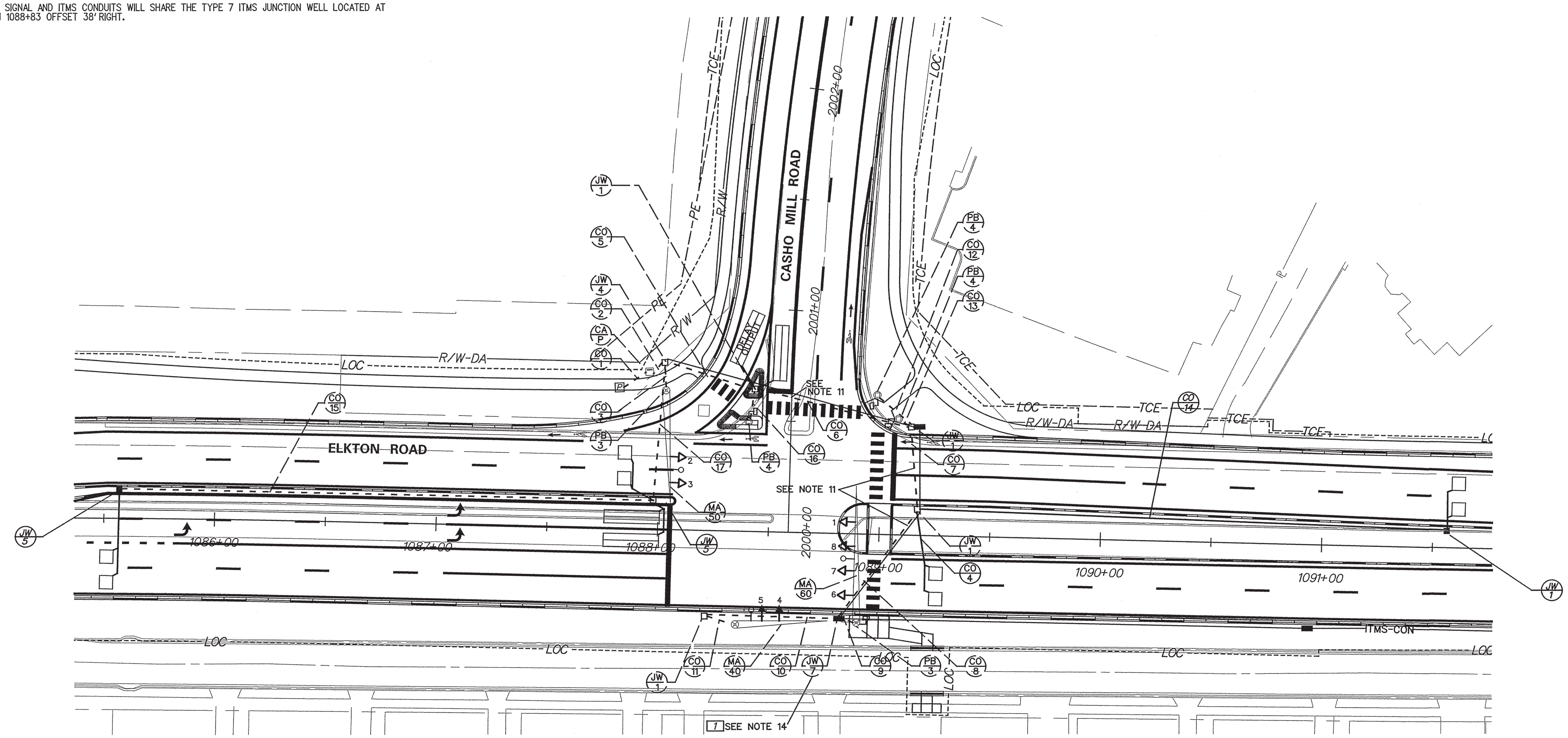
11. THE ITMS CONDUITS WILL BE INSTALLED DURING THE INSTALLATION OF SIGNAL CONDUIT RUN NUMBERS 6,7, AND 8.

12. THE SIGNAL JUNCTION WELL JW12 STA. 1089+14 OFFSET 11' LEFT WILL BE SHARED BY ITMS CONDUIT.

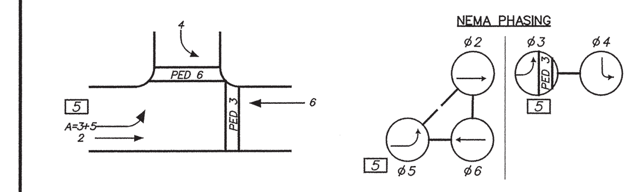
13. ALL PEDESTRIAN SIGNAL HEADS WILL BE COUNTDOWN SIGNALS.

7 14. THE SIGNAL AND ITMS CONDUITS WILL SHARE THE TYPE 7 ITMS JUNCTION WELL LOCATED AT STATION 1088+83 OFFSET 38' RIGHT.

ULTIMATE



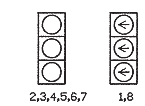
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

PROPOSED SIGNAL CABINET	REMOVE BY CONTRACTOR
EXISTING SIGNAL CABINET	REMOVE BY OTHERS
PROPOSED SIGNAL POLE BASE	ABANDON
EXISTING SIGNAL POLE BASE	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PROPOSED PEDESTRIAN POLE BASE	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
EXISTING PEDESTRIAN POLE BASE	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
PROPOSED WOOD POLE	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
EXISTING UTILITY POLE	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
PROPOSED JUNCTION WELL	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
EXISTING JUNCTION WELL	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
PROPOSED SIGNAL HEAD	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
EXISTING SIGNAL HEAD	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
PROPOSED PEDESTRIAN SIGNAL HEAD	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
EXISTING PEDESTRIAN SIGNAL HEAD	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED PEDESTRIAN PUSHBUTTON	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
EXISTING PEDESTRIAN PUSHBUTTON	PROPOSED SPAN WIRE
PROPOSED VIDEO DETECTION	EXISTING SPAN WIRE
EXISTING VIDEO DETECTION	RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED MICROWAVE DETECTION	PROPOSED SPAN INSULATOR
EXISTING MICROWAVE DETECTION	EXISTING SPAN INSULATOR
OVERHEAD SIGNING	SERVICE PEDESTAL
PROPOSED OPTICOM RECEIVER	PUCK DETECTION SYSTEM
EXISTING OPTICOM RECEIVER	
PROPOSED MAST ARM	
EXISTING MAST ARM	
PROPOSED LUMINAIRE	
EXISTING LUMINAIRE	
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)	
EXISTING LOOP DETECTOR (TYPE 1 OR 2)	

CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
*1	1	2"	11'	(1)2/#8 U. F. W/GROUND
*2	3 1	2.5"	5'	(3)16/#14, (10)4/#18, (4)9/#14
*3	1	2.5"	9'	(1)16/#14, (1)4/#18
4	1	1.5"	20'	(1)4/#18
*5	1	2.5"	39'	(2)16/#14, (4)9/#14, (6)4/#18
*6	1	2.5"	70'	(2)16/#14, (3)9/#14, (4)4/#18
*7	1	2.5"	35'	(2)16/#14, (1)9/#14, (4)4/#18
*8	1	2.5"	60'	(2)16/#14, (1)9/#14, (2)4/#18
*9	1	2.5"	19'	(1)16/#14, (1)9/#14, (1)4/#18
*10	1	2.5"	77'	(1)16/#14, (1)4/#18
*11	1	2.5"	4'	(1)16/#14, (1)4/#18
*12	1	2.5"	24'	(1)9/#14
*13	1	2.5"	3'	(1)9/#14
14	1	2.5"	240'	(1)4/#18
*15	1	2.5"	241'	(1)4/#18
*16	1	2.5"	15'	(1)9/#14
*17	1	2.5"	62'	(3)4/#18

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

POLE SCHEDULE

	NO.	TYPE	STATION	OFFSET
	*1	50' MAST ARM POLE W/ TYPE 3 BASE	1088+02	63' L
	*2	60' MAST ARM POLE W/ TYPE 3 BASE	1088+91	40' R
2	*3	40' MAST ARM POLE W/ TYPE 3 BASE	1088+36	42' R
	*4	PEDESTRIAN POLE W/ TYPE 4 BASE	1088+98	63' L
	*5	PEDESTRIAN POLE W/ TYPE 4 BASE	1089+08	52' L
2	*6	PEDESTRIAN POLE W/ TYPE 4 BASE	1088+40	49' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

JUNCTION WELL AND CABINET SCHEDULE

	NO.	STATION	OFFSET
	*J1	1088+07 ℄ SR 2	62' L
	J2	1088+03 ℄ SR 2	13' L
	*J3	1088+42 ℄ SR 2	64' L
	*J4	1089+13 ℄ SR 2	49' L
2	*J5	1089+17 ℄ SR 2	12' L
1	*J6	1088+83 ℄ SR 2	38' R
2	*J7	1088+22 ℄ SR 2	38' R
	J8	1091+56 ℄ SR 2	7' L
	J9	1085+57 ℄ SR 2	13' L
2	*CA	1087+95 ℄ SR 2	71' L

* EXISTING OR CONSTRUCTED DURING PREVIOUS PHASE

GENERAL SIGNAL NOTES

1. DETECTION - 45 M.P.H. - 4 SECONDS PASSAGE TIME AT 250 FEET FROM STOP BAR.

2. LOOP DETECTORS:
TYPE #1 - 6' x 6' - TO BE INSTALLED ON MAIN STREET THROUGH MOVEMENTS.
TYPE #2 - 6' x 25' - TO BE INSTALLED ON MAIN STREET LEFT TURN MOVEMENTS.
TYPE #2 - 6' x 25' - TO BE INSTALLED ON SIDE STREET LEFT AND RIGHT TURN MOVEMENTS.

3. ALL SIGNAL POLES WILL BE 21 FEET, EXCEPT WHERE SHOWN.

4. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.

5. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.

6. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.

7. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED Mi Wahed DATE: 1/20/10 | RECOMMENDED ____ DATE: ____ | RECOMMENDED ____ DATE: ____ | APPROVED TRAFFIC ENGINEER [signature] DATE: 1/17/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 1/18/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS
1 REVISED SHEET - MAW 12/3/2010
2 REVISED SHEET - MAW 05/4/2011
5 REVISED SHEET - MAW 01/13/2012

SCALE 0 30 60 90 FEET

ELKTON ROAD, CASHO MILL ROAD TO DELAWARE AVENUE

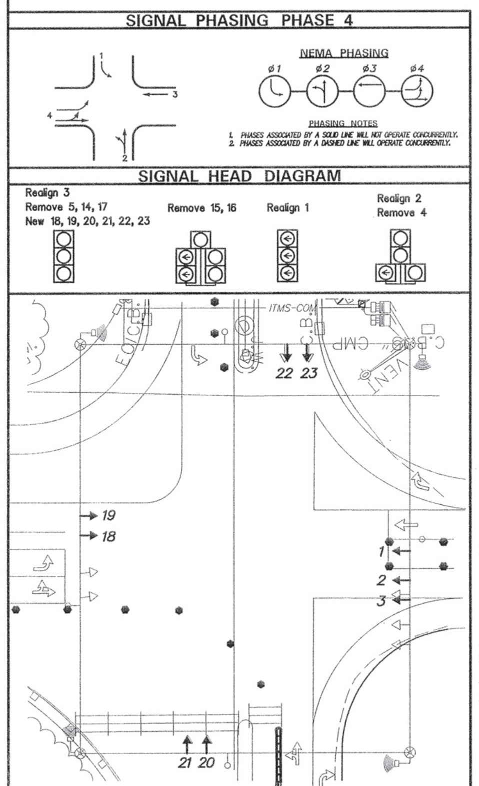
CONTRACT	PERMIT NO.	N 639	SIGNALIZATION PLAN	SHEET NO.
24-044-01	DESIGNED BY: JDS			349
COUNTY			ELKTON RD @ CASHO MILL RD	TOTAL SHTS.
NEW CASTLE	CHECKED BY: MAW			384

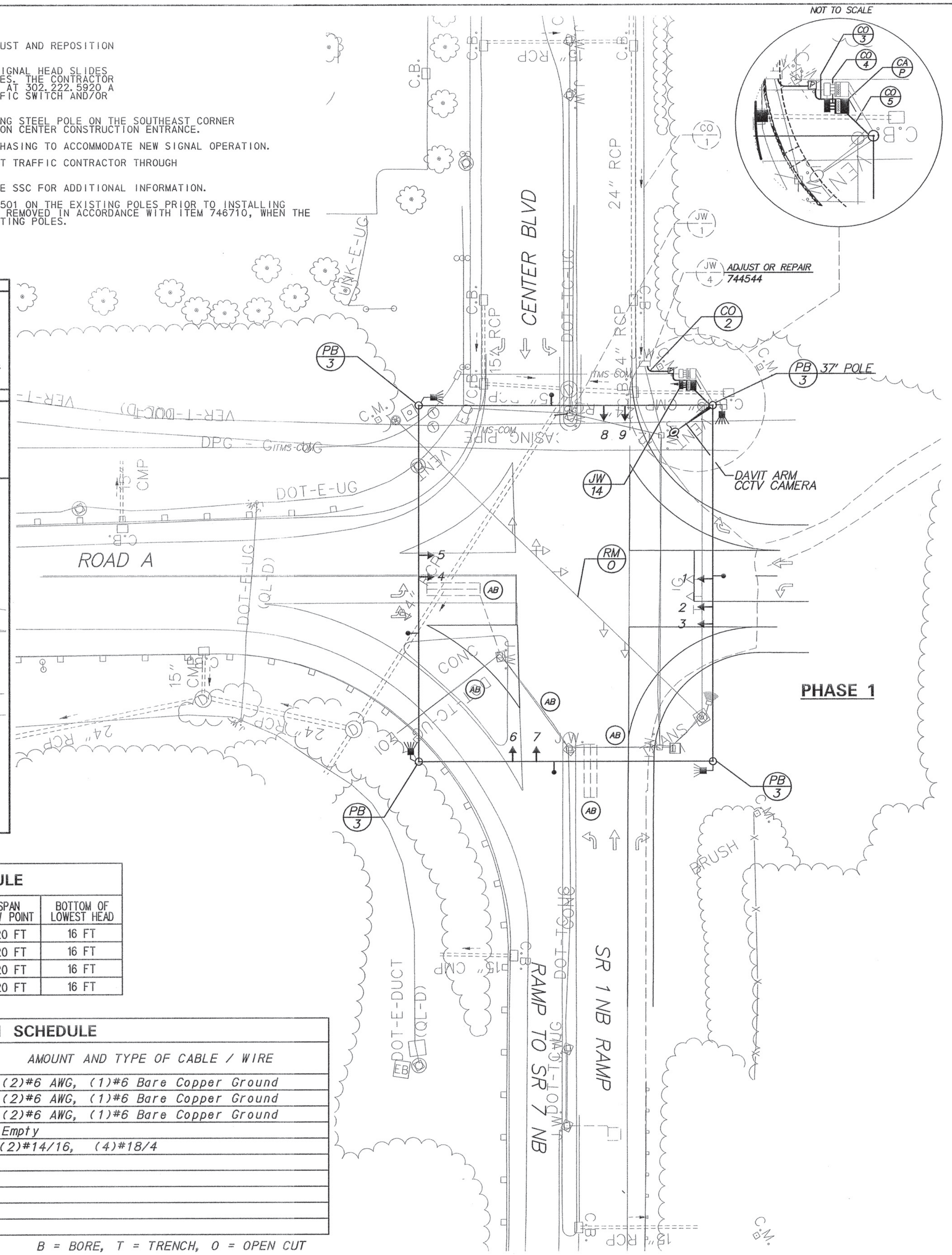
SUBMISSION STATUS: PS&E
DATE PLOTTED: 1/13/2012
JMT FILE LOCATION: Q:\NDE\020626_000Elkton_RD\020_CashoMillRd-DelAve\CADD\SG06_Ultimate.dgn

ADDITIONAL SIGNAL NOTES

7. DELDOT TRAFFIC FORCES TO INSTALL, REMOVE, ADJUST AND REPOSITION ALL OVERHEAD SIGNAL EQUIPMENT AS REQUIRED.
8. DELDOT TRAFFIC FORCES TO PERFORM ANY NEEDED SIGNAL HEAD SLIDES TO ACCOMMODATE ALL REQUIRED CONSTRUCTION PHASES. THE CONTRACTOR SHALL CONTACT THE SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 A MINIMUM OF 10 DAYS PRIOR TO ANY REQUIRED TRAFFIC SWITCH AND/OR HEAD SLIDES.
9. INSTALL PROPOSED MICROWAVE DETECTOR TO EXISTING STEEL POLE ON THE SOUTHEAST CORNER TO PROVIDED DETECTION FOR THE TEMPORARY FASHION CENTER CONSTRUCTION ENTRANCE.
10. DELDOT TMC FORCES TO MODIFY EXISTING SIGNAL PHASING TO ACCOMMODATE NEW SIGNAL OPERATION.
11. THE CONTRACTOR SHALL PROVIDE M.O.T. FOR DELDOT TRAFFIC CONTRACTOR THROUGH ALL PHASES OF NEEDED CONSTRUCTION.
12. ITMS SHOWN FOR INFORMATIONAL PROPOSES ONLY SEE SSC FOR ADDITIONAL INFORMATION.
13. INSTALL BACK GUYS IN ACCORDANCE WITH ITEM 746501 ON THE EXISTING POLES PRIOR TO INSTALLING PROPOSED SIGNAL POLES. THE BACK GUYS SHALL BE REMOVED IN ACCORDANCE WITH ITEM 746710, WHEN THE EXISTING SPAN WIRES ARE REMOVED FROM THE EXISTING POLES.

SIGNAL PHASING PHASE 4





SPAN WIRE SCHEDULE

SPAN	LENGTH	SPAN MOUNT HEIGHT	SAG	SPAN LOW POINT	BOTTOM OF LOWEST HEAD
NW - NE	135 FT	27 FT	6.75 FT @ 5%	20 FT	16 FT
NW - SW	167 FT	29 FT	8.35 FT @ 5%	20 FT	16 FT
NW - SW	135 FT	27 FT	6.75 FT @ 5%	20 FT	16 FT
NW - SW	167 FT	29 FT	8.35 FT @ 5%	20 FT	16 FT

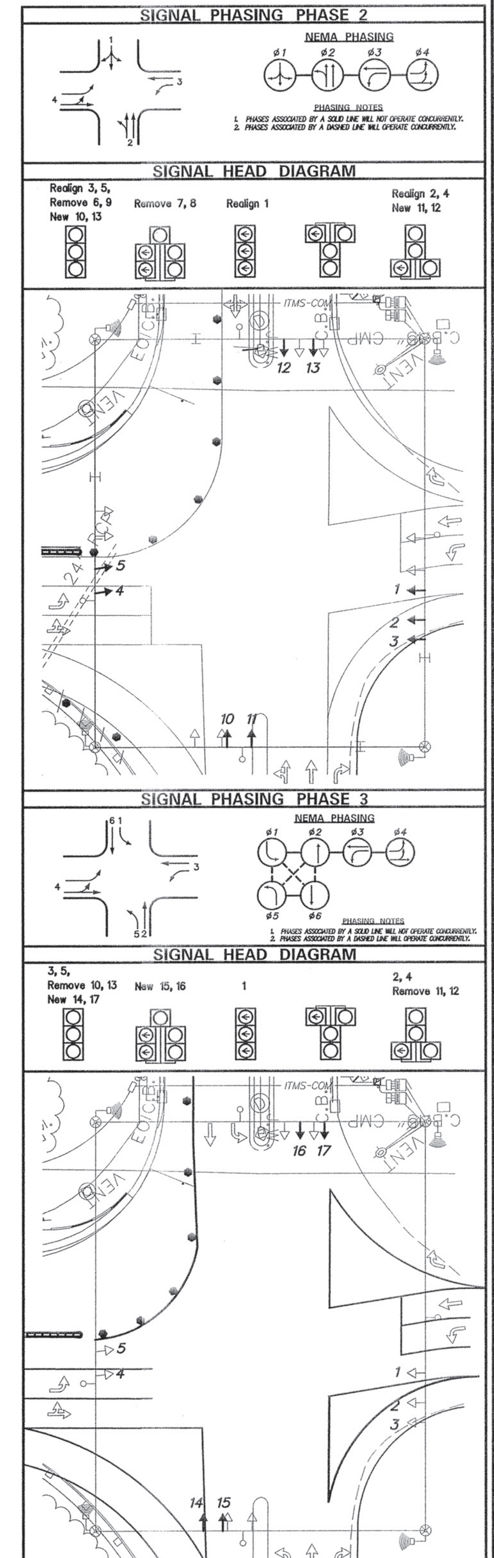
CONDUIT RUN SCHEDULE

CR NO.	NO. OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE / WIRE
*1	1	2"	--	--	(2)#6 AWG, (1)#6 Bare Copper Ground
2	1	2"	15'	T	(2)#6 AWG, (1)#6 Bare Copper Ground
3	1	2"	10'	T	(2)#6 AWG, (1)#6 Bare Copper Ground
4	3	4"	5'	T	Empty
5	1	3"	10'	T	(2)#14/16, (4)#18/4

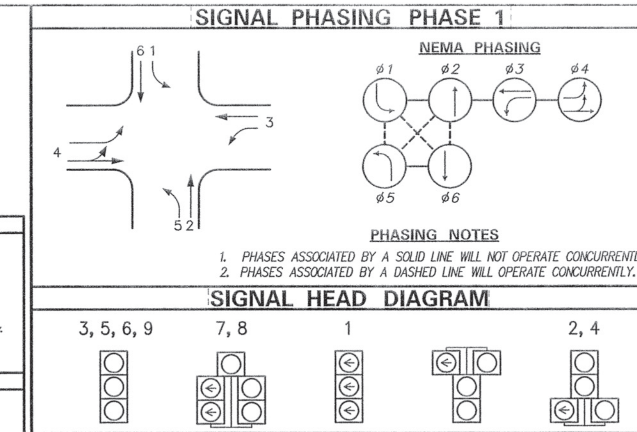
*DENOTES EXISTING B = BORE, T = TRENCH, O = OPEN CUT

PHASING

SIGNAL PHASING PHASE 2



SIGNAL PHASING PHASE 1



LEGEND

AB — ABANDON	OH — EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA X — EXISTING CABINET IDENTIFIER (TYPE OF CABINET)	OH — PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA X — PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	PB X — EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO — EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PB X — PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO — PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PL X — EXISTING POLE IDENTIFIER (# OF POLE)
JW X — EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PL X — PROPOSED POLE IDENTIFIER (# OF POLE)
JW X — PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	RM C — REMOVE BY CONTRACTOR
MA XX — EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)	RM O — REMOVE BY OTHERS
MA XX — PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)	RM TC — REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. ALL SIGNAL POLES WILL BE 32 FEET, EXCEPT WHERE SHOWN.
2. CO *1 IS NOT DRAWN TO SCALE, NOR IS THE DIRECTION NECESSARILY CORRECT.
3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
4. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS.SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ________ DATE: 8.29.13 | RECOMMENDED ________ DATE: ________ | RECOMMENDED ________ DATE: ________ | APPROVED TRAFFIC ENGINEER ________ DATE: 8/29/13 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ________ DATE: 8/30/13

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

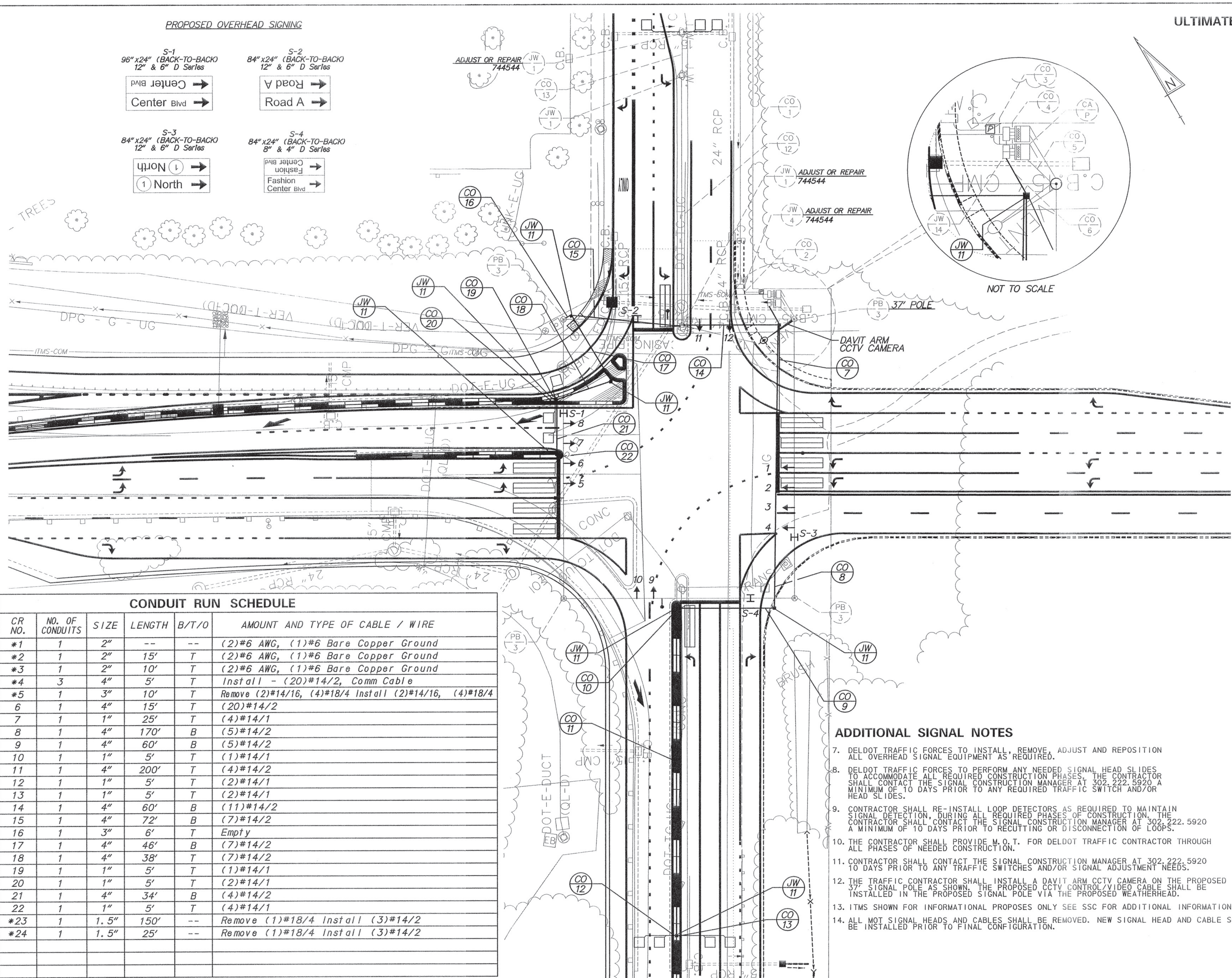
ROAD A /SR7
INTERSECTION IMPROVEMENTS

CONTRACT T201009002 | COUNTY NEW CASTLE | PERMIT NO. N538 | DESIGNED BY: JCR | CHECKED BY: MH

SIGNAL PLAN
DEL RT. 1 NB OFF RAMP at ROAD A

SHEET NO. 47 | TOTAL SHTS. 48

Y:\TRAFFIC\USERS\JASON\ROAD A\SG01_ROADA.DGN



CONDUIT RUN SCHEDULE

CR NO.	NO. OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE / WIRE
*1	1	2"	--	--	(2)#6 AWG, (1)#6 Bare Copper Ground
*2	1	2"	15'	T	(2)#6 AWG, (1)#6 Bare Copper Ground
*3	1	2"	10'	T	(2)#6 AWG, (1)#6 Bare Copper Ground
*4	3	4"	5'	T	Install - (20)#14/2, Comm Cable
*5	1	3"	10'	T	Remove (2)#14/16, (4)#18/4 Install (2)#14/16, (4)#18/4
6	1	4"	15'	T	(20)#14/2
7	1	1"	25'	T	(4)#14/1
8	1	4"	170'	B	(5)#14/2
9	1	4"	60'	B	(5)#14/2
10	1	1"	5'	T	(1)#14/1
11	1	4"	200'	T	(4)#14/2
12	1	1"	5'	T	(2)#14/1
13	1	1"	5'	T	(2)#14/1
14	1	4"	60'	B	(11)#14/2
15	1	4"	72'	B	(7)#14/2
16	1	3"	6'	T	Empty
17	1	4"	46'	B	(7)#14/2
18	1	4"	38'	T	(7)#14/2
19	1	1"	5'	T	(1)#14/1
20	1	1"	5'	T	(2)#14/1
21	1	4"	34'	B	(4)#14/2
22	1	1"	5'	T	(4)#14/1
*23	1	1.5"	150'	--	Remove (1)#18/4 Install (3)#14/2
*24	1	1.5"	25'	--	Remove (1)#18/4 Install (3)#14/2

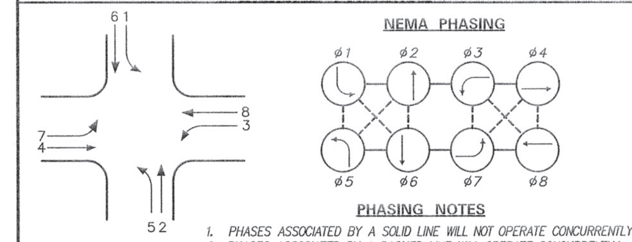
*DENOTES EXISTING

B = BORE, T = TRENCH, O = OPEN CUT

ADDITIONAL SIGNAL NOTES

7. DELDOT TRAFFIC FORCES TO INSTALL, REMOVE, ADJUST AND REPOSITION ALL OVERHEAD SIGNAL EQUIPMENT AS REQUIRED.
8. DELDOT TRAFFIC FORCES TO PERFORM ANY NEEDED SIGNAL HEAD SLIDES TO ACCOMMODATE ALL REQUIRED CONSTRUCTION PHASES. THE CONTRACTOR SHALL CONTACT THE SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 A MINIMUM OF 10 DAYS PRIOR TO ANY REQUIRED TRAFFIC SWITCH AND/OR HEAD SLIDES.
9. CONTRACTOR SHALL RE-INSTALL LOOP DETECTORS AS REQUIRED TO MAINTAIN SIGNAL DETECTION, DURING ALL REQUIRED PHASES OF CONSTRUCTION. THE CONTRACTOR SHALL CONTACT THE SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 A MINIMUM OF 10 DAYS PRIOR TO RECUTTING OR DISCONNECTION OF LOOPS.
10. THE CONTRACTOR SHALL PROVIDE M.O.T. FOR DELDOT TRAFFIC CONTRACTOR THROUGH ALL PHASES OF NEEDED CONSTRUCTION.
11. CONTRACTOR SHALL CONTACT THE SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 10 DAYS PRIOR TO ANY TRAFFIC SWITCHES AND/OR SIGNAL ADJUSTMENT NEEDS.
12. THE TRAFFIC CONTRACTOR SHALL INSTALL A DAVIT ARM CCTV CAMERA ON THE PROPOSED 37' SIGNAL POLE AS SHOWN. THE PROPOSED CCTV CONTROL/VIDEO CABLE SHALL BE INSTALLED IN THE PROPOSED SIGNAL POLE VIA THE PROPOSED WEATHERHEAD.
13. ITMS SHOWN FOR INFORMATIONAL PROPOSES ONLY SEE SSC FOR ADDITIONAL INFORMATION.
14. ALL MOT SIGNAL HEADS AND CABLES SHALL BE REMOVED. NEW SIGNAL HEAD AND CABLE SHALL BE INSTALLED PRIOR TO FINAL CONFIGURATION.

SIGNAL PHASING

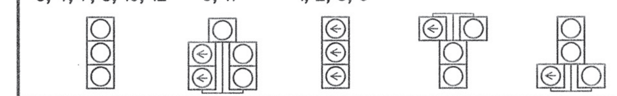


PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM

3, 4, 7, 8, 10, 12 — 9, 11 — 1, 2, 5, 6



LEGEND

- AB — ABANDON
- CA X — EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- CA X — PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CO # — EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO # — PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- JW X — EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW X — PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- MA XX — EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA XX — PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- OH — EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH — PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- PB X — EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB X — PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PL X — EXISTING POLE IDENTIFIER (# OF POLE)
- PL X — PROPOSED POLE IDENTIFIER (# OF POLE)
- RM C — REMOVE BY CONTRACTOR
- RM O — REMOVE BY OTHERS
- RM TC — REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		P
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. ALL SIGNAL POLES WILL BE 32 FEET, EXCEPT WHERE SHOWN.
2. CO *1 IS NOT DRAWN TO SCALE, NOR IS THE DIRECTION NECESSARILY CORRECT.
3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
4. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS.SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ____ DATE: 9.5.13 | RECOMMENDED ____ DATE: ____ | RECOMMENDED ____ DATE: ____ | APPROVED TRAFFIC ENGINEER ____ DATE: 9/5/13 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ____ DATE: 9/5/13

DELAWARE DEPARTMENT OF TRANSPORTATION

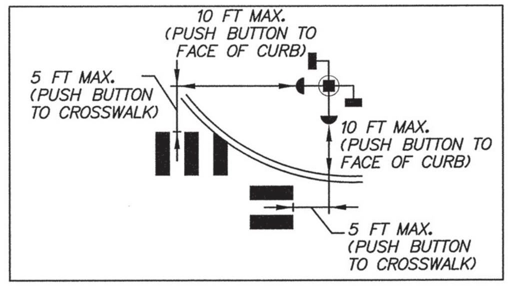
ADDENDUM / REVISIONS

ROAD A /SR7 INTERSECTION IMPROVEMENTS

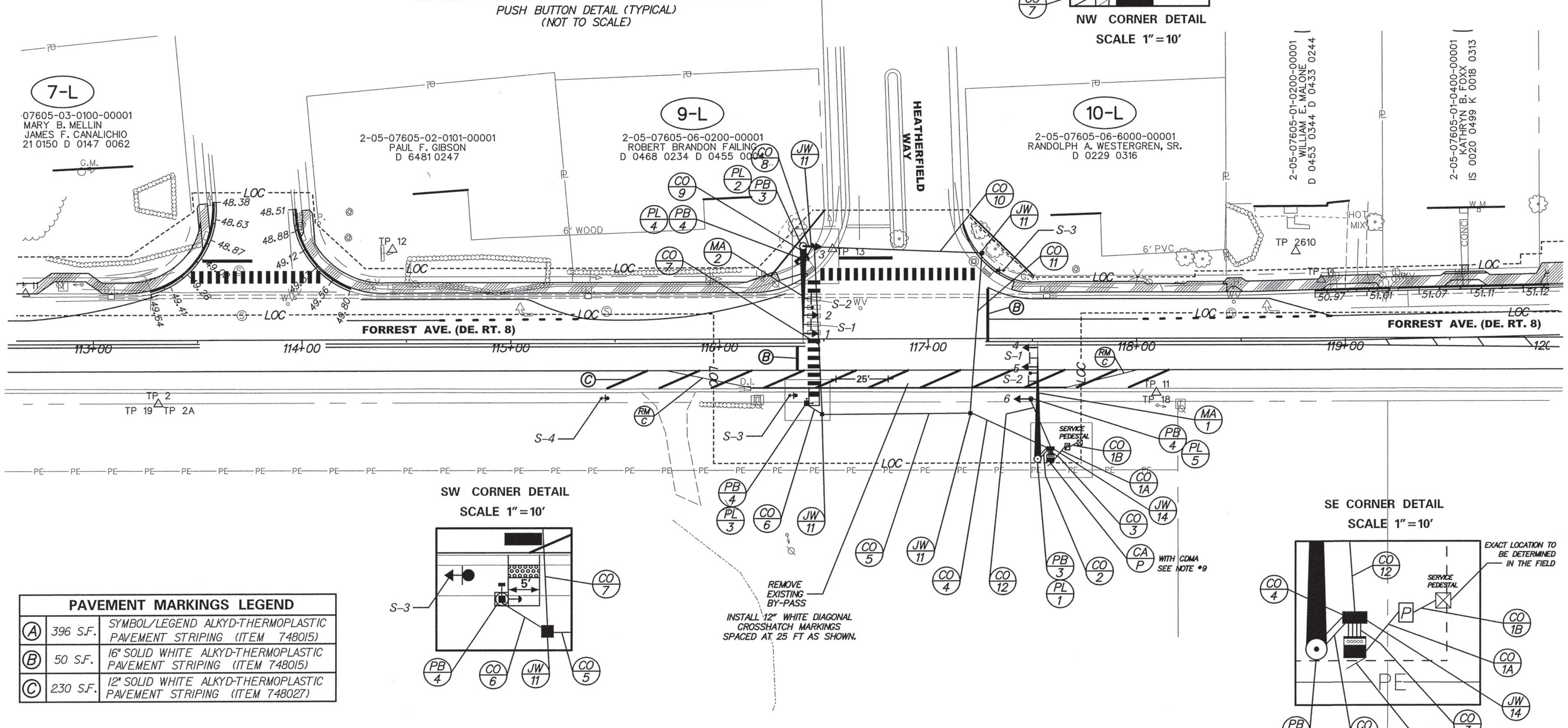
CONTRACT	PERMIT NO.	SIGNAL PLAN	SHEET NO.
T201009003	N538		48
COUNTY	DESIGNED BY: JCR	DEL RT. 1 NB OFF RAMP at ROAD A	TOTAL SHTS.
NEW CASTLE	CHECKED BY: MH		48

ADDITIONAL NOTES

7. ALL PEDESTRIAN SIGNALS SHALL CONTAIN PEDESTRIAN COUNTDOWN MODULES.
8. INSTALL CDMA FOR COMMUNICATION WITH TMC.
9. PROGRAM SIGNAL CONTROLLER TO KEEP A STEADY DON'T WALK FOR PEDS WHEN EMERGENCY PREEMPTION IS ACTIVATED.
10. AS PER CORRESPONDENCE WITH GARY LAWSON & STEVE ENSS OF CITY OF DOVER ELECTRIC DEPARTMENT, SERVICE PEDESTAL FOR 120 / 240 VOLTS SERVICE FROM BURIED UTILITY HAS ALREADY BEEN PROVIDED FOR THE HAWK SIGNAL.
11. RIGHT-OF-WAY ACQUISITION SHOWN FOR NE AND NW CORNERS TO BE DONE UNDER CONTRACT * T201401201. STATUS OF RIGHT-OF-WAY ACQUISITION TO BE VERIFIED PRIOR TO STARTING SIGNAL CONSTRUCTION WORK.



PUSH BUTTON DETAIL (TYPICAL)
(NOT TO SCALE)



PAVEMENT MARKINGS LEGEND

(A)	396 S.F.	SYMBOL/LEGEND ALKYD-THERMOPLASTIC PAVEMENT STRIPING (ITEM 748015)
(B)	50 S.F.	16" SOLID WHITE ALKYD-THERMOPLASTIC PAVEMENT STRIPING (ITEM 748015)
(C)	230 S.F.	12" SOLID WHITE ALKYD-THERMOPLASTIC PAVEMENT STRIPING (ITEM 748027)

CONDUIT RUN SCHEDULE

CR NO.	NO. OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE / WIRE
1A	1	2"	90'	(1) 2/#8 U.F. w/GROUND
1B	1	2"	10'	(1) 2/#8 U.F. w/GROUND
2	2	3"	5'	(1) 9/#14 (1) 4/#18 (1) #6
3	4	4"	5'	(2) 9/#14 (2) 4/#18 (3) 5/#14 (5)#6
4	1	4"	40'	(1) 9/#14 (1) 4/#18 (2) 5/#14 (3)#6
5	1	4"	70'	(1) 9/#14 (1) 4/#18 (2) 5/#14 (3)#6
6	1	2.5"	10'	(1) 5/#14 (1) #6
7	1	4"	80'	(1) 9/#14 (1) 4/#18 (1) #6
8	2	3"	5'	(1) 9/#14 (1) 4/#18 (1) #6
9	1	2.5"	10'	(1) 5/#14 (1) #6
10	1	4"	80'	(1) 5/#14 (1) #6
11	1	4"	80'	(1) 5/#14 (1) #6
12	1	2.5"	25'	(1) 5/#14 (1) #6

* DENOTES EXISTING

MAST ARM SCHEDULE

MA NO.	LENGTH OF ARM	NO. OF HEADS	S.F. OF SIGNING
1	55'	2	16.5
2	45'	2	16.5

SIGNAL POLE SCHEDULE

POLE#	POLE TYPE	HEIGHT	MATERIAL
1	STRAIN	21'	STEEL
2	STRAIN	21'	STEEL
3	PEDESTAL	10'	ALUMINUM
4	PEDESTAL	10'	ALUMINUM
5	PEDESTAL	10'	ALUMINUM

* DENOTES EXISTING

OVERHEAD SIGN DETAIL

S-1: CROSSWALK STOP ON RED — R10-23, 30" X 36"

S-2: S1-1 (FYG)

GROUND SIGN DETAIL

S-3: STOP HERE ON RED — R10-6, 24" X 36"

S-4: DO NOT PASS ON SHOULDER — R4-18, 24" X 30"

SIGNAL PHASING

1. THE PEDESTRIAN HYBRID BEACON REMAINS DARK (NOT ILLUMINATED) DURING PERIOD BETWEEN ACTUATIONS CONCURRENT WITH PEDESTRIAN DON'T WALK INDICATION.
2. UPON PEDESTRIAN ACTUATION, THE BEACON DISPLAYS A FLASHING YELLOW INDICATION CONCURRENT WITH THE PEDESTRIAN DON'T WALK INDICATION.
3. THE BEACON CHANGES TO A STEADY YELLOW INDICATION CONCURRENT WITH THE PEDESTRIAN DON'T WALK INDICATION.
4. THE BEACON CHANGES TO A STEADY RED INDICATION CONCURRENT WITH THE PEDESTRIAN WALK INTERVAL.
5. THE BEACON CHANGES TO AN ALTERNATING FLASHING RED INDICATION CONCURRENT WITH THE PEDESTRIAN COUNTDOWN INDICATION AND PEDESTRIAN CLEARANCE INTERVAL.
6. THE BEACON REVERTS BACK TO THE DARK CONDITION AFTER THE PEDESTRIAN CLEARANCE INTERVAL ENDS.

SIGNAL HEAD DIAGRAM

1 – 6

R R
Y

LEGEND

AB	ABANDON	OH	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA X	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)	OH	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA X	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	PB X	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PB X	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PL X	EXISTING POLE IDENTIFIER (# OF POLE)
JW X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PL X	PROPOSED POLE IDENTIFIER (# OF POLE)
JW X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	RM C	REMOVE BY CONTRACTOR
MA XX	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)	RM O	REMOVE BY OTHERS
MA XX	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)	RM TC	REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		P
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. ALL MAST ARM SIGNAL POLES WILL BE 21 FEET, EXCEPT WHERE SHOWN.
2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
3. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
4. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
6. PROPOSED POLE BASES SUPPORTING POLES WITH PEDESTRIAN PUSHBUTTONS SHALL BE CONSTRUCTED IMMEDIATELY ADJACENT TO THE FLAT (50:1 OR FLATTER) LANDING AREA OF THE CURB RAMP OR SIDEWALK IN ACCORDANCE WITH CURRENT ADA BEST PRACTICES. THESE POLE BASES SHALL BE FLUSH WITH THE ADJOINING LANDING AREA. THE PEDESTRIAN PUSH BUTTON SHALL BE INSTALLED AT HEIGHT OF 40-44 INCHES ABOVE THE LANDING AREA/ SIDEWALK AND SHALL BE LOCATED SUCH THAT MAXIMUM REACH DISTANCE IS 10 INCHES FROM THE LANDING AREA TO THE FACE OF THE SIDEWALK.

RECOMMENDED ______ DATE: ______ | RECOMMENDED ______ DATE: ______ | RECOMMENDED ______ DATE: 2/25/14 | APPROVED TRAFFIC ENGINEER ______ DATE: 2/26/14 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ______ DATE: 2/25/14

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE 0 30 60 90 FEET

SR 8, FORREST AVENUE PEDESTRIAN IMPROVEMENTS, CRANBERRY RUN DRIVE TO MARSH CREEK LANE

CONTRACT	PERMIT NO.	K312
T201401201	DESIGNED BY: MS	
COUNTY		
KENT	CHECKED BY: MH	

HAWK SIGNAL PLAN (PEDESTRIAN HYBRID BEACON) SR 8 & HEATHERFIELD WAY

SHEET NO. 19 TOTAL SHTS. 19

CONDUIT RUN SCHEDULE

CO*	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE	
1	1	2.0 IN	5 FT	T	(1) 2/#8 U.F. W/GROUND	
2	1	2.5 IN	7 FT	T	(2) 16/#14, (4) 4/#18	
3	3	2.5 IN	5 FT	T	(3) 9/#14, (9) 4/#18, (1) FIBER OPTIC, SINGLE-MODE, 6 CT.	SEE NOTE 11
4	1	2.0 IN	30 FT	T	(1) 2/#8 U.F. W/GROUND	
5	2	2.5 IN	42 FT	B	(3) 9/#14, (9) 4/#18	
6	1	4.0 IN	84 FT	B	(1) FIBER OPTIC, SINGLE-MODE, 6 CT.	SEE NOTE 11
7	1	2.5 IN	55 FT	T	(1) 9/#14, (7) 4/#18	
8	1	2.5 IN	222 FT	T	(2) 4/#18	
9	1	4.0 IN	240 FT	T	(1) FIBER OPTIC, SINGLE-MODE, 6 CT.	SEE NOTE 11
10*	1	4.0 IN	884 FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 12 CT.	
11*	1	4.0 IN	XX FT	-	EX. (1) FIBER OPTIC, SINGLE-MODE, 12 CT.	
12	1	2.5 IN	99 FT	T	(2) 4/#18	
13	1	2.5 IN	25 FT	T	(1) 4/#18	
14	1	2.5 IN	63 FT	B	(1) 9/#14, (1) 4/#18	
15	1	2.5 IN	34 FT	B	EMPTY	
16	1	2.5 IN	12 FT	T	EMPTY	
17	1	2.5 IN	38 FT	B	(1) 9/#14	
18	1	2.5 IN	55 FT	B	(1) 9/#14	
19	1	2.5 IN	12 FT	T	EMPTY	
20	1	2.5 IN	7 FT	T	(1) 9/#14	
21	1	2.5 IN	122 FT	B	(3) 4/#18	
22	1	2.5 IN	247 FT	T	(2) 4/#18	
23	1	2.5 IN	75 FT	T	(2) 4/#18	
24	1	2.5 IN	12 FT	T	(1) 4/#18	
25	1	2.5 IN	5 FT	T	(1) 9/#14	
26	1	2.5 IN	48 FT	B	(1) 9/#14, (2) 4/#18	
27	1	2.5 IN	50 FT	B	(1) 9/#14	
28	1	2.5 IN	7 FT	T	(2) 9/#14	
29	1	2.5 IN	9 FT	T	(1) 9/#14	
30	1	2.5 IN	45 FT	B	EMPTY	
31	1	2.5 IN	6 FT	T	EMPTY	

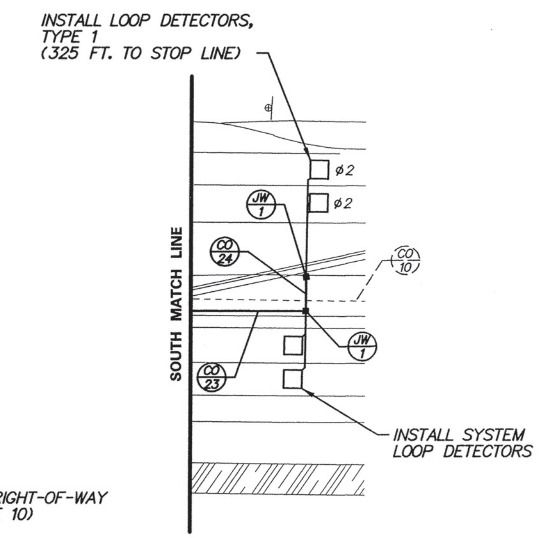
* DENOTES EXISTING CONDUIT

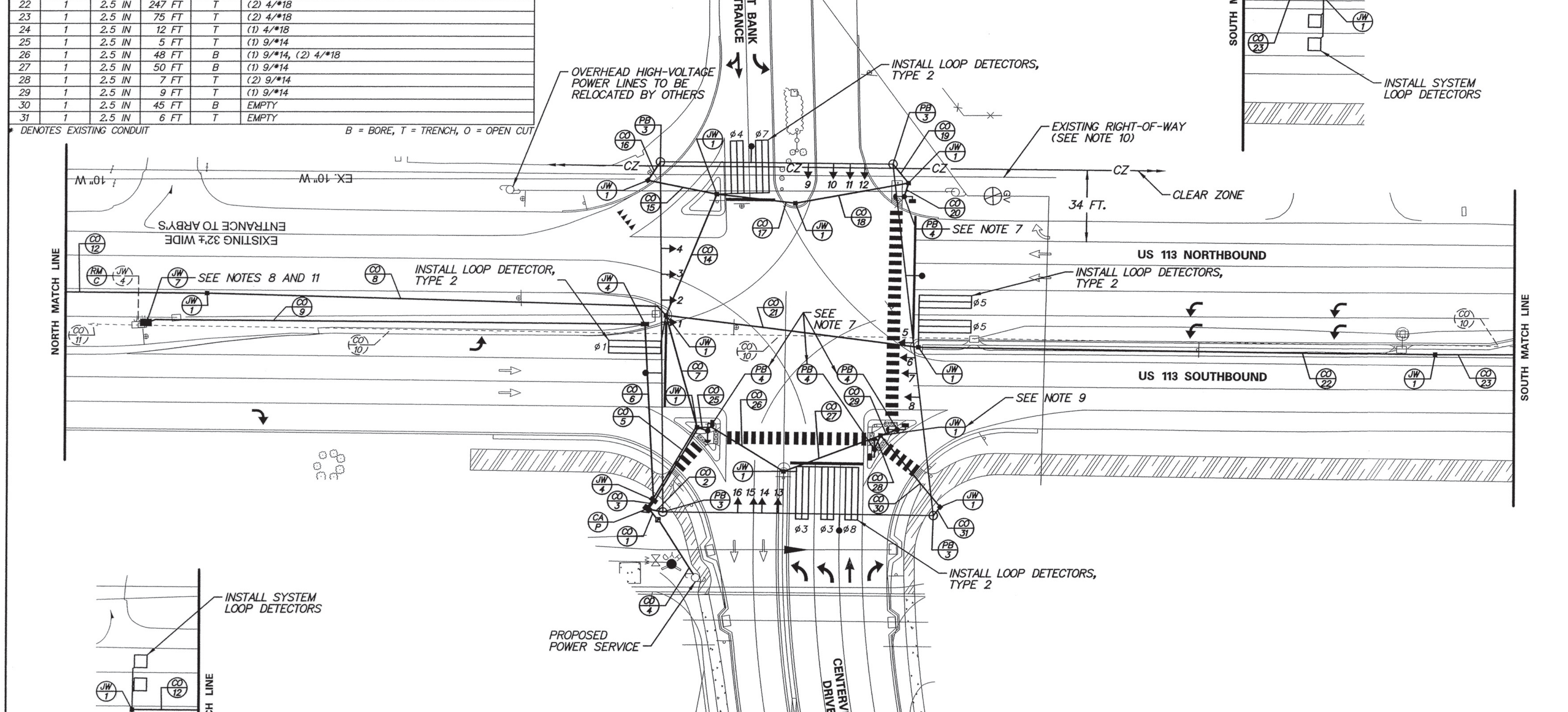
B = BORE, T = TRENCH, O = OPEN CUT

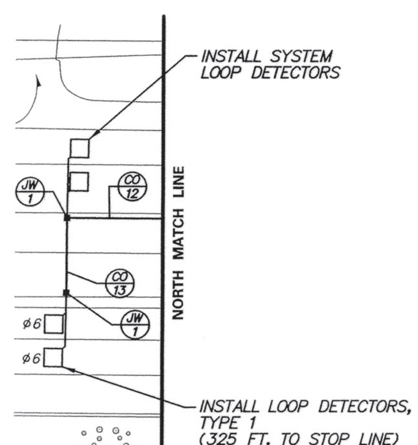
SPAN WIRE SCHEDULE

SPAN	LENGTH	SPAN MOUNT HEIGHT	5% SAG	SPAN MIDPOINT
NORTH	166 FT	30 FT	8.3 FT	21.7 FT
SOUTH	168 FT	30 FT	8.4 FT	21.6 FT
EAST	112 FT	27 FT	5.6 FT	21.4 FT
WEST	129 FT	28 FT	6.5 FT	21.5 FT

* FIELD ADJUSTMENTS AS REQUIRED







CONSTRUCTION NOTES:

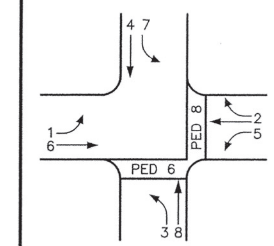
8. CONTRACTOR SHALL REMOVE EXISTING JUNCTION WELL, TYPE 4 AND INSTALL PROPOSED JUNCTION WELL, TYPE 7.

9. CONTRACTOR SHALL INSTALL PROPOSED JUNCTION WELL, TYPE 1 FLUSH WITH ADJOINING P.C.C. CURB RAMP, TYPE 5.

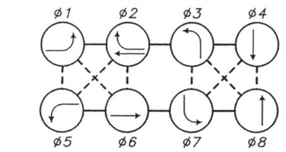
10. PER SIGNAL AGREEMENTS ON FILE WITH DELDOT TRAFFIC FOR PARCELS 233-5.00-10.01, 233-5.00-10.02, AND 233-5.00-10.03, CONTRACTOR AND DELDOT TRAFFIC RESERVE THE RIGHT TO INSTALL, MAINTAIN, OPERATE, AND MODIFY TRAFFIC SIGNAL EQUIPMENT OUTSIDE OF EXISTING RIGHT-OF-WAY.

11. DELDOT OIT SHALL COORDINATE THE SPLICING AND INSTALLATION OF ALL PROPOSED FIBER OPTIC CABLES.

SIGNAL PHASING



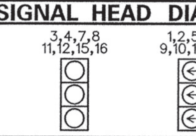
NEMA PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM/C REMOVE BY CONTRACTOR
- RM/O REMOVE BY OTHERS
- AB ABANDON
- PB/X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB/X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW/X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW/X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO/# PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO/# EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH/# PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH/# EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA/XX PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA/XX EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA/X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA/X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- XX EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P SERVICE PEDESTAL

GENERAL SIGNAL NOTES

1. DETECTION - 55 M.P.H. - 4.0 SECONDS PASSAGE TIME AT 325 FEET FROM THE STOP LINE.
2. LOOP DETECTORS:
   TYPE #1 - 6' x 6' - TO BE INSTALLED ON US 113 THROUGH MOVEMENTS.
   TYPE #2 - 6' x 25' - TO BE INSTALLED ON US 113 LEFT-TURN MOVEMENTS.
   TYPE #2 - 6' x 25' - TO BE INSTALLED ON SIDE-STREET THROUGH AND LEFT-TURN MOVEMENTS.
   SYSTEM - 6' x 6' - TO BE INSTALLED ALONG US 113 RECEIVING LANES, AS SHOWN.
3. ALL SIGNAL POLES SHALL BE 32 FEET. SPAN WIRES SHALL HAVE 5-PERCENT DISPLACEMENT (SAG) AT MIDPOINT, AS SHOWN IN THE SPAN WIRE SCHEDULE (FIELD ADJUSTMENTS AS REQUIRED).
4. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
7. PROPOSED POLE BASE, TYPE 4, AND PEDESTAL POLE FOR THE PEDESTRIAN SIGNAL SHALL BE CONSTRUCTED IMMEDIATELY ADJACENT TO THE LANDING AREA OF THE CURB RAMP OR SIDEWALK IN ACCORDANCE WITH CURRENT ASA BEST PRACTICES. THE PEDESTRIAN PUSHBUTTON SHALL BE INSTALLED AT A HEIGHT OF 42 INCHES ABOVE THE LANDING AREA/SIDEWALK ABD SHALL BE LOCATED SUCH THAT THE MAXIMUM REACH DISTANCE IS 10 INCHES FROM THE SIDEWALK.

RECOMMENDED ________ DATE: ________ | RECOMMENDED ________ DATE: ________ | RECOMMENDED [signature] DATE: 4/17/08 | APPROVED TRAFFIC ENGINEER [signature] DATE: 4/18/08 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 4/18/08

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE: 0 30 60 90 FEET

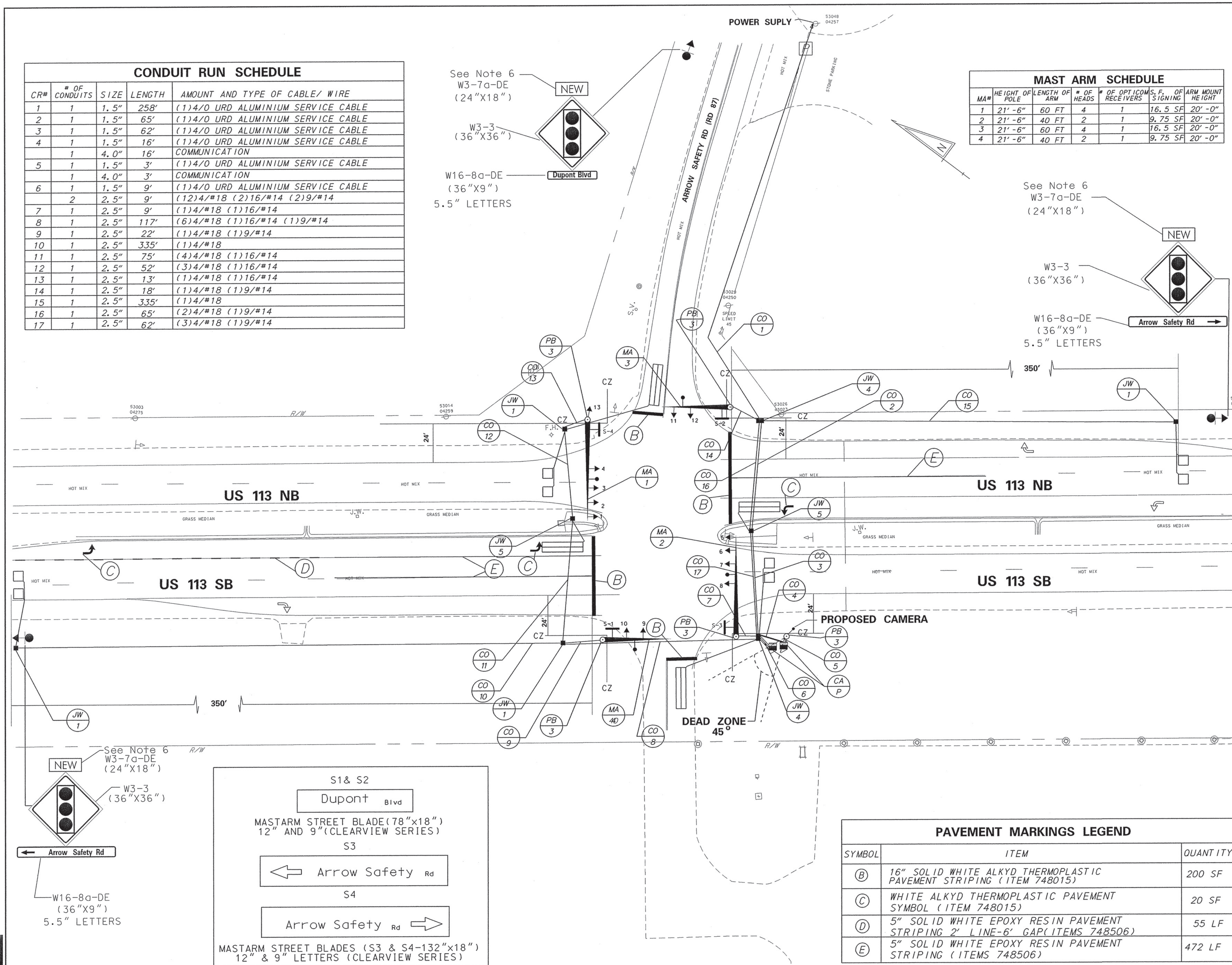
PENINSULA CROSSING

CONTRACT	PERMIT NO.	S-315
	DESIGNED BY: M.J.B. (WR&A)	
COUNTY: SUSSEX	CHECKED BY: M.J.B. (WR&A)	

SIGNAL PLAN
US 113 @ M&T BANK / CLEARVIEW DRIVE
(PENINSULA CROSSING NORTH)

SHEET NO. 1

TOTAL SHTS. 4



CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/ WIRE
1	1	1.5"	258'	(1)4/0 URD ALUMINIUM SERVICE CABLE
2	1	1.5"	65'	(1)4/0 URD ALUMINIUM SERVICE CABLE
3	1	1.5"	62'	(1)4/0 URD ALUMINIUM SERVICE CABLE
4	1	1.5"	16'	(1)4/0 URD ALUMINIUM SERVICE CABLE
	1	4.0"	16'	COMMUNICATION
5	1	1.5"	3'	(1)4/0 URD ALUMINIUM SERVICE CABLE
	1	4.0"	3'	COMMUNICATION
6	1	1.5"	9'	(1)4/0 URD ALUMINIUM SERVICE CABLE
	2	2.5"	9'	(12)4/#18 (2)16/#14 (2)9/#14
7	1	2.5"	9'	(1)4/#18 (1)16/#14
8	1	2.5"	117'	(6)4/#18 (1)16/#14 (1)9/#14
9	1	2.5"	22'	(1)4/#18 (1)9/#14
10	1	2.5"	335'	(1)4/#18
11	1	2.5"	75'	(4)4/#18 (1)16/#14
12	1	2.5"	52'	(3)4/#18 (1)16/#14
13	1	2.5"	13'	(1)4/#18 (1)16/#14
14	1	2.5"	18'	(1)4/#18 (1)9/#14
15	1	2.5"	335'	(1)4/#18
16	1	2.5"	65'	(2)4/#18 (1)9/#14
17	1	2.5"	62'	(3)4/#18 (1)9/#14

MAST ARM SCHEDULE

MA#	HEIGHT OF POLE	LENGTH OF ARM	# OF HEADS	# OF OPTICOM RECEIVERS	S.F. OF SIGNING	ARM MOUNT HEIGHT
1	21'-6"	60 FT	4	1	16.5 SF	20'-0"
2	21'-6"	40 FT	2	1	9.75 SF	20'-0"
3	21'-6"	60 FT	4	1	16.5 SF	20'-0"
4	21'-6"	40 FT	2	1	9.75 SF	20'-0"

S1& S2

Dupont Blvd

MASTARM STREET BLADE(78"x18")
12" AND 9"(CLEARVIEW SERIES)

S3

Arrow Safety Rd

S4

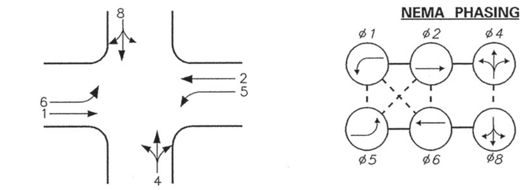
Arrow Safety Rd

MASTARM STREET BLADES (S3 & S4-132"x18")
12" & 9" LETTERS (CLEARVIEW SERIES)

PAVEMENT MARKINGS LEGEND

SYMBOL	ITEM	QUANTITY
B	16" SOLID WHITE ALKYD THERMOPLASTIC PAVEMENT STRIPING (ITEM 748015)	200 SF
C	WHITE ALKYD THERMOPLASTIC PAVEMENT SYMBOL (ITEM 748015)	20 SF
D	5" SOLID WHITE EPOXY RESIN PAVEMENT STRIPING 2' LINE-6' GAP(ITEMS 748506)	55 LF
E	5" SOLID WHITE EPOXY RESIN PAVEMENT STRIPING (ITEMS 748506)	472 LF

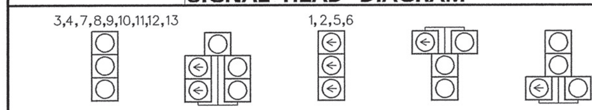
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

AB	ABANDON	OH	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA / X	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)	OH	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA / X	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	PB / X	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PB / X	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PL / X	EXISTING POLE IDENTIFIER (# OF POLE)
JW / X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PL / X	PROPOSED POLE IDENTIFIER (# OF POLE)
JW / X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	RM / C	REMOVE BY CONTRACTOR
MA / XX	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)	RM / O	REMOVE BY OTHERS
MA / XX	PROPOSED MAST ARM IDENTIFIER (# OF MAST ARM)	RM / TC	REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		P
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. ALL SIGNAL EQUIPMENTS REMOVED FROM A PROJECT IS TO BE RETURNRD TO DELDOT TRAFFIC-DOVER, DELAWARE.
2. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS.SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
3. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
4. THE PROPOSED "NEW" SIGNS(W3-7a-DE) SHALL BE INSTALLED ABOVE PROPOSED "SIGNAL AHEAD" SIGNS(W3-3) FOR A MINIMUM OF 30 DAYS AND MAXIMUM OF 90 DAYS.
5. THE CONTRACTOR SHALL REMOVE THE EXISTING SIDE ROAD WARNING SIGNS AND PLAQUE.
6. THE CONTRACTOR SHALL INSTALL PROPOSED "SIGNAL AHEAD(W3-3), "NEW"(W3-7a-DE) AND ADVANCED STREET NAME SIGNS(W16-8a-DE) 500' FROM STOP BAR.
7. THE CONTRACTOR SHALL REMOVE EXISTING "STOP AHEAD" SIGN ON ARROW SAFETY ROAD.
8. RIGHT OF WAY WAS OBTAINED FROM CONTRACT NUMBER 65-07-012 PLANS.
9. SEE SHEET 2 FOR ALL GROUND MOUNTED SIGNS & STRIPING REMOVAL. PROPOSED STRIPING IS ON THIS SHEET.

RECOMMENDED ____ DATE: ____ | RECOMMENDED ____ DATE: ____ | RECOMMENDED Chetna Dave DATE: 12/8/11 | APPROVED TRAFFIC ENGINEER ____ DATE: ____ | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 12/9/11

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE 0 30 60 90 FEET

US 113 & ARROW SAFETY RD

CONTRACT	T201209403	PERMIT NO.	S332
COUNTY	SUSSEX	DESIGNED BY:	CBD
		CHECKED BY:	ML

SIGNAL PLAN AT US 113 & ARROW SAFETY RD

SHEET NO. 1 | TOTAL SHTS. 2

CONDUIT RUN SCHEDULE

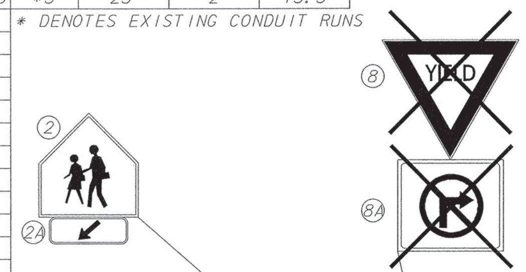
CR NO.	NO. OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE / WIRE
*1	2	1.5"	290'	(1)#18/4
*2	3	2.5"	5'	(5)#14/9 (7)#18/4 NEW(4)#14/5
*3	2	2.5"	90'	(4)#18/4 (3)#14/9 (1)#0/4URD NEW(3)#14/5
*4	1	2.5"	75'	(2)#18/4 (1)#14/9 NEW(1)#14/5
*5	1	1.5"	25'	(1)#18/4
*6	2	2.5"	60'	(1)#18/4 (2)#14/9 (1)#0/4 URD
*7	1	1.5"	64'	(1)4/#18
*8	2	2.5"	70'	(1)#18/4 (1)#14/9 (1)#0/4 URD
*9	2	2.5"	10'	(1)#8/4 (1)#14/6 (1)#0/4 URD
*10	2	2.5"	15'	(1)#14/9 (1)#0/4 URD
*11	1	2.5"	60'	(1)#18/4 (1)#14/9 NEW(1)#14/5
*12	1	1.5"	115'	(1)#18/4
*13	1	1.5"	220'	COMM (1)#18/4
*14	1	1.5"	40'	COMM (1)#18/4
*15	1	1.5"	UNK	COMM
*16	1	1.5"	290'	(1)#18/4
*17	1	2.5"	60'	(1)#0/4 URD
*18	2	2.5"	60'	(2)#18/4 (1)#14/9 (1)#0/4 URD
*19	1	2.5"	35'	(1)#8/2 U.F. W/GROUND
20	1	2.5"	5'	(1)#14/5
21	1	2.5"	14'	(1)#14/5
22	1	2.5"	15'	(2)#14/5

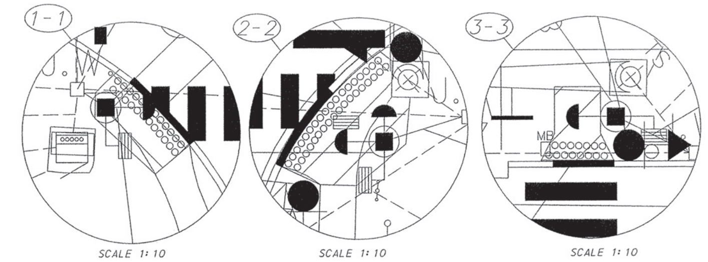
* DENOTES EXISTING CONDUIT RUNS

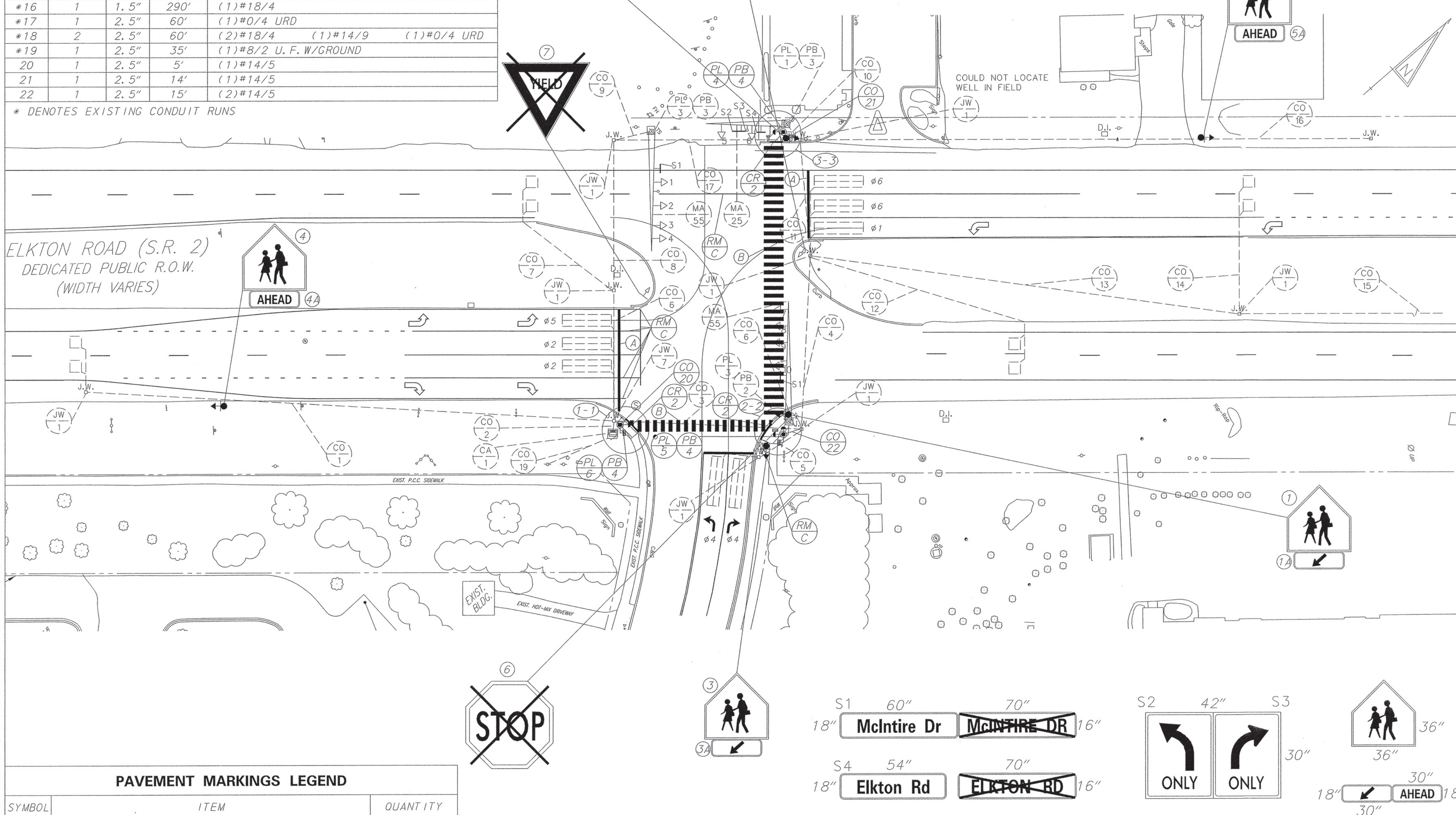
MAST ARM SCHEDULE

MA NO.	LENGTH OF ARM	NO. OF HEADS	S.F. OF SIGNING
*1	55'	4	7.8
*2	55'	4	7.8
*3	25'	2	15.5

* DENOTES EXISTING CONDUIT RUNS



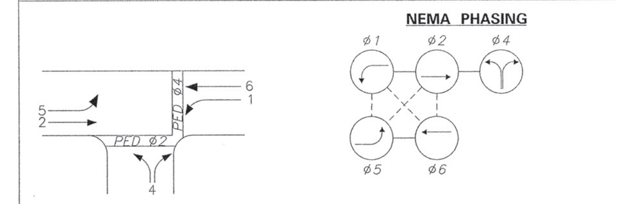




PAVEMENT MARKINGS LEGEND

SYMBOL	ITEM	QUANTITY
A	ALKYD-THERMOPLASTIC PAVEMENT STRIPING, WHITE 16" SOLID (ITEM 748015)	115 SF
B	ALKYD-THERMOPLASTIC PAVEMENT STRIPING, WHITE 24" SOLID (ITEM 748015)	916 SF

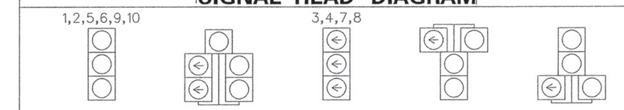
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

AB — ABANDON	OH — EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA — EXISTING CABINET IDENTIFIER (TYPE OF CABINET)	OH — PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA — PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	PB — EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO — EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PB — PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO — PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PL — EXISTING POLE IDENTIFIER (# OF POLE)
JW — EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PL — PROPOSED POLE IDENTIFIER (# OF POLE)
JW — PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	RM C — REMOVE BY CONTRACTOR
MA XX — EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)	RM O — REMOVE BY OTHERS
MA XX — PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)	RM TC — REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.

2. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.

3. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS.SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.

4. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

5. PROPOSED WORK TO BE PREFORMED IN ACCORDANCE WITH TRAFFIC SIGNAL INSTALLATION AGREEMENT BETWEEN THE STATE AND NEWARK CHARTER SCHOOL.

RECOMMENDED [signature] DATE: 11/22/13 | RECOMMENDED [signature] DATE: 11/22/13 | RECOMMENDED ______ DATE: ______ | APPROVED TRAFFIC ENGINEER [signature] DATE: 11/22/13 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 11/25/13

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE 0 30 60 90 FEET

NEWARK CHARTER HIGH SCHOOL PEDESTRIAN IMPROVEMENTS

CONTRACT – | COUNTY NEW CASTLE | PERMIT NO. N643 | DESIGNED BY: JWVH | CHECKED BY: ______

SIGNAL PLAN
ELKTON RD & McINTIRE DR

SHEET NO. 1 | TOTAL SHTS. 1

Y:\TRAFFIC\USERS\JEFF\SIGNAL DESIGNS\ELKTON RD & McINTIRE\ELKTON RD & McINTIRE DR.DGN

CONDUIT RUN SCHEDULE

CR NO.	NO. OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE / WIRE
*1	1	2"	50'	(1) 8/#2 W/ GROUND
*2	2	2.5"	15'	(2) 16/#14 (4) 4/#18 (SWEEP TO NEW RUN #18)
*3	2	2.5"	5'	(6) 4/#18 COMM. CABLE [NEW (2) 9/#14]
**4	1	2.5"	75'	(5) 4/#18 COMM. CABLE [NEW (2) 9/#14]
*5	1	2.5"	150'	(3) 4/#18 COMM. CABLE
*6	1	2.5"	120'	(1) 4/#18
*7	1	2.5"	155'	(1) 4/#18
*8	1	2.5"	80'	EMPTY
*9	1	2.5"	135'	(1) 4/#18
*10	1	2.5"	135'	(1) 4/#18
*11	1	2.5"	50'	(1) 4/#18
*12	1	2.5"	100'	(1) 4/#18
**13	1	2.5"	90'	[NEW (2) 9/#14 (1) 4/#18]
**14	1	2.5"	120'	[NEW (2) 9/#14 (1) 4/#18]
*15	1	2.5"	--	COMM. CABLE
*16	1	2.5"	--	COMM. CABLE

* DENOTES EXISTING
** ADD ADDITIONAL 4" SCH 80 PVC CONDUIT RUN

CONDUIT RUN SCHEDULE

CR NO.	NO. OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE / WIRE
17	4	4"	5'	(10) 4/#18 (2) 9/#14 (2) 16/#14 COMM. CABLE
18	2	3"	20'	(2) 16/#14 (4) 4/#18

SIGN 1

(Front & Back)

US 113

16"x60"

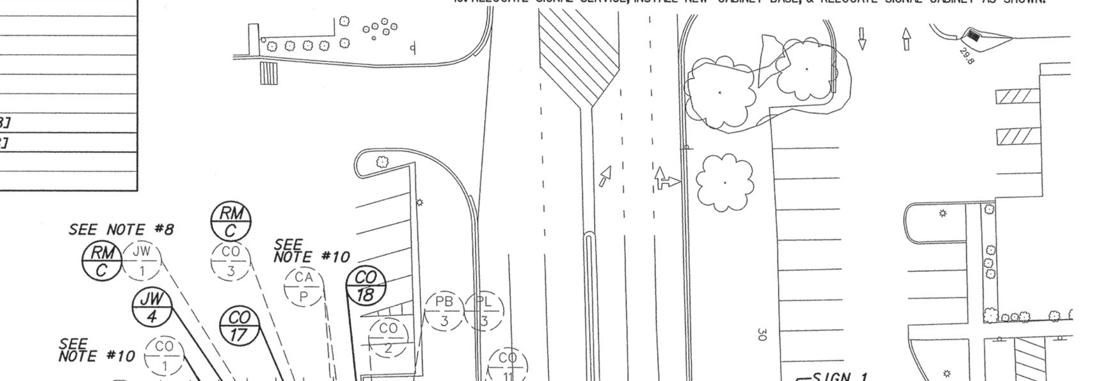
ADDITIONAL SIGNAL NOTES

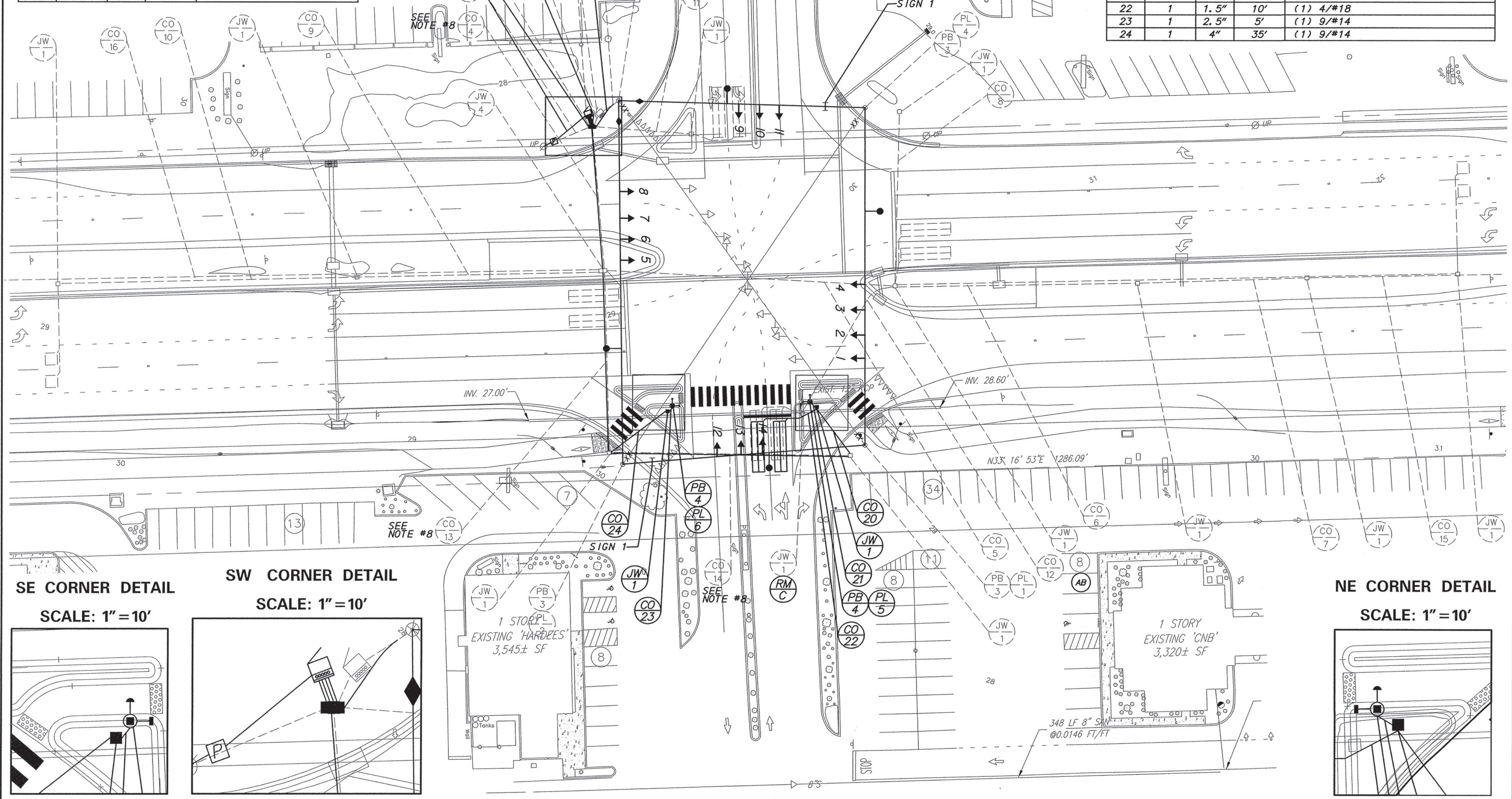
7. PROPOSED POLE BASES SUPPORTING POLES WITH PEDESTRIAN PUSHBUTTONS SHALL BE CONSTRUCTED IMMEDIATELY ADJACENT TO THE FLAT (50:1 OR FLATTER) LANDING AREA OF THE CURB RAMP OR SIDEWALK IN ACCORDANCE WITH CURRENT ADA BEST PRACTICES. THESE POLE BASES SHALL BE FLUSH WITH THE ADJOINING LANDING AREA. THE PEDESTRIAN PUSH BUTTON SHALL BE INSTALLED AT HEIGHT OF 40-44 INCHES ABOVE THE LANDING AREA/SIDEWALK AND SHALL BE LOCATED SUCH THAT MAXIMUM REACH DISTANCE IS 10 INCHES FROM THE LANDING AREA TO THE FACE OF THE SIDEWALK.

8. INSTALL ADDITIONAL 4" SCH 80 PVC CONDUIT FOR RUN # 4, 13, & 14 FOR PEDESTRIAN CABLES AS SHOWN ON PLAN. REPLACE EXISTING JUNCTION WELL TYPE 1 WITH TYPE 4.

9. ALL PEDESTRIAN SIGNALS SHALL CONTAIN PEDESTRIAN COUNTDOWN MODULES.

10. RELOCATE SIGNAL SERVICE, INSTALL NEW CABINET BASE, & RELOCATE SIGNAL CABINET AS SHOWN.





SIGNAL POLE SCHEDULE

POLE#	POLE TYPE	HEIGHT	MATERIAL
*1	STRAIN	28'	STEEL
*2	STRAIN	28'	STEEL
*3	STRAIN	28'	STEEL
*4	STRAIN	28'	STEEL
5	PEDESTAL	10'	ALUMINUM
6	PEDESTAL	10'	ALUMINUM

* DENOTES EXISTING

SPAN WIRE SCHEDULE

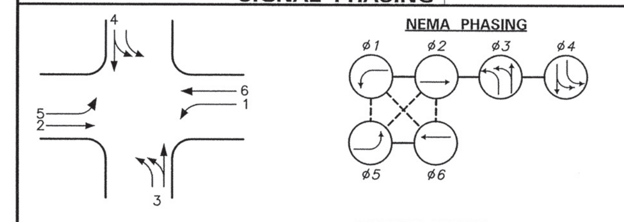
SPAN	LENGTH	SPAN MOUNT HEIGHT	4% SAG	SPAN LOW POINT	BOTTOM OF LOWEST HEAD
NORTH	168 FT	27 FT	6.72 FT	20.28 FT	16.28 FT
SOUTH	181 FT	27 FT	7.24 FT	19.76 FT	15.76 FT
EAST	122 FT	27 FT	4.88 FT	22.12 FT	18.12 FT
WEST	123 FT	27 FT	4.92 FT	22.08 FT	18.08 FT

* FIELD ADJUSTMENTS AS REQUIRED
** ALL EXISTING SIGNAL POLES ARE 28 FEET

CONDUIT RUN SCHEDULE

CR NO.	NO. OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE / WIRE
20	1	4"	30'	(1) 9/#14 (1) 4/#18
21	1	2.5"	5'	(1) 9/#14
22	1	1.5"	10'	(1) 4/#18
23	1	2.5"	5'	(1) 9/#14
24	1	4"	35'	(1) 9/#14

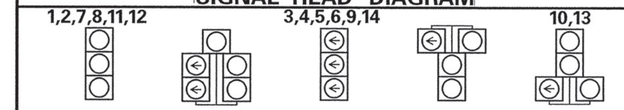
SIGNAL PHASING



PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

AB	ABANDON	OH / #	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA / X	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)	OH / #	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
CA / X	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	PB / X	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO / #	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PB / X	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
CO / #	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	PL / X	EXISTING POLE IDENTIFIER (# OF POLE)
JW / X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PL / X	PROPOSED POLE IDENTIFIER (# OF POLE)
JW / X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	RM / C	REMOVE BY CONTRACTOR
MA / XX	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)	RM / O	REMOVE BY OTHERS
MA / XX	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)	RM / TC	REMOVE BY TRAFFIC CONTRACTOR

	EXISTING SYMBOL	PROPOSED SYMBOL
JUNCTION WELL	J.W.	
LOOP DETECTOR, TYPE 1		
LOOP DETECTOR, TYPE 2		
LUMINAIRE		
MAST ARM		
MICROWAVE DETECTION		
OPTICOM RECEIVER		
OVERHEAD SIGNING		
PEDESTRIAN POLE/BASE		
PEDESTRIAN PUSHBUTTON		
PEDESTRIAN SIGNAL HEAD		
RIGHT-OF-WAY		R/W
SERVICE PEDESTAL		P
SIGNAL CABINET		
SIGNAL HEAD		
SIGNAL POLE/BASE		
SPAN INSULATOR		
SPAN WIRE	XX	
UTILITY POLE		
VIDEO DETECTION		

GENERAL SIGNAL NOTES

1. ALL EXISTING SIGNAL POLES ARE 28 FEET, EXCEPT WHERE SHOWN.
2. CO #1 IS NOT DRAWN TO SCALE, NOR IS THE DIRECTION NECESSARILY CORRECT.
3. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
4. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED [signature] DATE: 11/28/12 | RECOMMENDED ______ DATE: ______ | RECOMMENDED ______ DATE: ______ | APPROVED TRAFFIC ENGINEER [signature] DATE: 11/28/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 11/30/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE 0 30 60 90 FEET

THE PLAZA AT MILFORD EXPANSION AND ADDITION

CONTRACT	PERMIT NO.	K009
	DESIGNED BY: MS	
COUNTY		
KENT	CHECKED BY: MH / DH	

SIGNAL PLAN

US 113 & MILFORD PLAZA

SHEET NO.	1
TOTAL SHTS.	1

W:\MSV8\CELLS\PROJDEV\SB.CEL

ADDITIONAL SIGNAL NOTES

9 CONTRACTOR SHALL REMOVE EXISTING SPAN WIRE AND ALL ASSOCIATED HARDWARE & EQUIPMENT.

10 CONTRACTOR SHALL REMOVE EXISTING SIGNAL CABINET AND BASE.

11 CONTRACTOR TO REMOVE EXISTING PEDESTRIAN SIGNAL HEADS,PUSH BUTTONS AND ASSOCIATED WIRING.

12 CONTRACTOR SHALL INSTALL COUNT-DOWN PEDESTRIAN SIGN (R10-3e). WITH PROPER PEDESTRIAN MOVEMENT ARROW FOR RELEVANT CROSSWALK DIRECTION ABOVE EACH PEDESTRIAN PUSH BUTTON.

13 ALL CROSSWALKS SHALL BE 10-FOOT IN WIDTH.

14 CONTRACTOR SHALL INSTALL 10 FOOT CONCRETE SIDEWALK TO INTERSECTION. (TIE INTO EXISTING BLACKTOP SIDEWALK (AT EXISTING WIDTH) & EXISTING CONCRETE CURB) (APPROX.65 L.F.)
CONTRACTOR TO RELOCATE SIGN IMPACTED BY SIDEWALK INSTALLATION.

15 ALL EXISTING SIGNAL INSTALLATIONS SHALL REMAIN IN PLACE UNTIL PROPOSED SIGNAL INSTALLATION ARE COMPLETE AND IN OPERATION.

16 CONTRACTOR SHALL RESET,ADJUST,OR REPAIR EXISTING TYPE-1 JUNCTION WELL AS NECESSARY FOR INTEGRATION OF PROPOSED CONDUIT. THE EXISTING METAL LID SHALL BE REMOVED AND REPLACED WITH A COMPOSITE LID.

17 REMOVAL OF EXISTING #18/4 AERIAL CABLE FROM OVERHEAD LINES AND ASSOCIATED CONDUIT FOR EXISTING LOOP DETECTION OF PHASE 6.

18 TRAFFIC SIGNAL WILL HAVE CDMA INSTALLED FOR COMMUNICATION WITH TMC.

19 CONTRACTOR SHALL REMOVE EXISTING JW TYPE 1 AND REPLACE WITH PROPOSED JW TYPE 14. CARE SHALL BE TAKEN NOT TO DAMAGE ANY CONDUITS AND/OR CABLES IN THE REMOVAL AND INSTALLATION PROCESS. AFTER THE PROPOSED SIGNAL INSTALLATIONS HAVE BEEN AND THE EXISTING . CONTRACTOR SHALL REMOVE THE PORTIONS OF THE CONDUITS AND CABLES IN THE PROPOSED JW TYPE 14 AND PATCH UP/REPAIR PROPOSED JW.

20 RIGHT OF WAY SHOWN ON THIS PLAN TAKEN FROM:
DEED RECORD
1) 1098-326
2) 421-176
DELDOT CONTRACT NUMBER
1) 66-09-006

MAST ARM SCHEDULE

MA #	HEIGHT OF POLE	LENGTH OF ARM	# OF HEADS	# OF OPTICOM RECEIVERS	SF OF SIGNING	ARM MOUNT HEIGHT
1	25'-0"	40'	2	1	25	24'-0"
2	25'-0"	40'	2	1	16	24'-0"
3	25'-0"	40'	2	1	25	24'-0"
4	25'-0"	40'	2	1	16	24'-0"

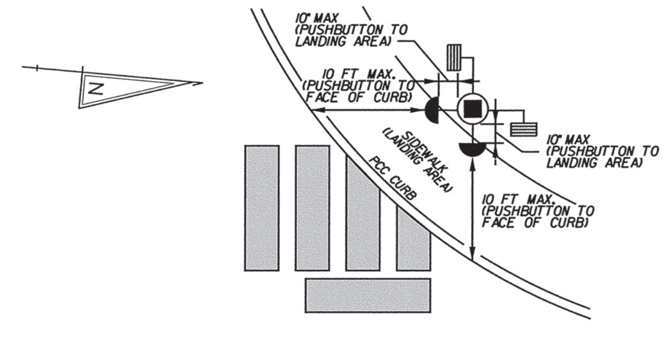
CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	TYPE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/WIRE
1A	1	2"	PVC	6'	T	NEW (1)#8/2 U.F.w/GROUND
1B	1	2"	PVC	40'	T	NEW (1)#8/2 U.F.w/GROUND
1C	1	4"	HDPE	50'	B	NEW (1)#8/2 U.F.w/GROUND
1D	1	2"	PVC	20'	T	NEW (1)#8/2 U.F.w/GROUND
1E	1	2"	PVC	5'	T	NEW (1)#8/2 U.F.w/GROUND
2	1	3"	PVC	10'	T	NEW [(1) #14/16 (1)#14/9 (1)#18/4 (1)#6 BARE COPPER]
3	3	4"	PVC	5'	T	NEW [(4)#14/16 (4)#14/9 (11) #18/4 (3)#6 BARE COPPER]
4	1	4"	HDPE	83'	B	NEW [(3)#14/16 (3)#14/9 (10)#18/4 (1)#6 BARE COPPER]
5	1	3"	PVC	5'	T	NEW [(1)#14/16 (1)#14/9 (1)#18/4 (1)#6 BARE COPPER]
6	1	4"	HDPE	60'	B	NEW [(2)#14/16 (2)#14/9 (7)#18/4 (1)#6 BARE COPPER]
7	1	2.5"	PVC	15'	T	NEW [(1)#14/9 (1)#6 BARE COPPER]
8	1	3"	PVC	35'	T	NEW [(1)#14/16 (1)#14/9 (1)#18/4 (1)#6 BARE COPPER]
9	1	4"	HDPE	82'	B	NEW [(1)#14/16 (1)#14/9 (4)#18/4 (1)#6 BARE COPPER]
10	1	3"	PVC	5'	T	NEW [(1)#14/16 (1)#14/9 (1)#18/4 (1)#6 BARE COPPER]
11	1	4"	PVC	205'	T	NEW [(1)#18/4 (1)#6 BARE COPPER]
12	1	1"	PVC	10'	T	NEW (2)#18/4
13	1	1"	PVC	60'	T	NEW (2)#18/4
X14	1	2"	-	92'	-	EXISTING (1)#8/2 U.F.w/GROUND REMOVE (1)#8/2 U.F.w/GROUND
X15	1	2.5"	-	6'	-	EXISTING [(1)#14/16 (2)#18/4] REMOVE [(1)#14/16 (2) #18/4]
X16	2	2.5"	-	15'	-	EXISTING (6)#14/4 REMOVE (6)#18/4
X17	1	1.5"	-	92'	-	EXISTING (1)#18/4 REMOVE (1)#18/4
X18	1	2.5"	-	81'	-	EXISTING (3)#18/4 REMOVE (3)#18/4
X19	1	2.5"	-	60'	-	EXISTING (1)#18/4 REMOVE (1)#18/4
X20	1	1.5"	-	115'	-	EXISTING (1)#18/4 REMOVE (1)#18/4 NEW [(1)#18/4 (1)#6 BARE COPPER]
X21	1	1.5"	-	160'	-	EXISTING (1)#18/4 REMOVE (1)#18/4 NEW [(1)#18/4 (1)#6 BARE COPPER]
X22	1	1.5"	-	5'	-	EXISTING (2)#18/4 REMOVE (2)#18/4
X23	1	1.5"	-	22'	-	EXISTING (2)#18/4 REMOVE (2)#18/4 NEW (2)#18/4
X24	1	1.5"	-	22'	-	EXISTING (2)#18/4 REMOVE (2)#18/4 NEW (4)#18/4
X25	1	1.5"	-	5'	-	EXISTING (2)#18/4 REMOVE (2)#18/4 NEW (4)#18/4
X26	1	1.5"	-	16'	-	EXISTING (2)#18/4 REMOVE (2)#18/4 NEW (4)#18/4
X27	1	1.5"		5'	-	EXISTING (2)#18/4 REMOVE (2)#18/4

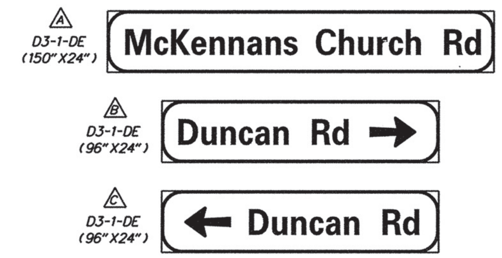
LEGEND
X- DENOTES EXISTING
SM- SINGLE MODE FIBER OPTICS
MM- MULTI MODE FIBER OPTICS
B- BORE
T- TRENCH
O- OPEN CUT
GALV - GALVANIZED
HDPE - HIGH DENSITY POLYETHYLENE

POLE SCHEDULE

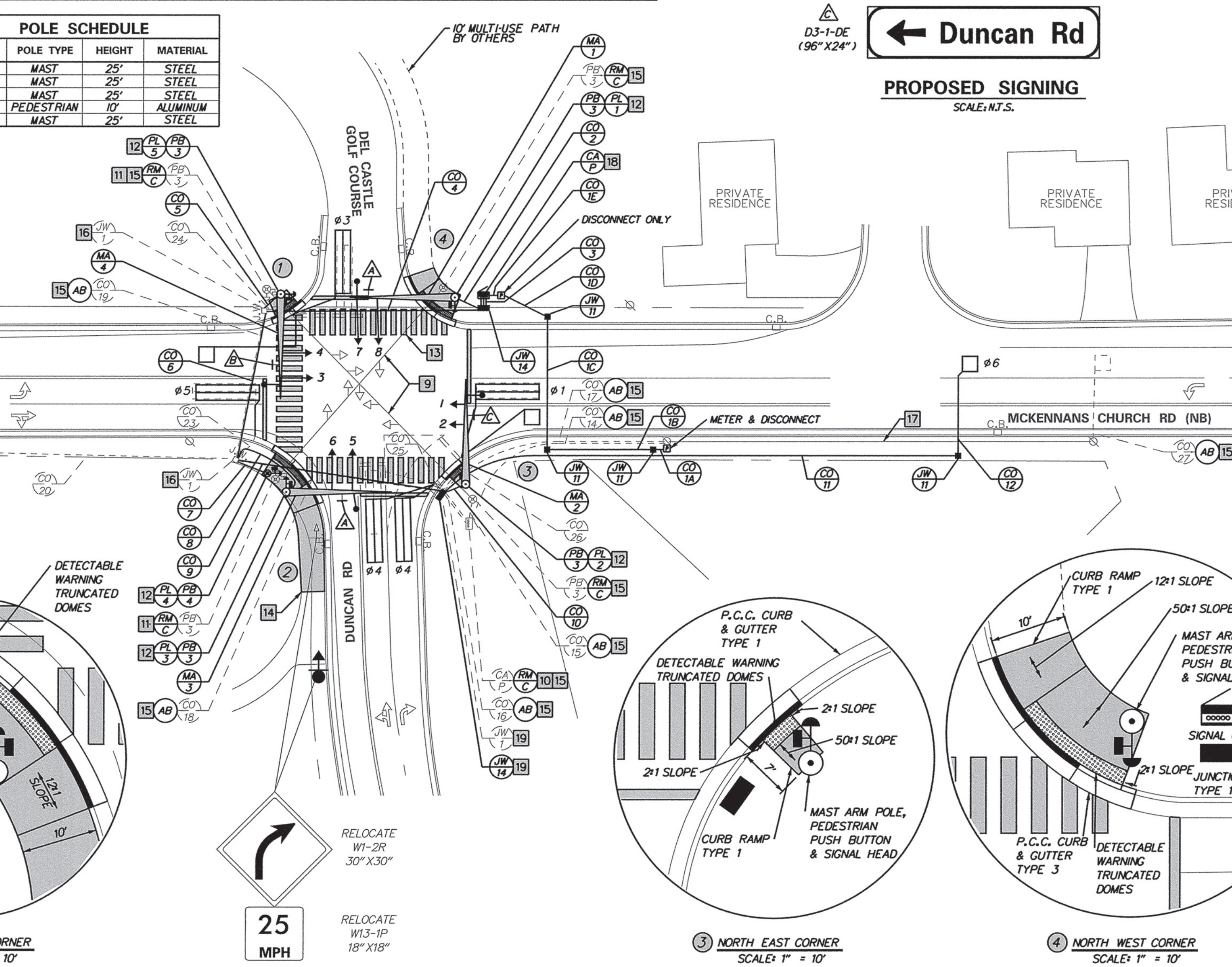
POLE #	POLE TYPE	HEIGHT	MATERIAL
1	MAST	25'	STEEL
2	MAST	25'	STEEL
3	MAST	25'	STEEL
4	PEDESTRIAN	10'	ALUMINUM
5	MAST	25'	STEEL

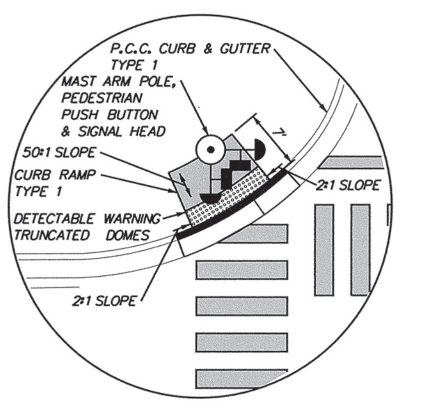


PUSH BUTTON DETAIL (TYPICAL)
SCALE: N.T.S.



PROPOSED SIGNING
SCALE: N.T.S.





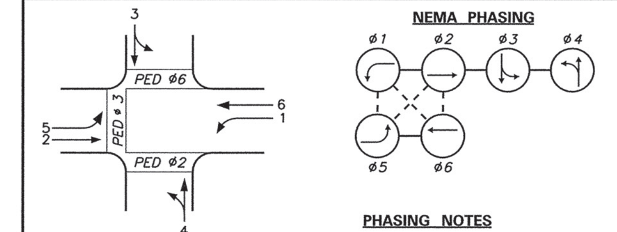
1 SOUTH WEST CORNER SCALE: 1" = 10'

2 SOUTH EAST CORNER SCALE: 1" = 10'

3 NORTH EAST CORNER SCALE: 1" = 10'

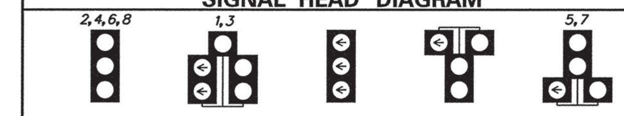
4 NORTH WEST CORNER SCALE: 1" = 10'

SIGNAL PHASING



PHASING NOTES
1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM/C REMOVE BY CONTRACTOR
- RM/O REMOVE BY OTHERS
- AB ABANDON
- PB/X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB/X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW/X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW/X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO/# PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO/# EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH/# PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH/# EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA/XX PROPOSED MAST ARM IDENTIFIER (SEE MAST ARM SCHEDULE)
- MA/XX EXISTING MAST ARM IDENTIFIER (SEE MAST ARM SCHEDULE)
- CA/X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA/X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- XX EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P SERVICE PEDESTAL
- PROPOSED CCTV
- EXISTING CCTV

GENERAL SIGNAL NOTES

1. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC-DOVER, DELAWARE.
2. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS ARE TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
3. PROPOSED POLE BASES SUPPORTING POLES WITH PEDESTRIAN PUSHBUTTONS SHALL BE CONSTRUCTED IMMEDIATELY ADJACENT TO THE FLAT (50:1 FLATTER) LANDING AREA OF THE CURB RAMP OR SIDEWALK IN ACCORDANCE WITH CURRENT ADA BEST PRACTICES, THESE POLE BASES SHALL BE FLUSH WITH THE ADJOINING LANDING AREA. THE PEDESTRIAN PUSHBUTTON SHOULD BE INSTALLED AT A HEIGHT OF 42 TO 48 INCHES ABOVE THE LANDING AREA/SIDEWALK,AND SHALL BE LOCATED SUCH THAT THE MAXIMUM REACH DISTANCE IS 10 INCHES FROM THE LANDING AREA TO THE FACE OF THE PUSHBUTTON. PEDESTRIAN SIGNAL HEADS SHALL BE MOUNTED WITH THE BOTTOM OF THE SIGNAL HOUSING INCLUDING BRACKETS NOT LESS THAN 7 FEET OR MORE THAN 10 FEET ABOVE SIDEWALK LEVEL.
4. ALL PEDESTRIAN SIGNAL HEADS SHALL BE COUNTDOWN TYPE.
5. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET, BOLTED AND COMPRESSION FITTINGS ARE NOT ACCEPTABLE.
6. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY ENTITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT IMMEDIATELY BEFORE CONSTRUCTION.
7. CONTRACTOR SHALL COORDINATE WITH TRAFFIC SIGNAL MAINTENANCE FOR THE IDENTIFICATION AND REMOVAL OF ALL UNUSED AND REDUNDANT COPPER CABLE.
8. CONTRACTOR SHALL STABILIZE ALL DISTURBED SOIL IN ACCORDANCE WITH DNREC SEDIMENT & EROSION HANDBOOK, (CURRENT EDITION).

RECOMMENDED [signature] DATE: 05/18/12 | RECOMMENDED ______ DATE: ______ | RECOMMENDED [signature] DATE: 5/29/12 | APPROVED TRAFFIC ENGINEER [signature] DATE: 5/29/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 5/30/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

SCALE 0 30 60 90 FEET

SIGNAL RE-BUILD PROGRAM

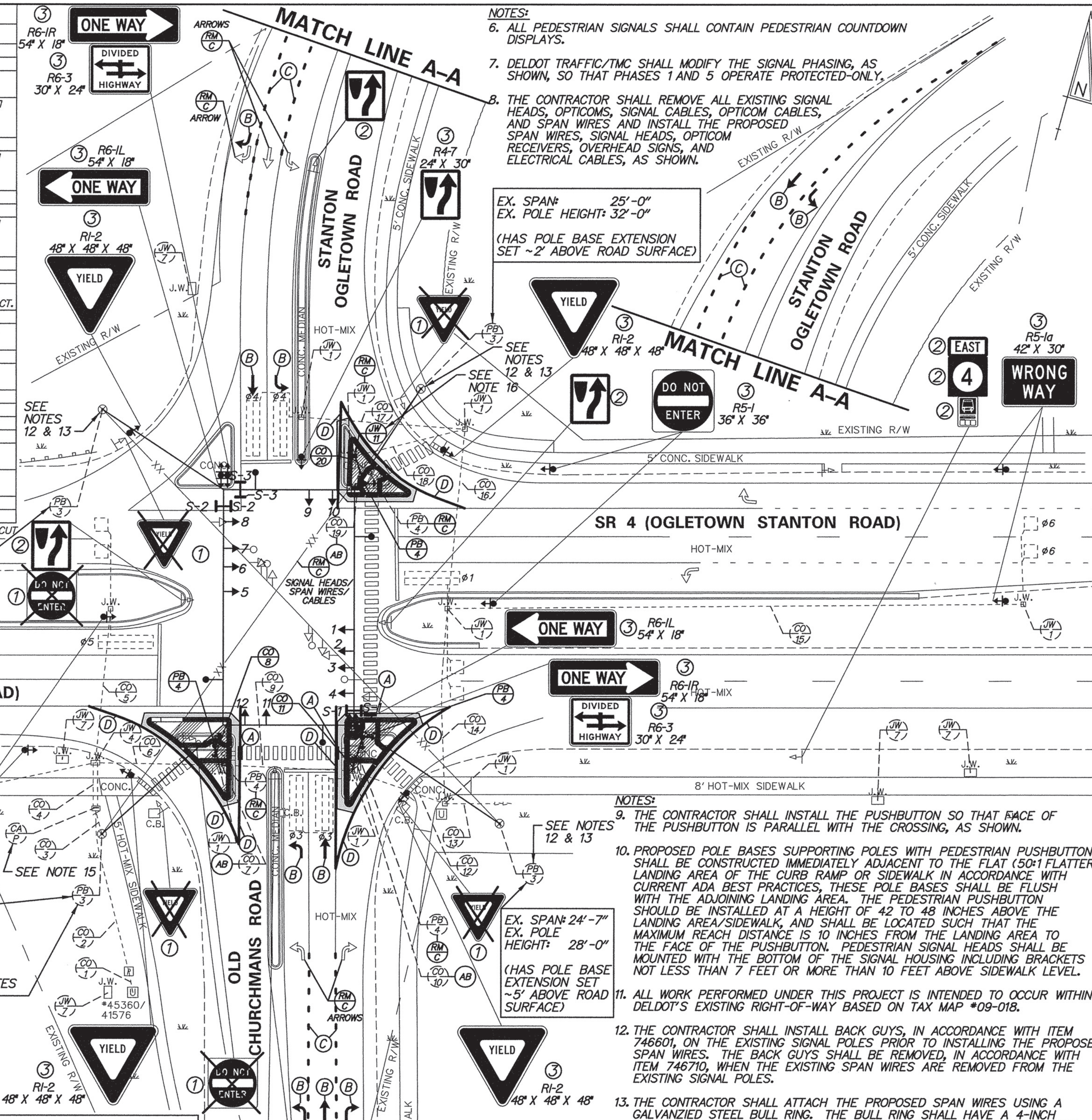
CONTRACT	PERMIT NO.	N551	SIGNAL PLAN	SHEET NO.
T201204116	DESIGNED BY:	MJP	MCKENNANS CHURCH RD @ DUNCAN RD	1
COUNTY				TOTAL SHTS.
NEW CASTLE	CHECKED BY:	BAM		1

5/29/2012 G:\PROJECTS\105022.00 Traffic - Task 4\105022.08 McKennas Duncan Signal\CADD FILES\Sheets\Signal\sg_N551_McKennas@Duncan.dgn 11:44:04 AM

CONDUIT RUN SCHEDULE					
CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1*	1	2.0 IN	10 FT	-	TO REMAIN - EX. (1) 2/#8 U.F. W/GROUND - LINE SIDE
2*	1	2.0 IN	76 FT	-	TO REMAIN - EX. (1) 2/#8 U.F. W/GROUND - LOAD SIDE
3*	1	2.5 IN	13 FT	-	[NEW (1) #6 GRD], [NEW (4) 4/#18], [NEW (2) 16/#14] <REMOVE EX. (4) 4/#18>, <REMOVE EX. (2) 16/#14>
4*	2	2.5 IN	21 FT	-	<REMOVE EX. (3) 9/#14>, [NEW (4) 5/#14], [NEW (2) #6 GRD] TO REMAIN - EX. (8) 4/#18, EX. (2) FIBER OPTIC, MULTI-MODE, 12 CT.
5*	1	2.5 IN	70 FT	-	TO REMAIN - EX. (2) 4/#18
6*	1	2.5 IN	57 FT	-	<REMOVE EX. (3) 9/#14>, [NEW (4) 5/#14], [NEW (1) #6 GRD] TO REMAIN - EX. (5) 4/#18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
7*	1	2.5 IN	3 FT	-	<REMOVE EX. (1) 9/#14>
8	1	2.5 IN	8 FT	T	[NEW (1) 5/#14], [NEW (1) #6 GRD]
9*	1	2.5 IN	62 FT	-	<REMOVE EX. (2) 9/#14>, [NEW (3) #5/14], [NEW (1) #6 GRD] TO REMAIN - EX. (5) 4/#18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
10*	1	2.5 IN	6 FT	-	<REMOVE EX. (1) 9/#14>
11	1	2.5 IN	13 FT	T	[NEW (2) 5/#14], [NEW (1) #6 GRD]
12*	1	2.5 IN	45 FT	-	<REMOVE EX. (1) 9/#14>, [NEW (1) 5/#14], [NEW (1) #6 GRD], TO REMAIN - (4) 4/#18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
13*	1	2.5 IN	-	-	EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
14*	1	2.5 IN	89 FT	-	<REMOVE EX. (1) 9/#14>, [NEW (1) 5/#14], [NEW (1) #6 GRD], TO REMAIN - EX. (4) 4/#18
15*	1	2.5 IN	263 FT	-	TO REMAIN - EX. (1) 4/#18
16*	1	2.5 IN	82 FT	-	<REMOVE EX. (1) 9/#14>, [NEW (1) 5/#14], [NEW (1) #6 GRD], TO REMAIN - EX. (1) 4/#18
17*	1	2.5 IN	75 FT	-	TO REMAIN - EX. (1) 4/#18
18*	1	2.5 IN	54 FT	-	<REMOVE EX. (1) 9/#14>, [NEW (1) 5/#14], [NEW (1) #6 GRD]
19*	1	2.5 IN	12 FT	-	<REMOVE EX. (1) 9/#14>
20	1	2.5 IN	15 FT	T	[NEW (1) 5/#14], [NEW (1) #6 GRD]
21*	1	2.5 IN	98 FT	-	TO REMAIN - EX. (1) 4/#18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
22*	1	2.5 IN	122 FT	-	TO REMAIN - EX. (1) 4/#18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
23*	1	2.5 IN	-	-	EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
24*	1	2.5 IN	43 FT	-	TO REMAIN - EX. (1) 4/#18

* DENOTES EXISTING CONDUIT B = BORE, T = TRENCH, O = OPEN CUT

SIGNING LEGEND	
1	REMOVE EXISTING SIGN
2	EXISTING SIGN TO REMAIN
3	PLACE NEW SIGN
4	RENEW EXISTING SIGN
5	REPOSITION EXISTING SIGN



NOTES:

6. ALL PEDESTRIAN SIGNALS SHALL CONTAIN PEDESTRIAN COUNTDOWN DISPLAYS.

7. DELDOT TRAFFIC/TMC SHALL MODIFY THE SIGNAL PHASING, AS SHOWN, SO THAT PHASES 1 AND 5 OPERATE PROTECTED-ONLY.

8. THE CONTRACTOR SHALL REMOVE ALL EXISTING SIGNAL HEADS, OPTICOMS, SIGNAL CABLES, OPTICOM CABLES, AND SPAN WIRES AND INSTALL THE PROPOSED SPAN WIRES, SIGNAL HEADS, OPTICOM RECEIVERS, OVERHEAD SIGNS, AND ELECTRICAL CABLES, AS SHOWN.

NOTES:

9. THE CONTRACTOR SHALL INSTALL THE PUSHBUTTON SO THAT FACE OF THE PUSHBUTTON IS PARALLEL WITH THE CROSSING, AS SHOWN.

10. PROPOSED POLE BASES SUPPORTING POLES WITH PEDESTRIAN PUSHBUTTONS SHALL BE CONSTRUCTED IMMEDIATELY ADJACENT TO THE FLAT (50:1 FLATTER) LANDING AREA OF THE CURB RAMP OR SIDEWALK IN ACCORDANCE WITH CURRENT ADA BEST PRACTICES, THESE POLE BASES SHALL BE FLUSH WITH THE ADJOINING LANDING AREA. THE PEDESTRIAN PUSHBUTTON SHOULD BE INSTALLED AT A HEIGHT OF 42 TO 48 INCHES ABOVE THE LANDING AREA/SIDEWALK, AND SHALL BE LOCATED SUCH THAT THE MAXIMUM REACH DISTANCE IS 10 INCHES FROM THE LANDING AREA TO THE FACE OF THE PUSHBUTTON. PEDESTRIAN SIGNAL HEADS SHALL BE MOUNTED WITH THE BOTTOM OF THE SIGNAL HOUSING INCLUDING BRACKETS NOT LESS THAN 7 FEET OR MORE THAN 10 FEET ABOVE SIDEWALK LEVEL.

11. ALL WORK PERFORMED UNDER THIS PROJECT IS INTENDED TO OCCUR WITHIN DELDOT'S EXISTING RIGHT-OF-WAY BASED ON TAX MAP #09-018.

12. THE CONTRACTOR SHALL INSTALL BACK GUYS, IN ACCORDANCE WITH ITEM 746601, ON THE EXISTING SIGNAL POLES PRIOR TO INSTALLING THE PROPOSED SPAN WIRES. THE BACK GUYS SHALL BE REMOVED, IN ACCORDANCE WITH ITEM 746710, WHEN THE EXISTING SPAN WIRES ARE REMOVED FROM THE EXISTING SIGNAL POLES.

13. THE CONTRACTOR SHALL ATTACH THE PROPOSED SPAN WIRES USING A GALVANZIED STEEL BULL RING. THE BULL RING SHALL HAVE A 4-INCH INSIDE DIAMETER AND BE FABRICATED FROM STEEL CONFORMING TO A668, QUENCHED AND TEMPERED. THE BAR DIAMETER SHALL NOT BE LESS THAN 7#8 INCHES. THE WELDLESS RINGS SHALL MEET FEDERAL SPECFICATION RR-C271B TYPE VI. THE RINGS SHALL BE HOT DIP GALVANIZED IN ACCORDANCE WITH A153 SPECIFICATIONS. TWO GALVANIZED 3-BOLT GUY CLAMPS AND A SERVICE SLEEVE SHALL BE INSTALLED FOR EACH SPAN WIRE ATTACHMENT IN ACCORDANCE WITH STANDARD NO. T-12 (2005).

14. SEE STANDARD CONSTRUCTION DETAIL C-2-3 FOR ADA SLOPE GUIDELINES.

15. DELDOT OIT SHALL COORDINATE THE CONNECTION OF THE EXISTING FIBER OPTIC CABLE IN THE EXISTING SIGNAL CABINET.

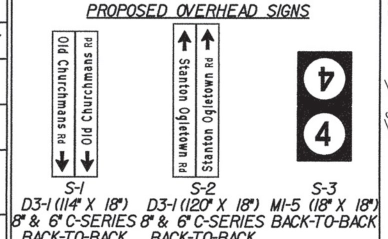
16. THE CONTRACTOR SHALL REMOVE THE EXISTING JUNCTION WELL, TYPE 1 AND INSTALL THE PROPOSED JUNCTION WELL, TYPE 11 SO THAT IT INTERCEPTS EXISTING CONDUIT RUN NO. 18 AND PROPOSED CONDUIT RUN NO. 20.

SPAN WIRE SCHEDULE							
SPAN	LENGTH	SPAN MOUNT HEIGHT	5% DROP	BULL RING HEIGHT	5% SAG	SPAN LOW POINT	BOTTOM OF LOWEST HEAD
NORTH	60 FT			26.35 FT	3.0 FT @ 5.0%	23.35 FT	19.35 FT
SOUTH	60 FT			26.35 FT	3.0 FT @ 5.0%	23.35 FT	19.35 FT
EAST	107 FT			26.35 FT	5.35 FT @ 5.0%	21.0 FT	17.0 FT
WEST	107 FT			26.35 FT	5.35 FT @ 5.0%	21.0 FT	17.0 FT
NORTHEAST	55 FT	29.10 FT	2.75 FT @ 5.0%	26.35 FT			
SOUTHEAST	80 FT	30.35 FT	4.0 FT @ 5.0%	26.35 FT			
NORTHWEST	66 FT	29.65 FT	3.3 FT @ 5.0%	26.35 FT			
SOUTHWEST	74 FT	30.05 FT	3.7 FT @ 5.0%	26.35 FT			

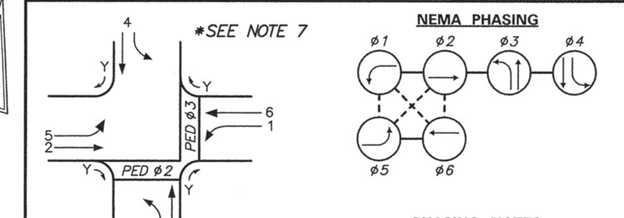
* FIELD ADJUSTMENTS AS REQUIRED
** ALL MOUNTING HEIGHTS ARE WITH RESPECT TO ROADWAY SURFACE

PAVEMENT MARKINGS LEGEND		
SYMBOL	ITEM	QUANTITY
A	6" x 2' SOLID WHITE ALKYD-THERMOPLASTIC, PERMANENT PAVEMENT STRIPING (ITEM 748015)	36 SF
B	PERMANENT PAVEMENT STRIPING, SYMBOL/LEGEND, ALKYD-THERMOPLASTIC (ITEM 748015)	143 SF
C	5" DOTTED WHITE PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, 2' LINE & 6' GAP (ITEM 748548)	725 LF
D	5" SOLID WHITE PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, (ITEM 748548)	441 LF

PROPOSED OVERHEAD SIGNS



SIGNAL PHASING

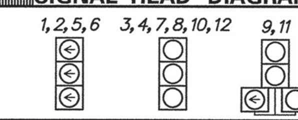


PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM

*ALL EXISTING SIGNAL HEADS SHALL BE REMOVED



LEGEND

- PROPOSED SIGNAL CABINET
- EXISTING SIGNAL CABINET
- PROPOSED SIGNAL POLE BASE
- EXISTING SIGNAL POLE BASE
- PROPOSED PEDESTRIAN POLE BASE
- EXISTING PEDESTRIAN POLE BASE
- PROPOSED WOOD POLE
- EXISTING UTILITY POLE
- PROPOSED JUNCTION WELL
- J.W. EXISTING JUNCTION WELL
- PROPOSED SIGNAL HEAD
- EXISTING SIGNAL HEAD
- PROPOSED PEDESTRIAN SIGNAL HEAD
- EXISTING PEDESTRIAN SIGNAL HEAD
- PROPOSED PEDESTRIAN PUSHBUTTON
- EXISTING PEDESTRIAN PUSHBUTTON
- PROPOSED VIDEO DETECTION
- EXISTING VIDEO DETECTION
- PROPOSED MICROWAVE DETECTION
- EXISTING MICROWAVE DETECTION
- OVERHEAD SIGNING
- PROPOSED OPTICOM RECEIVER
- EXISTING OPTICOM RECEIVER
- PROPOSED MAST ARM
- EXISTING MAST ARM
- PROPOSED LUMINAIRE
- EXISTING LUMINAIRE
- PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
- EXISTING LOOP DETECTOR (TYPE 1 OR 2)
- RM C REMOVE BY CONTRACTOR
- RM O REMOVE BY OTHERS
- AB ABANDON
- PB X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- PB X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- JW X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- JW X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- CO # PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CO # EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- OH # PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- OH # EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
- MA XX PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
- MA XX EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
- CA X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
- CA X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
- PROPOSED SPAN WIRE
- XX EXISTING SPAN WIRE
- RIGHT-OF-WAY OR PROPERTY LINE
- PROPOSED SPAN INSULATOR
- EXISTING SPAN INSULATOR
- P SERVICE PEDESTAL

GENERAL SIGNAL NOTES

1. EXISTING LOOP DETECTORS TO REMAIN:
   TYPE #1 - 6' x 6' - SR 4 THROUGH LANE MOVEMENTS.
   TYPE #2 - 6' x 25' - SR 4 LEFT-TURN MOVEMENTS.
   TYPE #2 - 6' x 25' - NORTHBOUND OLD CHURCHMANS ROAD LEFT-TURN AND THROUGH MOVEMENTS.
   TYPE #2 - 6' x 25' - SOUTHBOUND STANTON OGLETOWN ROAD LEFT-TURN AND THROUGH MOVEMENTS.
   SYSTEM - 6' x 6' - SR 4 RECEIVING LANES.
2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
3. POLE BASES AND CONDUIT JUNCTION WELLS ARE TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
4. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ____________ DATE: ________ RECOMMENDED ____________ DATE: ________ RECOMMENDED [signature] DATE: 1/15/14 APPROVED TRAFFIC ENGINEER [signature] DATE: 1/15/14 APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 1/16/14

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS	
1 CONVERTED SR 4 LEFTS TO PROTECTED-ONLY AND RE-BUILT SPAN & PEDS B.S.S. (WR&A) 01-14 (CONTRACT #T201400102)	

SCALE 0 30 60 90 FEET

FY 2012 HEP ADD-ON LOCATION

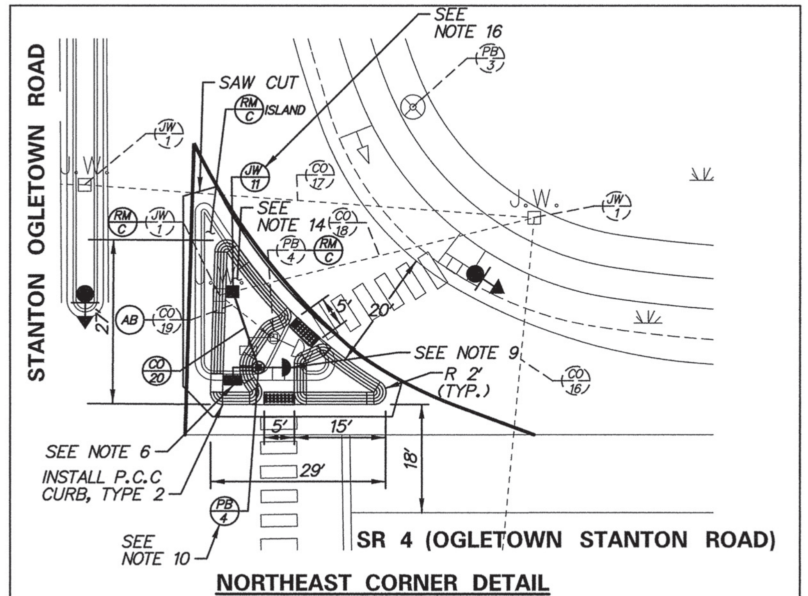
CONTRACT	T201400102	PERMIT NO.	N706
COUNTY	NEW CASTLE	DESIGNED BY: B.S.S. (WR&A)	CHECKED BY: M.J.B. (WR&A)

SIGNAL PLAN SR 4 @ OLD CHURCHMANS ROAD

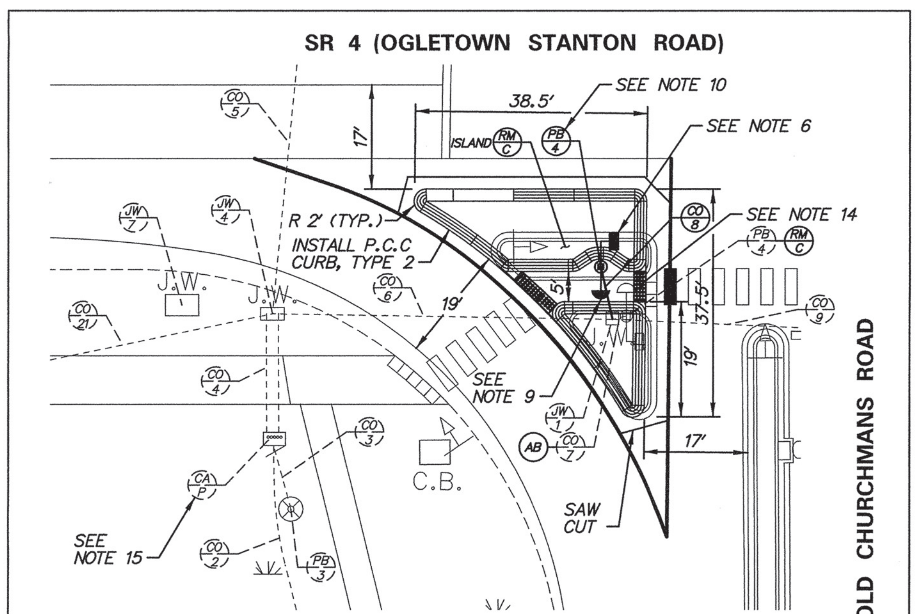
SHEET NO. 1 TOTAL SHTS. 2

CONDUIT RUN SCHEDULE					
CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1*	1	2.0 IN	10 FT	-	TO REMAIN - EX. (1) 2/*8 U.F. W/GROUND - LINE SIDE
2*	1	2.0 IN	76 FT	-	TO REMAIN - EX. (1) 2/*8 U.F. W/GROUND - LOAD SIDE
3*	1	2.5 IN	13 FT	-	[NEW (1) *6 GRD], [NEW (4) 4/*18], [NEW (2) 16/*14] <REMOVE EX. (4) 4/*18>, <REMOVE EX. (2) 16/*14>
4*	2	2.5 IN	21 FT	-	<REMOVE EX. (3) 9/*14>, [NEW (4) 5/*14], [NEW (2) *6 GRD] TO REMAIN - EX. (8) 4/*18, EX. (2) FIBER OPTIC, MULTI-MODE, 12 CT.
5*	1	2.5 IN	70 FT	-	TO REMAIN - EX. (2) 4/*18
6*	1	2.5 IN	57 FT	-	<REMOVE EX. (3) 9/*14>, [NEW (4) 5/*14], [NEW (1) *6 GRD] TO REMAIN - EX. (5) 4/*18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
7*	1	2.5 IN	3 FT	-	<REMOVE EX. (1) 9/*14>
8	1	2.5 IN	8 FT	T	[NEW (1) 5/*14], [NEW (1) *6 GRD]
9*	1	2.5 IN	62 FT	-	<REMOVE EX. (2) 9/*14>, [NEW (3) *5/14], [NEW (1) *6 GRD] TO REMAIN - EX. (5) 4/*18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
10*	1	2.5 IN	6 FT	-	<REMOVE EX. (1) 9/*14>
11	1	2.5 IN	13 FT	T	[NEW (2) 5/*14], [NEW (1) *6 GRD]
12*	1	2.5 IN	45 FT	-	<REMOVE EX. (1) 9/*14>, [NEW (1) 5/*14], [NEW (1) *6 GRD], TO REMAIN - (4) 4/*18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
13*	1	2.5 IN	-	-	EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
14*	1	2.5 IN	89 FT	-	<REMOVE EX. (1) 9/*14>, [NEW (1) 5/*14], [NEW (1) *6 GRD], TO REMAIN - EX. (4) 4/*18
15*	1	2.5 IN	263 FT	-	TO REMAIN - EX. (1) 4/*18
16*	1	2.5 IN	82 FT	-	<REMOVE EX. (1) 9/*14>, [NEW (1) 5/*14], [NEW (1) *6 GRD], TO REMAIN - EX. (1) 4/*18
17*	1	2.5 IN	75 FT	-	TO REMAIN - EX. (1) 4/*18
18*	1	2.5 IN	54 FT	-	<REMOVE EX. (1) 9/*14>, [NEW (1) 5/*14], [NEW (1) *6 GRD]
19*	1	2.5 IN	12 FT	-	<REMOVE EX. (1) 9/*14>
20	1	2.5 IN	15 FT	T	[NEW (1) 5/*14], [NEW (1) *6 GRD]
21*	1	2.5 IN	98 FT	-	TO REMAIN - EX. (1) 4/*18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
22*	1	2.5 IN	122 FT	-	TO REMAIN - EX. (1) 4/*18, EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
23*	1	2.5 IN	-	-	EX. (1) FIBER OPTIC, MULTI-MODE, 12 CT.
24*	1	2.5 IN	43 FT	-	TO REMAIN - EX. (1) 4/*18

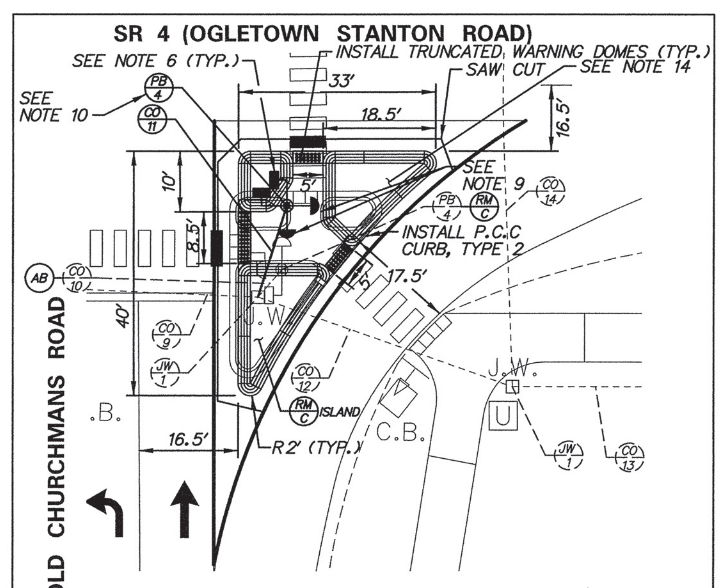
* DENOTES EXISTING CONDUIT   B = BORE, T = TRENCH, O = OPEN CUT



NORTHEAST CORNER DETAIL
SCALE: 1" = 15'



SOUTHWEST CORNER DETAIL
SCALE: 1" = 15'



SOUTHEAST CORNER DETAIL
SCALE: 1" = 15'

NOTES:

6. ALL PEDESTRIAN SIGNALS SHALL CONTAIN PEDESTRIAN COUNTDOWN DISPLAYS.

7. DELDOT TRAFFIC/TMC SHALL MODIFY THE SIGNAL PHASING, AS SHOWN.

8. THE CONTRACTOR SHALL REMOVE ALL EXISTING SIGNAL HEADS, OPTICOMS, SIGNAL CABLES, OPTICOM CABLES, AND SPAN WIRES AND INSTALL THE PROPOSED SPAN WIRES, SIGNAL HEADS, OPTICOM RECEIVERS, OVERHEAD SIGNS,AND ELECTRICAL CABLES, AS SHOWN.

9. THE CONTRACTOR SHALL INSTALL THE PUSHBUTTON SO THAT FACE OF THE PUSHBUTTON IS PARALLEL WITH THE CROSSING, AS SHOWN.

10. PROPOSED POLE BASES SUPPORTING POLES WITH PEDESTRIAN PUSHBUTTONS SHALL BE CONSTRUCTED IMMEDIATELY ADJACENT TO THE FLAT (50:1 FLATTER) LANDING AREA OF THE CURB RAMP OR SIDEWALK IN ACCORDANCE WITH CURRENT ADA BEST PRACTICES, THESE POLE BASES SHALL BE FLUSH WITH THE ADJOINING LANDING AREA. THE PEDESTRIAN PUSHBUTTON SHOULD BE INSTALLED AT A HEIGHT OF 42 TO 48 INCHES ABOVE THE LANDING AREA/SIDEWALK, AND SHALL BE LOCATED SUCH THAT THE MAXIMUM REACH DISTANCE IS 10 INCHES FROM THE LANDING AREA TO THE FACE OF THE PUSHBUTTON. PEDESTRIAN SIGNAL HEADS SHALL BE MOUNTED WITH THE BOTTOM OF THE SIGNAL HOUSING INCLUDING BRACKETS NOT LESS THAN 7 FEET OR MORE THAN 10 FEET ABOVE SIDEWALK LEVEL.

11. ALL WORK PERFORMED UNDER THIS PROJECT IS INTENDED TO OCCUR WITHIN DELDOT'S EXISTING RIGHT-OF-WAY BASED ON TAX MAP *09-018

12. THE CONTRACTOR SHALL INSTALL BACK GUYS, IN ACCORDANCE WITH ITEM 746601, ON THE EXISTING SIGNAL POLES PRIOR TO INSTALLING THE PROPOSED SPAN WIRES. THE BACK GUYS SHALL BE REMOVED, IN ACCORDANCE WITH ITEM 746710, WHEN THE EXISTING SPAN WIRES ARE REMOVED FROM THE EXISTING SIGNAL POLES.

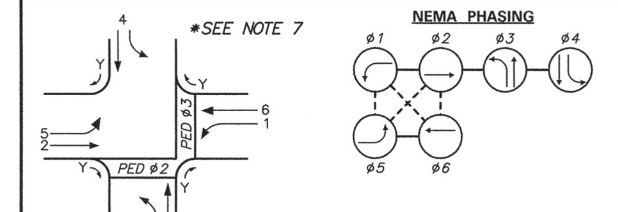
13. THE CONTRACTOR SHALL ATTACH THE PROPOSED SPAN WIRES USING A GALVANZIED STEEL BULL RING. THE BULL RING SHALL HAVE A 4-INCH INSIDE DIAMETER AND BE FABRICATED FROM STEEL CONFORMING TO A668, QUENCHED AND TEMPERED. THE BAR DIAMETER SHALL NOT BE LESS THAN 7*8 INCHES. THE WELDLESS RINGS SHALL MEET FEDERAL SPECFICATION RR-C271B TYPE VI. THE RINGS SHALL BE HOT DIP GALVANIZED IN ACCORDANCE WITH A153 SPECIFICATIONS. TWO GALVANIZED 3-BOLT GUY CLAMPS AND A SERVICE SLEEVE SHALL BE INSTALLED FOR EACH SPAN WIRE ATTACHMENT IN ACCORDANCE WITH STANDARD NO. T-12 (2005).

14. SEE STANDARD CONSTRUCTION DETAIL C-2-3 FOR ADA SLOPE GUIDELINES.

15. DELDOT OIT SHALL COORDINATE THE CONNECTION OF THE EXISTING FIBER OPTIC CABLE IN THE EXISTING SIGNAL CABINET.

16. THE CONTRACTOR SHALL REMOVE THE EXISTING JUNCTION WELL, TYPE 1 AND INSTALL THE PROPOSED JUNCTION WELL, TYPE 11 SO THAT IT INTERCEPTS EXISTING CONDUIT RUN NO. 18 AND PROPOSED CONDUIT RUN NO. 20.

SIGNAL PHASING

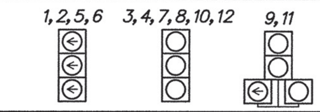


PHASING NOTES

1. PHASES ASSOCIATED BY A SOLID LINE WILL NOT OPERATE CONCURRENTLY.
2. PHASES ASSOCIATED BY A DASHED LINE WILL OPERATE CONCURRENTLY.

SIGNAL HEAD DIAGRAM

*ALL EXISTING SIGNAL HEADS SHALL BE REMOVED



LEGEND

PROPOSED SIGNAL CABINET
EXISTING SIGNAL CABINET
PROPOSED SIGNAL POLE BASE
EXISTING SIGNAL POLE BASE
PROPOSED PEDESTRIAN POLE BASE
EXISTING PEDESTRIAN POLE BASE
PROPOSED WOOD POLE
EXISTING UTILITY POLE
PROPOSED JUNCTION WELL
J.W. EXISTING JUNCTION WELL
PROPOSED SIGNAL HEAD
EXISTING SIGNAL HEAD
PROPOSED PEDESTRIAN SIGNAL HEAD
EXISTING PEDESTRIAN SIGNAL HEAD
PROPOSED PEDESTRIAN PUSHBUTTON
EXISTING PEDESTRIAN PUSHBUTTON
PROPOSED VIDEO DETECTION
EXISTING VIDEO DETECTION
PROPOSED MICROWAVE DETECTION
EXISTING MICROWAVE DETECTION
OVERHEAD SIGNING
PROPOSED OPTICOM RECEIVER
EXISTING OPTICOM RECEIVER
PROPOSED MAST ARM
EXISTING MAST ARM
PROPOSED LUMINAIRE
EXISTING LUMINAIRE
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
EXISTING LOOP DETECTOR (TYPE 1 OR 2)
RM/C REMOVE BY CONTRACTOR
RM/O REMOVE BY OTHERS
AB ABANDON
PB/X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PB/X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
JW/X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
JW/X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
CO/# PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
CO/# EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
OH/# PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
OH/# EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
MA/XX PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
MA/XX EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
CA/X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
CA/X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED SPAN WIRE
—XX— EXISTING SPAN WIRE
RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED SPAN INSULATOR
EXISTING SPAN INSULATOR
P SERVICE PEDESTAL

GENERAL SIGNAL NOTES

1. EXISTING LOOP DETECTORS TO REMAIN:
   TYPE *1 - 6' x 6' - SR 4 THROUGH LANE MOVEMENTS.
   TYPE *2 - 6' x 25' - SR 4 LEFT-TURN MOVEMENTS.
   TYPE *2 - 6' x 25' - NORTHBOUND OLD CHURCHMANS ROAD LEFT-TURN AND THROUGH MOVEMENTS.
   TYPE *2 - 6' x 25' - SOUTHBOUND STANTON OGLETOWN ROAD LEFT-TURN AND THROUGH MOVEMENTS.
   SYSTEM - 6' x 6' - SR 4 RECEIVING LANES.
2. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
3. POLE BASES AND CONDUIT JUNCTION WELLS ARE TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
4. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ______ DATE: ______
RECOMMENDED ______ DATE: ______
RECOMMENDED [signature] DATE: 1/15/14
APPROVED TRAFFIC ENGINEER [signature] DATE: 1/15/14
APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 1/16/14

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS
1 CONVERTED SR 4 LEFTS TO PROTECTED-ONLY AND RE-BUILT SPAN & PEDS B.S.S. (WR&A) 01-14 (CONTRACT *T201400102)

SCALE 0 30 60 90 FEET

FY 2012 HEP ADD-ON LOCATION

CONTRACT	T201400102
COUNTY	NEW CASTLE
PERMIT NO.	N706
DESIGNED BY:	B.S.S. (WR&A)
CHECKED BY:	M.J.B. (WR&A)
SHEET NO.	2
TOTAL SHTS.	2

SIGNAL PLAN SR 4 @ OLD CHURCHMANS ROAD

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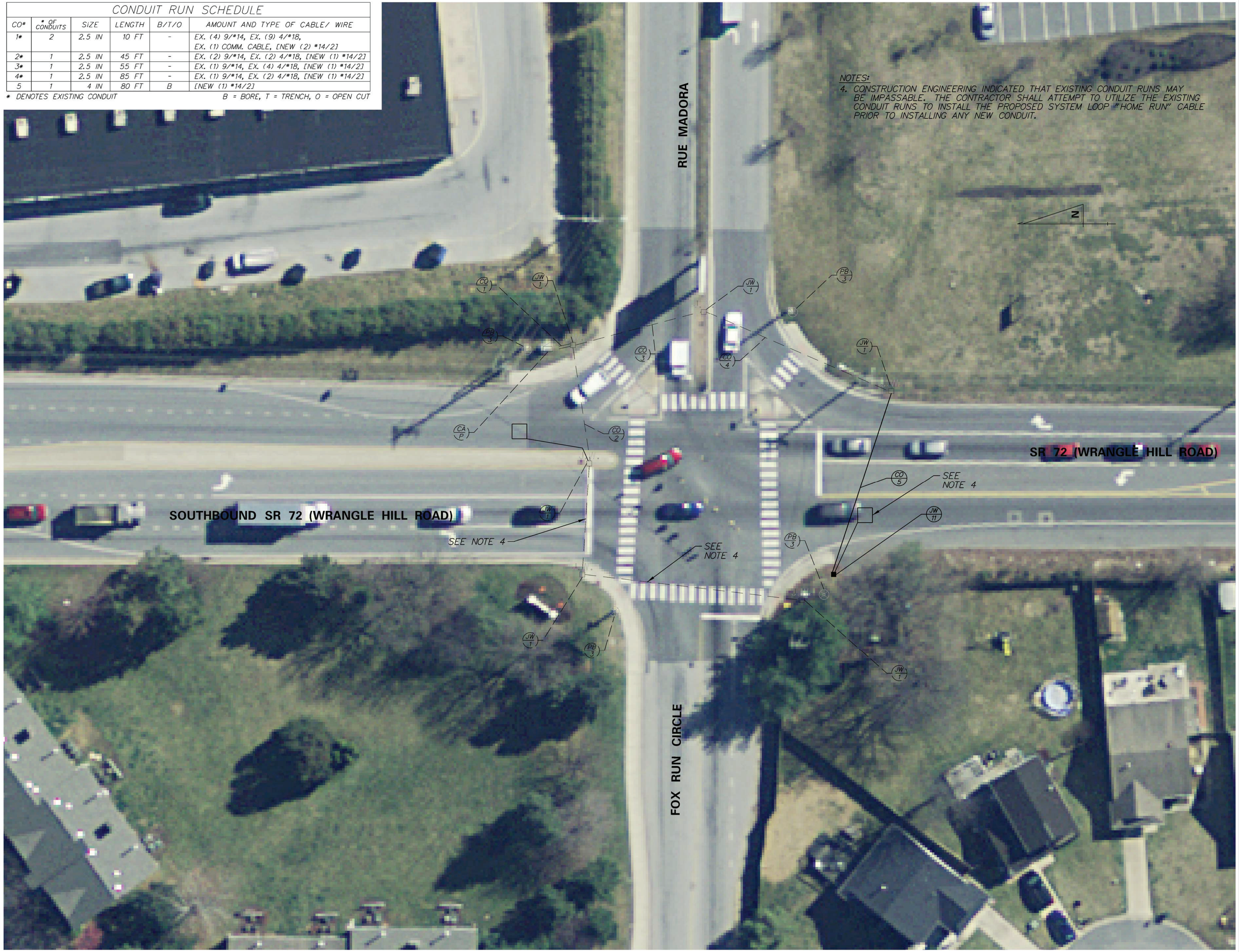
CONDUIT RUN SCHEDULE					
CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1*	2	2.5 IN	10 FT	-	EX. (4) 9/#14, EX. (9) 4/#18, EX. (1) COMM. CABLE, [NEW (2) #14/2]
2*	1	2.5 IN	45 FT	-	EX. (2) 9/#14, EX. (2) 4/#18, [NEW (1) #14/2]
3*	1	2.5 IN	55 FT	-	EX. (1) 9/#14, EX. (4) 4/#18, [NEW (1) #14/2]
4*	1	2.5 IN	85 FT	-	EX. (1) 9/#14, EX. (2) 4/#18, [NEW (1) #14/2]
5	1	4 IN	80 FT	B	[NEW (1) #14/2]

* DENOTES EXISTING CONDUIT   B = BORE, T = TRENCH, O = OPEN CUT



NOTES:
4. CONSTRUCTION ENGINEERING INDICATED THAT EXISTING CONDUIT RUNS MAY BE IMPASSABLE. THE CONTRACTOR SHALL ATTEMPT TO UTILIZE THE EXISTING CONDUIT RUNS TO INSTALL THE PROPOSED SYSTEM LOOP "HOME RUN" CABLE PRIOR TO INSTALLING ANY NEW CONDUIT.

SIGNAL PHASING

SIGNAL HEAD DIAGRAM

LEGEND

PROPOSED SIGNAL CABINET	REMOVE BY CONTRACTOR
EXISTING SIGNAL CABINET	REMOVE BY OTHERS
PROPOSED SIGNAL POLE BASE	ABANDON
EXISTING SIGNAL POLE BASE	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PROPOSED PEDESTRIAN POLE BASE	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
EXISTING PEDESTRIAN POLE BASE	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
PROPOSED WOOD POLE	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
EXISTING UTILITY POLE	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
PROPOSED JUNCTION WELL	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
EXISTING JUNCTION WELL	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
PROPOSED SIGNAL HEAD	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
EXISTING SIGNAL HEAD	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
PROPOSED PEDESTRIAN SIGNAL HEAD	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
EXISTING PEDESTRIAN SIGNAL HEAD	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED PEDESTRIAN PUSHBUTTON	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
EXISTING PEDESTRIAN PUSHBUTTON	PROPOSED SPAN WIRE
PROPOSED VIDEO DETECTION	EXISTING SPAN WIRE
EXISTING VIDEO DETECTION	RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED MICROWAVE DETECTION	PROPOSED SPAN INSULATOR
EXISTING MICROWAVE DETECTION	EXISTING SPAN INSULATOR
OVERHEAD SIGNING	SERVICE PEDESTAL
PROPOSED OPTICOM RECEIVER	
EXISTING OPTICOM RECEIVER	
PROPOSED MAST ARM	
EXISTING MAST ARM	
PROPOSED LUMINAIRE	
EXISTING LUMINAIRE	
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)	
EXISTING LOOP DETECTOR (TYPE 1 OR 2)	

GENERAL SIGNAL NOTES

1. PROPOSED LOOP DETECTORS:
   SYSTEM - 6' x 6' - TO BE INSTALLED IN SR 72 RECEIVING LANES, AS SHOWN.
2. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
3. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

RECOMMENDED ______ DATE: ______ RECOMMENDED ______ DATE: ______ RECOMMENDED ______ DATE: ______ APPROVED TRAFFIC ENGINEER ______ DATE: ______ APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ______ DATE: ______

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS
1 INSTALLED SYSTEM LOOPS D.W.C. (WR&A) 04-11 (CONTRACT NO. T201204701)

SCALE 0 20 40 60 FEET

System Loops

CONTRACT T201204701 | COUNTY NEW CASTLE | PERMIT NO. N523 | DESIGNED BY: D.W.C. (WR&A) | CHECKED BY: M.J.B. (WR&A)

SIGNAL PLAN
SR 72 (WRANGLE HILL ROAD) at FOX RUN CIRCLE / RUE MADORA

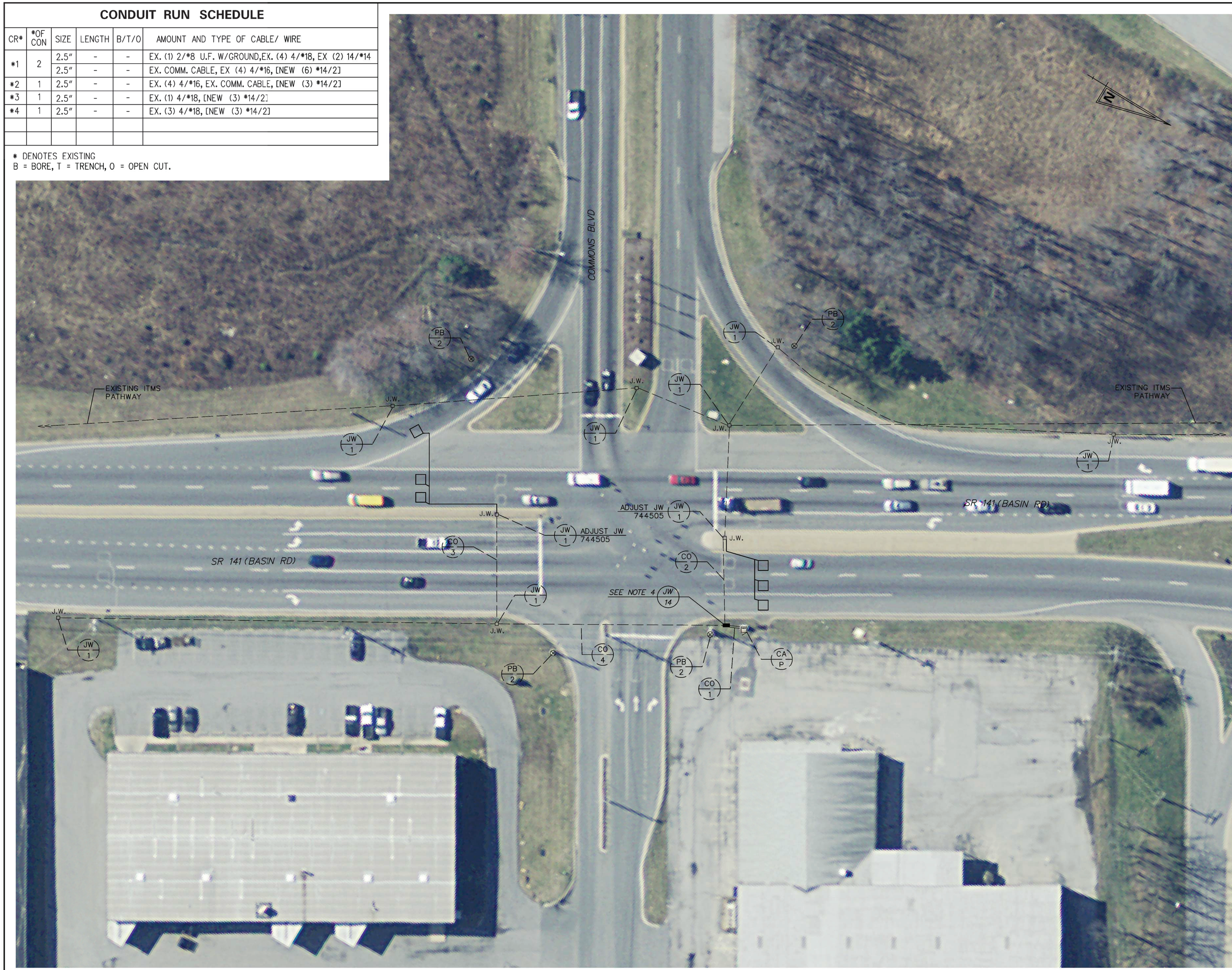
SHEET NO. 4 | TOTAL SHTS. 20

$DGNNAME$ $DATE$$ $TIME$

CONDUIT RUN SCHEDULE

CR#	#OF CON	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
*1	2	2.5"	-	-	EX. (1) 2/#8 U.F. W/GROUND, EX. (4) 4/#18, EX (2) 14/#14
		2.5"	-	-	EX. COMM. CABLE, EX (4) 4/#16, [NEW (6) #14/2]
*2	1	2.5"	-	-	EX. (4) 4/#16, EX. COMM. CABLE, [NEW (3) #14/2]
*3	1	2.5"	-	-	EX. (1) 4/#18, [NEW (3) #14/2]
*4	1	2.5"	-	-	EX. (3) 4/#18, [NEW (3) #14/2]

* DENOTES EXISTING
B = BORE, T = TRENCH, O = OPEN CUT.



SIGNAL PHASING

SIGNAL HEAD DIAGRAM

LEGEND

PROPOSED SIGNAL CABINET
EXISTING SIGNAL CABINET
PROPOSED SIGNAL POLE BASE
EXISTING SIGNAL POLE BASE
PROPOSED PEDESTRIAN POLE BASE
EXISTING PEDESTRIAN POLE BASE
PROPOSED WOOD POLE
EXISTING UTILITY POLE
PROPOSED JUNCTION WELL
J.W. EXISTING JUNCTION WELL
PROPOSED SIGNAL HEAD
EXISTING SIGNAL HEAD
PROPOSED PEDESTRIAN SIGNAL HEAD
EXISTING PEDESTRIAN SIGNAL HEAD
PROPOSED PEDESTRIAN PUSHBUTTON
EXISTING PEDESTRIAN PUSHBUTTON
PROPOSED VIDEO DETECTION
EXISTING VIDEO DETECTION
PROPOSED MICROWAVE DETECTION
EXISTING MICROWAVE DETECTION
OVERHEAD SIGNING
PROPOSED OPTICOM RECEIVER
EXISTING OPTICOM RECEIVER
PROPOSED MAST ARM
EXISTING MAST ARM
PROPOSED LUMINAIRE
EXISTING LUMINAIRE
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)
EXISTING LOOP DETECTOR (TYPE 1 OR 2)

RM/C REMOVE BY CONTRACTOR
RM/O REMOVE BY OTHERS
AB ABANDON
PB/X PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PB/X EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
JW/X PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
JW/X EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
CO/# PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
CO/# EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
OH/# PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
OH/# EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
MA/XX PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
MA/XX EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
CA/X PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
CA/X EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED SPAN WIRE
XX EXISTING SPAN WIRE
RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED SPAN INSULATOR
EXISTING SPAN INSULATOR
P SERVICE PEDESTAL

GENERAL SIGNAL NOTES

1. PROPOSED LOOP DETECTORS:
   SYSTEM: 6'X6' - TO BE INSTALLED IN SR 141 RECEIVING LANES, AS SHOWN.
2. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREWS, BOLTS, AND COMPRESSION FITTINGS ARE NOT ACCEPTABLE.
3. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
4. REMOVE EXISTING TYPE 1 JUNCTION WELL, AND INSTALL NEW TYPE 14 JUNCTION WELL IN SAME LOCATION.

RECOMMENDED ______________ DATE: ________ RECOMMENDED ______________ DATE: ________ RECOMMENDED ______________ DATE: ________ APPROVED TRAFFIC ENGINEER ______________ DATE: ________ APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ______________ DATE: ________

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS	
1 INSTALLED SYSTEM LOOPS SM (RK&K) 09-11 (CONTRACT T201204701)	

SCALE 0 30 60 90 FEET

CONTRACT	T201204701
COUNTY	NEW CASTLE
PERMIT NO.	N-303
DESIGNED BY:	SM (RK&K)
CHECKED BY:	JCR (RK&K)

TRAFFIC SIGNAL PLAN
SR 141 (BASIN RD)
at COMMONS BLVD

SHEET NO. 13
TOTAL SHTS. 20

APPENDIX F

Sample Traffic Statement

DELAWARE DEPARTMENT OF TRANSPORTATION

TRAFFIC ITMS ESTIMATE

SR1/I-95 Interchange

CONTRACT #	T200809003
F.A.P. #	IM-N056(35)
PROJECT:	SR1/I-95 Interchange

					ITMS	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	B	B
1	3	747506	6	EA	Cabinet Base		
2	65	746830	0.75	CY	Removal of Concrete Pole Bases and Cabinet Foundations		
3	69	745521	1577	LF	Supply of 4" SDR-13.5 HDPE Conduit (Bore)		
4	72	745524	13575	LF	Supply of 4" Schedule 80 PVC Conduit (Trench)		
5	75	745527	1110	LF	Supply of 2 1/2" Galvanized Steel Conduit		
6	76	745528	5140	LF	Supply of 2" Galvanized Steel Conduit		
7	77	745529	285	LF	Supply of 1 1/2" Galvanized Steel Conduit		
8	86	745538	555	LF	Supply of 1 1/2" Flexible Metallic-Liquidtight Conduit		
9	90	745542	1887	LF	Installation of Conduit under Existing Pavement - Directional Bore		
10	92	745544	15800	LF	Installation of Conduit in Unpaved Trench		
11	94	745546	555	LF	Installation of Conduit on Structure		
12	95	745547	1970	LF	Installation of Additional Conduits in Trench or Open Cut Pavement		
13	97	745549	315	LF	Installation of Bridge-Mounted Conduit from Work Area Above Bridge Deck		
14	111	744506	11	EA	Conduit Junction Well, Type 7, 36" x 60" Precast Polymer Concrete		
15	123	744520	24	EA	Conduit Junction Well, Type 1, 20" x 20" Precast Concrete		
16	126	744523	37	EA	Conduit Junction Well, Type 4, 20" x 42 ½" Precast Concrete		
17	179	746847	4	EA	Pole Base Type 3		
18	184	746852	10	EA	Pole Base Type 6		
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
					TOTAL PROJECT CONTRACTOR ITEMS	→	

					ITMS	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	B	B
1	12	746727	4100	LF	Supply of 8/2 UF W/ground (Electric Service)	2.10	8,610.00
2	32	746782	6345	LF	Installation of First Cable in Existing Empty Conduit	1.30	8,248.50
3	33	746783	18920	LF	Installation of Each Additional Cable in Existing Empty Conduit	0.25	4,730.00
4	36	746786	15	EA	Installation of Cable in Steel Pole w/ Existing Weatherhead	76.00	1,140.00
5	107	746717	7	EA	Electric Service on Pedestal with Service Riser	720.00	5,040.00
6	153	746507	1	EA	Installation of Steel Pole (Equal to or Greater than 17' and less than 40')	230.00	230.00
7	154	746528	13	EA	Installation of Steel Pole (Equal to or Greater than 40')	3400.00	44,200.00
8	162	746734	1	EA	Removal of Steel Pole (Equal to or Greater than 40')	2300.00	2,300.00
9	76	745528	300	LF	Supply of 2" Galvanized Steel Conduit	7.00	2,100.00
10	90	745542	295	LF	Installation of Conduit under Existing Pavement - Directional Bore	20.00	5,900.00
11	92	745544	5	LF	Installation of Conduit in Unpaved Trench	5.75	28.75
12	123	744520	2	EA	Conduit Junction Well, Type 1, 20" x 20" Precast Concrete	720.00	1,440.00
13	15	746730	11650	LF	Supply of #2 URD Aluminum Service Cable	2.05	23,882.50
14	5	746720	3745	LF	Supply of #2 THWN Stranded Copper	1.65	6,179.25
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
					TOTAL TRAFFIC CONTRACTOR ITEMS	→	114,029.00

					ITMS	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	B	B
1							
2	306	999424	3	EA	Camera Cabinet	2416.00	7,248.00
3	316	999458	14	EA	Patch Cables (One Per Cabinet)	240.00	3,360.00
4							
5	356	999475	1	EA	25' (7.6m) Steel Round Tapered Strain Pole	6414.10	6,414.10
6	397	999520	3	EA	75' (22.9m) CCTV Camera Pole	10662.00	31,986.00
7	315	999457	14	EA	Fiber Interconnect Modem - Singlemode	1098.00	15,372.00
8	510	999608	3	EA	Camera (Includes Lowering Device, Controller, and Video Encoder)	10814.00	32,442.00
9							
10		999999	10	EA	40' RTMS Detector Pole	8500.00	85,000.00
11		999999	10	Ea	K Cabinets	1750.00	17,500.00
12							
13							
14		999999	12	EA	Wavetronix	6500.00	78,000.00
15							
16		999999	1	EA	Weather Station	4500.00	4,500.00
17							
18		999999	8	EA	Wavetronix Solar System power feed	3198.07	25,584.56
19							
20		999999	1	LS	DMS Board Reloaction	24000.00	24,000.00
21							
22		999999	1	LS	Fiber Intergration	508310.00	508,310.00
23		999999	1	LS	Fiber Intergration (Equipment)	52160.00	52,160.00
24		999999	1	LS	Fiber Midigation (Construction/Fiber)	400146.75	400,146.75
25							
26							
27							
28							
29							
30							

TOTAL TRAFFIC SUPPLY ITEMS	→	1,292,023.41
TOTAL PROJECT CONTRACTOR ITEMS	→ →	0.00
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	114,029.00
TOTAL TRAFFIC SUPPLY ITEMS	→ →	1,292,023.41
CONTINGENCIES	→ →	281,210.48
TOTAL COST	→ →	1,687,262.89

DELAWARE DEPARTMENT OF TRANSPORTATION

TRAFFIC ITMS ESTIMATE

BR-3156 Indian River Inlet Bridge Replacement (Design Build)

CONTRACT #	T200607303
F.A.P. #	0
PROJECT:	BR-3156 Indian River Inlet Bridge Replacement (Design Build)

					ITMS	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	A	A
1							
2							
3							
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27							
28							
29							
30							
					TOTAL PROJECT CONTRACTOR ITEMS	→	

					ITMS	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	A	A
1	1	747504	1	EA	Installation or Removal of Pole or Post Mounted Cabinet	350.00	350.00
2	2	747505	1	EA	Installation or Removal of Base or Pad Mounted Cabinet	250.00	250.00
3	3	747506	1	EA	Cabinet Base	700.00	700.00
4	7	746722	150	LF	Supply of #6 THWN Stranded Copper	1.10	165.00
5	12	746727	250	LF	Supply of 8/2 UF W/ground (Electric Service)	1.00	250.00
6	28	746777	4	EA	Triplex Splice	125.00	500.00
7	29	746778	5	EA	Splicing of Electrical Cable, Above Ground	85.00	425.00
8	32	746782	400	LF	Installation of First Cable in Existing Empty Conduit	1.33	532.00
9	33	746783	100	LF	Installation of Each Additional Cable in Existing Empty Conduit	0.16	16.00
10	36	746786	8	EA	Installation of Cable in Steel Pole w/ Existing Weatherhead	32.00	256.00
11	69	745521	90	LF	Supply of 4" SDR-13.5 HDPE Conduit (Bore)	2.25	202.50
12	70	745522	55	LF	Supply of 3" Schedule 80 PVC Conduit	3.00	165.00
13	72	745524	415	LF	Supply of 4" Schedule 80 PVC Conduit (Trench)	5.00	2,075.00
14	75	745527	5	LF	Supply of 2 1/2" Galvanized Steel Conduit	11.00	55.00
15	76	745528	165	LF	Supply of 2" Galvanized Steel Conduit	6.50	1,072.50
16	77	745529	100	LF	Supply of 1 1/2" Galvanized Steel Conduit	4.00	400.00
17	91	745542	140	LF	Installation of Conduit under Existing Pavement - Directional Bore	21.00	2,940.00
18	93	745544	480	LF	Installation of Conduit in Unpaved Trench	5.10	2,448.00
19	96	745547	20	LF	Installation of Additional Conduits in Trench or Open Cut Pavement	1.50	30.00
20	98	745549	90	LF	Installation of Bridge-Mounted Conduit from Work Area Above Bridge Deck	20.00	1,800.00
21	108	746717	2	EA	Electric Service on Pedestal with Service Riser	815.00	1,630.00
22	109	746718	1	EA	Removal of Electrical Service on Wood or Metal Pole	100.00	100.00
23	111	744505	20	EA	Adjust or Repair Existing Conduit Junction Well	180.00	3,600.00
24	127	744523	3	EA	Conduit Junction Well, Type 4, 20" x 42 ½" Precast Concrete	1300.00	3,900.00
25	131	720527	480	EA-DY	Plastic Drums	3.50	1,680.00
26	134	742502	24	HR	Flagger, Sussex County, State	32.97	791.28
27	144	743003	25	EA-DY	Arrowpanels, Type C	40.00	1,000.00
28	145	743504	100	EA	Warning Signs	150.00	15,000.00
29	152	746507	1	EA	Installation of Steel Pole (Equal to or Greater than 17' and less than 40')	360.00	360.00
30	159	746700	2	EA	Assembly and Installation of Camera Mount	400.00	800.00
31	178	746847	1	EA	Pole Base Type 3	2200.00	2,200.00
32			1	EA	Pole Base Special (Repeater Tower Base)	2200.00	2,200.00
33			1	EA	Installation of WTMC Antenna Assembly	1000.00	1,000.00
34			1	EA	Installation of 40' Ground Rod	400.00	400.00
35			1	EA	Installation of 10" Diameter x 40.5' Augered Shaft for Ground Rod	4000.00	4,000.00
36			1	EA	Exotheric Weld 3" Copper Ground Strap and #6 THWN Stranded Bare Copper to Galv. Steel	300.00	300.00
37			50	LF	Supply 3" Copper Ground Strap	5.00	250.00
					TOTAL TRAFFIC CONTRACTOR ITEMS	→	53,843.28

					ITMS	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	A	A
1	308	999426	1	EA	ITMS Cabinet	2416.00	2,416.00
2	317	999458	3	EA	Patch Cables (One Per Cabinet)	240.00	720.00
3	336	999478	1	EA	25' (7.6m) Steel Round Tapered Strain Pole	6414.10	6,414.10
4	511	999611	1	EA	Camera (Includes Lowering Device, Controller, and Video Encoder)	11553.00	11,553.00
5							
6	513	999613	1	EA	Outside Plant-Fiber Optic Installation, Statewide	278520.00	278,520.00
7					*Fiber Installation*		
8							
9	513	999613	1	EA	Outside Plant-Fiber Optic Installation, Statewide	21456.44	21,456.44
10					*Comm Gear*		
11							
12	513	999613	1	EA	Outside Plant-Fiber Optic Installation, Statewide	5175.00	5,175.00
13					*Hub Building Power Hook-ups*		
14							
15			1	LS	RWIS System	50000.00	50,000.00
16			1	LS	RWIS Relocation	25000.00	25,000.00
17							
18		1001	1	EA	Supply WTMC Transmitter Module	2995.00	2,995.00
19					**(Contract No. 29-500-75.01)**		
20		2001	1	EA	GPS Synchronizer Module	3210.00	3,210.00
21					**(Contract No. 29-500-75.01)**		
22		1001	1	EA	Supply TIS Antenna	15795.00	15,795.00
23					**(Contract No. 29-500-76.01)**		
24		3001	1	EA	Barix Extreamer 100 MP3 IP Audio Decoder Without Display	295.00	295.00
25					**(Contract No. 29-500-75.01)**		
26		4001	1	EA	Broadcast Tools WVRC-4 Web, Voice & Serial Remote Control, 4 Channel	850.00	850.00
27					**(Contract No. 29-500-75.01)**		
28			1	EA	Supply Lynchole XIT System 2.5"dia x 40' grounding system-	3375.00	3,375.00
29					**(Contract No. 29-500-75.01)**		
30							
31	513	999613	1	EA	Outside Plant-Fiber Optic Installation, Statewide	8757.87	8,757.87
					Verizon hook up		

TOTAL TRAFFIC SUPPLY ITEMS	→	436,532.41

TOTAL PROJECT CONTRACTOR ITEMS	→	→	0.00
TOTAL TRAFFIC CONTRACTOR ITEMS	→	→	53,843.28
TOTAL TRAFFIC SUPPLY ITEMS	→	→	436,532.41
CONTINGENCIES	→	→	25,705.50
TOTAL COST	→	→	516,081.19

SIGN SCHEDULE

#	SHEET NO.	PLAN INDICATOR	CODE	QTY.	DESCRIPTION	ASSEMBLY NO.	SIGN WIDTH (IN)	SIGN HEIGHT (IN)	SIGN AREA (SF)	ITEM 749687 SINGLE POST (EACH)			ITEM 749690 MULTI POST (SF)			POST INSTALLATION TYPE	Code X11 12' Post (W/ Basepost)	ITEM 749688 4" HOLE, 0-6" (EACH)	ITEM 749689 4" HOLE, >6" (EACH)	REMARKS
										SIGN DISPOSTION	REMOVE	INSTALL	SIGN DISPOSTION	REMOVE	INSTALL					
359	SS-01	1-1	R5-1(36)	1	DO NOT ENTER - 36x36	1-1	36"	36"	9	RENEW	1	1					0	0	0	
359	SS--01	1-2	R5-1(36)	1	DO NOT ENTER - 36x36	1-2	36"	36"	9	NEW		1				SOIL	1	0	0	
392	SS-01	1-3	R6-1_R(36)	1	ONE WAY (ENCLOSED IN RIGHT ARROW) - 36x12	1-3	36"	12"	3	RENEW	1	1				SOIL	1	0	0	
394	SS-01	1-3	R6-1_L(36)	1	ONE WAY (ENCLOSED IN LEFT ARROW) - 36x12	1-3	36"	12"	3	RENEW	1	1					0	0	0	
4	SS-01	1-3	R1-1(36)	1	STOP	1-3	36"	36"	9	RENEW	1	1					0	0	0	
394	SS-01	1-4	R6-1_L(36)	1	ONE WAY (ENCLOSED IN LEFT ARROW) - 36x12	1-4	36"	12"	3	RENEW	1	1					0	0	0	
392	SS-01	1-4	R6-1_R(36)	1	ONE WAY (ENCLOSED IN RIGHT ARROW) - 36x12	1-4	36"	12"	3	RENEW	1	1					0	0	0	
4	SS-01	1-4	R1-1(36)	1	STOP	1-4	36"	36"	9	RENEW	1	1					0	0	0	
408	SS-01	1-4	R6-3a(30)	1	DIVIDED HIGHWAY CROSSING (T - Intersection) - 30x24	1-4	30"	24"	5	RENEW	1	1					0	0	0	
311	SS-01	1-5	R4-7(24)	1	KEEP RIGHT (Symbol) - 24x30	1-5	24"	30"	5	RENEW	1	1					0	0	0	
1955	SS-01	1-5	OM1-3	1	TYPE 1 OBJECT MARKER	1-5				REMOVE	1						0	0	0	
363	SS-01	1-6	R5-1a(42)	1	WRONG WAY - 42x30	1-6	42"	30"	8.75	NEW		1				SOIL	1	0	0	
363	SS-01	1-7	R5-1a(42)	1	WRONG WAY - 42x30	1-7	42"	30"	8.75	NEW		1				SOIL	1	0	0	
363	SS-02	2-1	R5-1a(42)	1	WRONG WAY - 42x30	2-1	42"	30"	8.75	NEW		1				SOIL	1	0	0	
363	SS-02	2-1	R5-1a(42)	1	WRONG WAY - 42x30	2-1				REMOVE	1						0	0	0	
363	SS-02	2-2	R5-1a(42)	1	WRONG WAY - 42x30	2-2	42"	30"	8.75	NEW		1				SOIL	1	0	0	
363	SS-02	2-2	R5-1a(42)	1	WRONG WAY - 42x30	2-2				REMOVE	1						0	0	0	
828	SS-02	2-3	W2-2_L(36)	1	SIDE ROAD (Perpendicular - Left) - 36x36	2-3	36"	36"	9	NEW		1				SOIL	1	0	0	
1367	SS-02	2-3	W16-8P	1	ADVANCE STREET NAME (1 - line plaque)	2-3	36"	8"	2	NEW		1					0	0	0	"Airport Rd"
828	SS-02	2-4	W2-2_L(36)	1	SIDE ROAD (Perpendicular - Left) - 36x36	2-4	36"	36"	9	RENEW	1	1				SOIL	1	0	0	
1367	SS-02	2-4	W16-8P	1	ADVANCE STREET NAME (1 - line plaque)	2-4	36"	8"	2	RENEW	1	1					0	0	0	"Airport Rd"
42	SS-03	3-1	R2-1-25(24)	1	SPEED LIMIT (25 MPH - 24x30)	3-1	24"	30"	5	NEW		1				SOIL	1	0	0	
1872	SS-03	3-1	D14-3-DE	1	ADOPT A HIGHWAY	3-1	24"	24"	4	RENEW	1	1					0	0	0	"MET / HVAC CLUB DELTECH"
1508	SS-03	3-2	M3-1(24)	1	CARDINAL DIRECTION - NORTH - 24x12	3-2	24"	12"	2	NEW		1				SOIL	1	0	0	
1489	SS-03	3-2	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	3-2	30"	24"	5	NEW		1					0	0	0	
1534	SS-03	3-2	M4-5(24)	1	TO - 24x12	3-2	24"	12"	2	NEW		1					0	0	0	White Letter -Blue Background
1472	SS-03	3-2	M1-1(24)	1	INTERSTATE ROUTE (2 - Digit Sign) - 24x24	3-2	24"	24"	2	NEW		1					0	0	0	White Letter -Blue Background
1605	SS-03	3-2	M6-1_L(21)	1	DIRECTIONAL ARROW (Left) - 21x15	3-2	21"	15"	2.2	NEW		1					0	0	0	White Arrow - Blue Background
389	SS-03	3-3	R5-10b	1	NO PEDESTRIANS OR BICYCLES	3-3	30"	18"	3.75	NEW		1				SOIL	1	0	0	
1508	SS-03	3-4	M3-1(24)	1	CARDINAL DIRECTION - NORTH - 24x12	3-4				REMOVE	1						0	0	0	
1485	SS-03	3-4	M1-4(30)	1	US ROUTE (3 - Digit Sign) - 30x24	3-4				REMOVE	1						0	0	0	
1489	SS-03	3-4	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	3-4				REMOVE	1						0	0	0	
901	SS-03	3-5	W4-1_R(48)	1	MERGE (Right) - 48x48	3-5	48"	48"	16				NEW		16	SOIL	2	0	0	
900	SS-03	3-5	W4-1_R(36)	1	MERGE (Right) - 36x36	3-5				REMOVE	1						0	0	0	
1924	SS-03	3-5	EM-1-DE	1	EVACUATION ROUTE	3-5				REMOVE	1						0	0	0	
1605	SS-03	3-5	M6-1_L(21)	1	DIRECTIONAL ARROW (Left) - 21x15	3-5				REMOVE	1						0	0	0	
359	SS-03	3-6	R5-1(36)	1	DO NOT ENTER - 36x36	3-6				REMOVE	1						0	0	0	
1509	SS-03	3-7	M3-1(36)	1	CARDINAL DIRECTION - NORTH - 36x18	3-7	36"	18"	4.5	RENEW	1	1				SOIL	0	0	0	
1487	SS-03	3-7	M1-4(45)	1	US ROUTE (3 - Digit Sign) - 45x36	3-7	45"	36"	11.25	RENEW	1	1					0	0	0	
-	SS-03	3-7	M5-2l	1	ADVANCE TURN ARROW (LEFT - 45)	3-7	30"	21"	4.38	NEW		1					0	0	0	
1924	SS-03	3-7	EM-1-DE	1	EVACUATION ROUTE	3-7	24"	24"	4	NEW		1					0	0	0	
1605	SS-03	3-7	M6-1_L(21)	1	DIRECTIONAL ARROW (Left) - 21x15	3-7	21"	15"	2.2	NEW		1					0	0	0	White Arrow - Blue Background
1301	SS-03	3-8	W13-2(36)	1	ADVISORY EXIT SPEED - 36x48	3-8	36"	48"	12	NEW			NEW		12	SOIL	2	0	0	
1509	SS-03	3-9	M3-1(36)	1	CARDINAL DIRECTION - NORTH - 36x18	3-9	36"	18"	4.5	NEW		1				SOIL	1	0	0	
1491	SS-03	3-9	M1-5(45)	1	STATE ROUTE (3 - Digit Sign) - 45x36	3-9	45"	36"	11.25	NEW		1					0	0	0	
1924	SS-03	3-9	EM-1-DE	1	EVACUATION ROUTE	3-9	24"	24"	4	NEW		1					0	0	0	
1619	SS-03	3-9	M6-3(21)	1	DIRECTIONAL ARROW (Up) - 21x15	3-9	21"	15"	2.2	NEW		1					0	0	0	White Arrow - Blue Background
9	SS-03	3-10	R1-2(48)	1	YIELD	3-10	48"	48"	8	RENEW	1	1				SOIL	1	0	0	
936	SS-03	3-11	W4-5_R(48)	1	ENTERING ROADWAY MERGE (Right) - 48x48	3-11	48"	48"	16				NEW		16	SOIL	2	0	0	
781	SS-03	3-12	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	3-12	30"	36"	7.5	NEW		1				SOIL	1	0	0	
389	SS-03	3-13	R5-10b	1	NO PEDESTRIANS OR BICYCLES	3-13	30"	18"	3.75	NEW		1					0	0	0	INSTALL ON CANTILEVER POLE
774	SS-03	3-14	W1-6_L(48)	1	ONE DIRECTIONAL LARGE ARROW (Left) - 48x24	3-14	48"	24"					NEW		8	SOIL	2	0	0	
394	SS-03	3-14	R6-1_L(36)	1	ONE WAY (ENCLOSED IN LEFT ARROW) - 36x12	3-14				REMOVE	1						0	0	0	
1964	SS-03	3-14	OM4-3	1	END OF ROAD OBJECT MARKER	3-14	18"	18"	2.25	RENEW	1	1					0	0	0	
1964	SS-03	3-14	OM4-3	1	END OF ROAD OBJECT MARKER	3-14	18"	18"	2.25	RENEW	1	1					0	0	0	
359	SS-03	3-15	R5-1(36)	1	DO NOT ENTER - 36x36	3-15	36"	36"	9	NEW		1				SOIL	1	0	0	
359	SS-03	3-16	R5-1(36)	1	DO NOT ENTER - 36x36	3-16	36"	36"	9	NEW		1				SOIL	1	0	0	
394	SS-03	3-17	R6-1_L(36)	1	ONE WAY (ENCLOSED IN LEFT ARROW) - 36x12	3-17	36"	12"	3	RENEW	1	1				SOIL	1	0	0	
4	SS-03	3-17	R1-1(36)	1	STOP	3-17	36"	36"	9	RENEW	1	1					0	0	0	
106	SS-03	3-17	R3-1(36)	1	RIGHT TURN PROHIBITION (Symbol) - 36x36	3-17	36"	36"	9	NEW		1					0	0	0	
813	SS-04	4-1	W1-15(36)	1	270-DEGREE LOOP - 36x36	4-1	36"	36"	9	NEW		1				SOIL	1	0	0	
1286	SS-04	4-1	W13-1P-25(24)	1	ADVISORY SPEED (25 MPH) 24x24	4-1	24"	24"	4	NEW		1					0	0	0	
PAGE TOTALS									**308.98**		30	47		0	52		26	0	0	

SIGN SCHEDULE

NO.	SHEET NO.	PLAN INDICATOR	CODE	QTY.	DISCRIPTION	ASSEMBLY NO.	SIGN WIDTH (IN)	SIGN HEIGHT (IN)	SIGN AREA (SF)	ITEM 749687 SINGLE POST (EACH)			ITEM 749690 MULTI POST (SF)			POST INSTALLATION TYPE	Code X11 12' Post (W/ Basepost)	ITEM 749688 4" HOLE, 0-6" (EACH)	ITEM 749689 4" HOLE, >6" (EACH)	REMARKS
										SIGN DISPOSTION	REMOVE	INSTALL	SIGN DISPOSTION	REMOVE	INSTALL					
1509	SS-04	4-2	M3-1(36)	1	CARDINAL DIRECTION - NORTH - 36x18	4-2	36"	18"	4.5	RENEW	1	1					0	0	0	INSTALL ON CANTILEVER POLE
1487	SS-04	4-2	M1-4(45)	1	US ROUTE (3 - Digit Sign) - 45x36	4-2	45"	36"	11.25	RENEW	1	1					0	0	0	INSTALL ON CANTILEVER POLE
1629	SS-04	4-2	M6-5_L(30)	1	DIRECTIONAL ARROW (Left to Right - 45) - 30x21	4-2	30"	21"	4.4	NEW		1					0	0	0	INSTALL ON CANTILEVER POLE
691	SS-04	4-3	SR1-12-DE	1	NO LITTERING UP TO $500 FINE	4-3				REMOVE	1						0	0	0	
389	SS-05	5-1	R5-10b	1	NO PEDESTRIANS OR BICYCLES	5-1				REMOVE	1						0	0	0	
1311	SS-05	5-2	W13-7(36)	1	COMBINATION HORIZONTAL ALIGNMENT/ADVISORY RAMP SPEED - 36x60	5-2	36"	60"	15				NEW		15	SOIL	2	0	0	
781	SS-05	5-3	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	5-3	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-05	5-4	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	5-4	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-05	5-5	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	5-5	30"	36"	7.5	NEW		1				SOIL	1	0	0	
9	SS-05	5-6	R1-2(48)	1	YIELD	5-6	48"	48"	8	NEW		1				SOIL	1	0	0	RELOCATE
936	SS-05	5-7	W4-5_R(48)	1	ENTERING ROADWAY MERGE (Right) - 48x48	5-7	48"	48"	16				NEW		16	SOIL	2	0	0	
901	SS-05	5-8	W4-1_R(48)	1	MERGE (Right) - 48x48	5-8	48"	48"	16				RENEW	16	16	SOIL	2	0	0	
1924	SS-05	5-8	EM-1-DE	1	EVACUATION ROUTE	5-8				REMOVE	1						0	0	0	
1604	SS-05	5-8	M6-1_R(21)	1	DIRECTIONAL ARROW (Right) - 21x15	5-8				REMOVE	1						0	0	0	
1924	SS-05	5-9	EM-1-DE	1	EVACUATION ROUTE	5-9	24"	24"	4	NEW		1				SOIL	1	0	0	
1604	SS-05	5-9	M6-1_R(21)	1	DIRECTIONAL ARROW (Right) - 21x15	5-9	21"	15"	2.2	NEW		1					0	0	0	White Arrow - Blue Background
	SS-05	5-10	-		-	5-10											0	0	0	SEE SIGN DETAIL SHEET
1304	SS-05	5-11	W13-3(36)	1	ADVISORY RAMP SPEED - 36x48	5-11				REMOVE	1						0	0	0	
920	SS-06	6-1	W4-3_L(48)	1	ADDED LANE (Left) - 48x48	6-1	48"	48"	16				RENEW	16	16	SOIL	2	0	0	
781	SS-06	6-2	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-2	30"	36"	7.5	NEW		1					1	0	0	
941	SS-06	6-3	W4-6_L(48)	1	ENTERING ROADWAY ADDED LANE (Left) - 48x48	6-3	48"	48"	16				RENEW	16	16	SOIL	2	0	0	
781	SS-06	6-4	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-4	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-06	6-5	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-5	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-06	6-6	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-6	30"	36"	7.5	NEW		1				SOIL	1	0	0	
8	SS-06	6-7	R1-2(36)	1	YIELD	6-7				REMOVE	1						0	0	0	
8	SS-06	6-8	R1-2(36)	1	YIELD	6-8				REMOVE	1						0	0	0	
389	SS-06	6-9	R5-10b	1	NO PEDESTRIANS OR BICYCLES	6-9	30"	18"	3.75	NEW		1				SOIL	1	0	0	
874	SS-06	6-10	W3-2(30)	1	YIELD AHEAD (Symbol) - 30x30	6-10				REMOVE	1						0	0	0	
724	SS-06	6-11	W1-2_L(36)	1	CURVE (Left) - 36x36	6-11	36"	36"	9	NEW		1				SOIL	1	0	0	
1292	SS-06	6-11	W13-1P-35(24)	1	ADVISORY SPEED (35 MPH) 24x24	6-11	24"	24"	4	NEW		1					0	0	0	
	SS-06	6-12	-		-	6-12											0	0	0	SEE SIGN DETAIL SHEET
1303	SS-06	6-13	W13-3(24)	1	ADVISORY RAMP SPEED - 24x30	6-13				REMOVE	1						0	0	0	
1304	SS-06	6-14	W13-3(36)	1	ADVISORY RAMP SPEED - 36x48	6-14	36"	48"	12				NEW		12	SOIL	2	0	0	
781	SS-06	6-15	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-15	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-06	6-16	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-16	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-06	6-17	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-17	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-06	6-18	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-18	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-06	6-19	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-19	30"	36"	7.5	NEW		1				SOIL	1	0	0	
941	SS-06	6-20	W4-6_L(48)	1	ENTERING ROADWAY ADDED LANE (Left) - 48x48	6-20	48"	48"	16				NEW		16	SOIL	2	0	0	
920	SS-06	6-21	W4-3_L(48)	1	ADDED LANE (Left) - 48x48	6-21	48"	48"	16				NEW		16	SOIL	2	0	0	
781	SS-06	6-22	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-22	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-06	6-23	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-23	30"	36"	7.5	NEW		1				CONCRETE	1	1	0	
781	SS-06	6-24	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-24	30"	36"	7.5	NEW							0	0	0	INSTALL ON P.P.C. BARRIER
781	SS-06	6-25	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-25	30"	36"	7.5	NEW							0	0	0	INSTALL ON P.P.C. BARRIER
781	SS-06	6-26	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-26	30"	36"	7.5	NEW							0	0	0	INSTALL ON P.P.C. BARRIER
781	SS-06	6-27	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	6-27	30"	36"	7.5	NEW							0	0	0	INSTALL ON P.P.C. BARRIER
813	SS-07	7-1	W1-15(36)	1	270-DEGREE LOOP - 36x36	7-1	36"	36"	9	NEW		1				SOIL	1	0	0	
1286	SS-07	7-1	W13-1P-25(24)	1	ADVISORY SPEED (25 MPH) 24x24	7-1	24"	24"	4	NEW		1					0	0	0	
1304	SS-07	7-2	W13-3(36)	1	ADVISORY RAMP SPEED - 36x48	7-2	36"	48"	12				RENEW		12	SOIL	2	0	0	RELOCATE
	SS-07	7-3	-		-	7-3											0	0	0	SEE SIGN DETAIL SHEET
781	SS-07	7-4	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-4	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-5	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-5	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-6	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-6	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-7	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-7	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-8	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-8	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-9	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-9	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-10	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-10	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-11	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-11	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-12	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-12	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-13	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-13	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-14	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-14	30"	36"	7.5	NEW		1				SOIL	1	0	0	
781	SS-07	7-15	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-15	30"	36"	7.5	NEW		1				SOIL	1	0	0	
					PAGE TOTALS				**424.1**		11	37		48	135		49	1	0	

SIGN SCHEDULE

NO.	SHEET NO.	PLAN INDICATOR	CODE	QTY.	DISCRIPTION	ASSEMBLY NO.	SIGN WIDTH (IN)	SIGN HEIGHT (IN)	SIGN AREA (SF)	ITEM 749687 SINGLE POST (EACH)			ITEM 749690 MULTI POST (SF)			POST INSTALLATION TYPE	Code X11 12' Post (W/ Basepost)	ITEM 749688 4" HOLE, 0-6" (EACH)	ITEM 749689 4" HOLE, >6" (EACH)	REMARKS
										SIGN DISPOSTION	REMOVE	INSTALL	SIGN DISPOSTION	REMOVE	INSTALL					
781	SS-07	7-16	W1-8(30)	1	CHEVRON ALIGNMENT - 30x36	7-16	30"	36"	7.5	NEW		1				SOIL	1	0	0	
9	SS-08	8-1	R1-2(48)	1	YIELD	8-1	48"	48"	8	RENEW	1	1					0	0	0	
901	SS-08	8-2	W4-1_R(48)	1	MERGE (Right) - 48x48	8-2	48"	48"	16				NEW		16	SOIL	2	0	0	
	SS-09	9-1	-		-	9-1											0	0	0	SEE SIGN DETAIL SHEET
10	SS-11	11-1	R1-2(60)	1	YIELD	11-1	60"	60"	12.5				NEW		12.5	SOIL	2	0	0	
42	SS-13	13-1	R2-1-25(24)	1	SPEED LIMIT (25 MPH - 24x30)	13-1	24"	30"	5	RENEW	1	1					0	0	0	
1508	SS-13	13-2	M3-1(24)	1	CARDINAL DIRECTION - NORTH - 24x12	13-2				REMOVE	1						0	0	0	
1489	SS-13	13-2	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	13-2				REMOVE	1						0	0	0	
1589	SS-13	13-2	M5-1_L	1	ADVANCE TURN ARROW (Left - 90)	13-2				REMOVE	1						0	0	0	
1674	SS-13	13-3	D3-1(12)	2	STREET NAME (1 Line)	13-3	30"	12"	5	RENEW	2	2				SOIL	1	0	0	REPOSITION. "Basin Rd"
1674	SS-13	13-3	D3-1(12)	2	STREET NAME (1 Line)	13-3	36"	12"	6	RENEW	2	2					0	0	0	REPOSITION, " Airport Rd"
9	SS-13	13-3	R1-2(48)	1	YIELD	13-3	48"	48"	8	RENEW	1	1					0	0	0	REPOSITION
1534	SS-13	13-4	M4-5(24)	1	TO - 24x12	13-4				REMOVE	1						0	0	0	
1484	SS-13	13-4	M1-4(24)	1	US ROUTE (2 - Digit Sign) - 24x24	13-4				REMOVE	1						0	0	0	
1626	SS-13	13-4	M6-5_R(21)	1	DIRECTIONAL ARROW (Right to Left - 45) - 21x15	13-4				REMOVE	1						0	0	0	
1534	SS-13	13-5	M4-5(24)	1	TO - 24x12	13-5	24"	12"	2	NEW		1				SOIL	1	0	0	
1508	SS-13	13-5	M3-1(24)	1	CARDINAL DIRECTION - NORTH - 24x12	13-5	24"	12"	2	NEW		1					0	0	0	
1489	SS-13	13-5	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	13-5	30"	24"	5	NEW		1					0	0	0	
1534	SS-13	13-5	M4-5(24)	1	TO - 24x12	13-5	24"	12"	2	NEW		1					0	0	0	White Letter - Blue Brackground
1472	SS-13	13-5	M1-1(24)	1	INTERSTATE ROUTE (2 - Digit Sign) - 24x24	13-5	24"	24"	2	NEW		1					0	0	0	White Letter - Blue Brackground
1619	SS-13	13-5	M6-3(21)	1	DIRECTIONAL ARROW (Up) - 21x15	13-5	21"	15"	2.2	NEW		1					0	0	0	White Arrow - Blue Background
1514	SS-13	13-5	M3-3(24)	1	CARDINAL DIRECTION - SOUTH - 24x12	13-5	24"	12"	2	NEW		1				SOIL	1	0	0	
1489	SS-13	13-5	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	13-5	30"	24"	5	NEW		1					0	0	0	
1534	SS-13	13-5	M4-5(24)	1	TO - 24x12	13-5	24"	12"	2	NEW		1					0	0	0	
1484	SS-13	13-5	M1-4(24)	1	US ROUTE (2 - Digit Sign) - 24x24	13-5	24"	24"	2	NEW		1					0	0	0	
1604	SS-13	13-5	M6-1_R(21)	1	DIRECTIONAL ARROW (Right) - 21x15	13-5	21"	15"	2.2	NEW		1					0	0	0	
1508	SS-13	13-6	M3-1(24)	1	CARDINAL DIRECTION - NORTH - 24x12	13-6				REMOVE	1						0	0	0	
1489	SS-13	13-6	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	13-6				REMOVE	1						0	0	0	
1619	SS-13	13-6	M6-3(21)	1	DIRECTIONAL ARROW (Up) - 21x15	13-6				REMOVE	1						0	0	0	
1514	SS-13	13-7	M3-3(24)	1	CARDINAL DIRECTION - SOUTH - 24x12	13-7				REMOVE	1						0	0	0	
1489	SS-13	13-7	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	13-7				REMOVE	1						0	0	0	
1604	SS-13	13-7	M6-1_R(21)	1	DIRECTIONAL ARROW (Right) - 21x15	13-7				REMOVE	1						0	0	0	
	SS-13	13-8	-	1	"NEW CASTLE AIRPORT"	13-8				REMAIN							0	0	0	STRAIGHTEN SIGN POST
	SS-13	13-8	-	1	DIRECTIONAL ARROW	13-8				REMAIN							0	0	0	
	SS-13	13-9	-	1	"AIR NATIONAL GUARD"	13-9				REMAIN							0	0	0	STRAIGHTEN SIGN POST
	SS-13	13-9	-	1	DIRECTIONAL ARROW	13-9				REMAIN							0	0	0	
54	SS-13	13-10	R2-1-40(24)	1	SPEED LIMIT (40 MPH - 24x30)	13-10	24"	30"	5	NEW		1				SOIL	1	0	0	
9	SS-13	13-11	R1-2(48)	1	YIELD	13-11	48"	48"	8	RENEW	1	1				SOIL	1	0	0	REPOSITION
359	SS-13	13-12	R5-1(36)	1	DO NOT ENTER - 36x36	13-12	36"	36"	9	NEW		1				SOIL	1	0	0	
359	SS-13	13-13	R5-1(36)	1	DO NOT ENTER - 36x36	13-13	36"	36"	9	NEW		1				SOIL	1	0	0	
389	SS-13	13-14	R5-10b	1	NO PEDESTRIANS OR BICYCLES	13-14	30"	18"	3.75	RENEW	1	1				SOIL	1	0	0	
624	SS-13	13-14	R12-4	1	WEIGHT LIMIT X TONS PER AXLE XX TONS GROSS	13-14	36"	24"	6	RENEW	1	1					0	0	0	
1882	SS-13	13-15	E5-1a(78)	1	EXIT GORE (1-, 2- Digit Exit Number)	13-15				REMAIN						SOIL	0	0	0	
363	SS-13	13-16	R5-1a(42)	1	WRONG WAY - 42x30	13-16	42"	30"	8.75	RENEW	1	1				SOIL	1	0	0	REPOSITION
363	SS-13	13-17	R5-1a(42)	1	WRONG WAY - 42x30	13-17	42"	30"	8.75	RENEW	1	1				SOIL	1	0	0	REPOSITION
1674	SS-13	13-18	D3-1(12)	2	STREET NAME (1 Line)	13-18	30"	12"	5	RENEW	2	2				SOIL	1	0	0	"Basin Rd"
1674	SS-13	13-18	D3-1(12)	2	STREET NAME (1 Line)	13-18	36"	12"	6	RENEW	2	2					0	0	0	"Airport Rd"
394	SS-13	13-18	R6-1_L(36)	1	ONE WAY (ENCLOSED IN LEFT ARROW) - 36x12	13-18	36"	12"	3	RENEW	1	1					0	0	0	
392	SS-13	13-18	R6-1_R(36)	1	ONE WAY (ENCLOSED IN RIGHT ARROW) - 36x12	13-18	36"	12"	3	RENEW	1	1					0	0	0	
105	SS-13	13-18	R3-1(24)	1	RIGHT TURN PROHIBITION (Symbol) - 24x24	13-18	24"	24"	4	RENEW	1	1					0	0	0	
110	SS-13	13-18	R3-2(24)	1	LEFT TURN PROHIBITION (Symbol) - 24x24	13-18	24"	24"	4	RENEW	1	1					0	0	0	
	SS-13	13-18	-	1	"ADOPT A WETLAND"	13-18				REMOVE	1						0	0	0	
1514	SS-13	13-19	M3-3(24)	1	CARDINAL DIRECTION - SOUTH - 24x12	13-19	24"	12"	2	NEW		1				SOIL	1	0	0	
1489	SS-13	13-19	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	13-19	30"	24"	5	NEW		1					0	0	0	
1605	SS-13	13-19	M6-1_L(21)	1	DIRECTIONAL ARROW (Left) - 21x15	13-19	21"	15"	2.2	NEW		1					0	0	0	
1504	SS-14	14-1	M2-1(21)	1	JUNCTION - 21x15	14-1	21"	15"	2.2	NEW		1				SOIL	1	0	0	
1489	SS-14	14-1	M1-5(30)	1	STATE ROUTE (3 - Digit Sign) - 30x24	14-1	30"	24"	5	NEW		1					0	0	0	
877	SS-14	14-2	W3-3(30)	1	SIGNAL AHEAD (Symbol) - 30x30	14-2	30"	30"	6.25	NEW		1				SOIL	1	0	0	
1367	SS-14	14-2	W16-8P	1	ADVANCE STREET NAME (1 - line plaque)	14-2	30"	8"	1.67	NEW		1					0	0	0	"Basin Rd"
1301	SS-15	15-1	W13-2(36)	1	ADVISORY EXIT SPEED - 36x48	15-1	36"	48"	12				NEW		12	SOIL	2	0	0	
					PAGE TOTALS				**215.97**		33	42		0	40.5		21	0	0	
					JOB TOTALS				**949.05**		74	126		48	227.5		96	1	0	

DELAWARE DEPARTMENT OF TRANSPORTATION

TRAFFIC ROADWAY SIGNING ESTIMATE

I-95 and SR 141 Interchange - Ramps G and F Improvements

T201109002

CONTRACT #: T201109002
F.A.P. #: 0
PROJECT: I-95 and SR 141 Interchange - Ramps G and F Improvements

PROJECT LOCATION: I-95 and SR 141 Interchange - Ramps G and F Improvements

LINE	ITEM #	QTY	DESCRIPTION - PROJECT CONTRACTOR ITEMS	UOM	
1	749687	200	INSTALLATION OR REMOVAL OF TRAFFIC SIGN ON SINGLE SIGN POST	EA	
2	749688	1	INSTALLATION OF 4" DIAMETER HOLE, LESS THAN OR EQUAL TO 6" IN DEPTH	EA	
3	749689	0	INSTALLATION OF 4" DIAMETER HOLE, GREATER THAN 6" IN DEPTH	EA	
4	749690	276	INSTALLATION OR REMOVAL OF TRAFFIC SIGN ON MULTIPLE SIGN POSTS	SF	

LINE	CODE #	QTY	SIGNING DESCRIPTION	SIZE	UNIT COST	TOTAL COST
5	X13		SALARY, OVER-TIME	EA-HR	40.00	
6	X14		SIGNFIX (FOR ANY SIGN WITH FLASHING BEACONS)	EACH	56.00	
7	X11	96	12' POSTS (W/ BASEPOST) NEEDED FOR PROJECT OR LOCATION	EACH	34.02	3,265.92
8	X12		6' DELINEATOR POST (W/ BOLT & ETC.)	EACH	5.00	
			TRAFFIC ONLY PROJECT			
9	X1		Installation of Sign Posts, 9', 10', 11', 12' in Unpaved Area or Existing Holes	EACH	26.00	
10	X2		Installation of 4" dia. Hole in Pavement or Concrete	EACH	52.00	
11	X3		Installation of 4" dia. Hole, in Excess of 6" per ea. additional inch drilled in Pavement	EACH	$52.75	
12	X4		Installation of Street Name Signs	EACH	$26.38	
13	X5		Installation of Signs (Two or More Mounting Holes)	S/F	2.75	
14	X6		Sets, Installation of Sign Bands and Buckles	EACH	52.75	
15	X7		Removal of Traffic Signs	EACH	26.38	
16	X8		Removal of Street Name Signs	EACH	26.38	
17	X9		Removal of Sign Posts	EACH	1.00	
18	X10		Straightening of Sign Posts	EACH	17.00	
					TOTAL FOR LABOR	0.00

TOTAL FOR SIGNING MATERIALS	15,129.05
TOTAL FOR LABOR	0.00
CONTINGENCIES	1,512.90
TOTAL ROADSIDE SIGNING COST	**$16,641.95**

DELAWARE DEPARTMENT OF TRANSPORTATION

TRAFFIC SIGNAL ESTIMATE

SR 72, McCOY RD TO SR 71

CONTRACT #:	T200601102
F.A.P. #:	
PROJECT:	SR 72, McCOY RD TO SR 71

INTERSECTION # 1: N266 SR 72 & SR 71 PHASE 7

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	260	745602	242	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)		
2	270	745604	331	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
3	320	744506	1	EA	Conduit Junction Well, Type 7, Precast Polymer Concrete		
4	360	744531	3	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame		
5	610	746847	1	EA	Pole Base Type 3		
6	615	746850	1	EA	Pole Base Type 4		
7							
8							
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28							
29							
30							
					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 1: N266 SR 72 & SR 71 PHASE 7

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	565	746507	1	EA	Installation of Steel Pole (Less than 40')	700.00	700.00
2	600	746831	1	EA	Installation of Pedestal Pole	350.00	350.00
3	680	746935	1	EA	Furnish & Install 16" LED Countdown Pedestrian Signal	880.00	880.00
4	690	746937	1	EA	Furnish & Install Pedestrian Pushbutton with Sign	350.00	350.00
5	740	746939	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type I	9000.00	9,000.00
6							
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	11,280.00

INTERSECTION # 1: N266 SR 72 & SR 71 PHASE 7

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST	TOTAL COST
						C	C
1	965	999481	1	EA	32' (9.8m) Steel Round Strain Pole	6785.00	6,785.00
2	1135	999515	1	EA	10' (3.0M) Steel Round Pedestal Pole	625.00	625.00
3	1175	999523	1	EA	Set of Four, Breakaway Couplings with one Hex Nut, Two Flat Washers and Two Shims Per Coupling	178.00	178.00
4	1180	999524	1	EA	Aluminum Skirt for Breakaway Couplings, 8" (203mm) B.C.	29.00	29.00
5	1195	999527	1	EA	Set of Four, 2' x 90" (51mm x 2286mm) Anchor Bolts with Two Hex Nuts and Two Flat Washers Per Bolt	978.00	978.00
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TOTAL TRAFFIC SUPPLY ITEMS	→	8,595.00
TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	11,280.00
TOTAL TRAFFIC SUPPLY ITEMS	→ →	8,595.00
CONTINGENCIES	→ →	1,987.50
TOTAL COST	→ →	21,862.50

INTERSECTION # 2: N266 SR 72 & SR 71 PHASE 10

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	260	745602	136	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)		
2	270	745604	38	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
3	280	745606	100	LF	Furnish & Install up to 4" Galvanized Steel Conduit (Trench)		
4	360	744531	2	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame		
5	610	746847	1	EA	Pole Base Type 3		
6	615	746850	2	EA	Pole Base Type 4		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 2: N266 SR 72 & SR 71 PHASE 10

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	440	743003	2	EA-DY	Arrow Panels, Type C	40.00	80.00
2	455	743006	60	EA-DY	Plastic Drums	4.00	240.00
3	460	743007	3	HR	Traffic Officers	75.00	225.00
4	470	743010	1	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	185.00
5	480	743024	16	EA-DY	Temporary Warning Signs and Plaques	12.00	192.00
6	485	743050	3	HR	Flagger, New Castle County, State	52.90	158.70
7	565	746507	1	EA	Installation of Steel Pole (Less than 40')	700.00	700.00
8	600	746831	2	EA	Installation of Pedestal Pole	350.00	700.00
9	635	746763	8	EA	Realign or Slide Existing Signal Head	350.00	2,800.00
10	680	746935	2	EA	Furnish & Install 16" LED Countdown Pedestrian Signal	880.00	1,760.00
11	690	746937	2	EA	Furnish & Install Pedestrian Pushbutton with Sign	350.00	700.00
12	715	746504	70	LF	Furnish & Install Span Wires, 7/16"	25.00	1,750.00
13	735	746706	1	EA	Transfer of Existing Span or Messenger Attachment	1000.00	1,000.00
14	740	746939	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type I	9000.00	9,000.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	19,490.70

INTERSECTION # 2: N266 SR 72 & SR 71 PHASE 10

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST	TOTAL COST
						C	C
1	965	999481	1	EA	32' (9.8m) Steel Round Strain Pole	6785.00	6,785.00
2	1135	999515	2	EA	10' (3.0M) Steel Round Pedestal Pole	625.00	1,250.00
3	1175	999523	2	EA	Set of Four, Breakaway Couplings with one Hex Nut, Two Flat Washers and Two Shims Per Coupling	178.00	356.00
4	1180	999524	2	EA	Aluminum Skirt for Breakaway Couplings, 8" (203mm) B.C.	29.00	58.00
5	1195	999527	1	EA	Set of Four, 2' x 90" (51mm x 2286mm) Anchor Bolts with Two Hex Nuts and Two Flat Washers Per Bolt	978.00	978.00
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					TOTAL TRAFFIC SUPPLY ITEMS	→	9,427.00

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	19,490.70
TOTAL TRAFFIC SUPPLY ITEMS	→ →	9,427.00
CONTINGENCIES	→ →	2,891.77
TOTAL COST	→ →	31,809.47

			INTERSECTION # 3:		N266 SR 72 & SR 71 PHASE 11	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	C	C
1	260	745602	412	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)		
2	270	745604	672	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
3	320	744506	1	EA	Conduit Junction Well, Type 7, Precast Polymer Concrete		
4	355	744530	1	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame		
5	360	744531	1	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame		
6	610	746847	1	EA	Pole Base Type 3		
7	615	746850	2	EA	Pole Base Type 4		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 3: N266 SR 72 & SR 71 PHASE 11

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	565	746507	1	EA	Installation of Steel Pole (Less than 40')	700.00	700.00
2	600	746831	2	EA	Installation of Pedestal Pole	350.00	700.00
3	680	746935	2	EA	Furnish & Install 16" LED Countdown Pedestrian Signal	880.00	1,760.00
4	690	746937	2	EA	Furnish & Install Pedestrian Pushbutton with Sign	350.00	700.00
5	740	746939	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type I	9000.00	9,000.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	12,860.00

INTERSECTION # 3: N266 SR 72 & SR 71 PHASE 11

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
1	965	999481	1	EA	32' (9.8m) Steel Round Strain Pole	6785.00	6,785.00
2	1135	999515	2	EA	10' (3.0M) Steel Round Pedestal Pole	625.00	1,250.00
3	1175	999523	2	EA	Set of Four, Breakaway Couplings with one Hex Nut, Two Flat Washers and Two Shims Per Coupling	178.00	356.00
4	1180	999524	2	EA	Aluminum Skirt for Breakaway Couplings, 8" (203mm) B.C.	29.00	58.00
5	1195	999527	1	EA	Set of Four, 2' x 90" (51mm x 2286mm) Anchor Bolts with Two Hex Nuts and Two Flat Washers Per Bolt	978.00	978.00
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					TOTAL TRAFFIC SUPPLY ITEMS	→	9,427.00

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	12,860.00
TOTAL TRAFFIC SUPPLY ITEMS	→ →	9,427.00
CONTINGENCIES	→ →	2,228.70
TOTAL COST	→ →	24,515.70

INTERSECTION # 4: N266 SR 72 & SR 71 PHASE 12

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	20	747516	1	EA	Cabinet Base Type P		
2	270	745604	112	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
3	280	745606	100	LF	Furnish & Install up to 4" Galvanized Steel Conduit (Trench)		
4	355	744530	1	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame		
5	610	746847	1	EA	Pole Base Type 3		
6	615	746850	1	EA	Pole Base Type 4		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 4: N266 SR 72 & SR 71 PHASE 12

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST	TOTAL COST
						C	C
1	30	746906	950	LF	Furnish & Install 4-conductor #18 AWG Shielded Opticom Cable	6.00	5,700.00
2	70	746914	35	LF	Furnish & Install #6 Bare Stranded Copper ground	2.00	70.00
3	75	746915	100	LF	Furnish & Install #8/2 wire UF W/ground	6.00	600.00
4	95	746920	100	LF	Furnish & Install 14/4 Traffic Control Cable	5.00	500.00
5	105	746922	625	LF	Furnish & Install 14/16 Traffic Control Cable	8.75	5,468.75
6	300	745610	30	LF	Furnish & Install up to 4" Nonmetallic Pole Riser Shield	20.00	600.00
7	305	746925	1	EA	Furnish & Install Embedded Metered Service Pedestal (100 AMP)	3500.00	3,500.00
8	440	743003	2	EA-DY	Arrow Panels, Type C	40.00	80.00
9	455	743006	60	EA-DY	Plastic Drums	4.00	240.00
10	460	743007	5	HR	Traffic Officers	75.00	375.00
11	470	743010	2	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	370.00
12	480	743024	16	EA-DY	Temporary Warning Signs and Plaques	12.00	192.00
13	485	743050	5	HR	Flagger, New Castle County, State	52.90	264.50
14	565	746507	1	EA	Installation of Steel Pole (Less than 40')	700.00	700.00
15	600	746831	1	EA	Installation of Pedestal Pole	350.00	350.00
16	605	746832	1	EA	Furnish & Install Weatherhead, up to 3", on Steel Pole	200.00	200.00
17	670	746933	8	EA	Furnish & Install 12" LED Signal Head Section Span Mount	600.00	4,800.00
18	680	746935	1	EA	Furnish & Install 16" LED Countdown Pedestrian Signal	880.00	880.00
19	690	746937	1	EA	Furnish & Install Pedestrian Pushbutton with Sign	350.00	350.00
20	715	746504	750	LF	Furnish & Install Span Wires, 7/16"	25.00	18,750.00
21	740	746939	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type I	9000.00	9,000.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	52,990.25

INTERSECTION # 4: N266 SR 72 & SR 71 PHASE 12

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
1	855	999421	1	EA	Complete Cabinet w/12 Channel EPAC Controller(includes Mounting Rack w/Power Supply, 5-4 Channel Loop Amplifiers, Load Switches, Conflict Monitor)	11765.00	11,765.00
2	935	999461	1	EA	Optical Receiver Card (Emergency Preemption)	2751.00	2,751.00
3	965	999481		EA	32' (9.8m) Steel Round Strain Pole	6785.00	
4	1135	999515	1	EA	10' (3.0M) Steel Round Pedestal Pole	625.00	625.00
5	1175	999523	1	EA	Set of Four, Breakaway Couplings with one Hex Nut, Two Flat Washers and Two Shims Per Coupling	178.00	178.00
6	1180	999524	1	EA	Aluminum Skirt for Breakaway Couplings, 8" (203mm) B.C.	29.00	29.00
7	1195	999527	1	EA	Set of Four, 2' x 90" (51mm x 2286mm) Anchor Bolts with Two Hex Nuts and Two Flat Washers Per Bolt	978.00	978.00
8	1270	99600	4	EA	Span Bullring	40.00	160.00
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					TOTAL TRAFFIC SUPPLY ITEMS	→	16,486.00

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	52,990.25
TOTAL TRAFFIC SUPPLY ITEMS	→ →	16,486.00
CONTINGENCIES	→ →	6,947.63
TOTAL COST	→ →	76,423.88

INTERSECTION # 5: N266 SR 72 & SR 71 PHASE 13

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST	TOTAL COST
						C	C
1	355	744530	1	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame		
2	360	744531	1	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 5: N266 SR 72 & SR 71 PHASE 13

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	635	746763	2	EA	Realign or Slide Existing Signal Head	350.00	700.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	700.00

INTERSECTION # 5: N266 SR 72 & SR 71 PHASE 13

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
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TOTAL TRAFFIC SUPPLY ITEMS	→	

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	700.00
TOTAL TRAFFIC SUPPLY ITEMS	→ →	
CONTINGENCIES	→ →	70.00
TOTAL COST	→ →	770.00

INTERSECTION # 6: N266 SR 72 & SR 71 PHASE 14

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 6: N266 SR 72 & SR 71 PHASE 14

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	635	746763	4	EA	Realign or Slide Existing Signal Head	350.00	1,400.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	1,400.00

INTERSECTION # 6: N266 SR 72 & SR 71 PHASE 14

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
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					TOTAL TRAFFIC SUPPLY ITEMS	→	

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	1,400.00
TOTAL TRAFFIC SUPPLY ITEMS	→ →	
CONTINGENCIES	→ →	140.00
TOTAL COST	→ →	1,540.00

INTERSECTION # 7: N266 SR 72 & SR 71 ULTIMATE

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	110	746923	52	LF	Furnish & Install a 1" Flexible Non-Metallic Liquidtight Conduit Detector Sleeve with Loop Wire		
2	115	746924	1200	LF	Furnish & Install Loop Wire 1-conductor #14 AWG encased in ¼" Flexible Tubing in a Loop Sawcut		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 7: N266 SR 72 & SR 71 ULTIMATE

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	65	746913	4500	LF	Furnish & Install 2-Conductor #14 AWG Aluminum Shielded Cable	2.50	11,250.00
2	70	746914	950	LF	Furnish & Install #6 Bare Stranded Copper ground	2.00	1,900.00
3	95	746920	100	LF	Furnish & Install 14/4 Traffic Control Cable	5.00	500.00
4	100	746921	1600	LF	Furnish & Install 14/9 Traffic Control Cable	6.50	10,400.00
5	440	743003	4	EA-DY	Arrow Panels, Type C	40.00	160.00
6	455	743006	120	EA-DY	Plastic Drums	4.00	480.00
7	460	743007	20	HR	Traffic Officers	75.00	1,500.00
8	470	743010	4	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	740.00
9	480	743024	32	EA-DY	Temporary Warning Signs and Plaques	12.00	384.00
10	485	743050	20	HR	Flagger, New Castle County, State	52.90	1,058.00
11	640	746775	4	EA	Furnish & Install Opticom Emergency Preemption Detector	1050.00	4,200.00
12	695	746938	4	EA	Install Overhead Sign	400.00	1,600.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	34,172.00

INTERSECTION # 7: N266 SR 72 & SR 71 ULTIMATE

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
1	920	999457	1	EA	Fiber Interconnect Modem - Singlemode	1098.00	1,098.00
2	925	999458	1	EA	Patch Cables (One Per Cabinet)	240.00	240.00
3	935	999461	1	EA	Optical Receiver Card (Emergency Preemption)	2751.00	2,751.00
4	1275	999601	8	EA	Rouleau Sign Brackets (2 per average sign, 3 per longer sign)	115.00	920.00
5	1330	999612	1	EA	Camera (Includes Lowering Device, Controller, and Video Encoder)	11553.00	11,553.00
6	1335	999613	1	EA	Strain Pole Camera Mounting Adapter (Includes Cable Assembly)	741.00	741.00
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TOTAL TRAFFIC SUPPLY ITEMS	→	17,303.00

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	34,172.00
TOTAL TRAFFIC SUPPLY ITEMS	→ →	17,303.00
CONTINGENCIES	→ →	5,147.50
TOTAL COST	→ →	56,622.50

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 2

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	20	747516	1	EA	Cabinet Base Type P		
2	260	745602	50	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)		
3	270	745604	1546	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
4	280	745606	100	LF	Furnish & Install up to 4" Galvanized Steel Conduit (Trench)		
5	320	744506	1	EA	Conduit Junction Well, Type 7, Precast Polymer Concrete		
6	355	744530	2	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame		
7	360	744531	4	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame		
8	610	746847	4	EA	Pole Base Type 3		
9	615	746850	2	EA	Pole Base Type 4		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

				INTERSECTION # 8:	N720 SR 72 & WILSON BLVD PHASE 2	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	C	C
1	30	746906	675	LF	Furnish & Install 4-conductor #18 AWG Shielded Opticom Cable	6.00	4,050.00
2	70	746914	200	LF	Furnish & Install #6 Bare Stranded Copper ground	2.00	400.00
3	75	746915	150	LF	Furnish & Install #8/2 wire UF W/ground	6.00	900.00
4	95	746920	125	LF	Furnish & Install 14/4 Traffic Control Cable	5.00	625.00
5	100	746921	350	LF	Furnish & Install 14/9 Traffic Control Cable	6.50	2,275.00
6	105	746922	500	LF	Furnish & Install 14/16 Traffic Control Cable	8.75	4,375.00
7	300	745610	30	LF	Furnish & Install up to 4" Nonmetallic Pole Riser Shield	20.00	600.00
8	305	746925	1	EA	Furnish & Install Embedded Metered Service Pedestal (100 AMP)	3500.00	3,500.00
9	440	743003	4	EA-DY	Arrow Panels, Type C	40.00	160.00
10	455	743006	120	EA-DY	Plastic Drums	4.00	480.00
11	460	743007	20	HR	Traffic Officers	75.00	1,500.00
12	470	743010	4	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	740.00
13	480	743024	32	EA-DY	Temporary Warning Signs and Plaques	12.00	384.00
14	485	743050	20	HR	Flagger, New Castle County, State	52.90	1,058.00
15	565	746507	4	EA	Installation of Steel Pole (Less than 40')	700.00	2,800.00
16	600	746831	2	EA	Installation of Pedestal Pole	350.00	700.00
17	605	746832	1	EA	Furnish & Install Weatherhead, up to 3", on Steel Pole	200.00	200.00
18	670	746933	6	EA	Furnish & Install 12" LED Signal Head Section Span Mount	600.00	3,600.00
19	680	746935	2	EA	Furnish & Install 16" LED Countdown Pedestrian Signal	880.00	1,760.00
20	690	746937	2	EA	Furnish & Install Pedestrian Pushbutton with Sign	350.00	700.00
21	715	746504	465	LF	Furnish & Install Span Wires, 7/16"	25.00	11,625.00
22	745	746940	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type II	13000.00	13,000.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	55,432.00

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 2

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
1	855	999421	1	EA	Complete Cabinet w/12 Channel EPAC Controller(includes Mounting Rack w/Power Supply, 5-4 Channel Loop Amplifiers, Load Switches, Conflict Monitor)	11765.00	11,765.00
2	935	999461	1	EA	Optical Receiver Card (Emergency Preemption)	2751.00	2,751.00
3	965	999481	4	EA	32' (9.8m) Steel Round Strain Pole	6785.00	27,140.00
4	1135	999515	2	EA	10' (3.0M) Steel Round Pedestal Pole	625.00	1,250.00
5	1175	999523	2	EA	Set of Four, Breakaway Couplings with one Hex Nut, Two Flat Washers and Two Shims Per Coupling	178.00	356.00
6	1180	999524	2	EA	Aluminum Skirt for Breakaway Couplings, 8" (203mm) B.C.	29.00	58.00
7	1195	999527	4	EA	Set of Four, 2' x 90" (51mm x 2286mm) Anchor Bolts with Two Hex Nuts and Two Flat Washers Per Bolt	978.00	3,912.00
8	1270	99600	4	EA	Span Bullring	40.00	160.00
9	1370	999620		EA	Outside Plant-Fiber Optic Installation, Statewide	Price	
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					TOTAL TRAFFIC SUPPLY ITEMS	→	47,392.00

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	55,432.00
TOTAL TRAFFIC SUPPLY ITEMS	→ →	47,392.00
CONTINGENCIES	→ →	10,282.40
TOTAL COST	→ →	113,106.40

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 8

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	260	745602	150	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)		
2	270	745604	71	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
3	280	745606		LF	Furnish & Install up to 4" Galvanized Steel Conduit (Trench)		
4	355	744530	3	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame		
5	615	746850	2	EA	Pole Base Type 4		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 8

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	600	746831	2	EA	Installation of Pedestal Pole	350.00	700.00
2	70	746914	250	LF	Furnish & Install #6 Bare Stranded Copper ground	2.00	500.00
3	95	746920	30	LF	Furnish & Install 14/4 Traffic Control Cable	5.00	150.00
4	100	746921	550	LF	Furnish & Install 14/9 Traffic Control Cable	6.50	3,575.00
5	440	743003	2	EA-DY	Arrow Panels, Type C	40.00	80.00
6	455	743006	60	EA-DY	Plastic Drums	4.00	240.00
7	460	743007	5	HR	Traffic Officers	75.00	375.00
8	470	743010	2	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	370.00
9	480	743024	16	EA-DY	Temporary Warning Signs and Plaques	12.00	192.00
10	485	743050	5	HR	Flagger, New Castle County, State	52.90	264.50
11	635	746763	3	EA	Realign or Slide Existing Signal Head	350.00	1,050.00
12	670	746933	3	EA	Furnish & Install 12" LED Signal Head Section Span Mount	600.00	1,800.00
13	680	746935	3	EA	Furnish & Install 16" LED Countdown Pedestrian Signal	880.00	2,640.00
14	690	746937	3	EA	Furnish & Install Pedestrian Pushbutton with Sign	350.00	1,050.00
15	740	746939	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type I	9000.00	9,000.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	21,986.50

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 8

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
1	1135	999515	2	EA	10' (3.0M) Steel Round Pedestal Pole	625.00	1,250.00
2	1175	999523	2	EA	Set of Four, Breakaway Couplings with one Hex Nut, Two Flat Washers and Two Shims Per Coupling	178.00	356.00
3	1180	999524	2	EA	Aluminum Skirt for Breakaway Couplings, 8" (203mm) B.C.	29.00	58.00
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TOTAL TRAFFIC SUPPLY ITEMS	→	1,664.00
TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	21,986.50
TOTAL TRAFFIC SUPPLY ITEMS	→ →	1,664.00
CONTINGENCIES	→ →	2,365.05
TOTAL COST	→ →	26,015.55

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 9

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	355	744530	2	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame		
2	260	745602	36	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)		
3	270	745604	53	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 9

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	440	743003	2	EA-DY	Arrow Panels, Type C	40.00	80.00
2	455	743006	60	EA-DY	Plastic Drums	4.00	240.00
3	460	743007	5	HR	Traffic Officers	75.00	375.00
4	470	743010	2	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	370.00
5	480	743024	16	EA-DY	Temporary Warning Signs and Plaques	12.00	192.00
6	485	743050	5	HR	Flagger, New Castle County, State	52.90	264.50
7	635	746763	2	EA	Realign or Slide Existing Signal Head	350.00	700.00
8	670	746933	2	EA	Furnish & Install 12" LED Signal Head Section Span Mount	600.00	1,200.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	3,421.50

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 9

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST	TOTAL COST
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					TOTAL TRAFFIC SUPPLY ITEMS	→	

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	3,421.50
TOTAL TRAFFIC SUPPLY ITEMS	→ →	
CONTINGENCIES	→ →	342.15
TOTAL COST	→ →	3,763.65

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 12

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 12

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	635	746763	4	EA	Realign or Slide Existing Signal Head	350.00	1,400.00
2	440	743003	2	EA-DY	Arrow Panels, Type C	40.00	80.00
3	455	743006	60	EA-DY	Plastic Drums	4.00	240.00
4	460	743007	5	HR	Traffic Officers	75.00	375.00
5	470	743010	2	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	370.00
6	480	743024	16	EA-DY	Temporary Warning Signs and Plaques	12.00	192.00
7	485	743050	5	HR	Flagger, New Castle County, State	52.90	264.50
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	2,921.50

INTERSECTION # 8: N720 SR 72 & WILSON BLVD PHASE 12

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
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					TOTAL TRAFFIC SUPPLY ITEMS →		

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	2,921.50
TOTAL TRAFFIC SUPPLY ITEMS	→ →	
CONTINGENCIES	→ →	292.15
TOTAL COST	→ →	3,213.65

INTERSECTION # 8: N720 SR 72 & WILSON BLVD ULTIMATE

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	110	746923	38	LF	Furnish & Install a 1" Flexible Non-Metallic Liquidtight Conduit Detector Sleeve with Loop Wire		
2	115	746924	800	LF	Furnish & Install Loop Wire 1-conductor #14 AWG encased in ¼" Flexible Tubing in a Loop Sawcut		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 8: N720 SR 72 & WILSON BLVD ULTIMATE

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	65	746913	2700	LF	Furnish & Install 2-Conductor #14 AWG Aluminum Shielded Cable	2.50	6,750.00
2	440	743003	2	EA-DY	Arrow Panels, Type C	40.00	80.00
3	455	743006	60	EA-DY	Plastic Drums	4.00	240.00
4	460	743007	5	HR	Traffic Officers	75.00	375.00
5	470	743010	2	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	370.00
6	480	743024	16	EA-DY	Temporary Warning Signs and Plaques	12.00	192.00
7	485	743050	5	HR	Flagger, New Castle County, State	52.90	264.50
8	635	746763	2	EA	Realign or Slide Existing Signal Head	350.00	700.00
9	670	746933	1	EA	Furnish & Install 12" LED Signal Head Section Span Mount	600.00	600.00
10	695	746938	4	EA	Install Overhead Sign	400.00	1,600.00
11	740	746939	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type I	9000.00	9,000.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	20,171.50

INTERSECTION # 8: N720 SR 72 & WILSON BLVD ULTIMATE

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST	TOTAL COST
						C	C
1	920	999457	1	EA	Fiber Interconnect Modem - Singlemode	1098.00	1,098.00
2	925	999458	1	EA	Patch Cables (One Per Cabinet)	240.00	240.00
3	1275	999601	8	EA	Rouleau Sign Brackets (2 per average sign, 3 per longer sign)	115.00	920.00
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TOTAL TRAFFIC SUPPLY ITEMS	→	2,258.00

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	20,171.50
TOTAL TRAFFIC SUPPLY ITEMS	→ →	2,258.00
CONTINGENCIES	→ →	2,242.95
TOTAL COST	→ →	24,672.45

INTERSECTION # 8: N720 SR 72 & SR 1 SB OFF RAMP

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1					PHASE 9		
2	270	745604	344	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
3	360	744531	2	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame		
4							
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8					ULTIMATE		
9	115	746924	100	LF	Furnish & Install Loop Wire 1-conductor #14 AWG encased in ¼" Flexible Tubing in a Loop Sawcut		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

INTERSECTION # 8: N720 SR 72 & SR 1 SB OFF RAMP

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	UNIT COST C	TOTAL COST C
1	65	746913		LF	Furnish & Install 2-Conductor #14 AWG Aluminum Shielded Cable	2.50	
2	440	743003	2	EA-DY	Arrow Panels, Type C	40.00	80.00
3	455	743006	60	EA-DY	Plastic Drums	4.00	240.00
4	460	743007	2	HR	Traffic Officers	75.00	150.00
5	470	743010	1	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	185.00	185.00
6	480	743024	16	EA-DY	Temporary Warning Signs and Plaques	12.00	192.00
7	485	743050	2	HR	Flagger, New Castle County, State	52.90	105.80
8	740	746939	1	EA	Traffic Control Device Equipment Turn on, Pick up, Removal & Maintenance, Type I	9000.00	9,000.00
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					TOTAL TRAFFIC CONTRACTOR ITEMS	→	9,952.80

INTERSECTION # 8: N720 SR 72 & SR 1 SB OFF RAMP

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST C	TOTAL COST C
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					TOTAL TRAFFIC SUPPLY ITEMS	→	

TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	9,952.80
TOTAL TRAFFIC SUPPLY ITEMS	→ →	
CONTINGENCIES	→ →	995.28
TOTAL COST	→ →	10,948.08

MULTIPLE INTERSECTION SUMMARY

Intersection #1:	N266 SR 72 & SR 71 PHASE 7			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	11,280.00
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	8,595.00
		CONTINGENCIES	→ →	1,987.50
Intersection #2:	N266 SR 72 & SR 71 PHASE 10			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	19,490.70
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	9,427.00
		CONTINGENCIES	→ →	2,891.77
Intersection #3:	N266 SR 72 & SR 71 PHASE 11			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	12,860.00
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	9,427.00
		CONTINGENCIES	→ →	2,228.70
Intersection #4:	N266 SR 72 & SR 71 PHASE 12			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	52,990.25
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	16,486.00
		CONTINGENCIES	→ →	6,947.63
Intersection #5:	N266 SR 72 & SR 71 PHASE 13			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	700.00
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	
		CONTINGENCIES	→ →	70.00
Intersection #6:	N266 SR 72 & SR 71 PHASE 14			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	1,400.00
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	
		CONTINGENCIES	→ →	140.00
Intersection #7:	N266 SR 72 & SR 71 ULTIMATE			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	34,172.00
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	17,303.00
		CONTINGENCIES	→ →	5,147.50
Intersection #8:	N720 SR 72 & WILSON BLVD PHASE 2			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	55,432.00
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	47,392.00
		CONTINGENCIES	→ →	10,282.40
Intersection #9:	N720 SR 72 & WILSON BLVD PHASE 8			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	21,986.50
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	1,664.00
		CONTINGENCIES	→ →	2,365.05
Intersection #10:	N720 SR 72 & WILSON BLVD PHASE 9			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	3,421.50
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	
		CONTINGENCIES	→ →	342.15
Intersection #11:	N720 SR 72 & WILSON BLVD PHASE 12			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	2,921.50
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	
		CONTINGENCIES	→ →	292.15
Intersection #12:	N720 SR 72 & WILSON BLVD ULTIMATE			
		TOTAL PROJECT CONTRACTOR ITEMS	→ →	
		TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	20,171.50
		TOTAL TRAFFIC SUPPLY ITEMS	→ →	2,258.00
		CONTINGENCIES	→ →	2,242.95
		TOTAL	→ →	384,315.75

J:\Signal Design Manual\Appendix\[2013 Version 1.2 Traffic Project Spreadsheet.xlsx]Signals

DELAWARE DEPARTMENT OF TRANSPORTATION

TRAFFIC SIGNAL ESTIMATE

SR 8, Forrest Avenue Pedestrian Impovements, Cranberry Run Dr. to Marsh Creek Lane

CONTRACT #:	T201401201
F.A.P. #:	N/A
PROJECT:	SR 8, Forrest Avenue Pedestrian Impovements, Cranberry Run Dr. to Marsh Creek Lane

INTERSECTION # 1: SR 8 @ Heatherfield Way - Hawk Signal (K312)

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (PROJECT CONTRACTOR ITEMS)	UNIT COST	TOTAL COST
						A	A
1	20	747516	1	EA	Cabinet Base Type P		
2	260	745602	250	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)		
3	270	745604	200	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)		
4	280	745606	100	LF	Furnish & Install up to 4" Galvanized Steel Conduit (Trench)		
5	355	744530	4	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame		
6	360	744531	1	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame		
7	610	746847	2	EA	Pole Base Type 3		
8	615	746850	3	EA	Pole Base Type 4		
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					TOTAL PROJECT CONTRACTOR ITEMS	→	

			INTERSECTION # 1:		SR 8 @ Heatherfield Way - Hawk Signal (K312)	UNIT COST	TOTAL COST
LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC CONTRACTOR ITEMS)	A	A
1	20	747516	1	EA	Cabinet Base Type P	2800.00	2,800.00
2	30	746906	300	LF	Furnish & Install 4-conductor #18 AWG Shielded Opticom Cable	2.00	600.00
3	70	746914	700	LF	Furnish & Install #6 Bare Stranded Copper ground	1.60	1,120.00
4	75	746915	100	LF	Furnish & Install #8/2 wire UF W/ground	3.00	300.00
5	100	746921	500	LF	Furnish & Install 14/9 Traffic Control Cable	3.25	1,625.00
6	110	746923	500	LF	Furnish & Install 14/5 Traffic Control Cable	3.15	1,575.00
7	210	705002	50	SF	Portland Cement Concrete Sidewalk, 6”	21.00	1,050.00
8	215	705007	10	SF	Sidewalk Surface Detectable Warning System	50.00	500.00
9	260	745602	250	LF	Furnish & Install up to 4" Schedule 80 HDPE Conduit (Bore)	35.00	8,750.00
10	270	745604	200	LF	Furnish & Install up to 4" Schedule 80 PVC Conduit (Trench)	17.00	3,400.00
11	280	745606	100	LF	Furnish & Install up to 4" Galvanized Steel Conduit (Trench)	30.00	3,000.00
12	305	746925	1	EA	Furnish & Install Embedded Metered Service Pedestal (100 AMP)	2200.00	2,200.00
13	355	744530	4	EA	Conduit Junction Well, Type 11, Precast Concrete/ Polymer Lid-Frame	1800.00	7,200.00
14	360	744531	1	EA	Conduit Junction Well, Type 14, Precast Concrete/ Polymer Lid-Frame	1400.00	1,400.00
15	440	743003	20	EA-DY	Arrow Panels, Type C	150.00	3,000.00
16	445	743004	20	EA-DY	Furnish & Maintain Portable Changeable Message Board	125.00	2,500.00
17	455	743006	600	EA-DY	Plastic Drums	7.00	4,200.00
18	470	743010	20	EA-DY	Furnish & Maintain Truck Mounted Attenuator, Type II	500.00	10,000.00
19	475	743023	160	LF-DY	Temporary Barricades, Type III	10.00	1,600.00
20	480	743024	160	EA-DY	Temporary Warning Signs and Plaques	30.00	4,800.00
21	490	743051	60	HR	Flagger, Kent County, State	46.66	2,799.60
22	600	746831	2	EA	Installation of Pedestal Pole	200.00	400.00
23	610	746847	2	EA	Pole Base Type 3	2600.00	5,200.00
24	615	746850	3	EA	Pole Base Type 4	900.00	2,700.00
25	625	746928	2	EA	Installation of Steel Mast Arm Pole with single or Twin Mast arms up to 70’	3000.00	6,000.00
26	640	746775	2	EA	Furnish & Install Opticom Emergency Preemption Detector	1000.00	2,000.00
27	665	746932	18	EA	Furnish & Install 12” LED Signal Head Section Rigid Mount	355.00	6,390.00
28	690	746937	2	EA	Furnish & Install Pedestrian Pushbutton with Sign	175.00	350.00
29	695	746938	4	EA	Install Overhead Sign	250.00	1,000.00
30	755	748015	450	SF	Permanent Pavement Striping, Symbol/Legend Alkyd-Thermoplastic	5.00	2,250.00
31	770	748027	230	LF	Permanent Pavement Striping, Alkyd-Thermoplastic, 12"	20.00	4,600.00
32							
33							
34							
35							
					TOTAL TRAFFIC CONTRACTOR ITEMS	→	95,309.60

INTERSECTION # 1: SR 8 @ Heatherfield Way - Hawk Signal (K312)

LINE	#	ITEM #	QTY	UOM	DESCRIPTION - (TRAFFIC SUPPLY ITEMS)	UNIT COST A	TOTAL COST A
1	855	999421	1	EA	Complete Cabinet w/12 Channel EPAC Controller(includes Mounting Rack w/Power Supply, 5-4 Cha	11765.00	11,765.00
2	935	999461	1	EA	Optical Receiver Card (Emergency Preemption)	2751.00	2,751.00
3	1005	999489	2	EA	Steel Round Mast Arm Pole, TYPE B (45' - 60' Arm Length or 2-60' Arms)	8479.00	16,958.00
4	1050	999498	1	EA	45' (13.7m) Steel Round Mast Arm	7472.00	7,472.00
5	1060	999500	1	EA	55' (16.8m) Steel Round Mast Arm	8309.00	8,309.00
6	1135	999515	3	EA	10' (3.0M) Steel Round Pedestal Pole	625.00	1,875.00
7	1175	999523	3	EA	Set of Four, Breakaway Couplings with one Hex Nut, Two Flat Washers and Two Shims Per Coupling	178.00	534.00
8	1180	999524	3	EA	Aluminum Skirt for Breakaway Couplings, 8" (203mm) B.C.	29.00	87.00
9	1185	999525	2	EA	Aluminum Skirt for Breakaway Couplings, 12" (305mm) B.C.	29.00	58.00
10	1195	999527	2	EA	Set of Four, 2' x 90" (51mm x 2286mm) Anchor Bolts with Two Hex Nuts and Two Flat Washers Per I	978.00	1,956.00
11							
12			1	EA	Clearing and Grubbing (Lump Sum)	5000.00	5,000.00
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TOTAL TRAFFIC SUPPLY ITEMS	→	56,765.00
TOTAL PROJECT CONTRACTOR ITEMS	→ →	
TOTAL TRAFFIC CONTRACTOR ITEMS	→ →	95,309.60
TOTAL TRAFFIC SUPPLY ITEMS	→ →	56,765.00
CONTINGENCIES	→ →	15,207.46
TOTAL COST	→ →	167,282.06

MULTIPLE INTERSECTION SUMMARY

Intersection #1: SR 8 @ Heatherfield Way - Hawk Signal (K312)

TOTAL PROJECT CONTRACTOR ITEMS	→	→	
TOTAL TRAFFIC CONTRACTOR ITEMS	→	→	95,309.60
TOTAL TRAFFIC SUPPLY ITEMS	→	→	56,765.00
CONTINGENCIES	→	→	15,207.46
TOTAL	→	→	167,282.06

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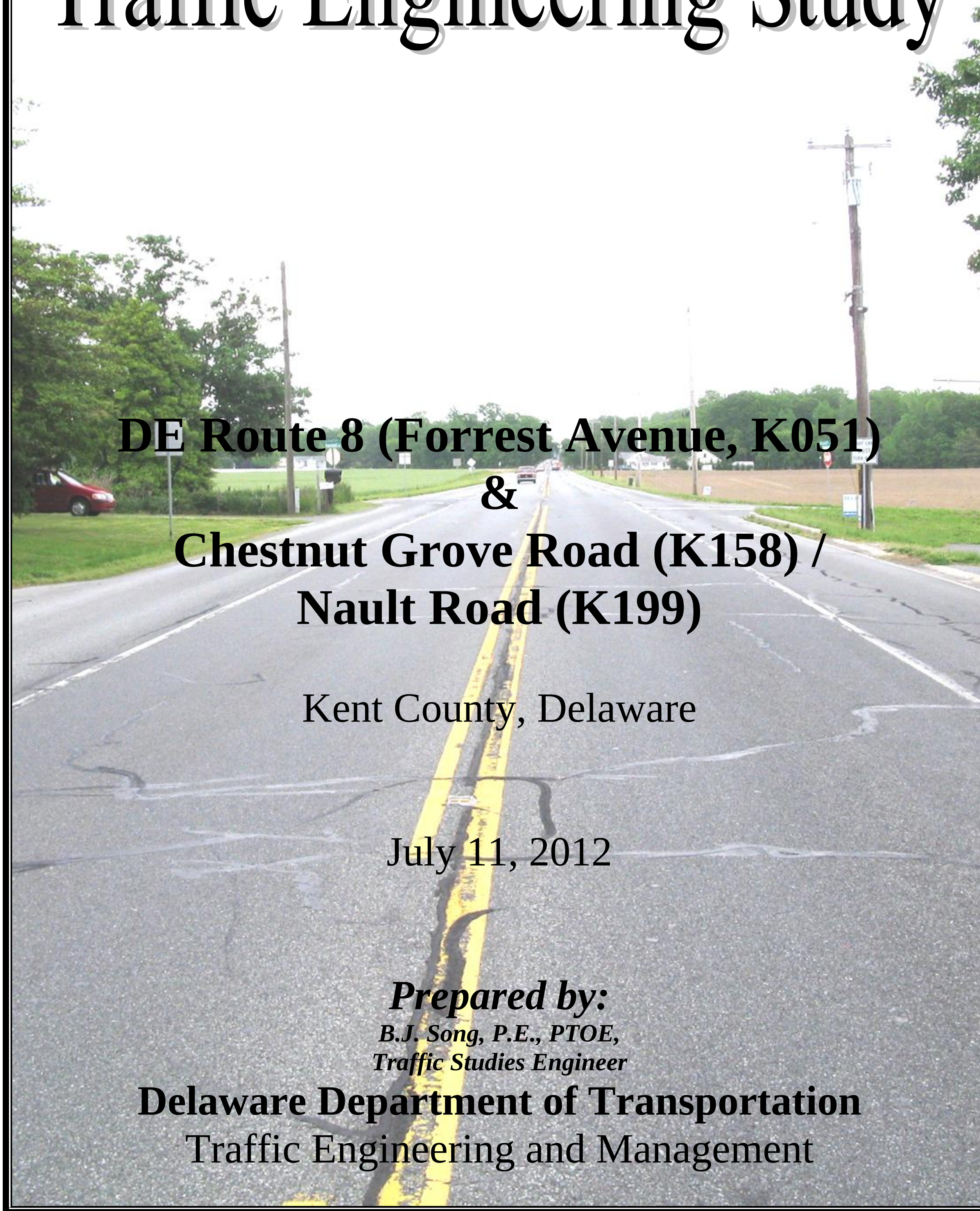
APPENDIX G

Sample Signal Study

Traffic Engineering Study



DE Route 8 (Forrest Avenue, K051)
&
Chestnut Grove Road (K158) /
Nault Road (K199)

Kent County, Delaware

July 11, 2012

Prepared by:

B.J. Song, P.E., PTOE,

Traffic Studies Engineer

Delaware Department of Transportation

Traffic Engineering and Management

EXECUTIVE SUMMARY

The Delaware Department of Transportation (DelDOT) has received a request to evaluate the intersection of DE Route 8 (Forrest Avenue, S051) and Chestnut Grove Road (K158) / Nault Road (K199), located west of the City of Dover in Kent County, Delaware. Senator David G. Lawson of Delaware Legislative District 15 forwarded concerns for safety at the intersection from his constituents. More specifically, he requested DelDOT to review the feasibility of installing a traffic signal at the intersection.

Accordingly, the purpose of this traffic engineering study is to evaluate safety and traffic operations at the above-mentioned intersection and determine the feasibility of installing a traffic signal, as well as any other roadway, signing and/or traffic control device improvements at this location. This study includes a 12-hour turning movement count, a site condition diagram with photographs; and evaluations of intersection sight distance, review of traffic control devices, intersection capacity, crash history and traffic signal warrant analysis. .

The significant findings of this traffic engineering study at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road are:

Intersection sight distance: From the Chestnut Grove Road approach and the Nault Road approach, the measured available intersection sight distance for vehicles looking left and right are greater than the distance recommended by AASHTO. The available intersection sight distances for vehicles turning left from the major street were also found to be greater than the minimums that are recommended by AASHTO.

Existing traffic volumes: The traffic count that was conducted for this study showed that the AM, Midday and PM peak hours of travel are 7:15 AM – 8:15 AM, 11:00 AM – 12:00 PM and 4:30 PM to 5:30 PM, respectively. The directional split of traffic indicates that the majority of traffic is traveling eastbound during the AM peak hour and evenly split during the Midday and PM peak hours on DE Route 8.

Existing intersection capacity: The results show that there are no delays (LOS A) for traffic turning left from both eastbound and westbound DE Route 8 during all three peak periods. The results also show that traffic approaching the intersection from the Nault Road approach operate with moderate delay (LOS C) during the Midday Peak period and heavy delay (LOS D & E) during the AM and the PM peak periods. The results also show that traffic approaching the intersection from the Chestnut Grove Road approach operate with minimal delay (LOS B) during the AM and the Midday peak periods and heavy delay (LOS D) during the PM peak period.

Speed Study Findings: The combined 85th percentile speed for both eastbound and westbound DE Route 8 was found to be 57 MPH for radar location 1, which indicates 85 percent of traffic is traveling at or below 57 MPH at location 1. Also, the combined 85th percentile speed for both eastbound and westbound DE Route 8 was found to be 56 MPH for radar location 2, which indicates 85 percent of traffic is traveling at or below 56 MPH at location 2. In addition, the data revealed that 68 percent of vehicles were traveling at speeds greater than the existing speed limit and 28 percent of vehicles were traveling at speeds 5 MPH or greater than the existing speed limit at radar location 1. Similarly, the data also revealed that 51 percent of vehicles were traveling at speeds greater than the existing speed limit and 20 percent of vehicles were traveling at speeds 5 MPH or greater than the existing speed limit at radar location 2.

Crash trend analysis: Crash data was obtained for this intersection covering the period from October 2008 to September 2011. The data showed that there were eleven (11) reported crashes occurring at this intersection. From January 2011 to December 2011, there were five (5) crashes that are susceptible to correction by the installation of a traffic signal.

Improvement Options:

- Based on the results of the traffic signal warrant analysis, a traffic signal is **warranted** at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.
- Based on observations of traffic operations at the intersection, upgrading the existing painted right-turn channelization islands to raised concrete islands should eliminate crashes involving vehicles using the right-turn lanes to pass stopped left-turning vehicles on DE Route 8.
- Field investigations revealed that the land use in the vicinity of the study intersection is predominantly residential. Installing rumble strips near a residential area could have a significant negative impact on the quality of life for nearby residents. Therefore, the installation of painted rumble strips is **not feasible** near the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.

Based on the results of the traffic observations, data and analysis contained within this report, DelDOT presents the following improvement options to be considered for this location:

Option 1: *Install a traffic signal at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.*

<u>Expected Benefits:</u>

- Installing a traffic signal should reduce excessive delay experienced by vehicles approaching the intersection from the Chestnut Grove Road / Nault Road approaches.
- Installing a traffic signal should reduce the number of angle crashes and left-turn crashes at the intersection.
- Lane configuration change needed for the traffic signal installation should eliminate the crashes involving vehicles using the right-turn lanes to pass stopped left-turning vehicles on DE Route 8.

<u>Possible Disadvantages:</u>

- Increased delays to motorists on DE Route 8.
- Cost of operating and maintaining the traffic signal.
- Cost of possible additional land acquisition.
- Possible increase in number of rear-end crashes on DE Route 8.

Option 2: *Upgrade existing painted right-turn channelization islands on DE Route 8 to raised concrete right-turn channelization islands.*

<u>Expected Benefits:</u>

- Implementing raised concrete right-turn channelization islands should prohibit through vehicles on DE Route 8 from using the right-turn lanes to pass stopped left-turning vehicles.
- The provision of the raised right-turn channelization islands should eliminate angle crashes and left-turn crashes involving vehicles traveling through the intersection using the right-turn lanes.

<u>Possible Disadvantages:</u>

- Increased delays to motorists on DE Route 8.
- Cost of installing and maintaining the raised concrete channelization islands.

It should be noted that separate left-turn lanes will be added to the DE Route 8 approaches when the traffic signal is installed and right-turn channelization islands on DE Route 8 must be relocated. This means the proposed raised concrete right-turn channelization islands must be relocated at the time of the traffic signal installation; however, DelDOT recommends the raised concrete right-turn channelization islands to be installed as an interim improvement before the traffic signal installation since the traffic signal installation will likely be a possible FY 2014 or FY2015 project.

DelDOT also considered installing Rumble Strips on the Chestnut Grove Road / Nault Road approaches. Field observations revealed that the land use in the vicinity of the study intersection is predominantly residential. Installing rumble strips near a residential area could have a significant negative impact on the quality of life for nearby residents. Therefore, DelDOT **does not recommend** installation of rumble strips at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.

Based on the results from the radar study, it appears that many motorists traveling on DE Route 8 are not complying with the existing speed limit of 50 MPH. Lowering the speed limit on DE Route 8 is not advisable since the majority of motorists are currently not obeying the existing speed limit. In order for a lower speed limit to be warranted, the 85th percentile speed should be lower than the existing posted speed limit and there should be roadside features or other factors that cause motorists to select lower speed. The only effective measure that can reduce the travel speeds of motorists is police enforcement. Police enforcement can influence lower travel speeds on a roadway for a short period of time; however, the resulting lower travel speed could increase when the police enforcement is discontinued. This is due to drivers being accustomed to driving at the speed at which they feel safe and are comfortable. Therefore, it is recommended that the existing speed limit of 50 MPH remain in effect on DE Route 8. In addition, DelDOT also recommends additional speed enforcements to be conducted by the Delaware State Police (DSP) on DE Route 8 at the locations where the safety of the police officers conducting the speed enforcement will not be compromised.

Field observations conducted at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road have identified the need for minor traffic control device improvements. The proposed improvements are listed below:

- Remove existing Stop Ahead sign (W3-1) on southbound Chestnut Grove Road, located north of DE Route 8.
- Install new Stop Ahead sign (W3-1) and an Advance Street Name plaque (W16-8a-DE) for Forrest Avenue on southbound Chestnut Grove Road, approximately 250 feet north of DE Route 8.
- Remove existing Watch Children sign (W21-11-DE) and Advisory Speed 30 MPH sign (W13-1-30) on southbound Nault Road, located immediately south of DE Route 8.
- Remove existing Stop Ahead sign (W3-1) on northbound Nault Road, located south of DE Route 8.
- Install Stop Ahead sign (W3-1) and an Advance Street Name plaque (W16-8a-DE) for Forrest Avenue on northbound Nault Road, approximately 250 feet south of DE Route 8.

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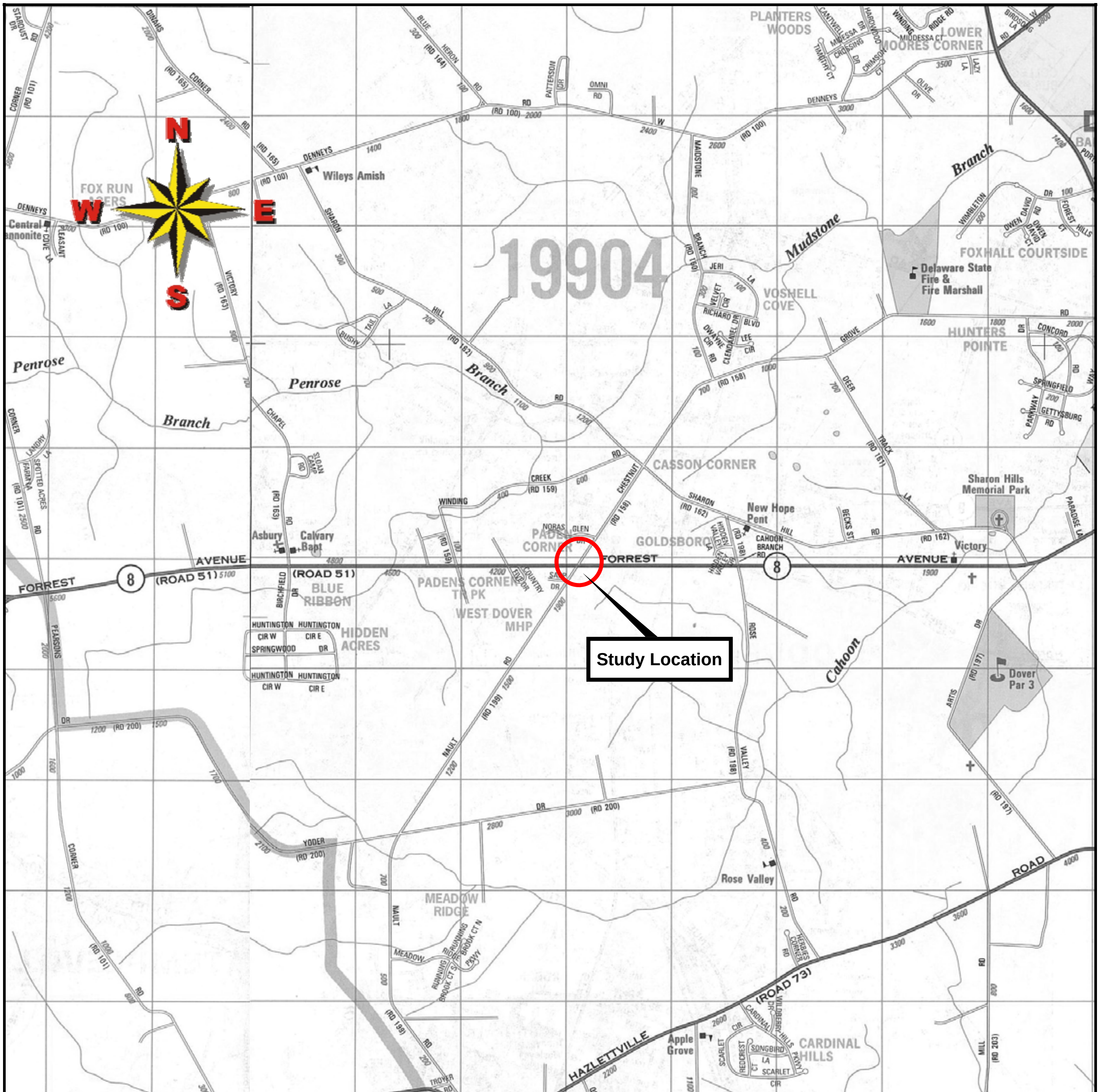
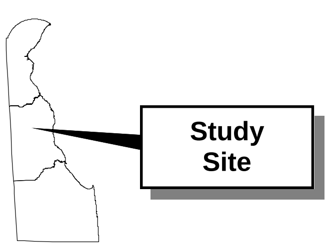




Study Area Map		
DE Route 8 (K051, Forrest Avenue) @ Chestnut Grove Road (K158) / Nault Road (K199)		
DelDOT Traffic	May 2012	Figure 1

I. Introduction

The Delaware Department of Transportation (DelDOT) has received a request to evaluate the intersection of DE Route 8 (Forrest Avenue, S051) and Chestnut Grove Road (K158) / Nault Road (K199), located west of the City of Dover in Kent County, Delaware. Senator David G. Lawson of Delaware Legislative District 15 forwarded concerns for safety at the intersection from his constituents. More specifically, he requested DelDOT to review the feasibility of installing a traffic signal at the intersection.

Accordingly, the purpose of this traffic engineering study is to evaluate safety and traffic operations at the above-mentioned intersection and determine the feasibility of installing a traffic signal, as well as any other roadway, signing and/or traffic control device improvements at this location. This study includes a 12-hour turning movement count, a site condition diagram with photographs; and evaluations of intersection sight distance, review of traffic control devices, intersection capacity, crash history and traffic signal warrant analysis.

All references to the American Association of State Highway and Transportation Officials (AASHTO) pertain to the 2011 edition of A Policy on Geometric Design of Highways and Streets. All references to the Delaware Manual on Uniform Traffic Control Devices (DEMUTCD) and to the Highway Capacity Manual (HCM) refer to the Year 2011 and the Year 2010 editions, respectively.

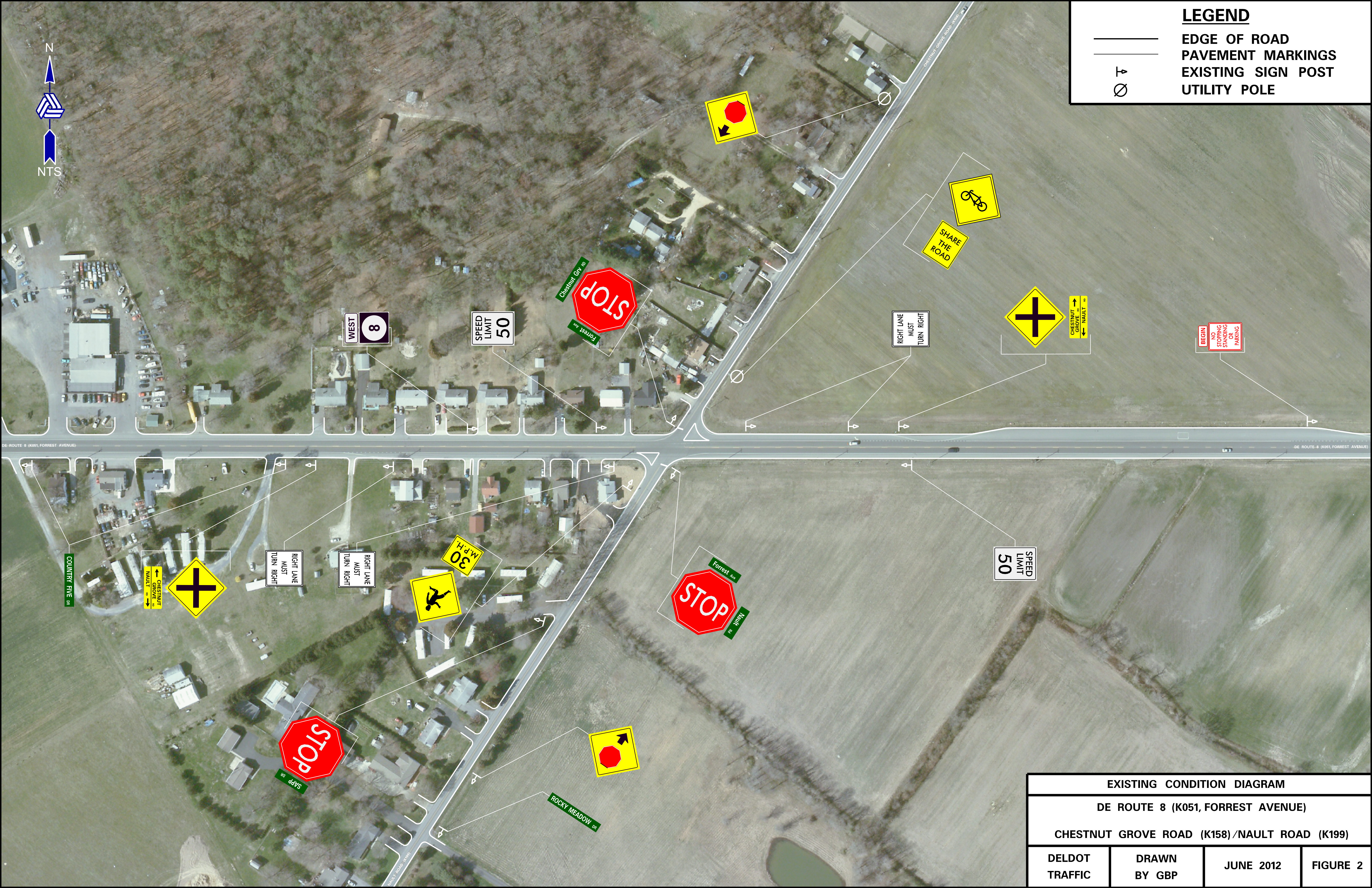
II. Previous Studies

Research of DelDOT archive revealed that the intersection of DE Route 8 and Chestnut Grove Road / Nault Road was previously studied in August 2006 and April 2009 for the consideration of a traffic signal. A traffic signal was not warranted based on the findings of both studies.

III. Roadway and Site Characteristics

The intersection of DE Route 8 and Chestnut Gove Road / Nault Road is located west of the City of Dover in Kent County (see Figure 1). DE Route 8 serves as the major roadway at the study intersection and the study segment of DE Route 8 is classified as a minor arterial according to DelDOT's 2005 Functional Classification Map for Kent County. According to DelDOT's Traffic Summary 2011, DE Route 8 has a 2011 Annual Average Daily Traffic (AADT) volume of 11,556 vehicles per day (vpd). DE Route 8 is a two-way roadway consisting of one lane in both the eastbound and westbound direction. DE Route 8 serves as one of the major east to west connectors in central Delaware connecting to the Delaware – Maryland state line to the west and to DE Route 9 (Bayside Drive, K017) to the east. DE Route 8 provides access to residential properties and agricultural properties in the vicinity of the study intersection. There are no separate left-turn lanes present on both the eastbound and the westbound DE Route 8; however, there are separate right-turn lanes present on both the eastbound and the westbound DE Route 8. The existing storage length for right-turn lanes are 500 feet and 350 feet for the eastbound and the westbound approach, respectively. A detailed sketch of the study intersection including lane widths, pavement markings and existing signing is shown in Figure 2.

Chestnut Grove Road / Nault Road serves as the minor roadway at the study intersection with Chestnut Grove Road referring to the portion of the roadway north of the DE Route 8 intersection and Nault Road referring to the portion of the roadway south of the DE Route 8 intersection. Both Chestnut Grove Road and Nault Road consist of one lane in both the northbound and southbound directions. The study segment of Chestnut Grove Road / Nault Road is classified as a local roadway according to DelDOT's 2005 Functional Classification Map for Kent County. According to DelDOT's Traffic Summary 2011, Chestnut Grove Road has AADT volume of 3,451 vehicles per day and Nault Road has AADT volume of 851 vehicles per day. Both Chestnut Grove Road / Nault Road provide access to residential and agricultural properties



EXISTING CONDITION DIAGRAM

DE ROUTE 8 (K051, FORREST AVENUE)

CHESTNUT GROVE ROAD (K158)/NAULT ROAD (K199)

DELDOT TRAFFIC	DRAWN BY GBP	JUNE 2012	FIGURE 2

in the vicinity of the study intersection. There are no dedicated turning lanes present on the Chestnut Grove Road / Nault Road approaches.

- **Horizontal and Vertical Alignment**

The intersection of DE Route 8 and Chestnut Grove Road / Nault Road is located within a level terrain. The following geometric features were observed during the field study:

- There are no visible horizontal or vertical curves present on DE Route 8 in the vicinity of the study intersection.

- There are no visible horizontal curves present on Chestnut Grove Road / Nault Road; however, Chestnut Grove Road and Nault Road form a smooth vertical crest curve though the DE Route 8 intersection.

- Skew between DE Route 8 and Chestnut Grove Road / Nault Road is approximately 56 degrees.

- **Sidewalks and Shoulders**

There are 11 feet wide shoulder lanes present on eastbound and westbound DE Route 8. It should be noted that the shoulder lanes become right-turn lanes near the Chestnut Grove Road / Nault Road intersection. There are no shoulder lanes present on Chestnut Grove Road / Nault Road in the study area.

There are no sidewalks present on DE Route 8 or Chestnut Grove Road / Nault Road in the vicinity of the study intersection.

- **Signing and Pavement Markings**

The existing signing and pavement markings present on DE Route 8 and Chestnut Grove Road / Nault Road appear to be in compliance to the standards mandated by the DEMUTCD, however, the following observations were noted during the field investigation:

- Double yellow centerline markings, edge line marking and shoulder lane marking present on DE Route 8 appear to be worn out.

- There was no Advance Street Name plaque (W16-8a-DE) for Forrest Avenue (DE Route 8) present underneath the existing STOP Ahead signs on the Chestnut Grove Road / Nault Road approaches.

- There are painted right-turn channelization islands present on both the eastbound and the westbound DE Route 8.

- **Roadway Lighting**

There is no roadway or pedestrian lighting present along DE Route 8 or Chestnut Grove Road / Nault Road adjacent to the travel lane in the vicinity of the study intersection.

- **Adjacent Land Use**

The adjacent land use surrounding the intersection of DE Route 8 and Chestnut Grove Road / Nault Road predominantly consists of residential and agricultural. The northwest and southwest quadrants of the intersection appear to be used for residential purposes and the northeast and southeast quadrants of the intersection appears to be used for agricultural purposes. It should be noted that there is a new commercial building in the southwest quadrant; however the building appears to be vacant.

- **Sight Distance**

The available intersection sight distances were measured for the turning movements from the Chestnut Grove Road approach and the Nault Road approach onto DE Route 8. AASHTO recommends intersection sight distances that are a function of the design and/or operating speed of the major roadway. Table 1 includes the recommended minimum intersection sight distances for each movement calculated using the existing speed limit along DE Route 8 (50 MPH).

Table 1

Intersection Sight Distance Evaluation

		Measured Available ISD (feet)	AASHTO (2004) Recommended ISD (feet)
Northbound Nault Road	**Left-turn from Minor Road (AASHTO Case B1)**	> 1,000' (Looking Left) > 855' (Looking Right)	555' (50 mph Existing Speed Limit)
	Right-turn/Cross from Minor Road (AASHTO Cases B2 & B3)	> 1,000' (Looking Left) > 855' (Looking Right)	480' (50 mph Existing Speed Limit)
Southbound Chestnut Grove Road	**Left-turn from Minor Road (AASHTO Case B1)**	> 590' (Looking Left) > 1,000' (Looking Right)	555' (50 mph Existing Speed Limit)
	Right-turn/Cross from Minor Road (AASHTO Cases B2 & B3)	> 590' (Looking Left) > 1,000’ (Looking Right)	480' (50 mph Existing Speed Limit)
Westbound DE Route 8	**Left-turn from Major Road (AASHTO Case F)**	> 1,000'	405' (50 mph Existing Speed Limit)
Eastbound DE Route 8	**Left-turn from Major Road (AASHTO Case F)**	> 1,000'	405' (50 mph Existing Speed Limit)

From the Chestnut Grove Road approach and the Nault Road approach, the measured available intersection sight distance for vehicles looking left and right are greater than the distance recommended by AASHTO.

AASHTO also provides recommended intersection sight distances for vehicles turning left from the major street. The available intersection sight distances for this case were also measured in the field and were found to be greater than the minimums that are recommended by AASHTO (see Table 1).

IV. Traffic Characteristics

- **Traffic Volumes**

An 8-hour turning movement count covering the AM, Midday and PM peak periods was performed at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road on Wednesday, May 2, 2012 and Thursday, May 3, 2012. Then a supplemental turning movement count covering the non-peak periods was performed on Wednesday May 23, 2012 and Tuesday, May 29, 2012 to complete a 12-hour count for the study intersection. The AM, Midday and PM peak hours of travel were identified as 7:15 AM – 8:15 AM, 11:00 AM – 12:00 PM and 4:30 PM – 5:30 PM, respectively. A summary of the peak hour turning movement volumes for the intersection is shown in Table 2. The complete results from the turning movement count are provided in Appendix A.

The directional split of traffic on DE Route 8, the major street of the study intersection, for each of the peak hours identified above was found to be 23% westbound / 77% eastbound during the AM peak hour, 41% westbound / 59% eastbound during the Midday peak hour and 50% westbound / 50% eastbound during the PM peak hour. The directional split of traffic indicates that the majority of traffic is traveling eastbound during the AM peak hour and evenly split during the Midday and PM peak hours on DE route 8.

Table 2
DE Route 8 @ Chestnut Grove Road / Nault Road
5/2/2012 and 5/3/2012 - Peak Hour Turning Movement Volumes

		AM Peak Hour (7:15 AM - 8:15 AM)				Midday Peak Hour (11:00 AM - 12:00 PM)				PM Peak Hour (4:30 PM - 5:30 PM)			
		L	**T**	**R**	***Total***	**L**	**T**	**R**	***Total***	**L**	**T**	**R**	***Total***
DE Route 8	WB	8	169	1	*178*	15	265	3	*283*	25	401	3	*429*
	EB	79	494	9	*582*	47	355	5	*407*	66	360	9	*435*
Chestnut Grove Road	SB	0	13	31	*44*	7	13	43	*63*	2	24	98	*125*
Nault Road	NB	2	34	29	*65*	8	12	27	*47*	6	19	16	*41*

- **Existing Capacity**

Capacity analyses were performed at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road using the traffic volumes shown in Table 3. These analyses were performed using the Highway Capacity Software 2010 v6.1 (HCS 2010) for unsignalized intersections. The HCS 2010 software is based on the capacity analysis theories and methodologies that are provided in the 2010 version of the Highway Capacity Manual. Unsignalized intersection capacity is measured in terms of Levels of Service (LOS) and delay, primarily for vehicles on the stop controlled approaches and vehicles turning left from the major street approaches. LOS A (delay ≤ 10 sec/veh) represents the best possible operating conditions or free flow operations, whereas LOS F (delay > 50 sec/veh) represents congested conditions, corresponding with traffic that has reached or exceeded available capacity, resulting in relatively high average delay per vehicle and a breakdown in the flow of traffic. The worksheets and software outputs for all of the capacity analyses are provided in Appendix A.

Table 3 shows the results of the capacity analyses for the intersection of DE Route 8 and Chestnut Grove Road / Nault Road using HCS 2010 for unsignalized intersections. The results show that there are no delays (LOS A) for traffic turning left from both eastbound and westbound DE Route 8 during all three peak periods. The results also show that traffic approaching the intersection from the Nault Road approach operate with moderate delay (LOS C) during the Midday Peak period and heavy delay (LOS D & E) during the AM and the PM peak periods. The results also show that traffic approaching the intersection from the Chestnut Grove Road approach operate with minimal delay (LOS B) during the AM and the Midday peak periods and heavy delay (LOS D) during the PM peak period.

Table 3 DE Route 8 @ Chestnut Grove Road / Nault Road Summary of HCS 2010 Unsignalized Analyses Results			
Approach	**AM Peak Hour**	**Midday Peak Hour**	**PM Peak Hour**
	Movement LOS (delay)	**Movement LOS (delay)**	**Movement LOS (delay)**
Eastbound DE Route 8 Left-Turn	A (7.8 seconds/vehicle)	A (8.0 seconds/vehicle)	A (8.7 seconds/vehicle)
Westbound DE Route 8 Left-Turn	A (9.0 seconds/vehicle)	A (8.1 seconds/vehicle)	A (8.4 seconds/vehicle)
Northbound Nault Road Left-Through-Right	D (25.9 seconds/vehicle)	C (16.1 seconds/vehicle)	E (39.0 seconds/vehicle)
Southbound Chestnut Grove Road Left-Through-Right	B (14.3 seconds/vehicle)	B (14.6 seconds/vehicle)	D (26.0 seconds/vehicle)

- **Speed Study Findings**

Speed study was performed using a conventional radar gun on DE Route 8 on Wednesday, May 2, 2012. In the speed study, vehicle travel speeds were measured at two locations on DE Route 8: approximately 800 feet east of the Chestnut Grove Road / Nault Road intersection (location 1) and approximately 1,200 feet west of the Chestnut Grove Road / Nault Road intersection (location 2). The speed data that was gathered was then used to determine the 85th percentile speed for DE Route 8. The 85th percentile speed is the speed at which 85 percent of the vehicles recorded are traveling at or below. This is based on the theory that most motorists select their speed based on roadway conditions and the surrounding environment. Setting artificial speed limits much lower or higher than the 85th percentile speed reduces the effectiveness of the speed limit and could lead to poor motorist compliance, which may increase the risk of being in a crash. The results of the speed study for DE Route 8 are provided in Table 4.

Table 4 DE Route 8 Radar Study Results				
Site	**Existing Speed Limit**	**Combined 85th Percentile Speed**	**% Vehicles Over Speed Limit**	**% Vehicles 5 MPH Over Speed Limit**
Location 1	50 MPH	57 MPH	68%	28%
Location 2	50 MPH	56 MPH	51%	20%

The combined 85th percentile speed for both eastbound and westbound DE Route 8 was found to be 57 MPH for radar location 1, which indicates 85 percent of traffic is traveling at or below 57 MPH at location 1. Also, the combined 85th percentile speed for both eastbound and westbound DE Route 8 was found to be 56 MPH for radar location 2, which indicates 85 percent of traffic is traveling at or below 56 MPH at location 2. In addition, the data revealed that 68 percent of vehicles were traveling at speeds greater than the existing speed limit and 28 percent of vehicles were traveling at speeds 5 MPH or greater than the existing speed limit at radar location 1. Similarly, the data also revealed that 51 percent of vehicles were traveling at speeds greater than the existing speed limit and 20 percent of vehicles were traveling at speeds 5 MPH or greater than the existing speed limit at radar location 2.

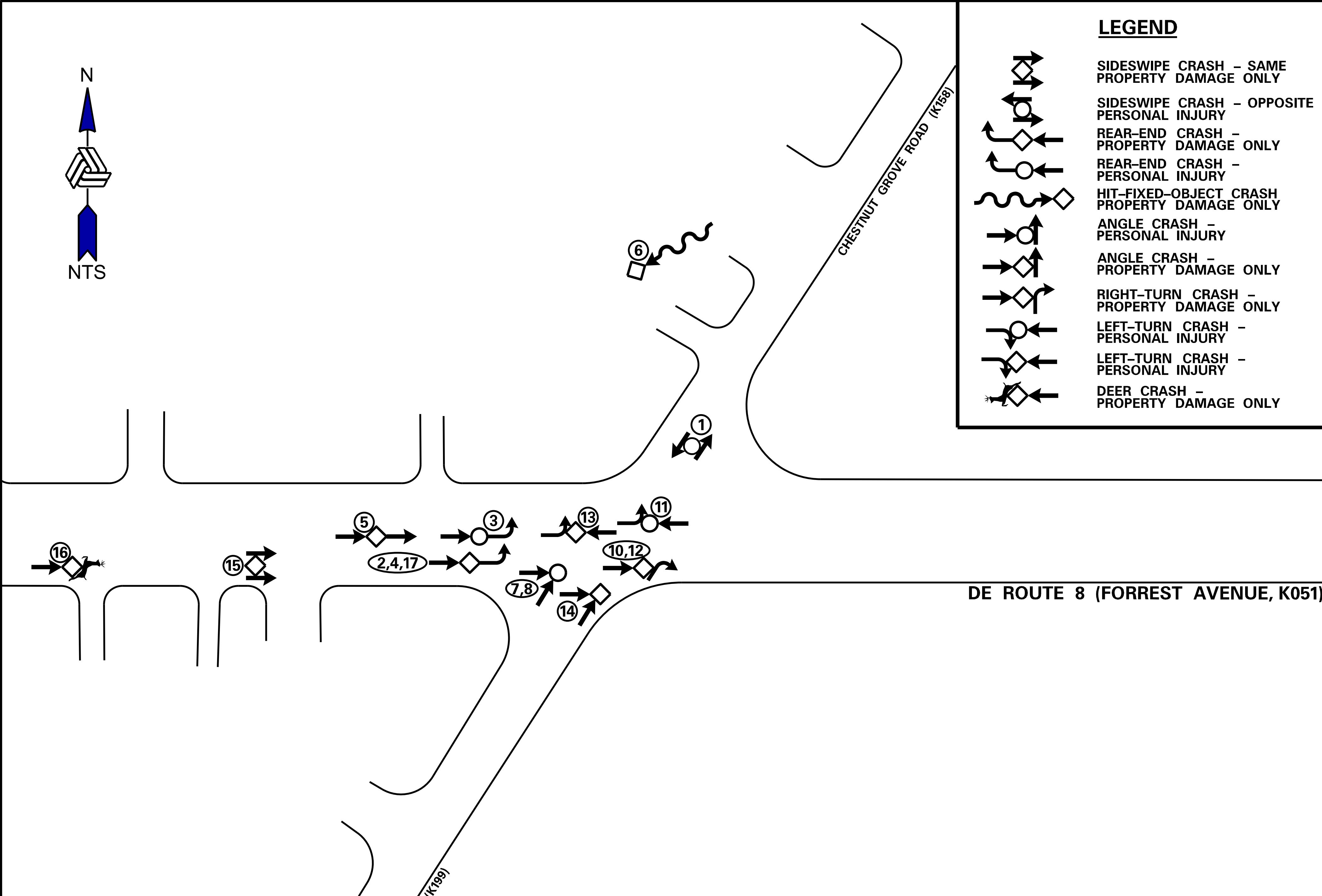
V. Crash Trend Analysis

The Planning Section of DelDOT provided the most recent crash data available for the study area, covering the period from April 2009 through April 2012. According to the available data, there were seventeen (17) reported crashes occurring at or near the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.

The following trends were identifiable in the crash data set:

- There were five (5) crashes that resulted in personal injury at this location.
- Twelve (12) crashes occurred during daytime and five (5) crashes occurred during night time.
- There were eight (8) crashes susceptible to correction by the installation of a traffic signal. Crash data revealed that there were six (6) angle crashes and two (2) left-turn crashes; however, it should be mentioned one (1) of the reported angle crashes appears to have been occurred on Nault Road at a driveway immediately adjacent to the intersection. It appears angle crashes were attributable to motorists failing to remain stopped from the minor road approaches and left-turn crashes were attributable to motorists failing to yield right-of-way from eastbound DE Route 8 while attempting to make a left-turn on to Chestnut Grove Road.
- There were five (5) rear-end crashes reported and four (4) of the rear-end crashes were attributable to inattentive driving and one (1) rear-end crash was attributable to a motorist following another vehicle too closely.
- There was one (1) same-direction-sideswipe crash reported and the crash was attributable to a motorist performing an unsafe lane change on eastbound DE Route 8.
- There was one (1) opposite-direction-sideswipe crash reported and the crash was attributable to an eastbound motorist crossing into the westbound lane on DE Route 8.
- There was one (1) crash involving a motor vehicle and a deer in the roadway.

It should be noted that there were five (5) crashes susceptible to correction via the installation of a traffic signal within a 12-month period between January 2011 and December 2011.



CRASH DIAGRAM			
DE ROUTE 8 (FORREST AVENUE, K051) CHESTNUT GROVE ROAD (K158)/NAULT ROAD (K198)			
DelDOT TRAFFIC	JUNE 2012	DRAWN BY BJS	FIGURE 3

Table 5

DE Route 8 @ Chestnut Grove Road / Nault Road
Summary of Crash Data

	Date	Time	Day of Week	Weather	Lighting	Manner of Impact	Severity	Contributing Circumstances
1	6/24/2009	4:19 PM	Wednesday	Clear	Daylight	Sideswipe	Injury	Vehicle crossing centerline
2	5/21/2009	1:50 PM	Thursday	Clear	Daylight	Rear-end	PDO	Inattentive Driving
3	12/7/2009	2:40 PM	Monday	Clear	Daylight	Rear-end	Injury	Inattentive Driving
4	8/30/2009	5:49 PM	Sunday	Clear	Daylight	Rear-end	PDO	Inattentive Driving
5	9/19/2009	4:04 PM	Saturday	Clear	Daylight	Rear-end	PDO	Following too closely
6	5/22/2010	9:50 PM	Saturday	Rain	Dark/Unlit	ROR/HFO	PDO	Unknown / Hit & Run
7	8/16/2010	1:12 PM	Monday	Clear	Daylight	Angle	Injury	Failed to remain stopped
8	6/6/2010	2:15 PM	Sunday	Clear	Daylight	Angle	Injury	Failed to remain stopped
9	4/11/2011	12:00 AM	Monday	Cloudy	Daylight	Angle	PDO	Failed to remain stopped
10	8/16/2011	4:43 PM	Tuesday	Clear	Daylight	Angle	PDO	Failed to remain stopped
11	11/29/2011	8:45 AM	Tuesday	Rain	Daylight	Left-turn	Injury	Failed to yield ROW
12	5/9/2011	6:49 AM	Monday	Clear	Daylight	Angle	PDO	Failed to remain stopped
13	11/11/2011	5:37 PM	Friday	Clear	Dark/Unlit	Left-turn	PDO	Failed to yield ROW
14	1/25/2011	12:22 PM	Tuesday	Clear	Daylight	Angle	PDO	Failed to remain stopped
15	1/26/2012	6:33 AM	Thursday	Rain	Dark/Unlit	Sideswipe	PDO	Unsafe lane change
16	3/30/2012	8:59 PM	Friday	Clear	Dark/Unlit	Hit Deer	PDO	Animal in roadway
17	2/18/2012	5:40 PM	Saturday	Clear	Dark/Unlit	Rear-end	PDO	Inattentive Driving

PDO = Property Damage Only

ROR/HFO = Runoff-the-Road / Hit-Fixed-Object

VI. Observations of Traffic Operations

The following observations were recorded during visits to the study area during peak and off-peak periods:

- Vehicles traveling on the major street (DE Route 8) do not arrive at this intersection in platoons.
- There are painted right-turn channelization islands present on both eastbound and westbound DE Route 8 at the intersection; however, through vehicles were observed traversing over the painted right-turn channelization islands to pass stopped or slowing left-turning vehicles on both DE Route 8 approaches.
- Vehicles approaching the intersection from the southbound Chestnut Grove Road approach were observed stopping beyond the existing painted STOP bar due to shrubbery and mailbox present within the northwest quadrant of the intersection.

VII. Improvement Options

Based on the results of the traffic observations, data obtained and analyses contained within this report, DelDOT considered the following three (3) improvement options at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road: installation of a traffic signal, installation of concrete right-turn channelization islands on DE Route 8 and installation of painted rumble strips on the Chestnut Grove Road / Nault Road approaches.

Option 1 – Traffic Signal

The State of Delaware Manual on Uniform Traffic Control Devices (DEMUTCD)[3] specifies nine (9) warrants that may be used in the process of determining whether a traffic signal is justified at an intersection. These warrants were reviewed using traffic volume information from the turning movement counts and the three year crash data for the intersection of DE Route 8 and Chestnut Grove Road / Nault Road. Results of the signal warrant analyses are summarized in Table 6. The individual signal warrants are described in detail following the summary table.

Results of the signal warrant study showed that **two** of the nine signal warrants were met at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road. In addition, there were five (5) crashes susceptible to correction via the installation of traffic signal at the intersection within a 12-month period. The following is a detailed summary of the requirements for each of the warrants for traffic signal installation as specified by the DEMUTCD.

Warrant 1, Eight-Hour Vehicular Volumes

This warrant is divided into three parts. The first part, Condition A, minimum vehicular volume, is intended for use at locations where a large volume of intersecting traffic is the principal reason to consider signalization. The second part, Condition B, interruption of continuous traffic, is intended for use at locations where Condition A is not satisfied and where the traffic volume on the major street is so heavy that traffic on the minor intersecting street suffers excessive delay or conflict in entering or crossing the major street. The third part of this warrant is the combination of Conditions A and B, which is intended for use at locations where Condition A or Condition B is not satisfied. The combination of A and B should only be applied after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

- The traffic volumes on the DE Route 8 approaches must be at least 500 vph for Condition A and 750 vph for Condition B. The volume requirement for the combination of Condition A and Condition B is 80% of these values.

- The traffic volume on the most heavily traveled minor street approach (Chestnut Grove Road / Nault Road) must be at least 150 vph for Condition A and 75 vph for Condition B. The volume requirement for the combination of Condition A and Condition B is 80% of these values.

*The requirements for this warrant were **satisfied** by the existing conditions at this intersection.*

Hours met: 2 of 8 hours for Condition A

9 of 8 hours for Condition B

Condition C is not applicable to this location

Warrant 2, Four-Hour Vehicular Volumes

This warrant is satisfied when, for each of any four hours on an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor street approach (one direction only) all fall above the curve in Figure 4C-1 of the DEMUTCD for the existing combination of approach lanes. Figure 4C-2 is used because the 70% criterion does apply to this location due to the speed limit on DE Route 8 being 50 MPH, which is greater than 40 MPH, as required by the warrant.

*The requirements for this warrant were **satisfied** by the existing conditions at this intersection.*

Hours Met: 4 of 4.

Warrant 3, Peak Hour

This warrant is intended for use at a location where traffic conditions are such that for a minimum of one hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street. The DEMUTCD specifically states, "This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time. If the location meets these criteria, the peak hour warrant is satisfied when:

- The total stopped time delay experienced by the traffic on one minor street approach (Chestnut Grove Road / Nault Road) controlled by a stop sign equals or exceeds 4 vehicle-hours for a one-lane approach, and;
- The volume on the same minor street approach (Chestnut Grove Road / Nault Road) equals or exceeds 100 vehicles per hour for one moving lane of traffic, and;
- The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with 4 or more approaches.

The warrant can also be satisfied if the plotted point representing the vehicles per hour on the major (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-4 for the existing combination of approach lanes. Figure 4C-4 is used because the 70% criterion does apply to this location.

*The intersection of DE Route 8 and Chestnut Grove Road / Nault Road cannot be considered an 'unusual case' since the intersection does not experience high volumes of vehicles entering and exiting this facility during short periods of time. Therefore, this warrant **does not apply** to the intersection of DE Route and Chestnut Grove Road / Nault Road.*

Warrant 4, Pedestrian Volume

This warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

- The pedestrian volume crossing the major street at an intersection or midblock location during an average day is 100 or more for each of any 4 hours or 190 or more during 1 hour, and;
- There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied.

*The requirements for this warrant were **not satisfied** by the existing conditions at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.*

Warrant 5, School Crossing

A traffic control signal may be warranted at an established school crossing when a traffic engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at the school crossing shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period.

This warrant does not apply to the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.

Table 6
Summary of Signal Warrant Analysis

	MUTCD Requirement	Current Condition	Criteria Met?	Warrant Met?
Warrant 1 – Eight-Hour Vehicular Volume				
A. Minimum Vehicular Volume (Condition A)	8 Hours	2 Hours	No	**Yes**
B. Minimum Vehicular Volume (Condition B)	8 Hours	9 Hours	No	
C. Combination of A and B	8 Hours	0 Hours	No	
Warrant 2 – Four-Hour Vehicular Volume				
Figure 4C-2 of the DE MUTCD	4 Hours	4 Hours	No	**Yes**
Warrant 3 – Peak Hour				
Delay on minor street for unusual locations	N/A	N/A	No	**No**
Warrant 4 – Pedestrian Volume				
A. Figure 4C-5	4 Hours	0 Hours	No	**No**
B. Figure 4C-7	1 Hour	0 Hours	No	
Warrant 5- School Crossing				
Frequency and adequacy of gaps in vehicular traffic stream	N/A	N/A	No	**No**
Warrant 6- Coordinate Signal System				
Adequate platooning of vehicles within a coordinated signal system	N/A	N/A	No	**No**
Warrant 7- Crash History				
Number of Crashes	5 Crashes	5 Crashes	Yes	**No**
Minimum Vehicular Volume	8 Hours	6 Hours	No	
Warrant 8 – Roadway Network				
All Warrants Failed?			Yes	**No**
Warrant 9 – Intersection Near a Grade Crossing				
This intersection is not Near a Grade Crossing				

<u>Warrant 6, Coordinated Signal System</u>

The need for a traffic signal shall be considered if adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation on a two-way street. This warrant should not be applied if the resultant spacing of traffic control signals would be less than 1,000 ft.

This warrant does not apply to the intersection of DE Route 8 and Chestnut Grove Road / Nault Road since the intersection is not part of a coordinated signal system.

<u>Warrant 7, Crash Experience</u>

The following requirements must be met in order for this warrant to be satisfied:

- Other safety improvement alternatives have failed to produce adequate results, and;
- Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and

- There exists a volume of vehicular and pedestrian traffic not less than 80 percent of the requirements specified in warrant 1.

The requirements for this warrant were ***not satisfied*** *by the existing conditions at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road. Safety improvements such as right-turn channelization islands have been implemented at the intersection and there were* ***five (5)*** *crashes susceptible to correction by a traffic signal in a 12-month study period between January 2011 and December 2011; however, the 80% volume warrant was only satisfied 6 of 8 hours.*

Warrant 8, Roadway Network

The intent of this warrant is to encourage concentration and organization of traffic flow networks. For this reason, all elements of this warrant refer to intersections of two or more "major streets."

A major street as used in this warrant has one or more of the following characteristics:

- It is part of the street or highway system that serves as the principal network for through traffic flow;
- It includes rural or suburban highways outside, entering or traversing a city;
- It appears as a major route on an official plan such as a major street plan in a transportation study.

For this warrant to be met, the junction of two of more major streets must:

- Have a total entering volume of at least 1,000 vehicles during the peak hours of a typical weekday and have five year projected volumes which meet one or more requirements of Warrants 1, 2 and 3 during an average weekday.
- Have a total of existing or immediately projected entering volume of at least 1,000 vehicles for each of any five hours on a Saturday and/or Sunday.

This warrant does not apply to the intersection of DE Route 8 and Chestnut Grove Road / Nault Road, because the minor street (Chestnut Grove Road / Nault Road) approaches does not meet the requirements of a "major street."

Warrant 9, Intersection near a Grade Crossing

This warrant is applicable at locations where a grade crossing is located on an approach to an intersection and a traffic signal is needed in order to prevent vehicles from stopping on the tracks.

This warrant does not apply to the intersection of DE Route 8 and Chestnut Grove Road / Nault Road, since there are no grade crossings in the vicinity of the intersection.

Based on the results of the traffic signal warrant analysis, a traffic signal is **warranted** at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.

Option 2 – Raised concrete right-turn channelization islands on DE Route 8

As mentioned in observations of traffic operations section, many vehicles were observed using the right-turn lane to pass vehicles stopped in the shared left-turn / through lane to make a left-turn. There are painted right-turn channelization islands present on both eastbound and westbound DE Route 8; however, vehicles using the right-turn lane to pass left-turning vehicles were observed traversing over the painted-right-turn channelization islands. In addition, vehicles making a right-turn from the minor street approaches (Chestnut Grove Road / Nault Road) were observed stopping beyond the existing painted stop line due to the skew at the intersection, which resulted in many near-miss crashes with vehicles passing on right-turn lanes at the intersection. Further review of the crash data at the intersection revealed that two (2) of the five (5) relevant angle crashes may have involved eastbound vehicles using the right-turn lane to pass left-turning vehicles. In addition, vehicles using the right-turn lane to pass left-turning vehicles created further conflicts with other through vehicles stopped behind left-turning vehicles when they proceeded through the intersection. Upgrading the existing painted right-turn channelization islands to raised concrete right-turn channelization islands should eliminate angle crashes involving vehicles using the right-turn lanes as bypass lanes.

Option 3 – Rumble Strips

DelDOT also determined the feasibility of installing painted rumble strips on the Chestnut Grove Road / Nault Road approaches. Field observation revealed that the land use in the vicinity of the study intersection is predominantly residential. Installing rumble strips near a residential area could have a significant negative impact on the quality of life for nearby residents. Therefore, installation of rumble strips near the intersection of DE Route 8 and Chestnut Grove Road / Nault Road is **not feasible**.

VIII. Conclusions

The significant findings of this traffic engineering study at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road are:

Intersection sight distance: From the Chestnut Grove Road approach and the Nault Road approach, the measured available intersection sight distance for vehicles looking left and right are greater than the distance recommended by AASHTO. The available intersection sight distances for vehicles turning left from the major street were also found to be greater than the minimums that are recommended by AASHTO.

Existing traffic volumes: The traffic count that was conducted for this study showed that the AM, Midday and PM peak hours of travel are 7:15 AM – 8:15 AM, 11:00 AM – 12:00 PM and 4:30 PM to 5:30 PM, respectively. The directional split of traffic indicates that the majority of traffic is traveling eastbound during the AM peak hour and evenly split during the Midday and PM peak hours on DE Route 8.

Existing intersection capacity: The results show that there are no delays (LOS A) for traffic turning left from both eastbound and westbound DE Route 8 during all three peak periods. The results also show that traffic approaching the intersection from the Nault Road approach operate with moderate delay (LOS C) during the Midday Peak period and heavy delay (LOS D & E) during the AM and the PM peak periods. The results also show that traffic approaching the intersection from the Chestnut Grove Road approach operate with minimal delay (LOS B) during the AM and the Midday peak periods and heavy delay (LOS D) during the PM peak period.

Speed Study Findings: The combined 85^{th} percentile speed for both eastbound and westbound DE Route 8 was found to be 57 MPH for radar location 1, which indicates 85 percent of traffic is traveling at or below 57 MPH at location 1. Also, the combined 85^{th} percentile speed for both eastbound and westbound DE Route 8 was found to be 56 MPH for radar location 2, which indicates 85 percent of traffic is traveling at or below 56 MPH at location 2. In addition, the data revealed that 68 percent of vehicles were traveling at speeds greater than the existing speed limit and 28 percent of vehicles were traveling at speeds 5 MPH or greater than the existing speed limit at radar location 1. Similarly, the data also revealed that 51 percent of vehicles were traveling at speeds greater than the existing speed limit and 20 percent of vehicles were traveling at speeds 5 MPH or greater than the existing speed limit at radar location 2.

Crash trend analysis: Crash data was obtained for this intersection covering the period from October 2008 to September 2011. The data showed that there were eleven (11) reported crashes occurring at this intersection. From January 2011 to December 2011, there were five (5) crashes that are susceptible to correction by the installation of a traffic signal.

Improvement Options:

- Based on the results of the traffic signal warrant analysis, a traffic signal is **warranted** at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.
- Based on observations of traffic operations at the intersection, upgrading the existing painted right-turn channelization islands to raised concrete islands should eliminate crashes involving vehicles using the right-turn lanes to pass stopped left-turning vehicles on DE Route 8.
- Field investigations revealed that the land use in the vicinity of the study intersection is predominantly residential. Installing rumble strips near a residential area could have a significant negative impact on the quality of life for nearby residents. Therefore, the installation of painted rumble strips is **not feasible** near the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.

IX. Recommendations

Based on the results of the traffic observations, data and analysis contained within this report, DelDOT presents the following improvement options to be considered for this location:

Option 1: *Install a traffic signal at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.*

Expected Benefits:
- Installing a traffic signal should reduce excessive delay experienced by vehicles approaching the intersection from the Chestnut Grove Road / Nault Road approaches.
- Installing a traffic signal should reduce the number of angle crashes and left-turn crashes at the intersection.
- Lane configuration change needed for the traffic signal installation should eliminate the crashes involving vehicles using the right-turn lanes to pass stopped left-turning vehicles on DE Route 8.

Possible Disadvantages:
- Increased delays to motorists on DE Route 8.
- Cost of operating and maintaining the traffic signal.
- Cost of possible additional land acquisition.
- Possible increase in number of rear-end crashes on DE Route 8.

Option 2: *Upgrade existing painted right-turn channelization islands on DE Route 8 to raised concrete right-turn channelization islands.*

Expected Benefits:
- Implementing raised concrete right-turn channelization islands should prohibit through vehicles on DE Route 8 from using the right-turn lanes to pass stopped left-turning vehicles.
- The provision of the raised right-turn channelization islands should eliminate angle crashes and left-turn crashes involving vehicles traveling through the intersection using the right-turn lanes.

Possible Disadvantages:
- Increased delays to motorists on DE Route 8.
- Cost of installing and maintaining the raised concrete channelization islands.

It should be noted that separate left-turn lanes will be added to the DE Route 8 approaches when the traffic signal is installed and right-turn channelization islands on DE Route 8 must be relocated. This means the proposed raised concrete right-turn channelization islands must be relocated at the time of the traffic signal installation; however, DelDOT recommends the raised concrete right-turn channelization islands to be installed as an interim improvement before the traffic signal installation since the traffic signal installation will likely be a possible FY 2014 or FY2015 project.

DelDOT also considered installing Rumble Strips on the Chestnut Grove Road / Nault Road approaches. Field observations revealed that the land use in the vicinity of the study intersection is predominantly residential. Installing rumble strips near a residential area could have a significant negative impact on the quality of life for nearby residents. Therefore, DelDOT **does not recommend** installation of rumble strips at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road.

Based on the results from the radar study, it appears that many motorists traveling on DE Route 8 are not complying with the existing speed limit of 50 MPH. Lowering the speed limit on DE Route 8 is not advisable since the majority of motorists are currently not obeying the existing speed limit. In order for a lower speed limit to be warranted, the 85th percentile speed should be lower than the existing posted speed limit and there should be roadside features or other factors that cause motorists to select lower speed. The only effective measure that can reduce the travel speeds of motorists is police enforcement. Police enforcement can influence lower travel speeds on a roadway for a short period of time; however, the resulting lower travel speed could increase when the police enforcement is discontinued. This is due to drivers being accustomed to driving at the speed at which they feel safe and are comfortable. Therefore, it is recommended that the existing speed limit of 50 MPH remain in effect on DE Route 8. In addition, DelDOT also recommends additional speed enforcements to be conducted by the Delaware State Police (DSP) on DE Route 8 at the locations where the safety of the police officers conducting the speed enforcement will not be compromised.

Field observations conducted at the intersection of DE Route 8 and Chestnut Grove Road / Nault Road have identified the need for minor traffic control device improvements. The proposed improvements are listed below:

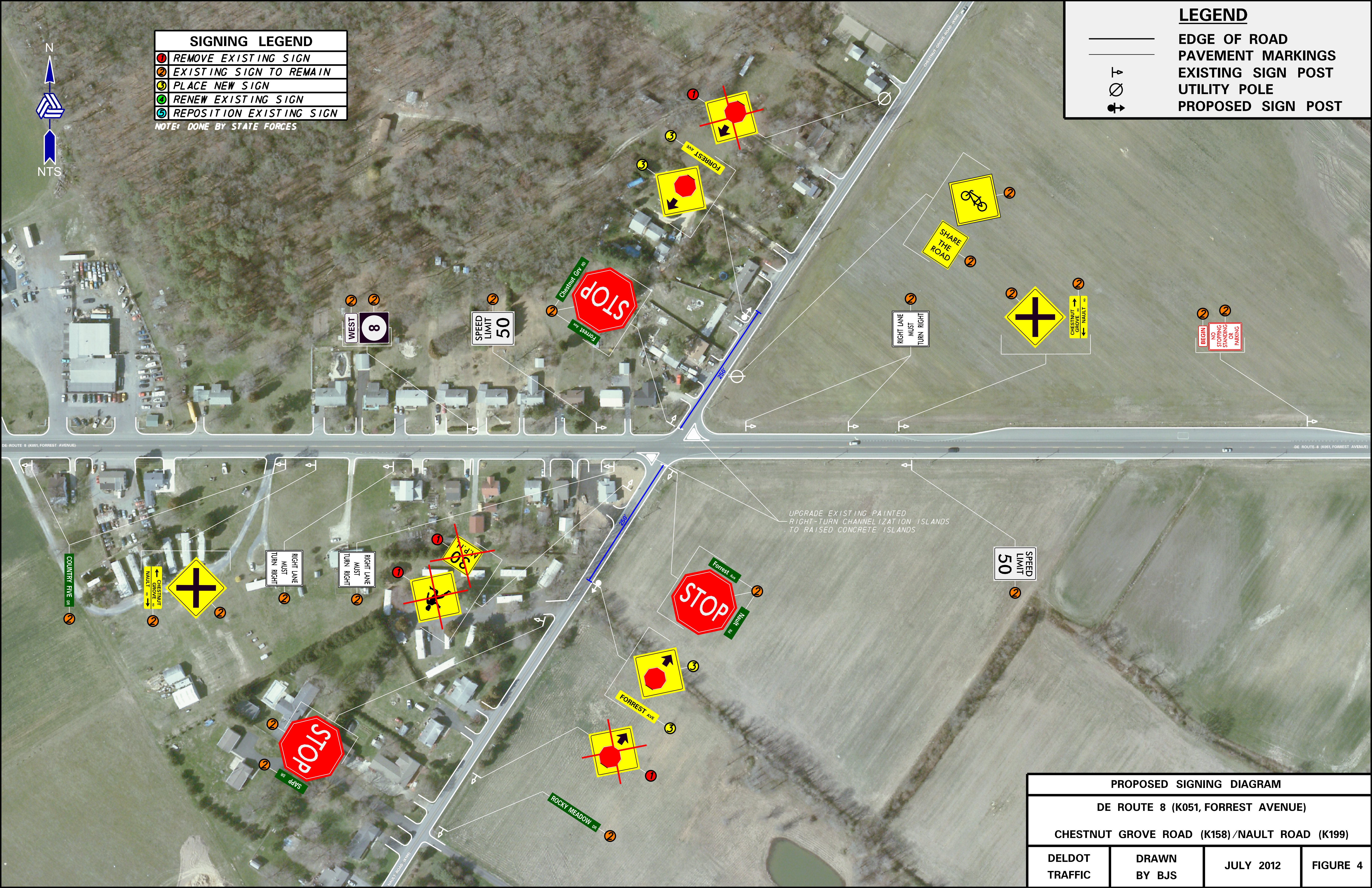
- Remove existing Stop Ahead sign (W3-1) on southbound Chestnut Grove Road, located north of DE Route 8.
- Install new Stop Ahead sign (W3-1) and an Advance Street Name plaque (W16-8a-DE) for Forrest Avenue on southbound Chestnut Grove Road, approximately 250 feet north of DE Route 8.
- Remove existing Watch Children sign (W21-11-DE) and Advisory Speed 30 MPH sign (W13-1-30) on southbound Nault Road, located immediately south of DE Route 8.
- Remove existing Stop Ahead sign (W3-1) on northbound Nault Road, located south of DE Route 8.
- Install Stop Ahead sign (W3-1) and an Advance Street Name plaque (W16-8a-DE) for Forrest Avenue on northbound Nault Road, approximately 250 feet south of DE Route 8.

X. Reference

i. AASHTO A Policy on Geometric Design of Highways and Streets. American Association of State Highway and Transportation Officials. Washington, D. C. 20001. 2004.

ii. Highway Capacity Manual. Transportation Research Board. Washington, D.C. 20001. 2010.

iii. State of Delaware Manual on Uniform Traffic Control Devices (DE MUTCD). Delaware Department of Transportation. Smyrna, DE 19977. 2011.


SIGNING LEGEND
1 REMOVE EXISTING SIGN
2 EXISTING SIGN TO REMAIN
3 PLACE NEW SIGN
4 RENEW EXISTING SIGN
5 REPOSITION EXISTING SIGN
NOTE: DONE BY STATE FORCES
N
NTS
LEGEND
EDGE OF ROAD
PAVEMENT MARKINGS
EXISTING SIGN POST
UTILITY POLE
PROPOSED SIGN POST
FORREST AVE
WEST
8
SPEED LIMIT 50
Chestnut Grv RD
STOP
Forrest Ave
SHARE THE ROAD
RIGHT LANE MUST TURN RIGHT
CHESTNUT GROVE RD
NAULT RD
BEGIN
NO STOPPING STANDING OR PARKING
250'
UPGRADE EXISTING PAINTED RIGHT-TURN CHANNELIZATION ISLANDS TO RAISED CONCRETE ISLANDS
COUNTRY FIVE DR
Nault Rd
SAPP DR
ROCKY MEADOW DR
PROPOSED SIGNING DIAGRAM
DE ROUTE 8 (K051, FORREST AVENUE)
CHESTNUT GROVE ROAD (K158)/NAULT ROAD (K199)
DELDOT TRAFFIC
DRAWN BY BJS
JULY 2012
FIGURE 4

APPENDIX A
Traffic Data

Existing Traffic Volume Data

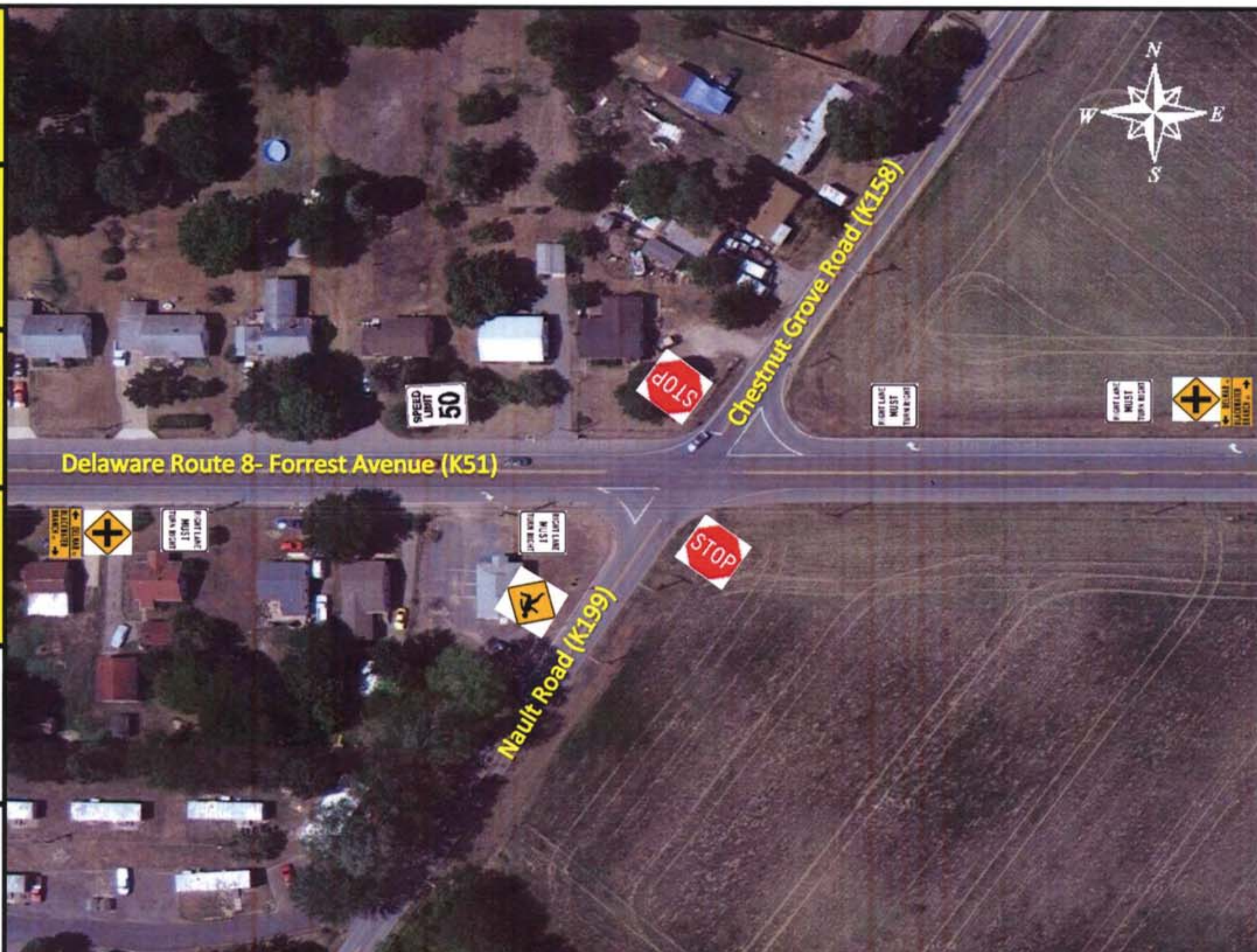
HCS2010 Analysis Worksheets

Turning Movement Field Data

Requestor:	B.J. Song
Counter Name / Number:	Heather Mantz/ T-2923
County / City:	Kent County/ Dover
Road Number / Name:	Delaware Route 8-Forrest Avenue (K51) & Nault Road (K199)- Chestnut Grove Road (K158)
Signalized? Yes No	

Notes: This count was seperated to count in Bank 1 as Truck Traffic and Bank 2 as Bicycle Traffic. Horse and Buggies were counted as vehicles. Motorists were observed passing left turning vehicles in the right turn lane.

Pedestrian Count	Day 1
Bicycle Count	Date
Turning Movement Count	05/02/12
Vehicle Separation	Wednesday
Classification Count	Daylight, Clear, Dry
Intersection Delay Study	Time
	7:00 - 9:00
	11:00 - 1:00
	2:00 - 6:00
	Day 2
	Date
	05/03/12
	Thursday
	Daylight, Clear, Dry
	Time
	7:00 - 9:00
	11:00 - 1:00
	2:00 - 6:00



DelDOT- Traffic Management Center

169 Brick Store Landing Road
Smyrna, DE 19977
Telephone: 302-659-4066

Counter No.: T-2923
Counted By: Heather Mantz
Weather: Daylight/Clear/Dry
Day of Week: Wednesday

File Name : ForrestAve-NaultRd-Chestnut
Site Code : 00000000
Start Date : 5/3/2012
Page No : 1

Groups Printed- General Traffic - Truck Traffic - Bicycle Traffic

	Chestnut Grove Road (K158) Southbound					DE8-Forrest Avenue (K51) Westbound					Nault Road (K199) Northbound					DE8-Forrest Avenue (K51) Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	7	2	0	0	9	0	30	0	0	30	8	3	0	0	11	0	62	6	0	68	118
07:15 AM	6	3	0	0	9	0	32	3	0	35	10	8	0	0	18	1	122	22	0	145	207
07:30 AM	11	3	0	0	14	0	52	1	0	53	8	11	1	0	20	4	166	21	0	191	278
07:45 AM	8	4	0	0	12	1	53	3	0	57	8	6	1	0	15	2	133	14	0	149	233
Total	32	12	0	0	44	1	167	7	0	175	34	28	2	0	64	7	483	63	0	553	836
08:00 AM	6	3	0	0	9	0	32	1	0	33	3	9	0	0	12	2	73	22	0	97	151
08:15 AM	6	0	1	0	7	1	39	0	0	40	8	6	3	0	17	0	97	16	0	113	177
08:30 AM	6	2	2	0	10	0	31	1	0	32	2	2	3	0	7	2	103	21	0	126	175
08:45 AM	7	0	1	0	8	0	32	2	0	34	8	3	1	0	12	3	91	13	0	107	161
Total	25	5	4	0	34	1	134	4	0	139	21	20	7	0	48	7	364	72	0	443	664
*** BREAK ***																					
11:00 AM	8	2	2	0	12	0	65	5	0	70	3	2	1	0	6	1	94	12	0	107	195
11:15 AM	12	2	2	0	16	1	60	3	0	64	8	5	2	0	15	2	91	8	0	101	196
11:30 AM	15	5	1	0	21	0	67	4	0	71	4	1	2	0	7	1	84	17	0	102	201
11:45 AM	8	4	2	0	14	2	73	3	0	78	12	4	3	0	19	1	86	10	0	97	208
Total	43	13	7	0	63	3	265	15	0	283	27	12	8	0	47	5	355	47	0	407	800
12:00 PM	7	5	1	0	13	0	60	5	0	65	0	4	0	0	4	2	83	7	0	92	174
12:15 PM	13	3	0	0	16	0	68	8	0	76	3	2	3	0	8	0	77	10	0	87	187
12:30 PM	11	2	1	0	14	1	77	2	0	80	3	6	2	0	11	2	67	10	0	79	184
12:45 PM	9	2	0	0	11	1	69	3	0	73	1	3	2	0	6	0	83	14	0	97	187
Total	40	12	2	0	54	2	274	18	0	294	7	15	7	0	29	4	310	41	0	355	732
*** BREAK ***																					
02:00 PM	13	0	1	0	14	2	75	3	0	80	2	2	0	0	4	1	73	11	0	85	183
02:15 PM	13	4	0	0	17	0	72	5	0	77	4	1	3	0	8	1	69	11	1	82	184
02:30 PM	7	3	1	0	11	1	77	4	0	82	4	7	2	0	13	1	84	8	0	93	199
02:45 PM	22	4	2	0	28	0	75	1	0	76	3	7	4	0	14	4	60	19	0	83	201
Total	55	11	4	0	70	3	299	13	0	315	13	17	9	0	39	7	286	49	1	343	767
03:00 PM	19	2	0	0	21	3	89	3	0	95	6	4	2	0	12	3	71	9	0	83	211
03:15 PM	18	8	0	0	26	0	76	5	0	81	2	2	5	0	9	6	74	11	0	91	207
03:30 PM	15	10	5	0	30	0	93	5	0	98	1	5	2	0	8	1	90	3	0	94	230
03:45 PM	21	6	1	0	28	0	114	11	0	125	4	3	7	0	14	2	77	15	0	94	261
Total	73	26	6	0	105	3	372	24	0	399	13	14	16	0	43	12	312	38	0	362	909
04:00 PM	18	6	0	0	24	0	94	1	0	95	4	6	3	0	13	0	78	13	0	91	223

DelDOT- Traffic Management Center

169 Brick Store Landing Road
Smyrna, DE 19977
Telephone: 302-659-4066

Counter No.: T-2923
Counted By: Heather Mantz
Weather: Daylight/Clear/Dry
Day of Week: Wednesday

File Name : ForrestAve-NaultRd-Chestnut
Site Code : 00000000
Start Date : 5/3/2012
Page No : 2

Groups Printed- General Traffic - Truck Traffic - Bicycle Traffic

	Chestnut Grove Road (K158) Southbound					DE8-Forrest Avenue (K51) Westbound					Nault Road (K199) Northbound					DE8-Forrest Avenue (K51) Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:15 PM	28	8	0	0	36	0	92	6	0	98	4	3	1	0	8	4	47	9	0	60	202
04:30 PM	31	10	0	0	41	0	82	6	0	88	6	9	3	0	18	3	79	12	0	94	241
04:45 PM	28	8	1	0	37	0	127	9	0	136	2	4	1	0	7	1	84	16	0	101	281
Total	105	32	1	0	138	0	395	22	0	417	16	22	8	0	46	8	288	50	0	346	947
05:00 PM	21	2	1	1	25	2	100	3	0	105	3	5	1	0	9	3	84	18	0	105	244
05:15 PM	18	4	0	0	22	1	92	7	0	100	5	1	1	0	7	2	113	20	0	135	264
05:30 PM	20	3	0	0	23	1	85	3	0	89	7	3	2	0	12	3	79	19	0	101	225
05:45 PM	16	9	1	0	26	0	82	3	0	85	6	3	3	0	12	0	83	11	0	94	217
Total	75	18	2	1	96	4	359	16	0	379	21	12	7	0	40	8	359	68	0	435	950
Grand Total	448	129	26	1	604	17	2265	119	0	2401	152	140	64	0	356	58	2757	428	1	3244	6605
Apprch %	74.2	21.4	4.3	0.2		0.7	94.3	5	0		42.7	39.3	18	0		1.8	85	13.2	0		
Total %	6.8	2	0.4	0	9.1	0.3	34.3	1.8	0	36.4	2.3	2.1	1	0	5.4	0.9	41.7	6.5	0	49.1	
General Traffic	447	128	26	1	602	17	2199	117	0	2333	145	138	63	0	346	55	2692	428	1	3176	6457
% General Traffic	99.8	99.2	100	100	99.7	100	97.1	98.3	0	97.2	95.4	98.6	98.4	0	97.2	94.8	97.6	100	100	97.9	97.8
Truck Traffic	1	1	0	0	2	0	66	2	0	68	7	2	0	0	9	2	65	0	0	67	146
% Truck Traffic	0.2	0.8	0	0	0.3	0	2.9	1.7	0	2.8	4.6	1.4	0	0	2.5	3.4	2.4	0	0	2.1	2.2
Bicycle Traffic	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
% Bicycle Traffic	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0	0.3	1.7	0	0	0	0	0

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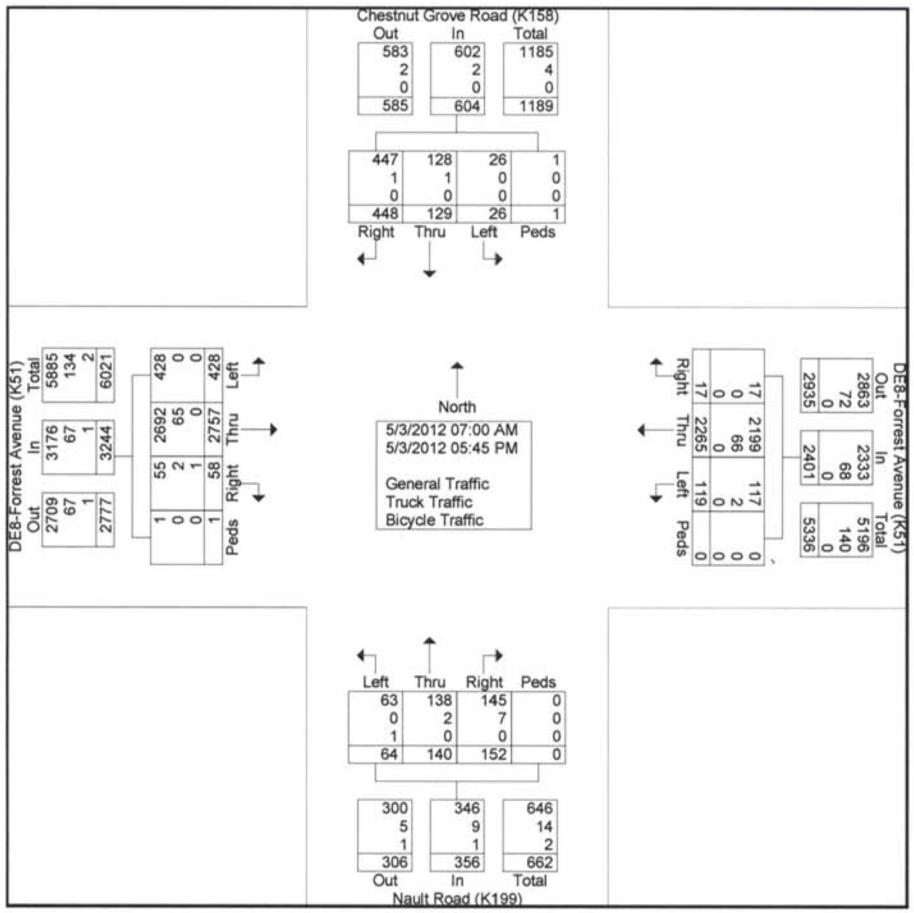

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	Chestnut Grove Road (K158) Southbound					DE8-Forrest Avenue (K51) Westbound					Nault Road (K199) Northbound					DE8-Forrest Avenue (K51) Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	6	3	0	0	9	0	32	**3**	0	35	**10**	8	0	0	18	1	122	**22**	0	145	207
07:30 AM	**11**	3	0	0	**14**	0	52	1	0	53	8	**11**	**1**	0	**20**	**4**	**166**	21	0	**191**	**278**
07:45 AM	8	**4**	0	0	12	**1**	**53**	3	0	**57**	8	6	1	0	15	2	133	14	0	149	233
08:00 AM	6	3	0	0	9	0	32	1	0	33	3	9	0	0	12	2	73	22	0	97	151
Total Volume	31	13	0	0	44	1	169	8	0	178	29	34	2	0	65	9	494	79	0	582	869
% App. Total	70.5	29.5	0	0		0.6	94.9	4.5	0		44.6	52.3	3.1	0		1.5	84.9	13.6	0		
PHF	.705	.813	.000	.000	.786	.250	.797	.667	.000	.781	.725	.773	.500	.000	.813	.563	.744	.898	.000	.762	.781

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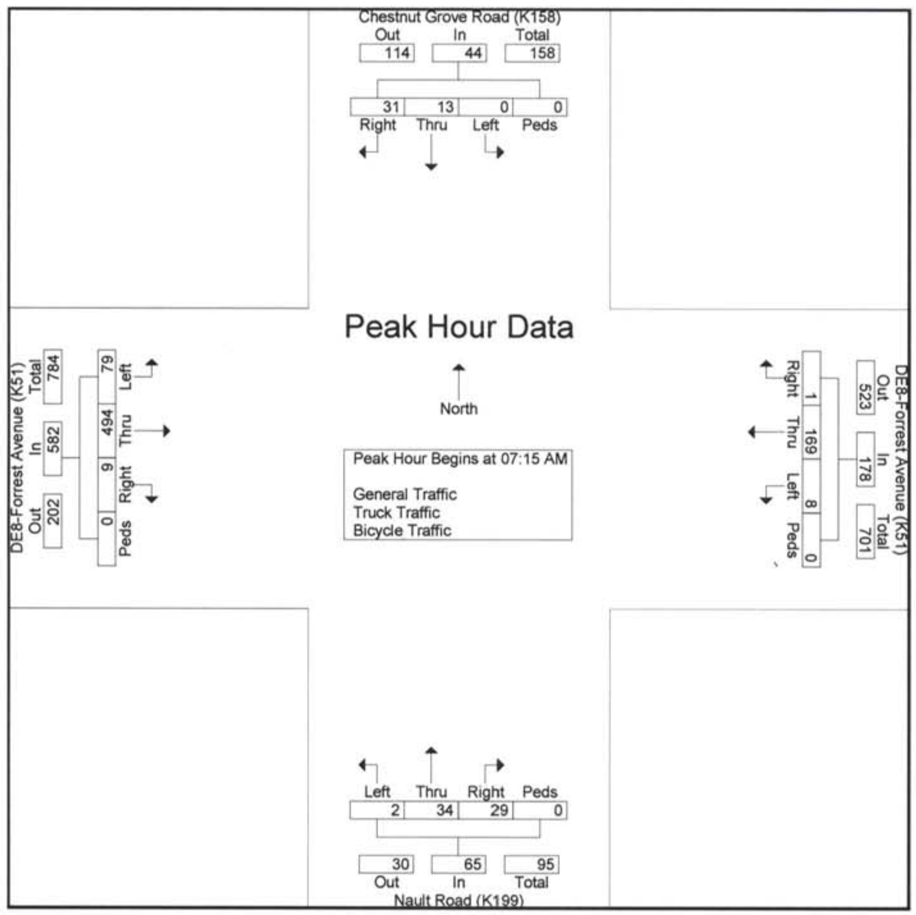

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Site Code : 00000000
Start Date : 5/3/2012
Page No : 6

	Chestnut Grove Road (K158) Southbound					DE8-Forrest Avenue (K51) Westbound					Nault Road (K199) Northbound					DE8-Forrest Avenue (K51) Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 11:00 AM																					
11:00 AM	8	2	**2**	0	12	0	65	**5**	0	70	3	2	1	0	6	1	**94**	12	0	**107**	195
11:15 AM	12	2	2	0	16	1	60	3	0	64	8	**5**	2	0	15	**2**	91	8	0	101	196
11:30 AM	**15**	**5**	1	0	**21**	0	67	4	0	71	4	1	2	0	7	1	84	**17**	0	102	201
11:45 AM	8	4	2	0	14	**2**	**73**	3	0	**78**	**12**	4	**3**	0	**19**	1	86	10	0	97	**208**
Total Volume	43	13	7	0	63	3	265	15	0	283	27	12	8	0	47	5	355	47	0	407	800
% App. Total	68.3	20.6	11.1	0		1.1	93.6	5.3	0		57.4	25.5	17	0		1.2	87.2	11.5	0		
PHF	.717	.650	.875	.000	.750	.375	.908	.750	.000	.907	.563	.600	.667	.000	.618	.625	.944	.691	.000	.951	.962

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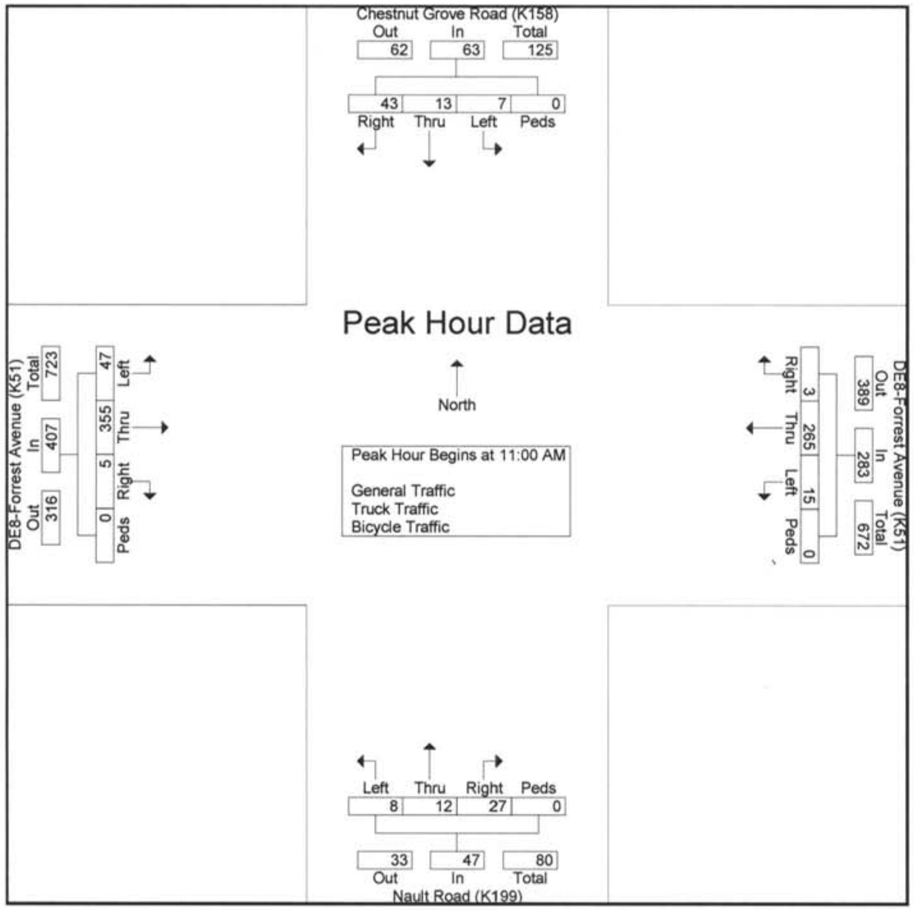

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Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 02:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	**31**	**10**	0	0	**41**	0	82	6	0	88	**6**	**9**	**3**	0	**18**	**3**	79	12	0	94	241
04:45 PM	28	8	**1**	0	37	0	**127**	**9**	0	**136**	2	4	1	0	7	1	84	16	0	101	**281**
05:00 PM	21	2	1	**1**	25	**2**	100	3	0	105	3	5	1	0	9	3	84	18	0	105	244
05:15 PM	18	4	0	0	22	1	92	7	0	100	5	1	1	0	7	2	**113**	**20**	0	**135**	264
Total Volume	98	24	2	1	125	3	401	25	0	429	16	19	6	0	41	9	360	66	0	435	1030
% App. Total	78.4	19.2	1.6	0.8		0.7	93.5	5.8	0		39	46.3	14.6	0		2.1	82.8	15.2	0		
PHF	.790	.600	.500	.250	.762	.375	.789	.694	.000	.789	.667	.528	.500	.000	.569	.750	.796	.825	.000	.806	.916

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Day of Week: Wednesday

File Name : ForrestAve-NaultRd-Chestnut
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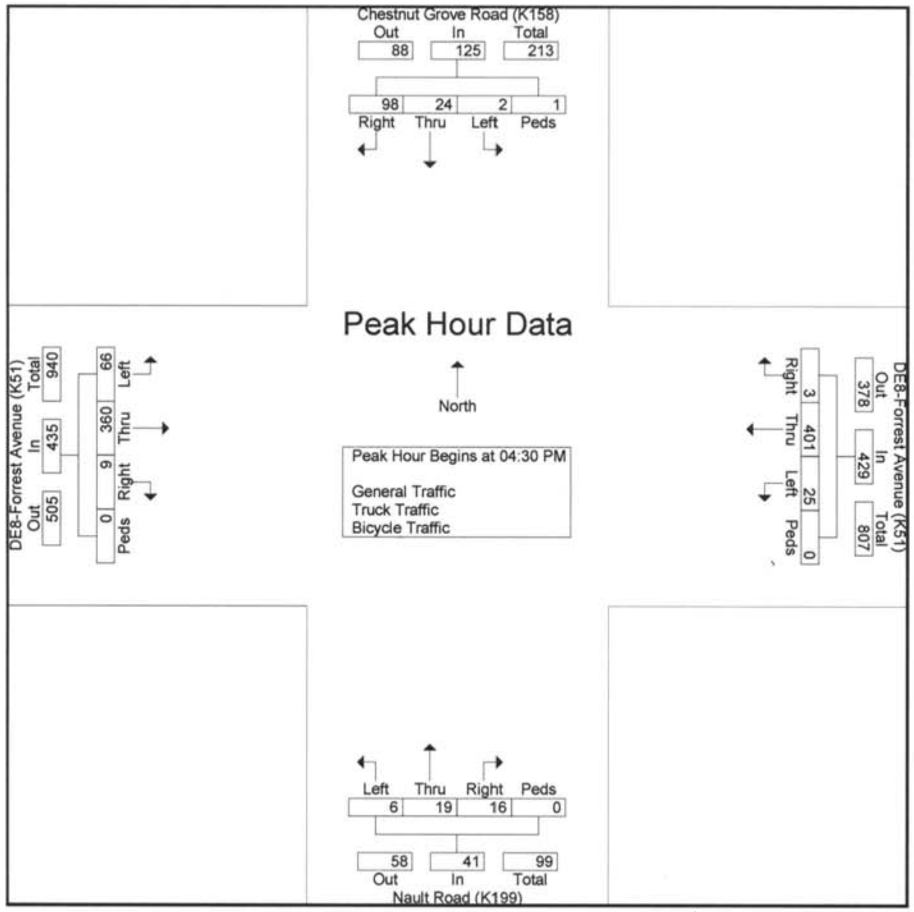
Start Date : 5/3/2012
Page No : 9



TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*BJS*
Agency/Co.	*DelDOT Traffic*
Date Performed	*6/26/2012*
Analysis Time Period	*AM Peak(7:15AM-8:15AM)*

Site Information

Intersection	*DE 8 @ K158 / K199*
Jurisdiction	*Kent County*
Analysis Year	*2012*

Project Description *DE Route 8 @ K158/K199 - Signal Warrant Study*

East/West Street: *DE Route 8*

North/South Street: *Chestnut Grove / Nault Road*

Intersection Orientation: *East-West*

Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	79	494	9	9	169	1
Peak-Hour Factor, PHF	0.90	0.74	0.56	0.67	0.80	0.25
Hourly Flow Rate, HFR (veh/h)	87	663	15	13	212	4
Percent Heavy Vehicles	0	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	1	0	1	1
Configuration	LT		R	LT		R
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	2	34	29	0	13	31
Peak-Hour Factor, PHF	0.50	0.77	0.73	1.00	0.81	0.70
Hourly Flow Rate, HFR (veh/h)	4	43	39	0	15	44
Percent Heavy Vehicles	2	1	5	0	1	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT	LT		LTR			LTR	
v (veh/h)	87	13		86			59	
C (m) (veh/h)	1366	914		257			448	
v/c	0.06	0.01		0.33			0.13	
95% queue length	0.20	0.04		1.42			0.45	
Control Delay (s/veh)	7.8	9.0		25.9			14.3	
LOS	A	A		D			B	
Approach Delay (s/veh)	--	--	25.9			14.3		
Approach LOS	--	--	D			B		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*BJS*
Agency/Co.	*DelDOT Traffic*
Date Performed	*6/26/2012*
Analysis Time Period	*MD Peak(11:00AM-12:00PM)*

Site Information

Intersection	*DE 8 @ K158 / K199*
Jurisdiction	*Kent County*
Analysis Year	*2012*

Project Description *DE Route 8 @ K158/K199 - Signal Warrant Study*

East/West Street: *DE Route 8*

North/South Street: *Chestnut Grove / Nault Road*

Intersection Orientation: *East-West*

Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	47	355	5	15	265	3
Peak-Hour Factor, PHF	0.69	0.94	0.63	0.75	0.91	0.38
Hourly Flow Rate, HFR (veh/h)	68	376	8	20	291	8
Percent Heavy Vehicles	0	--	--	2	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	1	0	1	1
Configuration	LT		R	LT		R
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	8	12	27	7	13	43
Peak-Hour Factor, PHF	0.67	0.60	0.56	0.88	0.65	0.72
Hourly Flow Rate, HFR (veh/h)	11	19	47	8	20	59
Percent Heavy Vehicles	2	1	5	0	1	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT	LT		LTR			LTR	
v (veh/h)	68	20		77			87	
C (m) (veh/h)	1274	1174		401			463	
v/c	0.05	0.02		0.19			0.19	
95% queue length	0.17	0.05		0.70			0.68	
Control Delay (s/veh)	8.0	8.1		16.1			14.6	
LOS	A	A		C			B	
Approach Delay (s/veh)	--	--	16.1			14.6		
Approach LOS	--	--	C			B		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*BJS*	Intersection	*DE 8 @ K158 / K199*
Agency/Co.	*DelDOT Traffic*	Jurisdiction	*Kent County*
Date Performed	*6/26/2012*	Analysis Year	*2012*
Analysis Time Period	*PM Peak(4:30PM-5:30PM)*		

Project Description *DE Route 8 @ K158/K199 - Signal Warrant Study*	
East/West Street: *DE Route 8*	North/South Street: *Chestnut Grove / Nault Road*
Intersection Orientation: *East-West*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*66*	*360*	*9*	*25*	*401*	*3*
Peak-Hour Factor, PHF	*0.83*	*0.80*	*0.75*	*0.69*	*0.79*	*0.38*
Hourly Flow Rate, HFR (veh/h)	*79*	*451*	*12*	*36*	*508*	*8*
Percent Heavy Vehicles	*0*	--	--	*2*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*1*	*0*	*1*	*1*
Configuration	*LT*		*R*	*LT*		*R*
Upstream Signal		*0*			*0*	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*6*	*19*	*16*	*2*	*24*	*98*
Peak-Hour Factor, PHF	*0.50*	*0.53*	*0.67*	*0.50*	*0.60*	*0.79*
Hourly Flow Rate, HFR (veh/h)	*12*	*35*	*23*	*4*	*39*	*124*
Percent Heavy Vehicles	*2*	*1*	*5*	*0*	*1*	*0*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration		*LTR*			*LTR*	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*	*LT*		*LTR*			*LTR*	
v (veh/h)	*79*	*36*		*70*			*167*	
C (m) (veh/h)	*1060*	*1098*		*174*			*335*	
v/c	*0.07*	*0.03*		*0.40*			*0.50*	
95% queue length	*0.24*	*0.10*		*1.78*			*2.65*	
Control Delay (s/veh)	*8.7*	*8.4*		*39.0*			*26.0*	
LOS	*A*	*A*		*E*			*D*	
Approach Delay (s/veh)	--	--	*39.0*			*26.0*		
Approach LOS	--	--	*E*			*D*		

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APPENDIX B

Radar Data

RADAR COLLECTION DATA

REQUESTED BY:	**B.J. Song**	SHEET NO.:	**One of Two**
COUNTY:	**Kent County**	DATE:	**5/2/2012**
ROAD NO.:	**K51**	BY:	**Heather Mantz**
ROAD NAME:	**Forrest Avenue**		

SPEED	EASTBOUND		WESTBOUND		TOTAL	SECONDS
65	I	1	I	1	2	0.93
64	I	1	I	1	2	
63			I	1	1	
62			II	2	2	
61			I	1	1	
60	II	2	II	2	4	1.0
59	III	3	I	1	4	
58	IIIII II	7	IIII	4	11	
57	IIII	4	IIII	4	8	
56	IIIII	5	IIII	4	9	
55	IIIII II	7	IIIII	5	12	
54	IIIII IIIII IIIII I	16	IIIII IIIII	10	26	1.1
53	IIIII II	7	IIIII IIIII II	12	19	
52	IIIII	5	IIIII IIII	9	14	
51	IIIII IIIII II	12	IIIII III	8	20	
50	IIIII IIIII IIIII	15	IIIII IIIII	10	25	1.2
49	IIIII	5	IIIII I	6	11	
48	IIII	4	IIIII	5	9	
47	I	1	IIII	4	5	
46	III	3	II	2	5	1.3
45	II	2	I	1	3	
44			II	2	2	
43			II	2	2	1.4
42			III	3	3	
41					0	
40					0	1.5
39					0	
38					0	
37					0	1.6
36					0	
35					0	1.7
34					0	
33					0	1.8
32					0	
31					0	1.9
30					0	2.0
29					0	2.1
28					0	
27					0	2.2
26					0	2.3
25					0	2.4
24					0	2.5
23					0	2.6
22					0	
21					0	2.8
20					0	3.0
TOTALS:		**100**		**100**	**200**	

POSTED SPEED: **50** MPH   WEATHER: **Daylight/Cloudy/Dry**

OBSERVATION POINT: On Forrest Avenue approximately 800' east of Nault Road (K199)

PERCENTILE SPEEDS:

	50%	85%	TIME:
EASTBOUND	53 MPH	57 MPH	**1:15 pm - 1:55 pm**
WESTBOUND	52 MPH	57 MPH	**1:15 pm - 1:55 pm**
COMBINED	53 MPH	57 MPH	**1:15 pm - 1:55 pm**

Field Notes:

RADAR COLLECTION DATA

REQUESTED BY:	**B.J. Song**	SHEET NO.:	**Two of Two**
COUNTY:	**Kent County**	DATE:	**5/2/2012**
ROAD NO.:	**K51**	BY:	**Heather Mantz**
ROAD NAME:	**Forrest Avenue**		

SPEED	EASTBOUND		WESTBOUND		TOTAL	SECONDS
65			I	1	1	0.93
64					0	
63			I	1	1	
62					0	
61	I	1	I	1	2	
60	II	2	I	1	3	1.0
59			II	2	2	
58	II	2	IIII	4	6	
57	IIIII	5	IIIII I	6	11	
56	IIII	4	III	3	7	
55	III	3	IIII	4	7	
54	IIIII II	7	IIIII II	7	14	1.1
53	IIIII III	8	IIIII I	6	14	
52	IIIII II	7	IIIII IIII	9	16	
51	IIIII IIIII I	11	IIIII II	7	18	
50	IIIII I	6	IIIII IIIII III	13	19	1.2
49	IIIII IIIII III	13	IIIII III	8	21	
48	IIIII IIII	9	IIIII	5	14	
47	IIII	4	IIII	4	8	
46	IIIII III	8	IIIII I	6	14	1.3
45	IIII	4	IIII	4	8	
44			IIIII I	6	6	
43	III	3	I	1	4	1.4
42	I	1	I	1	2	
41					0	
40	I	1			1	1.5
39					0	
38					0	
37	I	1			1	1.6
36					0	
35					0	1.7
34					0	
33					0	1.8
32					0	
31					0	1.9
30					0	2.0
29					0	2.1
28					0	
27					0	2.2
26					0	2.3
25					0	2.4
24					0	2.5
23					0	2.6
22					0	
21					0	2.8
20					0	3.0
TOTALS:		**100**		**100**	**200**	

POSTED SPEED: **50** MPH WEATHER: **Daylight/Cloudy/Dry**

OBSERVATION POINT: On Forrest Avenue approximately 1200' west of Nault Road (K199)

PERCENTILE SPEEDS:

	50%	85%	TIME:
EASTBOUND	51 MPH	55 MPH	**1:55 pm - 2:30 pm**
WESTBOUND	51 MPH	57 MPH	**1:55 pm - 2:30 pm**
COMBINED	51 MPH	56 MPH	**1:55 pm - 2:30 pm**

Field Notes:

APPENDIX C

Crash Data

Delaware Crash Analysis Reporting System (CARS)

Crash Study Time Period:	*Study Period from 04-27-2009 to 04-27-2012*
Query Type:	*singlePoint*
Description:	*reports - DE Rt 8 @ Chestnut Grove Road/Nault Road*

Study Requested By:	
Study Generated By:	TDTSDLR
Number of Crashes:	17
Includes Non-Reportable Crashes:	N
Study Code:	

Disclaimer for CARS: Crash data and associated police reports are intended for DelDOT use only and shall not be transmitted, copied, distributed or provided to any entity other than DelDOT unless written approval is received from the DelDOT Legal Section. Police reports are the property of the Delaware State Police.

DE Route 8 (K051, Forrest Avenue) @
Chestnut Grove Road (K158) / Nault Road (K199)

Crash History Table
(April 2009 - April 2012)

12/11/2012
DelDOT Traffic

	Date	Time	Weather	Lighting	Surface	Manner of Impact	Severity	Milepoint	Contributing Circumstances	Orientation	Location
1	6/24/2009	4:19 PM	Clear	Daylight	Dry	Siedswipe-opposite	Injury	2.08	Vehicle crossed centerline	WB/EB	At intersection
2	5/21/2009	1:50 PM	Clear	Daylight	Dry	Rear-end	PDO	2.08	Innatentive driving	EBLT/EB	At intersection
3	12/7/2009	2:40 PM	Clear	Daylight	Dry	Rear-end	Injury	2.08	Innatentive driving	EBLT/EB	At intersection
4	8/30/2009	5:49 PM	Clear	Daylight	Dry	Rear-end	PDO	2.08	Innatentive driving	EBLT/EB	At intersection
5	9/19/2009	4:04 PM	Clear	Daylight	Dry	Rear-end	PDO	2.08	Following too closely	EB/EB	At intersection
6	5/22/2010	9:50 PM	Rain	Dark-unlit	Wet	ROR/HFO	PDO	0.01	Unknown / Hit-and-run	SB	Chestnut Grove Road
7	8/16/2010	1:12 PM	Clear	Daylight	Dry	Angle	Injury	0.00	Failure to remain stopped at a STOP sign	EB/SB	At intersection
8	6/6/2010	2:15 PM	Clear	Daylight	Dry	Angle	Injury	2.08	Failure to remain stopped at a STOP sign	EB/SB	At intersection
9	4/11/2011	12:00 AM	Cloudy	Daylight	Dry	Angle	PDO	2.01	Failure to remain stopped at a STOP sign	NB/EB	Nault Road at Sapp Drive
10	8/16/2011	4:43 PM	Clear	Daylight	Dry	Angle	PDO	2.08	Failure to remain stopped at a STOP sign	EB/NBRT	At intersection
11	11/29/2011	8:45 AM	Rain	Daylight	Wet	Left-turn	Injury	0.00	Failure to yield right of way	WB/EBLT	At intersection
12	5/9/2011	6:49 AM	Clear	Daylight	Dry	Angle	PDO	2.08	Failure to remain stopped at a STOP sign	EB/NBRT	At intersection
13	11/11/2011	5:37 PM	Clear	Dark-unlit	Dry	Left-turn	PDO	0.00	Failure to yield right of way	WB/EBLT	At intersection
14	1/25/2011	12:22 PM	Clear	Daylight	Dry	Angle	PDO	1.86	Failure to remain stopped at a STOP sign	EB/NB	At intersection
15	1/26/2012	6:33 AM	Rain	Dark-unlit	Wet	Sideswipe-same	PDO	0.00	Unsafe lane change	EB/EB	At intersection
16	3/30/2012	8:59 PM	Clear	Dark-unlit	Dry	Hit deer	PDO	1.91	Animal in roadway	EB	165' W/O Nault Road
17	2/18/2012	5:40 PM	Clear	Dark-unlit	Dry	Rear-end	PDO	0.00	Innatentive driving	EBLT/EB	At intersection

ROR: Run-off the Road

PDO: Property Damage Only

APPENDIX D

Traffic Signal Warrant Worksheets

DELAWARE DEPARTMENT OF TRANSPORTATION

TRAFFIC ENGINEERING AND MANAGEMENT

SUPPLEMENTAL TRAFFIC SIGNAL EVALUATION FORM

This form is based on the Traffic Signal Warrants from the
2003 Edition of the Manual on Uniform Traffic Control Devices
published by the Federal Highway Administration

Location: DE Roue 8 @ Chestnut Grove Road / Nault Road
Date: June 4, 2012
County: Kent
Analyst: BJS

FORM NAVIGATION

Click on the links below to navigate to a particular location in this form

Intersection Characteristics		Warrant 5	*School Crossing*
Volume Input		Warrant 6	*Coordinated Signal System*
Warrant 1	*Eight-Hour Vehicular Volume*	Warrant 7	*Crash Experience*
Warrant 2	*Four-Hour Vehicular Volume*	Warrant 8	*Roadway Network*
Warrant 3	*Peak Hour*		
Warrant 4	*Pedestrian Volume*		

INTERSECTION CHARACTERISTICS

Major Road Name: DE Route 8 **Orientation:** East/West

Minor Road Name: Chestnut Grove Road / Nault Road **Orientation:** North/South

Choose the number of travel lanes on the MAJOR road and MINOR road, respectively.

Major Street Approach	Minor Street Approach
1 Lane	1 Lane

Does the 85th percentile speed of major street traffic or the speed limit exceed 40 MPH?
Please enter the major street 85th-percentile speed or roadway speed limit in the box at right. 50 MPH YES

Does the intersection lie within the built up area of an isolated community, having a population of less than 10,000? No

INPUT HOURLY AND PEDESTRIAN VOLUMES

Hours	Major Street Volumes				Minor Street Volumes		
	DE Route 8			Peds Crossing	Chestnut Grove Road / Nault Road		
	Eastbound	Westbound	Approach Total	Major Street	Northbound	Southbound	Maximum Volume
7 - 8 AM	553	175	***728***	0	69	44	***69***
8 - 9 AM	443	139	***582***	0	48	34	***48***
9 - 10 AM	383	185	***568***	0	41	41	***41***
10 - 11 AM	352	214	***566***	0	35	33	***35***
11 AM - 12 PM	407	283	***690***	0	47	63	***63***
12 - 1 PM	355	294	***649***	0	29	54	***54***
1 - 2 PM	370	258	***628***	0	38	54	***54***
2 - 3 PM	343	315	***658***	1	39	70	***70***
3 - 4 PM	362	399	***761***	0	43	105	***105***
4 - 5 PM	346	417	***763***	0	46	138	***138***
5 - 6 PM	435	379	***814***	0	40	96	***96***
6 - 7 PM	297	289	***586***	0	27	55	***55***

WARRANT 1 - EIGHT HOUR VEHICULAR VOLUME

The need for a traffic control signal shall be considered if an engineering study finds that Condition A or Condition B is met for each of any 8 hours of an average day.

Condition A
A minimum of **350** vehicles per hour required on the major road and a minimum of
105 vehicles per hour required on the higher volume minor road approach.
A total of **2** hours meet Condition A.

WARRANT 1 IS NOT SATISFIED BY CONDITION A - PROCEED TO CONDITION B

Condition B
A minimum of **525** vehicles per hour required on the major road and a minimum of
53 vehicles per hour required on the higher volume minor road approach.
A total of **9** hours meet Condition B.

WARRANT IS SATISFIED BY CONDITION B

The combination of Conditions A and B is intended for application at locations where Condition A and Condition B are not satisified.
The combination of Conditions A and B should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.
The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions are met for each of any 8 hours of an average day.

Question 1a: Have other alternatives that could cause less delay and inconvenience to traffic been tried at this location? **No**
Question 1b: If the answer to question 1a is yes, have those alternatives failed to correct the traffic problems?

Condition A
A minimum of **280** vehicles per hour required on the major road and a minimum of
84 vehicles per hour required on the higher volume minor road approach.
A total of **N/A** hours meet Condition A.

Condition B
A minimum of **420** vehicles per hour required on the major road and a minimum of
42 vehicles per hour required on the higher volume minor road approach.
A total of **N/A** hours meet Condition B.

A total of **N/A** hours meet the Combination of Condition A and Condition B.

THE COMBINATION OF CONDITIONS A & B IS NOT APPLICABLE TO THIS LOCATION

WARRANT 2 - FOUR HOUR VEHICULAR VOLUME

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied whre the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major-street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in the figures below for the existing combination of approach lanes.

Figure 4C-1 - Warrant 2, Four-Hour Vehicular Volume

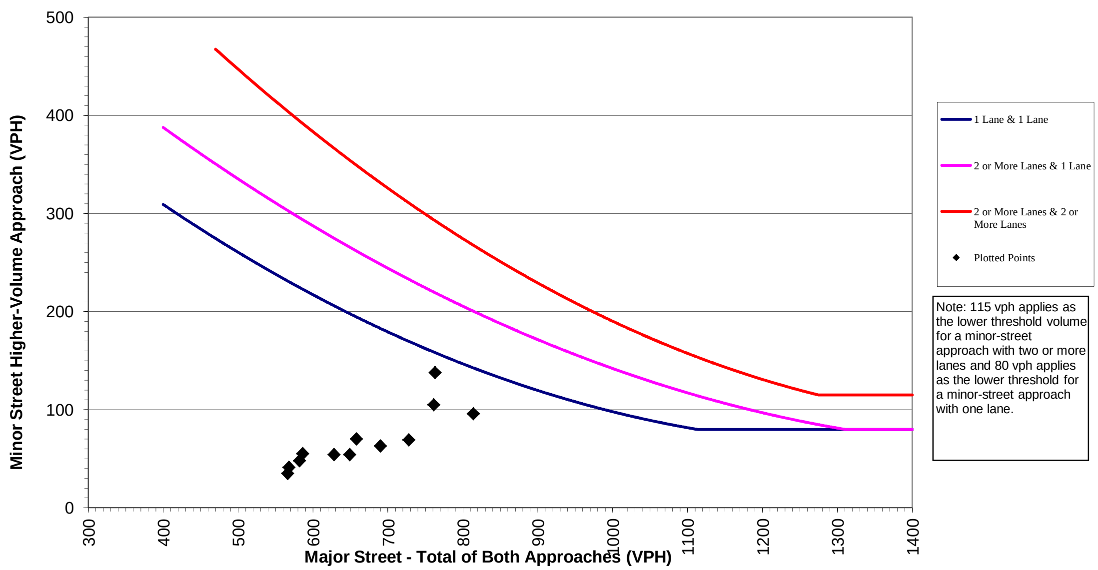
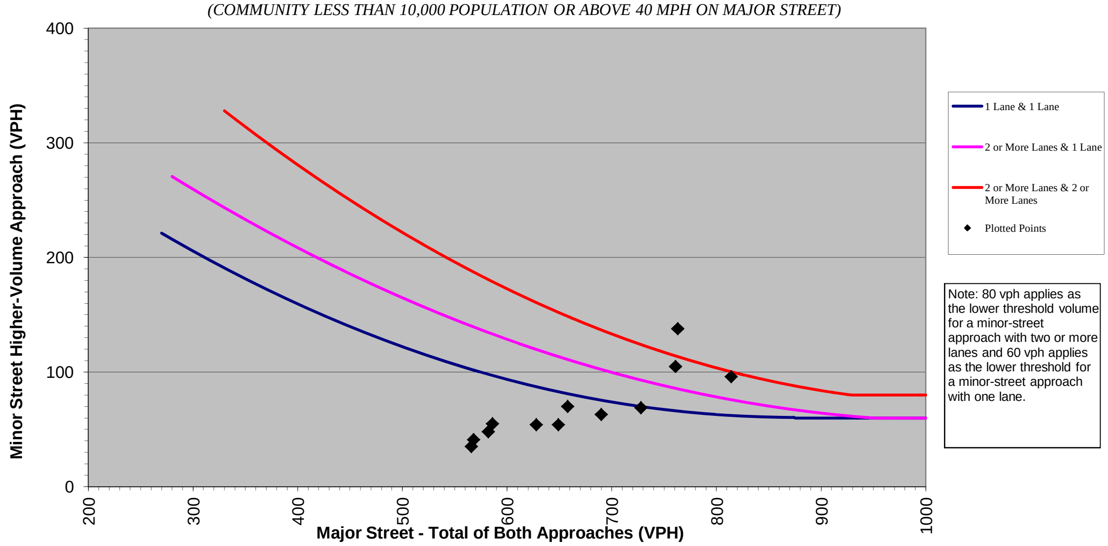


Figure 4C-2 - Warrant 2, Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



Enter the number of points that lie above the applicable curve in either Figure 4C-1 or Figure 4C-2	4

WARRANT 2 IS SATISFIED - PROCEED TO WARRANT 3

WARRANT 3 - PEAK HOUR

The Peak Hour signal warrant ins intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

Is this location an "unusual case" such as an office complex, manufacturing plant, industrial complex or high-occupancy vehicle facility that attracts or discharges large numbers of vehicles over a short time?	NO

Warrant 3 is not applicable to this intersection - Proceed to Warrant 4

The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:

Category A:	If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:	
Question 1:	Does the total stopped time delay experienced by the traffic on one minor-street approach (one direction only) that is controlled by a STOP sign equal or exceed: 4 vehicle-hours for a one-lane approach; or 5 vehicle-hours for a two-lane approach?	

NOTE: Delay must be determined from the completion of a STOP sign delay study performed in the field. Delay values from typical capacity analyses are not acceptable.

Question 2:	Does the volume on the same minor-street approach (one direction only) equal or exceed 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes?	
Question 3:	Does the total entering volume serviced during the hour equal or exceed 650 vehicles per hour for an intersection with three approaches or 800 vehicles per hour for intersections with four or more approaches?	
Category B:	Does the plotted point representing the vehicles per hour on the major-street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day fall above the applicable curve in Figure 4C-3 or Figure 4C-4, below, for the existing combination of approach lanes?	YES

Figure 4C-3 - Warrant 3, Peak Hour

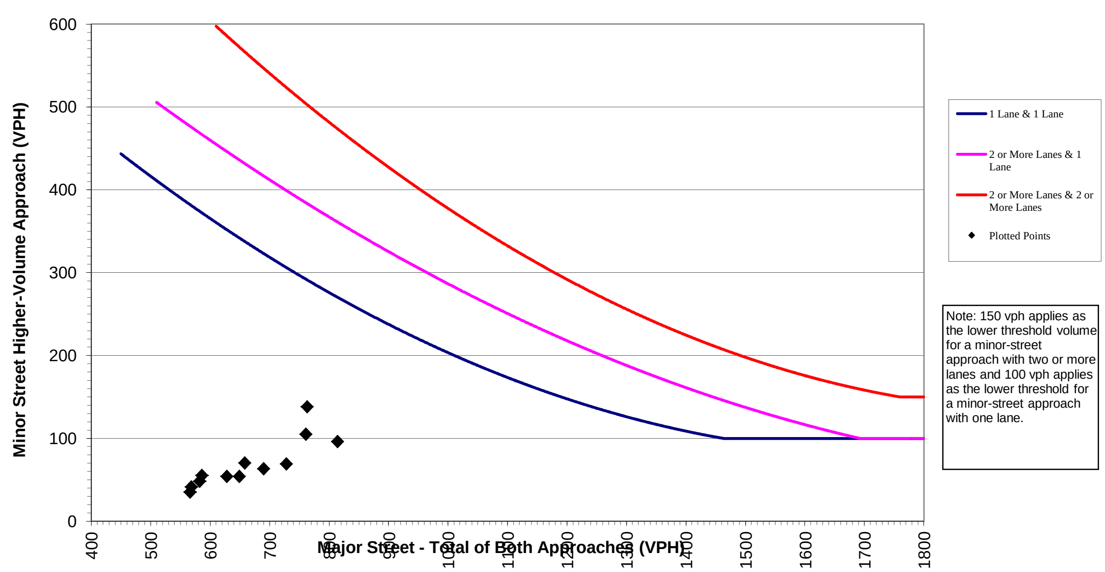
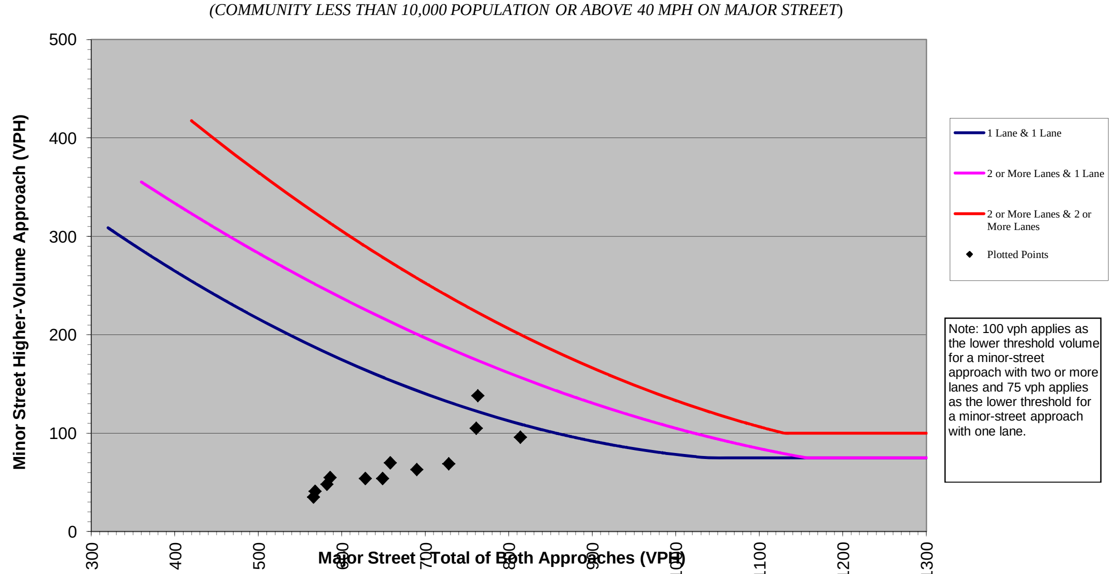


Figure 4C-4 - Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



Enter the number of points that lie above the applicable curve in either Figure 4C-3 or Figure 4C-4	1

WARRANT 3 IS NOT APPLICABLE TO THIS INTERSECTION - PROCEED TO WARRANT 4

WARRANT 4 - PEDESTRIAN VOLUME

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 ft (90 m), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Question 1a:	What is the distance to the nearest traffic control signal along the major street?	**10000**
Question 1b:	If the proposed signal is less than 300 feet from the nearest existing signal on the major street, will the proposed signal restrict the progressive movement of traffic?	**NO**

Proceed to next step

The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that both of the following criteria are met:

Criteria A:	Does the pedestrian volume crossing the major street at an intersection or midblock location during an average day equal 100 or more for each of any 4 hours or 190 or more during any 1 hour?	**NO**
Criteria B:	Are there fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied? *Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic*.	gaps/hour

NOTE: Gaps in vehicular traffic must be determined by performing a gap study in the field.

WARRANT 4 IS NOT SATISFIED - PROCEED TO WARRANT 5

WARRANT 5 - SCHOOL CROSSING

The School Crossing signal warrant is intended for applications where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal.

Question 1:	Is the study intersection within an established school zone?	**NO**

Warrant 5 is not applicable to this location - Proceed to Warrant 6

The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 ft (90 m), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Question 2a:	What is the distance to the nearest traffic control signal along the major street?	
Question 2b:	If the proposed signal is less than 300 feet from the nearest existing signal on the major street, will the proposed signal restrict the progressive movement of traffic?	

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period (see Section 7A.03 of the MUTCD) and there are a minimum of 20 students during the highest crossing hour.

Question 3a:	What is the number of adequate gaps in the traffic stream during the period when the children are using the crossing?	
Question 3b:	What is the number of minutes during the same period when the children are using the crossing?	
Question 3c:	What is the number of students during the highest crossing hour?	

WARRANT 5 IS NOT APPLICABLE TO THIS LOCATION - PROCEED TO WARRANT 6

WARRANT 6 - COORDINATED SIGNAL SYSTEM

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Question 1:	Is this unsignalized intersection within a corrdior of signals that operate on a coordinated signal system?	**NO**

Proceed to Warrant 7

Question 2:	If a signal was installed at this intersection, would the resultant spacing of traffic control signals be less than 1000 feet apart?	

The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:

Criteria A:	On a one-way street or a street that has traffic predominantly in one direction, are the adjacent traffic control signals so far apart that they do not provide the necessary degree of vehicular platooning?	
Criteria B:	On a two-way street, do the adjacent traffic control signals provide the necessary degree of platooning?	
Question 3:	Will the proposed and adjacent traffic control signals collectively provide a progressive operation?	

WARRANT 6 IS NOT APPLICABLE TO THIS INTERSECTION - PROCEED TO WARRANT 7

WARRANT 7 - CRASH EXPERIENCE

The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

Criteria A:	Has an adequate trial of alternatives with satisfactory observance and enforcement failed to reduce the crash frequency?		**No**
	If answer to Criteria A is YES, please list the failed alternatives below:		
Criteria B:	Has five (5) or more crashes, of types susceptible to correction by a traffic control signal, occurred within a 12-month period? Each crash must involve personal injury or property damage exceeding the applicable requirements for a reportable crash.		**YES**
	Number of crashes of types susceptible to correction by a traffic control signal occurring within a 12-month period.	**5**	
Criteria C:	Are 80% of the requirements of Warrant 1 or Warrant 4 met?		**YES**

WARRANT 7 IS NOT SATISFIED - PROCEED TO WARRANT 8

WARRANT 8 - ROADWAY NETWORK

Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Question 1: **In order for this warrant to be applicable to the study intersection, the study intersection must be the junction of two (2) or more major routes. A major route as used in this signal warrant shall have one or more of the following characteristics:**

Criteria A:	Is each route part of the street or highway system tat serves as the principal roadway network for through traffic flow?	**No**
Criteria B:	Does each route include rural or suburban highways outside, entering or traversing a City?	
Criteria C:	Does each route appear as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study?	**No**

The study intersection is not the junction of two or more major routes - Warrant 8 is not applicable to this intersection, Proceed to the end of the worksheet

The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

Criteria A:	Does the intersection have a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and have a 5-year preojcted traffic volume, based on an engineering study, that meets one or more of Warrants 1, 2, and 3 during an average weekday?	**No**
Criteria B:	Does the intersection have a total existing, or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a nonnormal business day (Saturday or Sunday)?	**No**

WARRANT 8 IS NOT APPLICABLE

APPENDIX E

Site Photographs

1) DE Route 8 looking West toward Chestnut Grove Road / Nault Road

2) DE Route 8 looking East toward Chestnut Grove Road / Nault Road

3) Chestnut Grove Road Looking South Toward DE Route 8

4) Nault Road Looking North Toward DE Route 8

5) Southbound Chestnut Grove Road Looking Left (East)

6) Southbound Chestnut Grove Road Looking Right (West)

7) Northbound Nault Road Looking Left (West)


8) Northbound Nault Road Looking Right (East)

APPENDIX H

Sample Highway Safety Manual Predictive Method

Chapter 10: Predictive Method for Rural Two-Lane, Two-Way Roads

Site Conditions

Approach	Functional Classification	AADT (veh/day)
DE 42/Seven Hickories Road	Rural Major Collector	7,711
DE 15/Brenford Road	Rural Major Collector	2,171
Seeneytown Road	Rural Local	1,688

Intersection Skew: 90°
Left Turn Lanes: SB Brenford Road
Right Turn Lanes: None
Lighting: SW and SE quadrants
Analysis Year: 2012

Predictive Model for Intersections (Equation 10-3):

$$N_{predicted,int} = N_{SPF,int} \times C_i \times (CMF_{1i} \times CMF_{2i} \times CMF_{3i} \times CMF_{4i})$$

Safety Performance Function for Four-Leg, Stop-Controlled Intersections (Equation 10-9):

$$N_{SPF,4ST} = exp[-8.56 + 0.60 \times ln(AADT_{maj}) + 0.61 \times ln(AADT_{min})]$$

NOTE: Since side streets have two different AADT volumes, use the greater value.

$$N_{SPF,4ST} = exp[-8.56 + 0.60 \times ln(7,711) + 0.61 \times ln(2,171)]$$
$$N_{SPF,4ST} = 4.47\ crashes/year$$

Inclusion of Crash Modification Factors (CMFs):

Skew (Base Condition = 90°):
$$CMF_{1i} = exp(0.0054 \times skew)$$
$$CMF_{1i} = 1.00$$

Left Turn Lanes (Base Condition = None)
NOTE: Left turn lanes on side street approaches have no effect on the CMF, therefore it can be disregarded.

$$CMF_{2i} = 1.00$$

Right Turn Lanes (Base Condition = None)
$$CMF_{3i} = 1.00$$

Lighting (Base Condition = None)

$$CMF_{4i} = 1 - 0.38 \times p_{ni}$$

$$CMF_{4i} = 1 - 0.38 \times 0.244 \quad \textbf{(Table 10-15)}$$

$$CMF_{4i} = 0.91$$

Inclusion of Calibration Factor (C_i):

$$C_i = 1.00$$

NOTE: DelDOT is in the process of formulating local calibration factors. Until a formal set of calibration factors has been issued by the Department, the value of C_i is assumed to be 1.00.

Inclusion in Predictive Model:

$$N_{predicted,int} = 4.47 \times 1.00 \times (1.00 \times 1.00 \times 1.00 \times 0.91)$$

$$\boxed{N_{predicted,int} = 4.06\ crashes/year}$$

Safety Performance Function for Four-Leg, Signalized Intersections (Equation 10-10):

$$N_{SPF,4SG} = exp[-5.13 + 0.60 \times ln(AADT_{maj}) + 0.20 \times ln(AADT_{min})]$$

NOTE: Since side streets have two different AADT volumes, use the greater value.

$$N_{SPF,4SG} = exp[-5.13 + 0.60 \times ln(7,711) + 0.20 \times ln(2,171)]$$
$$N_{SPF,4SG} = 5.91\ crashes/year$$

Inclusion of Crash Modification Factors (CMFs):

Skew (Base Condition = 90°):
$$CMF_{1i} = exp(0.0054 \times skew)$$
$$CMF_{1i} = 1.00$$

Left Turn Lanes (Base Condition = None)
NOTE: Left turn lanes on side street approaches have no effect on the CMF, therefore it can be disregarded.

$$CMF_{2i} = 1.00$$

Right Turn Lanes (Base Condition = None)
$$CMF_{3i} = 1.00$$

Lighting (Base Condition = None)
$$CMF_{4i} = 1 - 0.38 \times p_{ni}$$
$$CMF_{4i} = 1 - 0.38 \times 0.286 \quad \textbf{(Table 10-15)}$$
$$CMF_{4i} = 0.89$$

Inclusion of Calibration Factor (C_i):
$$C_i = 1.00$$

Inclusion in Predictive Model:

$$N_{predicted,int} = 4.47 \times 1.00 \times (1.00 \times 1.00 \times 1.00 \times 0.89)$$

$$\boxed{N_{predicted,int} = 5.26\ crashes/year}$$

Predicted Crash Type Distribution Comparison for All Severities (Table 10-6):

All Severities		Stop-Controlled N = 4.06		Signalized N = 5.26	
	Collision Type	%	# Crashes	%	# Crashes
Single Vehicle Crashes	Animal	1.0%	0.04	0.2%	0.01
	Bicycle	0.1%	0.00	0.1%	0.01
	Pedestrian	0.1%	0.00	0.1%	0.01
	Overturn	0.5%	0.02	0.3%	0.02
	Run Off Road	12.2%	**0.50**	6.4%	**0.34**
	Other	0.8%	0.03	0.5%	0.03
	Total Single Vehicle Crashes	*14.7%*	*0.60*	*7.6%*	*0.40*
Multi-Vehicle Crashes	Angle	43.1%	**1.75**	27.4%	1.44
	Head On	4.0%	0.16	5.4%	0.28
	Rear End	24.2%	0.98	42.6%	**2.24**
	Sideswipe	10.1%	0.41	11.8%	0.62
	Other	3.9%	0.16	5.2%	0.27
	Total Multi-Vehicle Crashes	*85.3%*	*3.46*	*92.4%*	*4.86*
Total Crashes		***100.0%***	***4.06***	***100.0%***	***5.26***

Chapter 14: Crash Modification Factors (CMFs) for Intersections

Crash Summary, 1/1/2012 to 12/31/2012 (0.1-mile along all legs of intersection)
7 Crashes

5 Property Damage Only
2 Personal Injury
0 Fatality

3 Angle
2 Rear End
1 Left Turn
1 Other (Single Vehicle Crash)

Treatment #1: Convert Four-Leg Stop-Controlled Intersection to Four-Leg Signalized Intersection

Table 14-7: Rural Four-Leg

Crash Type	CMF	# Crashes (2012)	Predicted # Crashes per Year
Right Angle	0.23	3	0.7
Left Turn	0.4	1	0.4
Rear End	1.58	2	3.2
All Types	*0.56*	*7*	***3.9***

By using the CMF method for this specific treatment, we can conclude that this intersection will experience approximately 4 crashes per year.

Treatment #2: Convert Four-Leg Stop-Controlled Intersection to Four-Leg, All-Way Stop Intersection

Table 14-5: Rural, Assume all MUTCD warrants met

Crash Type	CMF	# Crashes (2012)	Predicted # Crashes per Year
All Types	*0.52*	*7*	***3.6***

By using the CMF method for this specific treatment, we can conclude that this intersection will experience approximately 4 crashes per year.

Treatment #3: Convert Four-Leg Stop-Controlled Intersection to Modern Roundabout

Table 14-4: Rural, Assume One-Lane

Crash Type	CMF	# Crashes (2012)	Predicted # Crashes per Year
All Types	*0.29*	*7*	***2.0***

By using the CMF method for this specific treatment, we can conclude that this intersection will experience approximately 2 crashes per year.

Crash Rates for Historical Countermeasures

At the intersection of DE 42 (Seven Hickories Road) & DE 15 (Brenford Road)/Seeneytown Road, two historical crash countermeasures have been implemented:

- Lighting on the southeast and southwest quadrants was installed on 1/5/2009.
- Solar-Powered, Flashing Red Beacons were installed on both STOP signs in the northbound and southbound directions on 11/8/2010.

Base Condition	Countermeasure	Study Period	# Years in Study Period	# Crashes in Study Period	Crash Rate (crashes per year)
No Treatment	Install Lighting	1/5/2006 - 1/5/2009	3.00	8	**2.67**
Lighting	Install Flashing Beacons	1/6/2009 - 11/8/2010	1.84	8	**4.35**
Flashing Beacons	Present	11/9/2010 - 7/19/2013	2.70	16	**5.93**

Chapter 12: Predictive Method for Urban and Suburban Arterials

Site Conditions

Approach	Functional Classification	AADT (veh/day)
South Broad Street	Urban Arterial	7,842
East Green Street	Urban Local	2,000
West Green Street	Urban Local	2,000

- Stop-controlled on side streets
- Intersection Skew: 90°
- Left Turn Lanes: All approaches
- Right Turn Lanes: All approaches
- Lighting: All quadrants
- Analysis Year: 2012
- 2 Bus Stops within 1,000 ft of intersection
- No Schools within 1,000 ft of intersection
- No Alcohol Sales Establishments within 1,000 ft of intersection
- Pedestrian Volume (PedVol): 40 Peds/day
- Maximum # of lanes for pedestrian crossing (n_{lanes}): 6

Determine the predicted number of crashes at the existing stop-controlled intersection and a proposed signalized intersection.

*****Determine the predicted number of crashes at the existing stop-controlled intersection.***

Safety Performance Function for Multi-Vehicle Crashes at Four-Leg, Stop-Controlled Intersections

$$N_{bimv,4ST} = exp[a + b \times ln(AADT_{maj}) + c \times ln(AADT_{min})]$$ **(Equation 12-21)**

NOTE: If side streets have two different AADT volumes, use the greater value.

Use Table 12-10 to find SPF coefficients for 4ST.

$$N_{bimv,4ST} = exp[-8.90 + 0.82 \times ln(7,842) + 0.25 \times ln(2,000)]$$
$$N_{bimv,4ST} = 1.42\ crashes/year$$

If desired, find the number of multi-vehicle crashes based on severity level: Fatal/Injury (FI) and Property Damage Only (PDO). Use Equation 12-21 with appropriate crash severity coefficients from Table 12-10.

Fatal/Injury Crashes
$$N'_{bimv(FI),4ST} = exp[-11.13 + 0.93 \times ln(7,842) + 0.28 \times ln(2,000)]$$
$$N'_{bimv(FI),4ST} = 0.51\ crashes/year$$

Property Damage Only Crashes
$$N'_{bimv(PDO),4ST} = exp[-8.74 + 0.77 \times ln(7,842) + 0.23 \times ln(2,000)]$$
$$N'_{bimv(PDO),4ST} = 0.91\ crashes/year$$

Therefore, in order to assure that $N_{bimv(FI),4ST}$ and $N_{bimv(PDO),4ST}$ sum to $N_{bimv(total),4ST}$,

$$N_{bimv(FI),4ST} = N_{bimv(total),4ST} \times \left(\frac{N'_{bimv(FI)}}{N'_{bimv(FI)} + N'_{bimv(PDO)}}\right)$$ **(Equation 12-22)**

$$N_{bimv(FI),4ST} = 1.42 \times \left(\frac{0.51}{0.51 + 0.91}\right)$$
$$N_{bimv(FI),4ST} = 0.51\ crashes/year$$

And thus,

$$N_{bimv(PDO),4ST} = N_{bimv(total),4ST} - N_{bimv(FI),4ST}$$ **(Equation 12-23)**
$$N_{bimv(PDO),4ST} = 1.42 - 0.51$$
$$N_{bimv(PDO),4ST} = 0.91\ crashes/year$$

Safety Performance Function for Single-Vehicle Crashes at Four-Leg, Stop-Controlled Intersections

$$N_{bisv,4ST} = exp[a + b \times ln(AADT_{maj}) + c \times ln(AADT_{min})]$$ **(Equation 12-24)**

NOTE: If side streets have two different AADT volumes, use the greater value.

Use Table 12-12 to find SPF coefficients for 4ST.

$$N_{bisv,4ST} = exp[-5.33 + 0.33 \times ln(7,842) + 0.12 \times ln(2,000)]$$
$$N_{bisv,4ST} = 0.23\ crashes/year$$

Add results from both crash type totals.

$$N_{SPF,int} = N_{bimv,4ST} + N_{bisv,4ST}$$ **(Equation 12-7)**
$$N_{SPF,int} = 1.42 + 0.23$$
$$N_{SPF,int} = 1.65\ crashes/year$$

If desired, find the number of single-vehicle crashes based on severity level: Fatal/Injury (FI) and Property Damage Only (PDO). Use Equation 12-24 with appropriate crash severity coefficients from Table 12-12.

Fatal/Injury Crashes
***NOTE: No models are available for Fatal/Injury crashes for 4ST. Instead, use:*

$$N_{bisv(FI),4ST} = N_{bisv(total)} \times (f_{bisv})$$ **(Equation 12-27)**

Where

$$f_{bisv} = proportion\ of\ fatal\ \&\ injury\ crashes\ for\ combined\ sites = 0.28\ for\ 4ST$$

Therefore,

$$N'_{bisv(FI),4ST} = 0.23 \times (0.28)$$
$$N'_{bisv(FI),4ST} = 0.06\ crashes/year$$

Property Damage Only Crashes
$$N'_{bisv(PDO),4ST} = exp[-7.04 + 0.36 \times ln(7,842) + 0.25 \times ln(2,000)]$$
$$N'_{bisv(PDO),4ST} = 0.16\ crashes/year$$

Therefore, in order to assure that $N_{bisv(FI),4ST}$ and $N_{bisv(PDO),4ST}$ sum to $N_{bisv(total),4ST}$,

$$N_{bisv(FI),4ST} = N_{bisv(total),4ST} \times \left(\frac{N'_{bisv(FI)}}{N'_{bisv(FI)}+N'_{bisv(PDO)}}\right)$$ **(Equation 12-25)**

$$N_{bisv(FI),4ST} = 0.23 \times \left(\frac{0.06}{0.06+0.15}\right)$$
$$N_{bisv(FI),4ST} = 0.07\ crashes/year$$

And thus,

$$N_{bisv(PDO),4ST} = N_{bisv(total),4ST} - N_{bisv(FI),4ST}$$ **(Equation 12-23)**
$$N_{bisv(PDO),4ST} = 0.23 - 0.07$$
$$N_{bisv(PDO),4ST} = 0.16\ crashes/year$$

Inclusion of *Intersection* Crash Modification Factors (CMFs):

Intersection Left Turn Lanes (Table 12-24)
NOTE: Left turn lanes on side street approaches have no effect on the CMF for stop-controlled intersections, therefore these two approaches can be disregarded.

$$CMF_{1i} = 0.53$$

Intersection Left-Turn Phasing (Table 12-25)
Note: This CMF is only applicable to signalized intersections. For unsignalized intersections, use 1.00.

$$CMF_{2i} = 1.00$$

Intersection Right Turn Lanes (Table 12-26)
NOTE: Right turn lanes on side street approaches have no effect on the CMF for stop-controlled intersections, therefore these two approaches can be disregarded.

$$CMF_{3i} = 0.74$$

Right Turn on Red
Note: This CMF is only applicable to signalized intersections. For unsignalized intersections, use 1.00.

$$CMF_{4i} = 1.00$$

Lighting (Table 12-27)

$$CMF_{5i} = 1 - 0.38 \times p_{ni}$$ **(Equation 12-36)**
$$CMF_{5i} = 1 - 0.38 \times (0.229)$$
$$CMF_{5i} = 0.91$$

Red-Light Cameras

Note: This CMF is only applicable to signalized intersections. For unsignalized intersections, use 1.00.

$$CMF_{6i} = 1.00$$

**There are no pedestrian-vehicle CMFs for intersection type 4ST. To determine pedestrian and bicycle crash rates for 4ST, use the following:

$$N_{bi} = N_{SPF,int} \times (CMF_{1i} \times ... \times CMF_{6i})$$ **(Equation 12-6)**

$$N_{bi} = (1.65) \times (0.53) \times (1.00) \times (0.74) \times (1.00) \times (0.91) \times (1.00)$$

$$N_{bi} = 0.59\ crashes/year$$

$$N_{pedi} = N_{bi} \times (f_{pedi})$$ **(Equation 12-30)**

Use Table 12-16 to determine f_{pedi}

$$N_{pedi} = 0.59 \times (0.022)$$

$$N_{pedi} = 0.01\ crashes/year$$

$$N_{bikei} = N_{pedi} \times (f_{bikei})$$ **(Equation 12-31)**

Use Table 12-17 to determine f_{bikei}

$$N_{bikei} = 0.01 \times (0.018)$$

$$N_{bikei} = 0.00\ crashes/year$$

Inclusion of Calibration Factor C_i :

$$C_i = 1.00$$

NOTE: DelDOT is in the process of formulating local calibration factors. Until a formal set of calibration factors has been issued by the Department, the value of C_i is assumed to be 1.00.

Inclusion in Predictive Model:

$$N_{predicted,int} = C_i \times (N_{bi} + N_{pedi} + N_{bikei})$$ **(Equation 12-5)**

$$N_{predicted,int} = 1.00 \times (0.59 + 0.01 + 0.00)$$

$$\boxed{N_{predicted,int} = 0.60\ crashes/year}$$

****Determine the predicted number of crashes at the intersection, should a signal be installed.**

<u>**Safety Performance Function for Multi-Vehicle Crashes at Four-Leg, Signalized Intersections**</u>

$$N_{bimv,4SG} = exp[a + b \times ln(AADT_{maj}) + c \times ln(AADT_{min})]$$ **(Equation 12-21)**

NOTE: If side streets have two different AADT volumes, use the greater value.

Use Table 12-10 to find SPF coefficients for 4SG.

$$N_{bimv,4SG} = exp[-10.99 + 1.07 \times ln(7{,}842) + 0.23 \times ln(2{,}000)]$$
$$N_{bimv,4SG} = 1.42\ crashes/year$$

If desired, find the number of multi-vehicle crashes based on severity level: Fatal/Injury (FI) and Property Damage Only (PDO). Use Equation 12-21 with appropriate crash severity coefficients from Table 12-10.

<u>Fatal/Injury Crashes</u>

$$N'_{bimv(FI),4SG} = exp[-13.14 + 1.18 \times ln(7{,}842) + 0.22 \times ln(2{,}000)]$$
$$N'_{bimv(FI),4SG} = 0.44\ crashes/year$$

<u>Property Damage Only Crashes</u>

$$N'_{bimv(PDO),4SG} = exp[-11.02 + 1.02 \times ln(7{,}842) + 0.24 \times ln(2{,}000)]$$
$$N'_{bimv(PDO),4SG} = 0.98\ crashes/year$$

Therefore, in order to assure that $N_{bimv(FI),4SG}$ and $N_{bimv(PDO),4SG}$ sum to $N_{bimv(total),4SG}$,

$$N_{bimv(FI),4SG} = N_{bimv(total),4SG} \times \left(\frac{N'_{bimv(FI)}}{N'_{bimv(FI)} + N'_{bimv(PDO)}}\right)$$ **(Equation 12-22)**

$$N_{bimv(FI),4SG} = 1.42 \times \left(\frac{0.44}{0.44 + 0.98}\right)$$
$$N_{bimv(FI),4SG} = 0.44\ crashes/year$$

And thus,

$$N_{bimv(PDO),4SG} = N_{bimv(total),4SG} - N_{bimv(FI),4SG}$$ **(Equation 12-23)**
$$N_{bimv(PDO),4SG} = 1.42 - 0.44$$
$$N_{bimv(PDO),4SG} = 0.98\ crashes/year$$

Safety Performance Function for Single-Vehicle Crashes at Four-Leg, Signalized Intersections

$$N_{bisv,4SG} = exp[a + b \times ln(AADT_{maj}) + c \times ln(AADT_{min})] \qquad \textbf{(Equation 12-24)}$$

NOTE: If side streets have two different AADT volumes, use the greater value.

Use Table 12-12 to find SPF coefficients for 4SG.

$$N_{bisv,4SG} = exp[-10.21 + 0.68 \times ln(7,842) + 0.27 \times ln(2,000)]$$
$$N_{bisv,4SG} = 0.13\ crashes/year$$

Add results from both crash types.

$$N_{SPF,int} = N_{bimv,4SG} + N_{bisv,4SG} \qquad \textbf{(Equation 12-7)}$$
$$N_{SPF,int} = 1.42 + 0.13$$
$$N_{SPF,int} = 1.55\ crashes/year$$

If desired, find the number of single-vehicle crashes based on severity level: Fatal/Injury (FI) and Property Damage Only (PDO). Use Equation 12-24 with appropriate crash severity coefficients from Table 12-12.

<u>Fatal/Injury Crashes</u>
$$N'_{bisv(FI),4SG} = exp[-9.25 + 0.43 \times ln(7,842) + 0.29 \times ln(2,000)]$$
$$N'_{bisv(FI),4SG} = 0.04\ crashes/year$$

<u>Property Damage Only Crashes</u>
$$N'_{bisv(PDO),4SG} = exp[-11.34 + 0.78 \times ln(7,842) + 0.25 \times ln(2,000)]$$
$$N'_{bisv(PDO),4SG} = 0.09\ crashes/year$$

Therefore, in order to assure that $N_{bisv(FI),4SG}$ and $N_{bisv(PDO),4SG}$ sum to $N_{bisv(total),4SG}$,

$$N_{bisv(FI),4SG} = N_{bisv(total),4SG} \times \left(\frac{N'_{bisv(FI)}}{N'_{bisv(FI)} + N'_{bisv(PDO)}}\right) \qquad \textbf{(Equation 12-25)}$$

$$N_{bisv(FI),4SG} = 0.13 \times \left(\frac{0.04}{0.04 + 0.09}\right)$$
$$N_{bisv(FI),4SG} = 0.04\ crashes/year$$

And thus,

$$N_{bisv(PDO),4SG} = N_{bisv(total),4SG} - N_{bisv(FI),4SG} \qquad \textbf{(Equation 12-23)}$$

$$N_{bisv(PDO),4SG} = 0.13 - 0.04$$
$$N_{bisv(PDO),4SG} = 0.09\ crashes/year$$

Inclusion of *Intersection* Crash Modification Factors (CMFs):

Intersection Left Turn Lanes (Table 12-24)

$$CMF_{1i} = 0.66$$

Intersection Left-Turn Phasing (Table 12-25)
Note: Protected/Permissive left-turn phasing is assumed for this intersection.

$$CMF_{2i} = 0.99$$

Intersection Right Turn Lanes (Table 12-26)

$$CMF_{3i} = 0.85$$

Right Turn on Red
Note: Assume right turns on red are permitted on all approaches.

$$CMF_{4i} = 1.00$$

Lighting (Table 12-27)

$$CMF_{5i} = 1 - 0.38 \times p_{ni}$$ **(Equation 12-36)**
$$CMF_{5i} = 1 - 0.38 \times (0.235)$$
$$CMF_{5i} = 0.91$$

Red-Light Cameras
Note: Assume no red-light cameras will be in use at this intersection.

$$CMF_{6i} = 1.00$$

Therefore,

$$N_{bi} = N_{SPF,int} \times (CMF_{1i} \times \ldots \times CMF_{6i})$$ **(Equation 12-6)**
$$N_{bi} = 1.55 \times (0.66 \times 0.99 \times 0.85 \times 1.00 \times 0.91 \times 1.00)$$
$$N_{bi} = 0.78\ crashes/year$$

Inclusion of *Pedestrian* Crash Modification Factors (CMFs):

Bus Stops (Table 12-28)

$$CMF_{1p} = 2.78$$

Schools (Table 12-29)

$$CMF_{2p} = 1.00$$

Alcohol Sales Establishments (Table 12-30)

$$CMF_{3p} = 1.00$$

To determine pedestrian and bicycle crash rates for 4SG, use the following:

$$N_{pedi} = N_{pedbase} \times CMF_{1p} \times CMF_{2p} \times CMF_{3p}$$ **(Equation 12-28)**

Where: **(Equation 12-29, Table 12-14)**

$$N_{pedbase} = exp(a + b \times ln(AADT_{total}) + c \times ln\left(\frac{AADT_{min}}{AADT_{maj}}\right) + d \times ln(PedVol) + e \times n_{lanes}$$

$$N_{pedbase} = exp(-9.53 + 0.40 \times ln(9{,}842) + 0.26 \times ln\left(\frac{2{,}000}{7{,}842}\right) + 0.45 \times ln(40) + 0.04 \times (6)$$
$$N_{pedbase} = 0.01\ crashes/year$$

Therefore,

$$N_{pedi} = 0.01 \times (2.78) \times (1.00) \times (1.00)$$
$$N_{pedi} = 0.04\ crashes/year$$

And therefore,

$$N_{bikei} = N_{bi} \times f_{bikei}$$ **(Equation 12-31)**

Use Table 12-17 to determine f_{bikei}

$$N_{bikei} = 0.78 \times (0.015)$$
$$N_{bikei} = 0.01\ crashes/year$$

Inclusion of Calibration Factor C_i :

$$C_i = 1.00$$

NOTE: DelDOT is in the process of formulating local calibration factors. Until a formal set of calibration factors has been issued by the Department, the value of C_i is assumed to be 1.00.

Inclusion in Predictive Model:

$$N_{predicted,int} = C_i \times (N_{bi} + N_{pedi} + N_{bikei}) \quad \textbf{(Equation 12-5)}$$
$$N_{predicted,int} = 1.00 \times (0.78 + 0.04 + 0.01)$$

$$\boxed{N_{predicted,int} = 0.83\ crashes/year}$$

Final Results:

$$N_{predicted,int,4ST} = 0.60\ crashes/year$$
$$N_{predicted,int,4SG} = 0.83\ crashes/year$$

APPENDIX I

Guidelines for Conducting CMS Analysis

Note: This form will be regularly updated. View most recent version online.

Appendix P *Critical Movement Summation (CMS) How-To Guide*

P.1 BACKGROUND

The critical movement summation (CMS) method focuses on "raw" intersection capacity, that is, the ability for an intersection to process a given traffic demand with a given lane use configuration and given phase sequence.

Traffic signal phasing is one component of the analysis, but it is important to note that most of the subtleties of traffic signal phasing and operation are not included in the analysis.

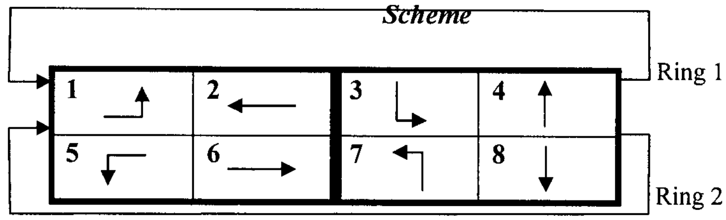
The analyst can use this simple hands-on approach to get right to the point of an intersection's ability to handle traffic demands. CMS looks at each of the "critical" movements at an intersection. It is a volume-based measure.

P.2 PROCESS

Step 1. Gather CMS Inputs

- Hourly Volumes – Use vehicles per hour. If analyzing the peak hour, use the largest sum of 4 consecutive 15-minute periods for that intersection, e.g. 7:45 – 8:45 AM.
- Lane Use Configurations – Determined through observation of existing geometry and operations.
- Signal Phasing – Use National Electrical Manufacturers Association (NEMA) standard 8-phase operation with adjustments as needed. The top line of phasing on the CMS worksheet is intended to show existing phasing. The adjacent line below is workspace intended for conceptual improvements to phasing. See Figure P.1 for a typical NEMA phase numbering schemes.

Figure P-1 Typical Phase numbering Scheme



Step 2. Fill in CMS Worksheet

For each row, fill in the columns:

- Movement (describe in words, e.g. NB through, SB through, EB left, etc.)
- Phase (indicate movement number)
- Volume (in the case of a shared lane, write each volume long-hand, and then sum, e.g. 100 + 150 + 25)
- LU (Lane Use factor, see table at bottom of worksheet.)
- Lane Volume (multiply the Volume by the Lane Use Factor.)
- OL (Opposing Lefts, to be added. See description of Permissive Only Lefts below.)

- LTC (Left Turn Credit, to be subtracted. See description of Concurrent Lefts or Lead/Lead-Lag Left below.)
- Critical Lane Volume (apply OL or LTC to the Lane Volume to get this Critical Lane Volume.)

Step 3. Determine Critical Movements

In the CM column, note the highest of each movement pair (e.g. highest of NB/SB through, highest of NB left/SB left, etc.) with an asterisk*. There should be an asterisk (*) corresponding to each block in the top line of phasing on the CMS worksheet.

Step 4. Sum the Critical Movements

Fill in the "Total" by adding the movements that have asterisks*. Assign a Level of Service (LOS) by using the Level of Service table at the bottom of the CMS worksheet.

P.3 RULES FOR TURNING MOVEMENTS

P.3.1 RIGHT TURNS

If right-turn is "hot" or "free" (i.e. has a dedicated, channelized deceleration and acceleration lanes) and is not signal controlled, leave out of computation.

If right-turn has a dedicated lane and is signal controlled with right-turn-on-red permitted, assume 50% of right-turn volume.

If right-turn has a dedicated lane and is signal controlled with "No right turn on red," assume 100% of right-turn volume.

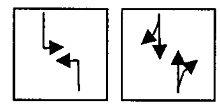
If right-turn has a dedicated lane and is signal controlled for rights to move concurrently with lefts (e.g. NB rights move with WB lefts), reduce the right-turn volume in the amount of the left-turn volume.

If there is a shared through/right lane, add through and right volumes.

P.3.2 LEFT TURNS

Left turns are to be treated as either protected (signalized left-turn arrow) or permissive (no left-turn arrow). If existing condition allows a left-turn movement to be both protected and permissive, analyze as protected (only) in CMS.

P.3.2.1 Concurrent Lefts

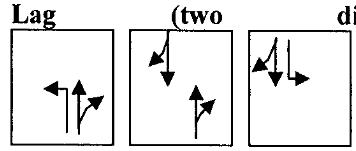


Account for Left Turn Credit (LTC) as follows:

- Calculate lane volumes for left-turn moves
- Apply lane-use factor
- Calculate difference of lefts (e.g. NB/SB lefts or EB/WB lefts)
- Subtract this difference from the through movement that's in the same direction as the greater left-turn volume.

CMS may over or underestimate the impact of left turn traffic on shared left-through-right lane in situations where through opposing volume is high. Additional Analysis (such as the methods of the *Highway Capacity Manual)* may be warranted.

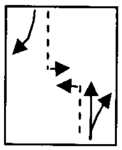
P.3.2.2 Lead Left (one direction), or Lead-Lag (two directions)



Account for Left Turn Credit (LTC) as follows:

- Identify left-turn volume associated with the lead (or lag) phase.
- Apply lane-use factor.
- Subtract that left-turn volume from the through movement on the same approach.

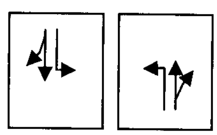
P.3.2.3 Permissive Only Lefts (no left-turn arrow)



Account for Opposing Lefts (OL) as follows:

- Identify left-turn volume that will be awaiting gaps in the through volume. (These lefts are considered "opposing lefts" – opposing the through volume being analyzed.)
- Add that left-turn volume to the opposing through movement.
- The left turns cannot move until the opposing through movement is complete. So you must consider the total of these two movements, since they cannot move simultaneously.

P.3.2.4 Split Phasing



- Left-turn credit (LTC) does not apply.
- Opposing lefts (OL) do not apply.

P.4 SIGNAL TIMING

CMS can be used as a prerequisite to signal timings. The following steps follow CMS to determine cycle length and required green and clearance (yellow and all red) time:

Step 1. Transfer phasing and Critical Lane Volume (CLV) Inputs from CMS worksheet onto the Traffic Signal Timing Worksheet (see Figure P-2)

Step 2. Determine number of vehicles per cycle per phase. The table included in the Traffic Signal Timing Worksheet can be used to determine the number of cycles in an hour (or simply divide 3600 seconds by the cycle length).

Step 3. Determine green time required from Greenshield's model (see Figure P-3)

Step 4. Determine clearance and pedestrian timings.

Step 5. Determine total time required and compare to cycle length.

P.5 CMS SAMPLE EXERCISE PROBLEMS

See Figures P-5 through P-14 for CMS sample exercise problems.

P.6 SIGNAL TIMING SAMPLE EXERCISE PROBLEM

See Figure P-16 for a sample signal timing exercise problem.

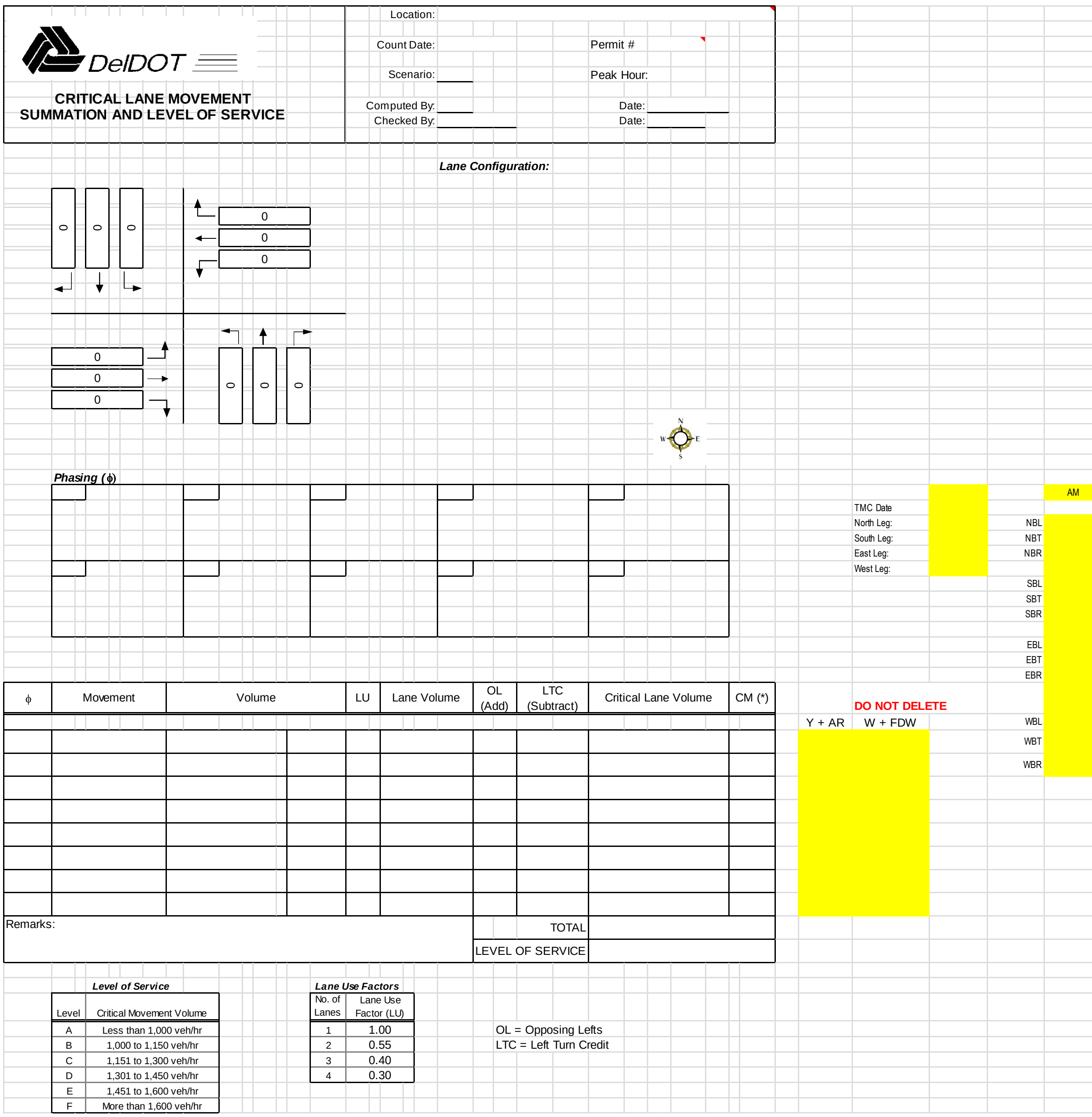
Critical Movement Sheets (CMS) How-to

The goal of the CMS sheets is to determine the level of service (LOS) at specific intersections for peak periods. CMS sheets do not take into account delay or timing of traffic signals so the CMS LOS is a basis of what the intersection could get to if timed perfectly with the current volume. You will need the count data for the intersection and phase data or the timesheet. For more information, refer to Appendix P.

Needed to Complete CMS:

- Count Data
- Phase Data/Timesheet
- Lane Configuration

1. Start with the CMS template shown below.

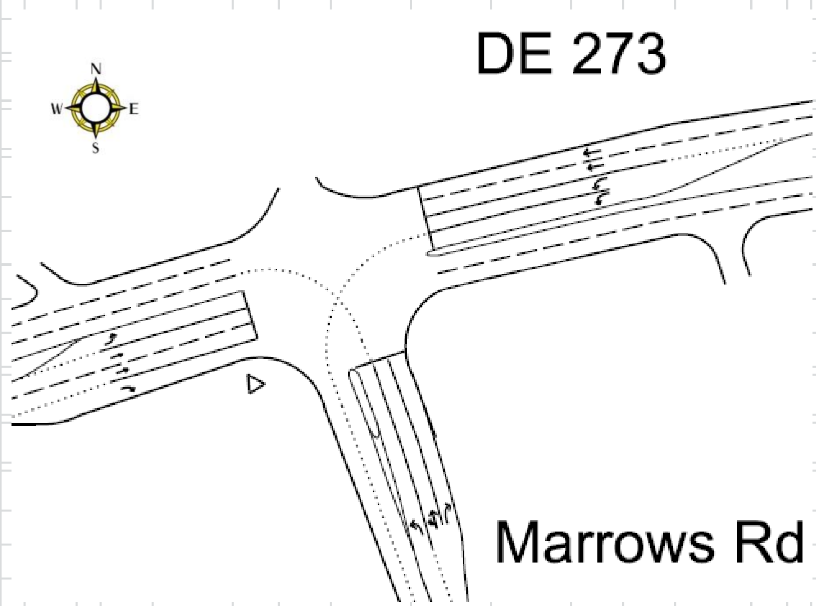


2. Begin by inputting data into the title block. This includes intersection name, count data, permit #, peak hour, whether the sheet is for AM or PM peak (separate sheets must be computed for both), your name, date you are working on the sheet, name of whoever will check your work, and the date the sheet is checked. An example is shown below.

Location:	DE 273 & Marrows		
Count Date:	4/10/2012	Permit #	N247
Scenario:	PM Peak	Peak Hour:	4:30-5:30
Computed By:	CDM	Date:	4/18/2012
Checked By:	MJL	Date:	4/23/2012

3. Next, insert a Microstation drawing or Google Earth image of the intersection under where it says Lane Configuration. Make sure that the picture is sent backwards in order to see the north arrow clip art. The drawing should show the number of lanes in each direction and the general layout of the intersection. Make sure that the top of the intersection is north because of the different formulas located within the spreadsheet.

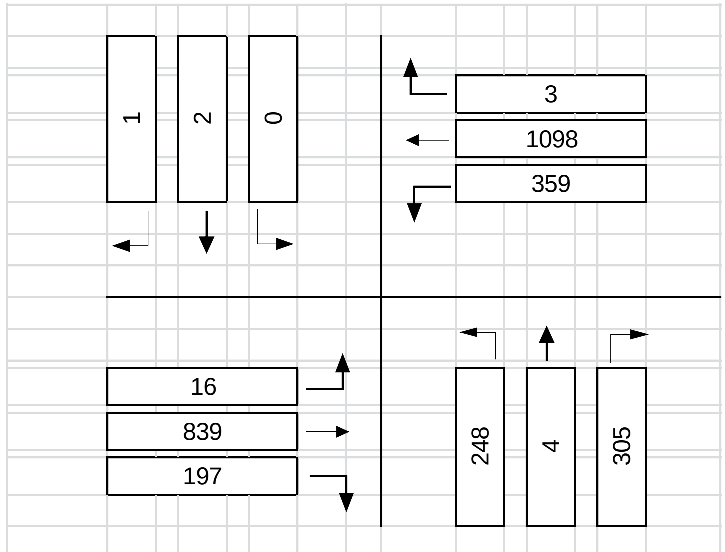
Lane Configuration:



4. Because of how the template is set up, volumes get entered into the highlighted boxes, and the individual turning volumes will populate into the boxes by themselves. Inputting data here:

NBL	248
NBT	4
NBR	305
SBL	0
SBT	2
SBR	1
EBL	16
EBT	839
EBR	197
WBL	359
WBT	1098
WBR	3

will populate here:



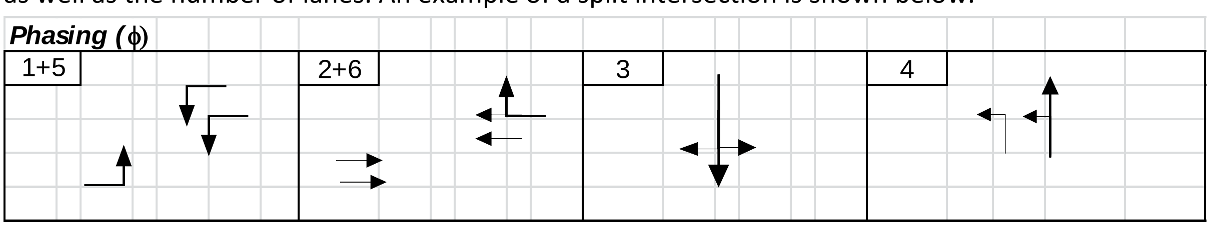
.

Volumes inputted are all peak hour volumes, not two hour count data.

5. The next input needed is the phasing data. All of this can be found on the timesheet for the intersection. The timesheet will indicate the phase number of each turning movement, as well as the ring structure for the whole intersection and whether there are any overlaps. If the ring structure is standard and there are no overlaps, the phasing is as follows:

Ring 1	1	2	3	4
Ring 2	5	6	7	8

where phases 1 & 5 are the major street left turns, phases 2 & 6 are the major street through movements, phases 3 & 7 are the minor street left turns, and phases 4 & 8 are the minor street through movements. If the intersection is considered to be a split intersection, where each minor street runs independently of the other, phases 7 & 8 will be excluded. Phase 3 would be considered left and through movements of minor street 1 and phase 4 would be considered left and through movements of minor street 2. Examples of different phasing are can be found at the end of the document. The phasing data must be filled in in the correct order that traffic moves in the field. The phase numbers are placed in the upper left-hand corner box and directional arrows are placed in the box to show the direction of traffic as well as the number of lanes. An example of a split intersection is shown below.



Placing the arrows on top of each other indicates that there is a shared lane. If right turning traffic has a dedicated lane, they are not included in the CMS sheet.

6. Now that all of the data has been inputted, it is time to calculate LOS. First list each phase number and the respective turning movement in order of how they were shown in the phasing

diagram above. If the intersection is split (as above) and has multiple lanes, list each lane separately. This is only if the intersection is split and the side road includes more than one lane. If the intersection is a standard 8-phase intersection, ignore splitting up each lane. The diagram below shows the correct phases and movements from the phasing diagram above. Notice how phase 4 is split into two different rows. The first row includes ½ NB L because there is one lane that is only left turns. The second lane is a shared through and left turn lane, meaning that ½ NB L turners and all of the through traffic will be utilizing that lane. The reason that the movement needs to be split up is that you need to determine which lane will be the critical movement for determining how much green time is needed.

Split Intersection

ϕ	Movement
1	WB L
5	EB L
2	EB T
6	WB TR
3	SB LTR
4	1/2 NB L
4	NB T + 1/2 L

Standard 8-Phase Intersection

ϕ	Movement
1	WB L
5	EB L
2	EB T
6	WB T
3	SB L
7	NB L
4	NB T
8	SB T

7. The next step is to input the volumes. For a standard 8-phase intersection, this is simply pulling the data from the volumes that you have already entered. In the case of a split intersection, you may have to do some calculations to determine what percentage of traffic uses one lane over another. For the split intersection shown above, ½ NB L and NB T + ½ NB L must be calculated.

Split Intersection | Standard 8-Phase Intersection

Movement	Volume		Volume	
WB L		359		247
EB L		16		157
EB T		839		786
WB TR		1101		1943
SB LTR		3		32
1/2 NB L	.=.5*248	124		508
NB T + 1/2 L	.=.5*248 + 4	128		54
				21

You can see above how there are no calculations that need to be completed for the standard 8-phase intersection.

8. Next, lane usage factors must be applied. At the bottom of the spreadsheet, there is a table with factors depending on how many lanes there are in each direction. A shared lane is considered to only be one lane even though there are two turning movements using the same lane.

Lane Use Factors

No. of Lanes	Lane Use Factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

9. The next step is to multiply the volumes by the lane use factor to get lane volumes. Make sure to round up the lane volume. There cannot be a fraction of a car.

Volume		LU	Lane Volume
	359	0.55	197
	16	1.00	16
	839	0.55	461
	1101	0.55	606
	3	1.00	3
.=.5*248	124	1.00	124
.=.5*248 + 4	128	1.00	128

10. The next step is to identify if there are any opposing lefts. Opposing lefts are only calculated if the left turning movement is permissive only (there is no left turn arrow). They do not apply to split intersections. First, identify if there are left turners who must wait for gaps in the opposing through traffic. That volume is then placed in the OL column of the opposing through movement and will later be added to the lane volume.

11. The next column is the left turn credit (LTC). This is to take into account if one left turning movement is higher than the other so that the through movement can move while the left turning traffic is still clearing through the intersection. If EB L and WB L are green at the same time but EB L has 100 more cars than WB L, the WB L signal is going to turn red while the EB L is still green to allow a certain amount of EB T vehicles to move through the intersection before the WB T vehicles are allowed to go. That number of through vehicles is what is being accounted for in the LTC. To determine the volume for LTC, calculate the difference of the left turn lane volumes (not just volumes) and place in the column for the through movement that is in the same direction as the higher left turn volume. This will later be subtracted from the lane volume. This does not apply to split intersections.

Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)
WB L		359	0.55	197		
EB L		16	1.00	16		
EB T		839	0.55	461		
WB TR		1101	0.55	606		181
SB LTR		3	1.00	3		
1/2 NB L	.=.5*248	124	1.00	124		
NB T + 1/2 L	.=.5*248 + 4	128	1.00	128		

In the table above, WB L are significantly higher than EB L. Subtract 16 from 197 to get a difference of 181 vehicles. Since WB L volumes are higher than EB L, 181 vehicles is subtracted (placed in the LTC column) from WB T lane volumes. 181 through vehicles are moving through the intersection before the through signal even technically turns green and those vehicles are already accounted for under the WB L lane volume. If those vehicles were not subtracted out, those vehicles would be accounted for twice and could drastically change the LOS of the intersection.

12. The critical lane volume must be calculated for each phase. The critical lane volume is simply the lane volume + opposing lefts – left turn credit. If there are neither opposing lefts nor a LTC, then the lane volume equals the critical lane volume. Once the critical lane volume is calculated for

each phase, the critical movement for each phase grouping must be determined. This relates back to the phase diagram. Since phases 1 and 5 typically move together, only one of them can be the critical movement for that phase group. There should be four critical movements at both a standard 8-phase intersection and a split intersection. Since each side road moves independently at a split intersection, that movement automatically becomes the critical movement. However, if there is more than one lane on a side road at a split intersection, you must determine which of those lanes the critical movement for that phase is. An asterisk (*) is placed in the same row as the critical movement so that the spreadsheet can calculate the total critical volume, and then calculate the LOS of the intersection based on the total critical volume.

ϕ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	WB L		359	0.55	197			197	*
5	EB L		16	1.00	16			16	
2	EB T		839	0.55	461			461	*
6	WB TR		1101	0.55	606		181	425	
3	SB LTR		3	1.00	3			3	*
4	1/2 NB L	.=.5*248	124	1.00	124			124	
4	NB T + 1/2 L	.=.5*248 + 4	128	1.00	128			128	*
Remarks: EB/NB rights in dedicated lanes and not included.							TOTAL	790	
						LEVEL OF SERVICE		A	

In this example, it is a split intersection with multiple lanes in the NB direction. Since NB T + ½ NB L is greater in critical lane volume than ½ NB L, NB T + ½ NB L is considered to be the critical movement for that phase group.

The remarks box at the bottom of the table is where any notes on right turning movements should go. In this case, two right turn movements are included and two are excluded.

13. The last step is to calculate the LOS for the intersection. As mentioned above, the critical movement volumes are totaled and then the LOS can be calculated. A separate table is shown below for calculating LOS:

	Level of Service
Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

Examples

Standard 8-Phase intersection

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

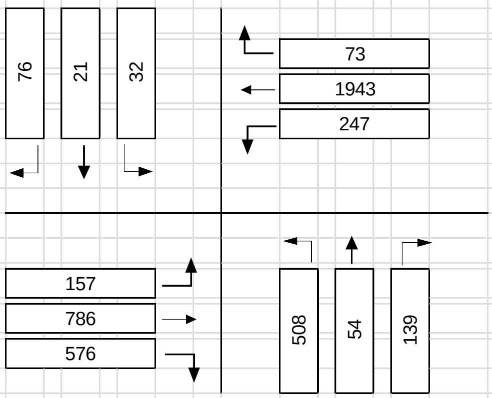
Location: DE 273 & Chapmans Rd

Count Date: 10/4/2011 | Permit # N367

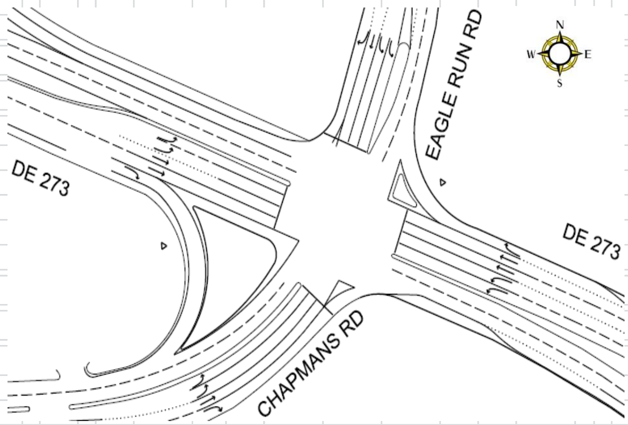
Scenario: AM Peak | Peak Hour: 7:15-8:15

Computed By: CDM | Date: 4/17/2012

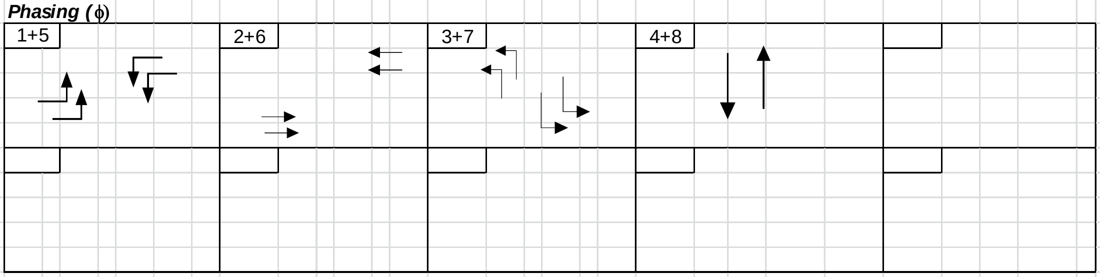
Checked By: MJL | Date: 4/24/2012



Lane Configuration:



Phasing (ϕ)



ϕ	Movement	Volume	LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	WB L	247	0.55	136			136	*
5	EB L	157	0.55	86			86	
2	EB T	786	0.55	432			432	
6	WB T	1943	0.55	1069		50	1019	*
3	SB L	32	0.55	18			18	
7	NB L	508	0.55	279			279	*
4	NB T	54	1.00	54		261	0	
8	SB T	21	1.00	21			21	*
						TOTAL	1455	
						LEVEL OF SERVICE	E	

Remarks: All rights in dedicated lanes and not included.

Split Intersection with one lane in each direction of the Side Rd

DelDOT

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

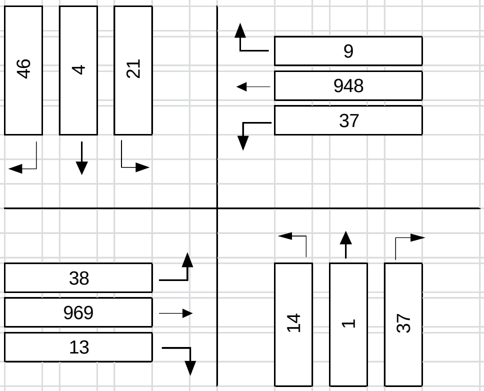
Location: SR 4 and State St

Count Date: 9/25/2012 Permit # N338

Scenario: AM Peak Peak Hour: 7:15-8:15

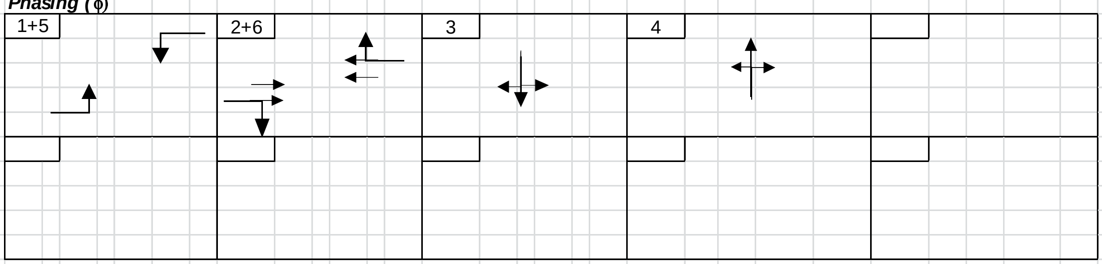
Computed By: MJL Date: 1/19/2013

Checked By: Date:



Lane Configuration:

Phasing (ϕ)



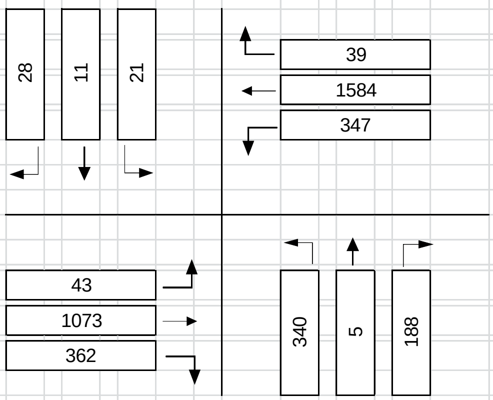
ϕ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
5	EB L		38	1.00	38			38	*
1	WB L		37	1.00	37			37	
6	WB TR		957	0.55	526			526	
2	EB TR		982	0.55	540		1	539	*
3	SB LTR		71	1.00	71			71	*
4	NB LTR		52	1.00	52			52	*

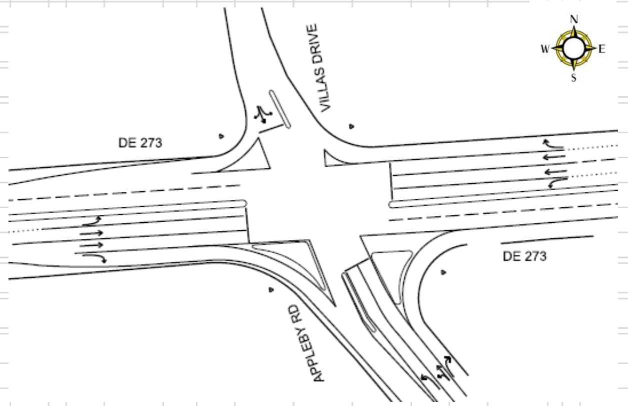
Remarks: All rights included.		
	TOTAL	700
	LEVEL OF SERVICE	A

Split Intersection with multiple lanes on the Side Road

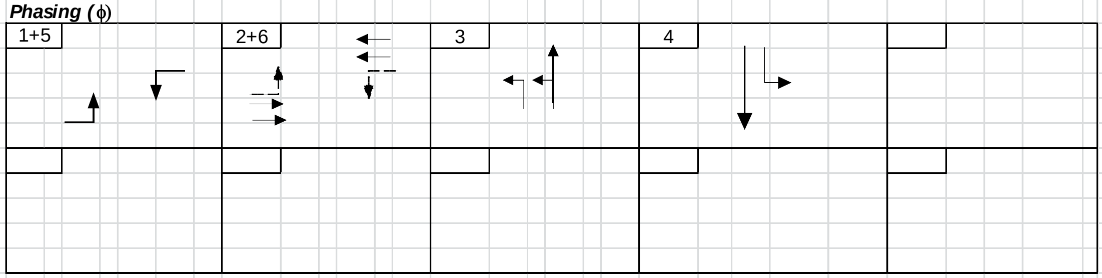
DelDOT	Location: DE 273 & Appleby		
	Count Date: 1/20/2011	Permit #	N460
	Scenario: PM Peak	Peak Hour:	4:45-5:45
CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE	Computed By: CDM	Date:	4/16/2012
	Checked By: MJL	Date:	4/25/2012

Lane Configuration:





Phasing (ϕ)



ϕ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	WB L		347	1.00	347			347	*
5	EB L		43	1.00	43			43	
2	EB T		1073	0.55	590			590	*
6	WB T		1584	0.55	871		304	567	
3	1/2 NB L	.=0.5*340	170	1.00	170			170	
3	1/2 NB L + NB T	.=0.5*340 + 5	175	1.00	175			175	*
4	SB T		11	1.00	11			11	
4	SB L		21	1.00	21			21	*
Remarks: All rights in dedicated lanes and not included.							TOTAL	1133	
							LEVEL OF SERVICE	B	

3-Legged T Intersection

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

Location:	SR 4 and Troy Ave		
Count Date:	9/20/2012	Permit #	N202
Scenario:	AM Peak	Peak Hour:	7:00-8:00
Computed By:	AD	Date:	1/15/2013
Checked By:	MJL	Date:	1/21/2013

69 0 23

3
697
0

37
802
0

0 0 0

Lane Configuration:

Phasing (ϕ)

2+6

4

ϕ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
2	EB LT		839	0.55	461			461	*
6	WB TR		700	0.55	385			385	
4	SB LR		92	1.00	92			92	*

Remarks: All rights included.

TOTAL	553
LEVEL OF SERVICE	A

APPENDIX J

Signal Design / Modification Request Form

Signal Design / Modification Request Form

169 Brick Store Landing Road, Smyrna, DE

This form, as well as the attached Signal Design Checklist, should be completed for all new signals and for all existing signals requiring design modifications on state maintained highways in the state of Delaware.

Location: ________________________________

____

County: ________________________________

Signal: ☐ New (Proposed)

☐ Existing (Permit #: ___________)

If **new,** signal warrants met:
(signal warrant evaluation forms should be attached)

- ☐ Warrant #1
- ☐ Warrant #2
- ☐ Warrant #3
- ☐ Warrant #4
- ☐ Warrant #5
- ☐ Warrant #6
- ☐ Warrant #7
- ☐ Warrant #8
- ☐ Warrant #9

If **existing**, proposed changes:

- ☐ Pedestrian upgrades
- ☐ Maintenance upgrades
- ☐ Developer
- ☐ Other ________________________________
- ☐ Phase / Operational Upgrades
- ☐ Intersection Improvements
- ☐ Paving & Rehabilitation

Requested By: ________________________________ **Date:** ______________________

Recommended By: ________________________________ **Date:** ______________________
(DelDOT / Consultant) (Circle One)

Approved By: ________________________________ **Date:** ______________________
(DelDOT Chief Traffic Engineer or Designee)

Signal Design Checklist (attached)

Completed By: ________________________________ **Date:** ______________________
(DelDOT / Consultant) (Circle One)

Checked By: ________________________________ **Date:** ______________________
(DelDOT)

Approved By: ________________________________ **Date:** ______________________
(DelDOT)

DELDOT TRAFFIC SIGNAL PLAN REVIEW CHECKLIST

	Yes	No	N/A	Comments
The following items are included and shown correctly on the Plan Sheets:				
• Existing and proposed conditions (Only pertinent information should be shown on plans. All other levels should be turned off.)	☐	☐	☐	
• Limits of work	☐	☐	☐	
• Base mapping	☐	☐	☐	
• North arrow	☐	☐	☐	
• Correct scale	☐	☐	☐	
• Consultant logo	☐	☐	☐	
• Legend	☐	☐	☐	
• Right-of-way lines and labels (existing and proposed)	☐	☐	☐	
• Equipment within Right-of-Way	☐	☐	☐	
• Overhead utilities (heights indicated)	☐	☐	☐	
• General Notes	☐	☐	☐	
• Street names	☐	☐	☐	
• Route numbers with cardinal direction (e.g. I-70 (WBL)) and road names	☐	☐	☐	
• Current borders / signature / revision block	☐	☐	☐	
• Construction details (if required)	☐	☐	☐	
Existing Signal Information				
• Existing signal plans have been verified	☐	☐	☐	
• Site characteristics have been inventoried and examined	☐	☐	☐	
• Existing signals to be removed are noted	☐	☐	☐	
Proposed Signal Information				
• Appropriate signal structures	☐	☐	☐	
• Appropriate signal structure configuration / placement	☐	☐	☐	
○ Lateral clearance requirements are met	☐	☐	☐	
○ Alternative pole configurations are used where applicable	☐	☐	☐	
• Signal controller cabinet location and type	☐	☐	☐	
○ Cabinet location permits safe access by maintenance	☐	☐	☐	
○ Cabinet is located near a power source (if possible)	☐	☐	☐	
○ Cabinet is protected (if needed)	☐	☐	☐	
○ Cabinet does not restrict driver visibility	☐	☐	☐	
• Signal heads are numbered and placement is correct	☐	☐	☐	
○ Distances from stop line are acceptable (40’ to 120’; up to 180’ with near side)	☐	☐	☐	
○ Minimum of two signal heads are provided for each movement	☐	☐	☐	
○ Vertical signal head clearance requirements are met	☐	☐	☐	
○ Adequate signal visibility is provided	☐	☐	☐	
○ Appropriate signal head sections	☐	☐	☐	

DELDOT TRAFFIC SIGNAL PLAN REVIEW CHECKLIST				
	Yes	No	N/A	Comments
• Countdown pedestrian signals and pushbuttons follow Design and Installation Guidelines	☐	☐	☐	
○ Countdown signal located near and visible within crosswalk	☐	☐	☐	
○ Pushbuttons located correctly and readily accessible from 60”x60” level landing area on the sidewalk (maximum 10 feet from curb)	☐	☐	☐	
• Availability of electrical power determined	☐	☐	☐	
○ Power location and feed coordination with utility company complete	☐	☐	☐	
○ Power service with pole number and transformer number	☐	☐	☐	
○ Confirm cabinet / service pedestal / electrical service equipment locations are constructible as shown	☐	☐	☐	
• Metered service pedestal	☐	☐	☐	
• Utility pole or transformer number labeled	☐	☐	☐	
○ Confirm service load is available	☐	☐	☐	
• Signal equipment meets clear zone requirements	☐	☐	☐	
• Junction wells are appropriately located	☐	☐	☐	
• Junction wells, conduit and wire are correct size and type	☐	☐	☐	
• Conduit sizes accommodate fill requirements (26% maximum fill for new construction, 35% for modifications)	☐	☐	☐	
• Signal preemption provided	☐	☐	☐	
• Numbering (including signs) is correct	☐	☐	☐	
• Signal legend matches plan	☐	☐	☐	
Signs				
• Street name signs	☐	☐	☐	
• Route marker / shield assemblies	☐	☐	☐	
• Signal warning signs	☐	☐	☐	
• Turn prohibitions	☐	☐	☐	
○ LTOR / RTOR	☐	☐	☐	
• Lane use control signs	☐	☐	☐	
• Remove Stop / Stop Ahead signs	☐	☐	☐	
• Pedestrian pushbutton and sign (oriented correctly)	☐	☐	☐	
• Special sign layouts	☐	☐	☐	
• Sign legend matches plan	☐	☐	☐	
• New signal warning signs with NEW plaque and flags	☐	☐	☐	
• Signs on signal plans match signing plans	☐	☐	☐	

DELDOT TRAFFIC SIGNAL PLAN REVIEW CHECKLIST

	Yes	No	N/A	Comments
Pavement Markings				
• Arrow / Only for lane drops	☐	☐	☐	
• Stop lines (perpendicular to curb)	☐	☐	☐	
• Edgelines, centerlines, lane lines	☐	☐	☐	
• Turn bays	☐	☐	☐	
• Crosswalks	☐	☐	☐	
• Other markings per DE MUTCD	☐	☐	☐	
NEMA Phasing				
• Correct orientation	☐	☐	☐	
• Solid / Dashed lines shown correctly	☐	☐	☐	
• Notes	☐	☐	☐	
• Pedestrian phases	☐	☐	☐	
• Split phasing	☐	☐	☐	
Dimensions / Stationing				
• Pavement Markings	☐	☐	☐	
• Signals and Signs	☐	☐	☐	
• Detectors (presence and advanced)	☐	☐	☐	
• Poles	☐	☐	☐	
• Controller cabinet	☐	☐	☐	
• Breaklines	☐	☐	☐	
Detectors				
• Detection included and applied properly	☐	☐	☐	
• Location of presence detection (2' behind stop line) is correct	☐	☐	☐	
• Location of system detection is correct	☐	☐	☐	
• Sizes and locations are correct	☐	☐	☐	
• Detector sleeves conduit for loops	☐	☐	☐	
• Video detection equipment locations are correct	☐	☐	☐	
• Dilemma zone at correct distance	☐	☐	☐	
Geometrics				
• Stop line set back adequate distance for turning vehicles	☐	☐	☐	
• Crosswalk curb ramps are correctly located and ADA compliant	☐	☐	☐	
• Pad or sidewalk provides access to pedestrian push button	☐	☐	☐	
• Detectable Warning Surfaces (DWS) are applied correctly	☐	☐	☐	
Maintenance of Traffic				
• Standards specified as needed	☐	☐	☐	

DELDOT TRAFFIC SIGNAL PLAN REVIEW CHECKLIST

	Yes	No	N/A	Comments
OTHER DESIGN CONSIDERATIONS				
• ADA requirements are met	☐	☐	☐	
• Median disturbance is minimized	☐	☐	☐	
• Design addresses environmental concerns (if present)	☐	☐	☐	
• Design addressed unique construction problems (if present)	☐	☐	☐	
• Design adheres to driver expectancy for the corridor	☐	☐	☐	
• Equipment locations do not hinder maintenance activities	☐	☐	☐	
• Coordination has occurred with the Telecommunication Group	☐	☐	☐	
• Other facilities within the project limits that require traffic signal devices (i.e. schools) are noted	☐	☐	☐	
• Railroad signal interconnect is provided (if required)	☐	☐	☐	
• Signal is not in conflict with any utilities	☐	☐	☐	
• Special design considerations such as HIBs, pedestrians, preemption or interconnection are addressed	☐	☐	☐	
• Signal will work as a system with the roadway, signing and marking design	☐	☐	☐	
• Design is in accordance with Federal and DelDOT standards	☐	☐	☐	
UTILITIES				
• Overhead utility conflicts avoided	☐	☐	☐	
• Underground utility conflicts avoided	☐	☐	☐	
• Special signal poles detailed (if needed)	☐	☐	☐	
• Special pole foundations detailed (if needed)	☐	☐	☐	
• Utility relocations coordinated	☐	☐	☐	
○ Utility relocation details provided (if required)	☐	☐	☐	
• Overhead clearance callouts at cable crossing with signal structure are provided	☐	☐	☐	
RIGHT-OF-WAY				
• Adequate right-of-way is available for proposed pole locations	☐	☐	☐	
• Required right-of-way acquisitions are noted (if needed)	☐	☐	☐	
• Easement for special purpose is noted (if needed)	☐	☐	☐	

APPENDIX K

Signal Deactivation Guidance

DelDOT Guidelines for Signal Deactivation

1. **30 days prior** to converting existing signal to flash mode:

   - Install SIGNAL UNDER STUDY FOR REMOVAL signs on each approach.
   - Inform all affected agencies (TMC, DelDOT public relations department, local municipalities, police, emergency service providers, local businesses, etc) about the planned signal deactivation.

2. **One week prior** to converting existing signal to flash mode:

   - Address sight distance restrictions from the approach that will be STOP controlled. (move stop line towards the intersection, etc)
   - Install NEW TRAFFIC PATTERN STARTING XX/XX/XXXX message boards on each intersection approach.
   - Inform local municipalities about the proposed date of the conversion, and suggest they have uniformed law enforcement officers available, if necessary.

3. **Day of converting** existing signal to flash mode:

   - Place the signal on flash, mirroring future two-way stop control. Provide flashing yellow on the major street approaches, and flashing red on the minor street approach(es).
   - Observe the operation at the intersection at the time when signal is placed on flash mode to make sure it operates as planned.
   - Install STOP sign on the minor street approach(es) immediately after transition to flash mode.
   - Change the legend on the message boards to NEW TRAFFIC PATTERN AHEAD.

4. **One week after** the transition to flash mode:

   - Remove the message boards.
   - Review traffic operations at the intersection

5. **Two months after** the transition to flash mode:

   - Review traffic operations at the intersection.

6. **Six months after** the transition to flash mode:

   - Conduct a crash data analysis based on 6-months of crash data after the transition to flash mode.
   - If the crash analysis indicates that STOP-control is an adequate form of traffic control at the intersection, remove all traffic signal equipment and abandon conduits; remove stop-lines on the major street approaches, and remove SIGNAL UNDER STUDY FOR REMOVAL signs.
   - Remove other conflicting pavement markings.

7. **One year after** the transition to flash mode:

   - Complete another crash data analysis based on 12-months of crash data after the transition to flash mode.

APPENDIX L

Requests for APS Application Form

Accessible Pedestrian System: Intersection Planning Sheet

Project City:______________________

Purchaser:________________________

Project Coordinator:________________

# of APS to be installed:__________

Sign Legend: Choose __________

Retro-Reflective Sign: No

Intersection:______________________

Purchase Order Number:____________

Pedestrian Station Size: Choose __________

Body Color: Choose

Actuator Color: Choose__________

Braille Grade 2 : No

RRFB: None

Solar: No

Project Target Date:___________

AGPS ◯ AAPS ◯

10 foot separation of stations: No

Generic Voice Messages: No

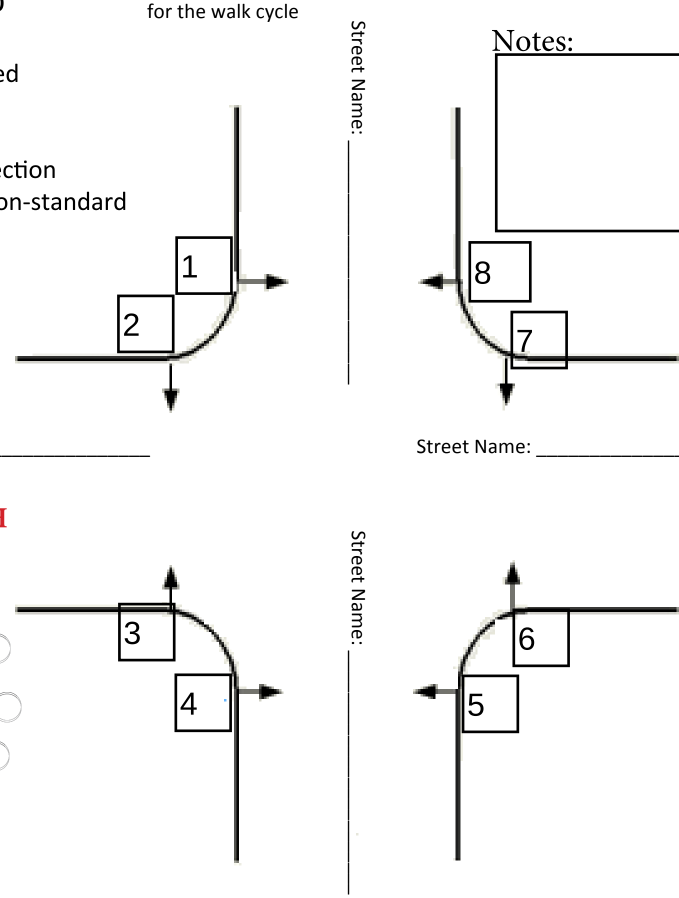
MUTCD 4E.10 Pedestrian stations with < 10' separation will utilize a voice message for the walk cycle

Pedestrian stations with 10' of separation will utilize a Percussive tone for the walk cycle

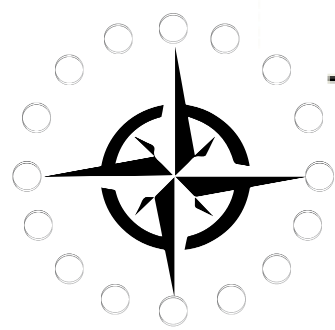
Stn #	Dir of Arrow		Ped Phase	Ped Group	Walk Cycle Message: Verbal	Tone
1	L	R				
2	L	R				
3	L	R				
4	L	R				
5	L	R				
6	L	R				
7	L	R				
8	L	R				
9	L	R				
10	L	R				
11	L	R				
12	L	R				
13	L	R				
14	L	R				
15	L	R				
16	L	R				

Please indicate on diagram:
A.Circle station to be installed
B.Place an arrow on the
C.Street Names
D.Peculiarities of the intersection
E.Sketch a diagram of any non-standard intersection.

Notes:



Please indicate NORTH



If Dbl or No arrow add to Note Section
Stations set in default mode unless noted

Print

Reset Form

Submit

DELAWARE DEPARTMENT OF TRANSPORTATION INTERIM GUIDELINES FOR THE INSTALLATION OF ACCESSIBLE PEDESTRIAN SIGNALS DECEMBER 11, 2007

I. INTRODUCTION

A. Background

The Transportation Equity Act for the 21st Century (TEA-21) directs that pedestrian safety considerations, including the installation of accessible traffic signals, where appropriate, be included in new transportation plans and projects [Sec. 1202(g)(2)]. The bill was signed into law by the President on June 9, 1998.

The Americans with Disabilities Act (ADA) requires access to the public right-of-way for people with disabilities. Access to traffic and signal information is an important feature of accessible sidewalks and street crossings for pedestrians who have vision impairments. While most intersections pose little difficulty for independent travelers who are blind or have low vision, there are some situations in which the information provided by an accessible pedestrian signal is necessary for independent and safe crossing.

An Accessible Pedestrian Signal (APS) is a device that is used in conjunction with pedestrian signals that communicates pedestrian signal information in nonvisual formats such as audible tones, verbal messages, and/or vibrating surfaces. APS let pedestrians who are blind or visually impaired know when the WALK interval begins and terminates. Pedestrians who know when the crossing interval begins will be able to start a crossing before turning cars enter the intersection and can complete a crossing with less delay. Audible signals can also provide directional guidance, which is particularly useful at non-perpendicular intersections and at wide multi-lane crossings.

B. Purpose and Scope

These interim guidelines provide the Delaware Department of Transportation (DelDOT) with a process to evaluate and prioritize APS installations when they are requested. These interim guidelines describe a process in which an intersection must first meet basic conditions in order to be considered for APS. If APS should be considered, an intersection must be evaluated to determine the need relative to other locations where APS has been requested. The scores received in the evaluation determine this relative need and can be used to develop a prioritized list of intersections to be funded. The goal is that all requests for APS installation receive a fair and equal assessment and that funds are expended in the most effective manner.

It should be noted that these guidelines apply only at locations where APS is requested. This approach is being taken due to potential changes resulting from comments on the Revised Draft Guidelines for Accessible Public Rights-of-Way (PROWAG). Additional guidelines concerning the installation of APS at new intersections or intersections that are undergoing improvements will be developed following finalization of PROWAG by the federal government.

II. GUIDELINES

The following is the procedure for determining whether APS installations should be considered at intersections. Three basic conditions should be met (as determined by DelDOT Traffic) for APS to be considered:

1) APS must be requested
2) Intersections must be signalized
3) Retrofitting the signal to include APS must be feasible[1]

For APS to be considered "requested," the "Request for the Installation of Accessible Pedestrian Signals Form" (see Appendix A) must be completed and submitted to DelDOT. This form is available on DelDOT's website and in hard copy from DelDOT's Public Relations office. A blind or visually impaired person also has the option of calling DelDOT Public Relations office at 1-800-652-5600 to give the information verbally so that it can be transcribed onto the form for DelDOT's records. The requestor should be a blind or visually impaired individual or a person or agency filing on his or her behalf.

If these three conditions are met, there are three cases that may be encountered, as discussed below. These cases apply to the specific crossing that is being requested. If it is determined that APS should be installed at the specific crossing that is being requested, APS should be installed at all signalized pedestrian crossings at the intersection to the maximum extent feasible.[1]

Case 1 – The crossing for which APS is being requested is equipped with pedestrian signals and there are no current improvements proposed to the pedestrian signal, perform an evaluation using the "Accessible Pedestrian Signal Evaluation Form" (see Appendix B). The evaluation form will determine the priority of the APS installation relative to other intersections for which APS has been requested. The scores received in the evaluation will be used to develop a prioritized list of intersections to be funded.

Case 2 – If there are plans for the installation of new pedestrian signals or plans for improvements to existing pedestrian signals on the crossing for which APS is being requested, revise the plans to include APS to the maximum extent feasible[1]. In this case, the intersection need not be evaluated.

Case 3 – If there is no pedestrian signal and no plans for them, conduct a traffic engineering study to determine if pedestrian signals are warranted. If warranted, include the appropriate

[1] From the Draft Public Rights-of-Way Accessibility Guidelines, "the phrase 'to the maximum extent feasible' applies to the occasional case where the nature of an existing facility makes it virtually impossible to comply fully with applicable accessibility standards through a planned alteration. In these circumstances, the alteration shall provide the maximum physical accessibility feasible. Any altered features of the facility that can be made accessible shall be made accessible."

"Existing conditions (e.g., underlying terrain, right-of-way availability, underground structures, adjacent developed facilities, drainage, the presence of a notable natural or historic feature) may limit choices in an alterations project. In determining the maximum feasible accessibility that can be achieved for pedestrians with disabilities within a given alterations project, covered entities may consider constructability limits commensurate with those of the project as a whole."

APS when the pedestrian signals are installed to the maximum extent feasible[1]. In this case, the intersection need not be evaluated using the “Accessible Pedestrian Signal Evaluation Form” (see Appendix B). If a pedestrian signal is not warranted, do not install APS.

III. INTERSECTION EVALUATION

A. Overview of Procedure

If the three basic requirements are met and there are no current improvements proposed by DelDOT to the existing pedestrian signal (Case 1), an evaluation shall be performed during a site visit to derive a score for each crossing where APS is being requested. The evaluation team should include the requesting blind or visually impaired person or their representative, DelDOT’s ADA Coordinator, and a representative from DelDOT Traffic. If necessary at complex intersections, a certified orientation and mobility specialist may be included on the evaluation team.

The evaluation should be performed during the time of day when the requesting blind or visually impaired person typically crosses the intersection and/or when crossing the intersection would be most difficult. During the intersection visit, the evaluation team should thoroughly discuss all possible solutions to address the crossing needs of the requesting blind or visually impaired person. These discussions should include, but not be limited to, minor intersection improvements, installation of new crosswalks, installation of pedestrian signals with APS on crossings for which APS are not being requested, consideration of the needs of other potential blind or visually impaired individuals, and consideration of the intersection’s characteristics after improvements are made. In addition, if APS are to be installed at nearby signalized intersections, it is important that signals from one intersection cannot be heard at other intersections.

At any point deemed appropriate by DelDOT or the requestor, an intersection may be reevaluated to account for changes that would influence the evaluation score and hence the ranking on the prioritized list. Similarly, if more than a year elapses between the intersection’s evaluation and the design or installation of the APS system, DelDOT Traffic should ensure that there is a continued need for the APS. For example, the requesting blind or visually impaired person may have relocated since submitting the request.

B. Evaluation Factors and Rating Methodology

The following factors and rating methodology and the “Accessible Pedestrian Signal Evaluation Form” (see Appendix B) should be used to evaluate intersections for which APS installation has been requested (Case 1 only). The evaluation should be performed for the specific crossing(s) where APS is being requested. Some factors are more important than others, and the evaluation process allows the evaluation team to distinguish and account for this distinction through the use of the point system. The highest total points per requested crossing (north, south, east or west) will be used as the overall intersection score.

The evaluation will determine the specific needs of the requesting blind or visually impaired person and allow DelDOT to prioritize installations because funding is limited.

Following is a summary of the factors used in the evaluation process:

1. Configuration of Intersection: The number of approaches to an intersection and the geometric design (offset, skewed, etc.) can affect the ability of the blind or visually impaired pedestrian to cross the roadway safely. The blind or visually impaired pedestrian listens for the traffic going straight through the intersection that is close and parallel with the crosswalk being traversed to guide his or her passage across the roadway. Accordingly, when an intersection's configuration is skewed, offset, or does not have straight through movements (as is the case in a three-legged intersection), a crossing can become more difficult for the blind or visually impaired pedestrian.

2. Width of Crossing: Wider streets are more difficult for the blind/visually impaired pedestrian to safely cross. Points are assigned on the basis of the width of the crossing. Crossing width is measured from the curb at the embarkation point to the curb at the destination point including perpendicular ramp areas. Islands and medians should be included in the total crossing distance even if they are equipped with separate pedestrian pushbuttons. Efforts should be made to permit blind/visually impaired pedestrians to cross in one continuous movement. Divided streets with or without a pedestrian pushbutton in the median should be handled as a single crossing, with the width measured across the entire street.

3. Pedestrian Crashes: Past pedestrian crash experience at the intersection can be used as an indicator of potential safety. Accordingly, the higher the occurrence of crashes, the higher number of points given.

4. Posted Speed Limit or 85th Percentile Speed on Street to Be Crossed: The speed of approaching traffic reflects the capability of approaching drivers to stop for pedestrians clearing the intersection as the traffic signals and pedestrian signals change. Points are assigned on the basis of the posted speed limit or 85th percentile speed on the street to be crossed. To determine 85th percentile speeds, free flow speeds should be measured on the roadway approach to the pedestrian crossing. More points are assigned for higher speeds.

5. Traffic Volumes/Queues: The volume of traffic and queues on the street parallel to the crossing may help or hinder the capability of a blind/visually impaired pedestrian to cross the street. Optimal crossing conditions occur at locations with a moderate but steady flow of traffic through the intersection with a minimum of turning movements. Traffic volumes and queues that are light or erratic make it difficult for the pedestrian to pick up audible clues as to whether the light is red or green. Accordingly, more points are assigned for shorter queues on the roadway parallel to the crossing. Traffic volumes and queues should be collected during the time of day when the requesting blind or visually impaired person typically crosses the intersection and/or when crossing the intersection would be most difficult. Off-peak periods on weekdays from 9 AM to 3 PM and on weekends from 7 AM to 6 PM should be considered when assessing queues and traffic volumes. In resort areas or other special areas, off-peak season traffic volumes should be considered.

6. Right-Turn Operations: Heavy right-turn volumes from the street parallel to the pedestrian crossing may hinder the capability of a blind/visually impaired pedestrian to cross the street. Accordingly, points are assigned for higher right-turn volumes.

7. Free Right-Turn Operations: Free flow right-turn lanes (i.e. right-turns that are channelized and do not operate under signal control) hinder the capability of a blind or visually impaired pedestrian to cross the street. Special care must be taken when installing APS to mitigate the problems associated with this condition. Accordingly, points are assigned if this condition impacts the crossing.

8. Special Signal Conditions: Certain signals operations including the presence of a lead pedestrian phase, an exclusive pedestrian phase, a mid-block exclusive pedestrian signal, or split phasing may hinder the capability of a blind or visually impaired pedestrian to cross the street. Accordingly, points are assigned if any of these conditions impact the crossing.

9. Proximity of Intersection to Key Facilities: APS should be considered at intersections that are close to facilities that attract or generate significant amounts of pedestrian traffic. APS would improve the safety and mobility of the blind or visually impaired pedestrian and make these facilities more accessible. Examples are medical, educational, social, recreational, commercial, shopping, public, governmental facilities, and transit stops. Pedestrian demand is based in part on how close the intersection is to these facilities; i.e., the closer a facility, the more the demand. Likewise, points are assigned based on the closeness of these facilities to the intersection; i.e., the closer a facility, the more the points. In the case of multiple facilities, points should be assigned using the closest facility to the proposed APS site.

10. Other Special Traffic and Mobility Conditions: This factor is intended to provide the evaluation team an opportunity to add 15 points based on special conditions not adequately covered by previous factors or based on special needs of the requesting party (e.g. disabled pedestrian generators in close proximity to the crossing).

IV. FUNDING PROCESS

At intersections where APS is installed under Cases 2 and 3, funding for APS will be included in the cost of the pedestrian signal project or capital project.

Intersections where APS is requested and approved and there are no current improvements proposed (Case 1) are generally funded on a “first come, first served” basis as funds are available. If funds are not available, the approved intersections are put on hold or carried over to the next funding cycle (typically a fiscal year). The new funds are distributed first to the carried over intersections based on the priority established by the Overall Intersection Score. If funds still remain after being distributed to the prioritized list, further requests for APS retrofit installations are once again funded, designed, and scheduled for implementation on a first come, first served basis until the funds are depleted. This basic process is repeated year after year.

It should also be noted that some traffic signals cannot be retrofitted with APS without major intersection modifications. If APS cannot be implemented by DelDOT Traffic’s on-call contractors due to right-of-way impacts, utility relocations, drainage improvements, or extensive geometric modifications required to install APS, the project may be forwarded to the Project Development Pipeline.

DelDOT
Delaware Department of Transportation

Appendix A

REQUEST FOR THE INSTALLATION OF ACCESSIBLE PEDESTRIAN SIGNALS FORM

Requesting Party's Name:

____
(Blind or visually impaired pedestrian)

Address: ____City:_______________________

State: _________Zip Code: ________

Telephone (Home): ______________________ Telephone (Work): _____________________

I request that the Delaware Department of Transportation install Accessible Pedestrian Signals (APS) to cross the **NORTH** ☐ **SOUTH** ☐ **EAST** ☐ **WEST** ☐ *(check all that apply)* side of ____*(Route Number/Street Name)* where it crosses ____ *(Route Number/Street Name)* in ____ *(city, town, or county).*

Please describe the difficulty you have in crossing:

Signature: _______________________________________ Date: __________________________

Please call DelDOT at 1-800-652-5600 or 302-760-2080 with questions and/or mail form to:

DelDOT Public Relations
P.O. Box 778
Dover, DE 19903

E-mail: dotpr@state.de.us

For Office Use Only

Date Received: _________________ Received by: __________________________________

Appendix B

ACCESSIBLE PEDESTRIAN SIGNAL EVALUATION FORM

Location:		
Date:	Day:	Time of Day:
Weather Conditions:		
Evaluation Team Members:		
Specific Needs of Requesting Party:		

	INTERSECTION LEGS			
REQUESTED APS CROSSINGS - Check all that apply (Evaluation of other crossings may be performed, but the scores should not be used when ranking intersections)	**North**	**South**	**East**	**West**
EVALUATION FACTOR	**POINTS**			
1. Configuration of Intersection	**North**	**South**	**East**	**West**

Configuration	Points	Comments:
(Points should be assigned to legs of the intersection affected by the configuration)		
4-leg right angle intersection	2	
3-leg tee intersection	4	
3 or 4-leg skewed intersection	6	
4-leg offset intersection	8	
Other complex or multiple leg intersections	10	

2. Width of Crossing	**North**	**South**	**East**	**West**

Width (feet)	Points	Comments:
40 or less	2	
41 to 52	4	
53 to 68	6	
69 to 78	8	
79 or more	10	

3. Pedestrian Crashes	**North**	**South**	**East**	**West**

Crashes / 5 Years	Points	Comments:
(Points should be assigned to all legs of the intersection)		
1	2	
2	4	
3	6	
4	8	
5 or more	10	

4. Posted Speed Limit (or 85th %ile Speed) on Street to be Crossed	North	South	East	West

Speed (mph)	Points	Comments:
0 to 25	1
26 to 30	2
31 to 35	3
36 to 40	4
41 or more	5

5. Traffic Volumes/Queues	North	South	East	West

Queues on Parallel Street — Points — Comments:

(Queues should be measured during the time of day when the requesting blind of visually impaired person typically crosses the intersection and/or when crossing the intersection would be most difficult.)

Queues on Parallel Street	Points
> 2 vehicle queue per cycle	2
2 vehicle queue per cycle	4
1 vehicle queue per cycle	6
Average < 1 vehicle per cycle	8
0 vehicles per any 5 minute period	10

6. Right Turn Operations	North	South	East	West

Assign points for peak hour right-turn volumes from the street parallel with the pedestrian crossing.

Volume (vph)	Points	Comments:
20 to 40	2	
41 to 60	4	
61 to 80	6	
81 to 100	8	
> 100	10	

7. Free Right Turn Operations	North	South	East	West

If there is a free flow right-turn lane (i.e. right turn that is channelized and does not operate under signal control) that impacts the crossing, assign 5 points.

Comments:

8. Special Signal Conditions	North	South	East	West

If there are lead pedestrian phases, exclusive pedestrian phases, mid-block exclusive pedestrian signals, or split phasing that impact the crossing, assign 15 points.

Comments:

9. Proximity of Intersection to Key Facilities	North	South	East	West

Proximity to Facility	Points	Comments:
1201 ft to 2400 ft	2	
801 ft to 1200 ft	4	
401 ft to 800 ft	6	
Less than 400 ft	8	
At the Facility	10	

10. Other Special Traffic and Mobility Conditions	North	South	East	West

If special traffic and mobility conditions do exist, assign up to 15 points.

Comments:

TOTAL POINTS	North	South	East	West

OVERALL INTERSECTION SCORE (Highest Total Points By Approach)	

Additional Comments by Evaluation Team:

APPENDIX M

Memo – Requests for Electric Power Service (October 19, 2011)

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

SHAILEN P. BHATT
SECRETARY

MEMORANDUM

TO: Assistant Directors and Section Heads in the Divisions of Transportation Solutions and Maintenance and Operations

FROM: Natalie Barnhart, Chief Engineer, Director of Transportation Solutions NB
Joe Wright, Director of Maintenance & Operations

DATE: October 19, 2011

SUBJECT: Processing of Requests for Electric Power Service for Roadway Lighting, Traffic Signals, and ITS Equipment

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The following will serve to establish and document the acceptable procedure for processing requests for electric power service on DelDOT construction projects:

- As this work is not a relocation of utilities subject to the provisions of 17 Del. C., §143, electrical power needs must be coordinated across multiple Sections of the Department to account for the type, size, location, maintenance responsibility, and installation cost specific to each project, and monthly billing arrangements.
- Project Designer (PD) & Traffic will identify power supply needs for roadway appurtenances on DelDOT projects (typically roadway lighting, traffic signals, and ITS devices) as early in the design phase as possible. PD and other appropriate sections of DelDOT (such as DTC, Tolls, etc.) will identify power supply needs for buildings proposed as part of DelDOT projects. This memorandum does not address building projects which will need to be discussed on a case by case basis.
- PD, Traffic, and Utility Coordinator will meet with the power supply company during the design phase of the project to discuss power needs, costs to the Department, whether service will be metered or tariff, and request a design and cost estimate from the utility company.
- PD, Traffic and Utility Coordinator will prepare Traffic and Utility Statements to reflect the scope of work to be performed by the utility company related to provision of new or modifications to the electric power service. The Utility Statement will provide the description of work and identify that the work associated with provision of new electrical service is to be paid for by the Department. The Traffic Statement will show the electrical service noted as an item of work with the associated cost estimate. For any projects involving roadway lighting, a copy of the Utility Statement shall be sent to North District and Business Management. A Utility Bar Chart shall be prepared to show the timing of the power supply work and made a part of the Utility Statement for the project.

DelDOT

APPENDIX N

Wiring Guidelines

Appendices

Appendix –

Signal Wiring/Cabling

There are a variety of conductors and cables specifically designed for the traffic signal industry. The type and size of conductors and cables should conform to the National Electrical Code and to IMSA cable specifications as a matter of good practice. In some cases, manufacturers may recommend specific types of wire or cable for proper operation of their equipment. **Table 1** shows information related to wiring typically used by DelDOT Traffic.

Table 1
Wiring Diagram Supplemental Information

Device	Cable Type	Size	Volt. (AC)
HIB, Jumper Wire	4-ConductorElectrical Cable	No. 14 AWG [(2)]	12
Pedestrian Signal Head and Push Button (1 Way), Pedestrian Signal Head and Push Button (2 Way)	5-Conductor Electrical Cable	No. 14 AWG [(2)]	110
1- & 2-Section Signal Heads, 3-Sect. Head w/Arrows & Jumper Wire (Mast arm)	4-Conductor Electrical Cable [(1)]	No. 14 AWG [(2)]	110
4- and 5-Section Signal Heads (Mast arm)	9-Conductor Electrical Cable [(1)]	No. 14 AWG [(2)]	110
Signal Heads (span wire)	16-Conductor Electric Cable	No. 14 AWG [(2)]	110
Loop Wire	1-Conductor (Aluminum shielded)	No. 14 AWG	12
Loop Detector Lead-in Cable	2-Conductor (Aluminum shielded)	No. 14 AWG	12
Opticom Detector	4-Conductor Detector Cable	No. 18 AWG	24
Grounding	Strand. Bare Cop. Gnd. Wire	No. 6 AWG [(2)]	----
Power Feed (Disconnect to Cabinet)	8-Conductor Electrical Cable	No. 8/ 2 UF w/G [(2)]	110/220
Electrical Service (Transformer to Disconnect)	1 – Conductor Electrical Cable	No. 8/ 2 UF w/G [(2)]	110/220

NOTES:
[(1)] For longer runs, heavier gauge cable may be required to reduce voltage drop.

Field Cabling

Signal head wiring originates at the control cabinet and terminates at the signal head. Cables composed of multiple conductors are used for this application. The number of conductors making up the cables is standardized to three or four combinations to reduce inventory requirements. DelDOT Signal Construction uses cables with 4, 9, and 16 conductors per cable. Additional sizes may be used, if required but, prior approval from the Signal Construction Manager shall be required.

A separate ground wire shall be used for signal display returns for each approach to the intersection. One ground wire shall be used for a maximum of five (5) signal faces, all directed toward the same approach to the intersection. Separate ground wires shall be used for pedestrian signal displays, and for pedestrian detector returns.

a. Cable Sizing

The number of conductors needed in a cable can be determined by counting the number of indications to be controlled, adding the conductors needed for ground, and providing at least one spare. After the number of conductors needed is known, the cable size that is appropriate from the normal inventory can be selected. **Table IV-8** shows the resulting preferred cable type for each device.

The signal cable shall typically be continuous and unbroken between the control cabinet and the first signal head that it services. However, while they should generally be avoided, signal cable splices may be used in the bottom of steel poles or nearest junction well for the following circumstances, such as:

- Mast Arm Designs
- Pre-wired pedestrian poles
- For emergency signal repairs

Cabling may be overhead or underground, depending on the type of signal installation and the availability of pole lines and/or underground conduits.

b. Span Wire Cabling and Splice configurations

Signal head cables for a span wire installation are typically underground from the control cabinet to the nearest steel pole, up the pole, and onto the span through a weather head.

2 - 16 conductors shall be installed for normal signal span installations. One conductor will be used to serve both one major street approach and one side street approach. The other cable will be used for the remaining approaches.

Signal heads facing the same approach that will display identical displays throughout the signal cycle may be jumped together with 4 conductor and spliced into the appropriate 16 conductor, leading back to the control cabinet.

Table 2 illustrates the standard practices of signal wiring and color codes for span wire configuration.

Table 2
Standard Practices of Signal Wiring and Color Codes

Conductor Colors	16/#14 Cable #1 Direction	16/#14 Cable #2 Direction	Signal Color
Typical Installation			
Green	NB or EB Artery	SB or WB Artery	Green
Orange			Yellow
Red			Red
White			Ground
Green / Black	NB or EB Side Street	SB or WB Side Street	Green
Orange / Black			Yellow
Red / Black			Red
White / Black			Ground
Green / White	NB or EB Artery Left Turn (If Used)	SB or WB Artery Left Turn (If Used)	Green
Black / White			Yellow
Red / White			Red
Blue / White			Ground
Blue	NB or EB Side Street Left Turn (If Used)	SB or WB Side Street Left Turn (If Used)	Green
Black			Yellow
Black / Red			Red
Blue / Black			Ground
Permissive Left Turns (5 section signal head)			
Green	NB or EB Artery Left Turn	SB or WB Artery Left Turn	Green
Yellow			Yellow
Red			Red
Blue			Green ←
Black			Yellow ←
White			Ground

c. Mast Arm Pole Cabling and Splicing Configurations

Signal head cabling for a mast arm pole typically needs fewer conductors and more cables than a span wire installation. Below is the typical cable layout for mast arm designs.
Signal head cables for a mast arm pole installation are typically underground from the control cabinet to a junction well located near the up-right of the structure. The number of conductors required at each mast arm is based on the number of phase being displayed. For a single phase layout 1 - 9 conductor, for 2 - 3 phases 1 - 16 conductor, for 4 phases 2 -16 conductors. Additional 4 and 9 conductors may be required to accommodate pedestrian and pre- emption devices based on design requirements

A single 4 conductor for 1-4 section indications and a single 9 conductor for 5 section indications shall be installed for each signal head installed on the mast arm pole to the base of the mast arm up-right, with no splices. At the bottom of the pole signal head conductors shall be spliced into the proposed conductor from the controller cabinet. The splices shall twisted and wire nuts to ensure a good connection. All splices shall be covered secured with electrical tape or a similar form of protection. All splices should occur in the hand hole at the base of the up-right.

Table 3a – 3d below illustrates the standard practices for wiring various types of signal equipment for a mast arm design.

Table 3a
Four Conductor Cable Wiring and Color Codes

Conductor Colors	Single Section Signal Head	3 Section Signal Head
Green	Not used	Green lens
Black	Power Feed	Yellow Lens
Red	Not used	Red Lens
White	Ground	Ground

Table 3b
Nine Conductor Signal Wiring and Color Codes

Conductor Colors	Single Ped Signal	2-way Ped Signal	4-section "T" Head	4-section "⊥" Head	5-section Head
Green	Walk	#1 Walk	Green	Green Arrow	Green
Orange	Not used	Not used	Yellow	Yellow	Yellow Arrow
Red	Don't Walk	#1 Don't Walk	Red	Red	Red
White	Signal Ground	Signal Ground	Ground	Ground	Ground
Green / Black	Not used	#2 Walk	Not used	Green Arrow	Not used
Black	P.B. Output	#1 P.B.	Not used	Not used	Yellow Arrow
Red / Black	Not used	#2 Don't Walk	Red Arrow	Not used	Not used
White / Black	P.B. Ground	P.B. Ground	Not used	Not used	Not used
Blue	Not used	#2 P.B.	Not used	Not used	Green Arrow

Table 3c
Left Turn Signal Head Wiring

Option #1 5-Section Signal Head			
Orange / Black	Side Street	Side Street	Yellow
Red / Black	Left Turn	Left Turn	Red
Blue / Black			Green ←
Black / Red			Yellow ←
White / Black			Ground
Option #2 Flashing Red Arrow (4-Section "**T**" Head) Artery Left Turns Only			
Green / White	N.B. or E.B.	SB or W.B.	Green ←
Black / White	Artery	Artery	Yellow ←
Red / White	Left Turn	Left Turn	Red
Black / Red			FL Red ←
Blue / White			Ground

Table 3d 16 Conductor of Signal Wiring and Color Codes			
Conductor Colors	**16/#14 Cable #1 Direction**	**16/#14 Cable #2 Direction**	**Signal Color**
Typical Installation			
Green	NB or EB Artery	SB or WB Artery	Green
Orange			Yellow
Red			Red
White			Ground
Green / Black	NB or EB Side Street	SB or WB Side Street	Green
Orange / Black			Yellow
Red / Black			Red
White / Black			Ground
Green / White	NB or EB Artery Left Turn (If Used)	SB or WB Artery Left Turn (If Used)	Green
Black / White			Yellow
Red / White			Red
Blue / White			Ground
Blue	NB or EB Side Street Left Turn (If Used)	SB or WB Side Street Left Turn (If Used)	Green
Black			Yellow
Black / Red			Red
Blue / Black			Ground
Permissive Left Turns (5 section signal head)			
Green	NB or EB Artery Left Turn	SB or WB Artery Left Turn	Green
Yellow			Yellow
Red			Red
Blue			Green ←
Black			Yellow ←
White			Ground

d. Detector Wiring

Detector wiring generally consists of electrically connecting the detector (usually an inductive loop detector) with its electronics in the control cabinet. DelDOT Traffic has specific requirements for loop detectors, optical detectors and video detectors:

Loop Detectors: These loops are formed by sawcutting the roadway and placing 1 – conductor incased in flexible tubing in the sawcut which is then sealed. To ensure that the wire is protected from the transition from roadway to the nearest junction well all loop wires should be placed in a 1" flexible non-metallic liquid tight conduit in this transition area. The detector connection from the junction well to the controller cabinet shall be a 2 conductor (aluminum-shielded) lead-in cable for each loop detector. The lead-in cable shall be a continuous run, without splices, between the control cabinet and the junction well adjacent to the loop installation.

The loop detector shall be spliced to the "homerun" cable in the junction well adjacent to the loop installation. All connections in the loop splice shall be soldered and individually insulated, with heat shrink tubing. When all connections are completed, the entire splice shall be encased in an epoxy-filled splicing kit (for example, 3M Scotch Cast #82-A1 or approved equal).

These installation procedures will minimize noise in the cable, which could interfere with the proper operation of the detector. Each splice will inevitably add electrical resistance, which would impede the proper operation of the detector. Therefore, only one splice will be allowed between the loop location and the control cabinet.

Optical and Video Detectors: Shall comply to all the recommended manufacture wiring requirements to achieve maximum data output.

e. Grounding

The following guidelines should be followed to ensure proper grounding of all wire:

- For poles and pedestals, a continuous ground wire shall be connected between the pole or pedestal and the ground rod installed in the concrete pole base.
- In the control cabinet:
    - The white wire and the ground (bare copper) wire from the service shall be connected directly to the ground rod in the concrete cabinet base. The white wire shall continue, unbroken, to the ground buss on the "Power Panel."
    - The green ground wire in the cabinet shall be connected as directly as possible to the ground rod.
    - All individual signal ground returns shall be connected to the ground buss on the "Power Panel."

f. Calculation of Wiring for Signal Heads

Many applications for signal head wiring use two (2) 16/#14 cables to accommodate all movements. The following is a list of steps taken to determine the cable size:

1. Determine the furthest grouping of heads for one movement
2. Determine all signal heads that will operate together
3. One wire will be used for each of these signal head groups
4. Add one wire for grounding

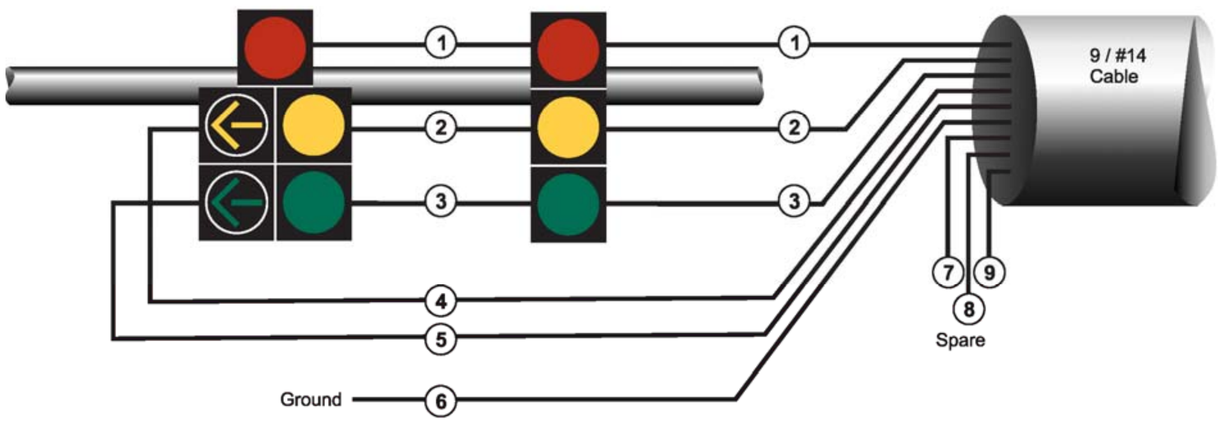


Figure IV-26. Example Wiring for Signal Heads

The example shown above will need a minimum of 6/#14 to accommodate all heads. However, to allow for wire failures and the addition of signal heads in the future, a 9/#14 should be used for this installation.

APPENDIX O

Soil Boring Request form Sample

Note: This form will be regularly updated. View most recent version online.

Project Name:	DE 24 @ US 113 (proposed 70' mast arm on NE co	**Del-DOT contact Person**	**Hany Fekry, PE** 302-760-2551
Project Number	T201101001		hany.fekry@state.de.us

Priority	Boring No.	Structure and Location Description	Northing	Easting	Station	Offset		Ground Surface Elevation	Total Boring Depth (feet)	INF Test (Y/N)	AASHTO T206 Continues Depth/ SPT	Others to Coordinate With (Ex. DNREC, town, USACE) (Y/N)	Coordinate with Property Owner (Y/N)	Notes	AASHTO T288 & T289 pH / Corrosion (Y/N)	AASHTO T99 or T180 Standard Proctor (Y/N)	AASHTO T193 CBR (Y/N)	AASHTO T216-07 Consolidation Test (Y/N)	AASHTO T236 Direct Shear (Y/N)	AASHTO T297 CU Triaxial (Y/N)
High	1	DE 24 @ US 113 (NE corner)	38°35'9.12" N	75°17'42.11 "W					50	N					N	N	N	N	N	N
High	2	DE 24 @ US 113 (SB left turn island)	38°35'8.99" N	75°17'43.13 "W					50	N					N	N	N	N	N	N
High	3	DE 24 @ US 113 (NB left turn island)	38°35'7.51" N	75°17'42.05 "W					50	N					N	N	N	N	N	N

APPENDIX P

Guidance on Overhead Street Signs Mounted on Traffic Signals

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

SHAILEN P. BHATT
SECRETARY

MEMORANDUM

To: All Users of Delaware Manual on Uniform Traffic Control Devices

From: Mark Luszcz, P.E., PTOE ML
Chief Traffic Engineer

Date: November 5, 2013

Subject: Overhead Street Signs Mounted on Traffic Signals

The DelDOT design criteria for overhead mounted street names differs from the recommended minimum lettering heights provided in **Paragraph 07** of **Section 2D.43** of the ***Delaware Manual on Uniform Control Devices for Streets and Highways*** (DE MUTCD). As a result, sign heights per the design criteria also differ from that recommended in **Table 2D-2** of the **DE MUTCD**. Our experience has indicated that an 8-inch letter height is typically of sufficient size, when mounted on traffic signal span wires or mast arms, to properly convey street name information to the driving public. Although this does not meet the recommended MUTCD criteria on higher speed roadways for letter height and legibility distance, taken in context with advanced street name signing, the conspicuous mounting location (overhead), and the presence of a significant traffic control "landmark" (the traffic signal), signs with 8-inch capital/6-inch lower case letters are sufficient. Furthermore, we have experienced significant problems with bracket mounting hardware, and many failures that have resulted in overhead signs falling to the ground when we attempted to utilize signs with larger letter heights. Finally, we could consider using a larger letter height on the same sized sign (18-inches sign height); however, the reduction of the margins on the sign would violate a standard in the MUTCD (Section 2A.11, Paragraph 2).

This memorandum is therefore issued to document the DelDOT design criteria for overhead mounted street name signs and provide details/illustrations of the overhead street name signs and mounting hardware.

DESIGN CRITERIA

1. All new traffic control signals, and traffic control signals that are undergoing significant retrofits, should include overhead street name signs (SNS) unless otherwise noted in this document, or other valid engineering or community involvement reasons are documented (i.e., DelDOT and a municipality agree that overhead SNSs are not needed in a specific low speed, downtown area due to aesthetic concerns).

2. All SNSs on span wires and on mast arms should have the following characteristics:

    a. Be dual sided (except for one-way streets)
    b. Be hung below the span wire or mast arm
    c. Have a maximum width of 120 inches (10 feet)
    d. Have an initial upper case height of eight inches (8"), and lower case height of six inches (6"), Highway Gothic D Lettering
    e. Have seventeen feet (17 feet) minimum clearance from roadway surface to bottom of sign
    f. Be installed **only** when the angle of the mast arm or span wire perpendicular to the direction of travel is less than 30 degrees. Regulatory signs can be hung with a pivot bracket.

3. Overhead SNSs conforming to the design criteria outlined above may incorporate a route shield when the roadway meets the conditions set out in the **DE MUTCD Section 2D.43 Paragraph 02**. State Route and US Route markers can be added to the left portion of the SNS; but shall not extend the length beyond 120" or increase the height of the sign. The symbol should be proportioned on the sign, so as not to distort the State Route or US Route symbol. If the length of the road name is so long that the 120 inches maximum width will be exceeded, the state or US route shield with the GREEN border measuring 18" X 18" overall, may be used without the street name (see page 5)

4. The designer should avoid overhead street name signs with two lines of lettering if at all possible. Typically, if a cross street has different names on either side of the intersection; two separate one-line signs should be used. In circumstances where a two line sign cannot be avoided, the designer should bring the issue up for discussion at the Project Process Meeting for an agreement regarding whether the sign should be used or not. If the use of the two-line street name sign is agreed, the designer should then contact Lori Hutson (302.760.2581; lori.hutson@state.de.us) for sizing based on the new design criteria.

5. Single line SNSs should not be tethered. Two line SNSs with a back plate application may be tethered, at the Engineers direction.

6. Note that regulatory signs mounted on mast arms should be rigid mounted to the mast arm (not hanging). Proposed new hardware should be used to mount regulatory signs mounted on span wires. Such span-mount signs will not be tethered unless special circumstances, such as size, dictate so.

7. The combination of possible geometric intersection designs (i.e., number of approaches, skew angles, etc.) and signal designs (e.g., box span, four mast arm, double mast arm, various unconventional options, etc.) make it impractical to develop a specific policy that will show exactly where every overhead sign should be located. The following principles should be followed:

   a. Avoid placing the SNS between traffic signal heads. Generally place overhead SNSs to the right of the far right traffic signal head, e.g., over the paved shoulder.
   b. For an undivided roadway with good visibility in both directions (e.g., not a skewed intersection), generally only one SNS is needed which can serve both directions of travel. So for the intersection of two undivided roadways that do not change names at the intersection, intersecting at a 90-degree angle without other sight obstructions, typically only two SNS are needed – one for each roadway. Sometimes even if the intersection is skewed, one sign may be visible from both directions if properly placed.
   c. When the cross street has different names on either side of the intersection, or if one SNS does not result in good visibility in both directions, two signs for the roadway in question will be needed. If possible, the first option is to place the SNSs on the far side right and near side left. The next option is near side right and/or far side left. The road to the right is shown on both sides (forward and reverse) on the right side SNS (whether far or near side), and the road to the left is shown on the left side SNS. Arrows should be included to indicate the direction in which the road name is valid.
   d. Divided highways should typically have one SNS for each direction of travel, generally following the placement guidelines noted in (c) above. Arrows should not be used if the cross street name is the same on either side.
   e. For installations where the vertical support is on the right, AND is in close proximity to the edge of roadway, AND the SNS would conflict with signal heads on the mast arm or span wire, the SNS may be mounted on the vertical support. If any portion of the SNS will extend over the roadway, the seventeen (17) feet minimum clearance will apply.
   f. If overhead SNSs properly convey all street names at an intersection, then ground mount SNSs should be omitted or if existing, removed. If one or more streets cannot feasibly be signed with overhead SNSs, then all streets should be designated with ground mount SNSs (even if one street has redundant overhead and ground mount SNSs).

8. Before the Project Process Meeting, the designer should contact the County 911 Centers to obtain official street names for all SNS:

    a. New Castle county – Bill Streets @ wfstreets@nccde.org or (302) 395-8213

    b. Kent County – Sabrina Fite @ (302) 744-2420

    c. Sussex County – Lindsey Stubbs @ (302) 855-1176

    d. Statewide Administrator @ (302) 744-2682

9. Additionally, when in doubt about sizing, the designer should contact Lori Hutson (302.760.2581; lori.hutson@state.de.us) for accurate sizing of overhead SNS before the Project Process Meeting.

CONSTRUCTION CRITERIA

1. Construction Manager will be notified on the Handoff Form of overhead signs. The order for overhead signs should be placed with DelDOT Sign Shop as early as possible to account for sign fabrication lead time.
2. Signs are to be mounted using the mounting hardware and details on the following pages.
3. If overhead SNSs cannot be installed per plan for any reason, the Construction Inspector should consult with the Designer on the proposed modifications.

OVERHEAD SIGN SIZING AND MOUNTING HARDWARE DETAILS /ILLUSTRATIONS

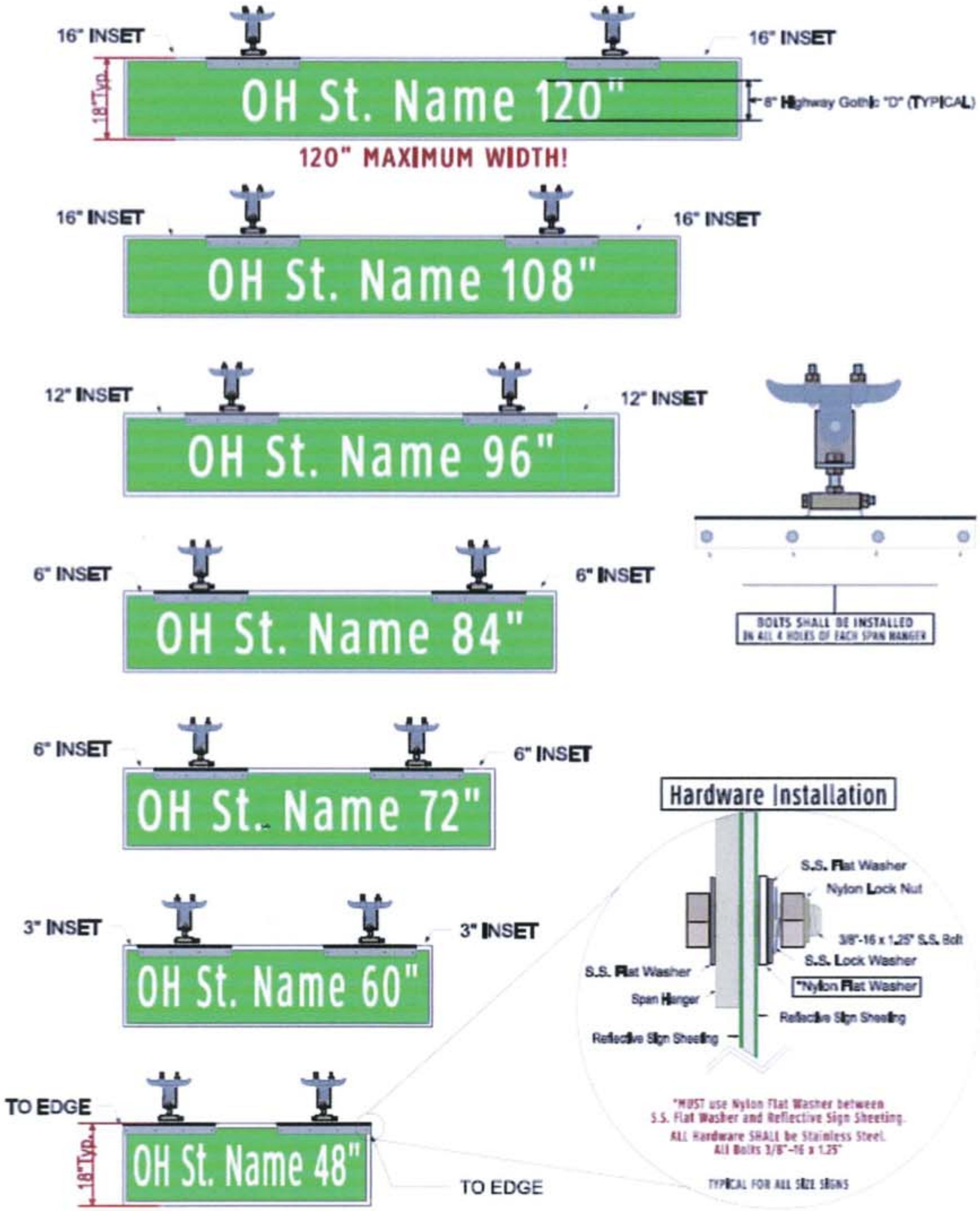
The following are details/illustrations for the design and mounting hardware for overhead mounted signs on span wires and on mast arms. These details/illustrations are not intended to restrict usage to specific manufacturers/suppliers. Alternate manufacturers/suppliers meeting the same specifications may be utilized.

State Route Overhead Street Name Sign: Number Only

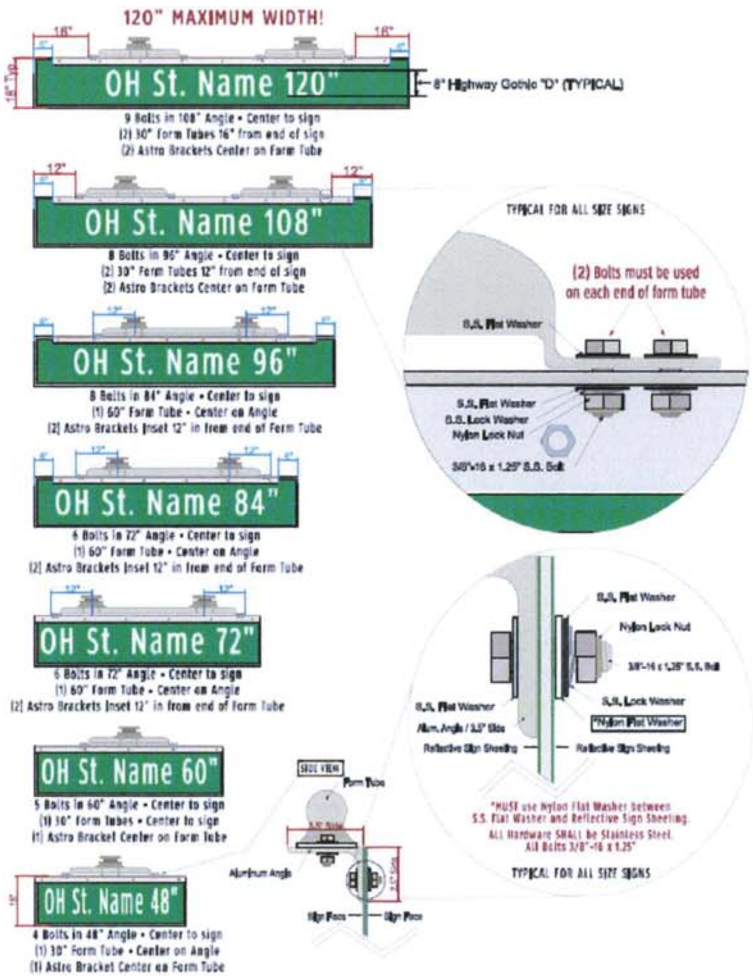
State Route Overhead Street Name Sign: Route Shield & Road Name

8" Capital Letters

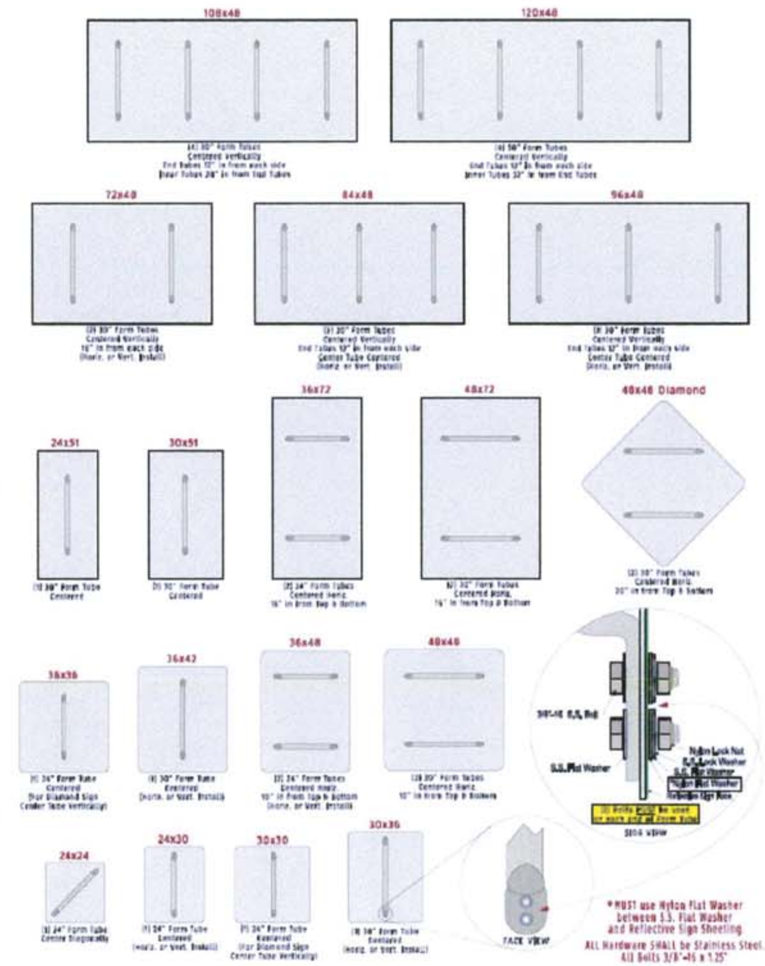
Dual Face Span Wire - Street Name Sign Hardware Installation Specifications



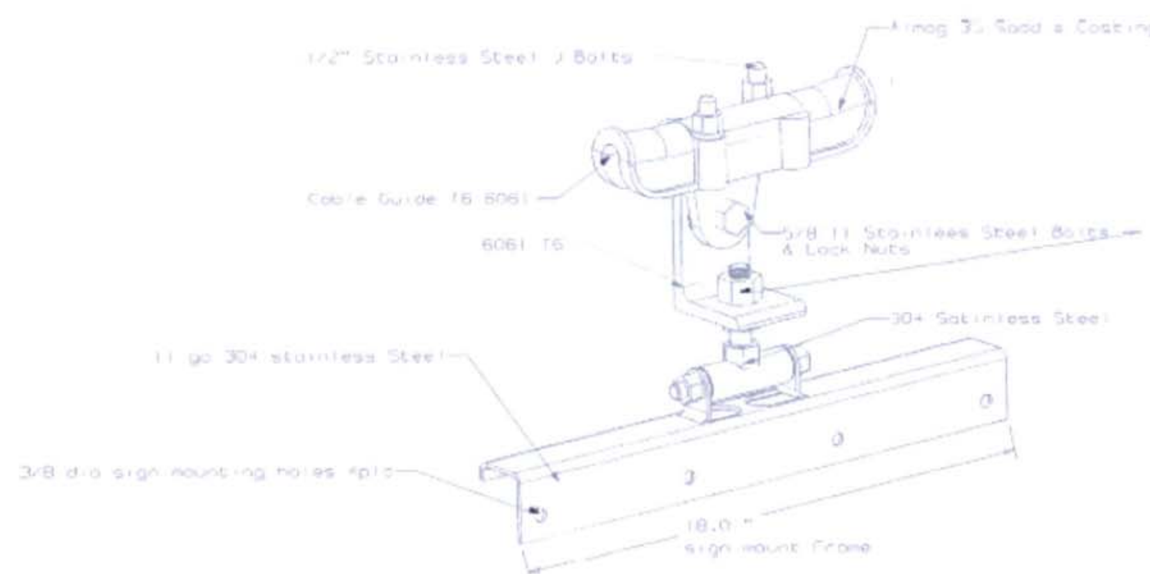
Dual Face Mast Arm / Street Name Sign Hardware Installation Specifications



Single Face Mast Arm / Pole Mount Sheet Sign Hardware Installation Specifications



TS+T Are Vendors



Toffic Enterprises Inc
Adjustable overhead Span
Wire Sign Bracket model AS305SDM

AS305SDM is adjustable overhead sign bracket system capable of being fully assembled on the ground
and hung over the span wire cable prior to inserting the cable guide and 304 stainless steel 1/2" bolts washers & nuts.
The Cable clamp is made of ALMAG 35 for superior strength.
Adjustment in the plane of a supporting cable for setting lateral angle of a sign, adjustment about a substantially vertical axis
for setting direction in which a sign is to face, and provision permitting a sign to swing in the plane of the direction in which
facing to lessen the magnitude of wind loads,
provides improved access and swinging clearance at the adjustment about a substantially vertical axis, in the form of a centrally
located vertical locking bolt as the shank portion of an integral inverted "T" member consisting of Stainless Steel Components Followed
by a Stainless Steel Sign Mounting Frame.

Astro Sign-Brac Formed Tubes Stellar Series

Pelco manufactures a variety of sign brackets in rigid and free-swinging mounts for both flat and internally illuminated signs.

SIGN MOUNTINGS

pelco

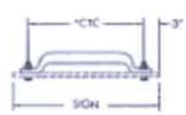
Astro Sign-Brac, Stellar Band Mount, Formed Tube

AS-0105 - [CTC] - [Band Length] - [Coating]

CTC: *See Chart

Band Length: 29 = 29" Band; 36 = 36" Band; 42 = 42" Band; 48 = 48" Band; 56 = 56" Band

Coating: PNC = Process No Color; P__ = Paint

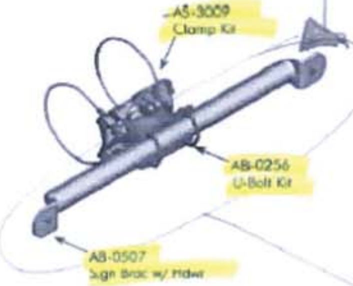


Sign Mount	
TUBE *CTC	SIGN
9"	15"
12"	18"
15"	21"
18"	24"
24"	30"
30"	36"
36"	42"
42"	48"
48"	54"
60"	66"
66"	72"
72"	78"

Note:
Specify stainless upgrade by including -SS in the part number, i.e., AS-0105-09-29-SS-PNC

This is how most arm assemblies look installed
AB 3009

Astro Sign-Brac, Stellar Cable Mount, Formed Tube

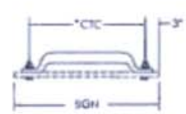


AS-0142 - [CTC] - [Cable Length] - [Coating]

CTC: *See Chart

Cable Length: 62 = 62" Cable; 84 = 84" Cable; 96 = 96" Cable

Coating: PNC = Process No Color; P__ = Paint



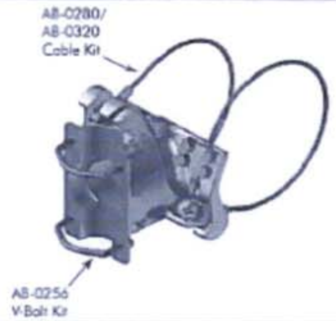
Sign Mount	
TUBE *CTC	SIGN
9"	15"
12"	18"
15"	21"
18"	24"
24"	30"
30"	36"
36"	42"
42"	48"
48"	54"
60"	66"
66"	72"
72"	78"

Note:
Specify stainless upgrade by including -SS in the part number, i.e., AS-0142-09-62-SS-PNC.

Note: 1. All assemblies are supplied standard with stainless fasteners. Stainless upgrade to include stainless steel clamp screws or cable where applicable.
2. Suggested maximum sign face of 16 sq. ft. per bracket.
3. See Reference Section for available paint colors.

Cable Mount Clamp Kits

These high tensile aluminum alloy clamp kits provide strength with maximum adjustability and complete clamping versatility. They feature high strength galvanized aircraft cable and stainless steel swaged fittings. Supplied complete with all necessary attaching hardware.



Astro-Brac, Stellar Series Clamp Kit, Cable Mount

AS-3009 - [Cable Length] - [Coating]

Cable Length:
62 =62" Cable
84 =84" Cable
96 =96" Cable
110" =110" Cable
120" =120" Cable
132 =132" Cable
144 =144" Cable

Coating:
PNC =Process No Color
P_ _ =Paint

Note:
Stainless steel upgrade available; includes stainless cable.
Specify by including -SS in the part number, i.e., AS-3009-62-SS-PNC.

Astro-Brac Clamp Kit, Cable Mount

AB-3009 - [Cable Length] - [Coating]

Cable Length:
62 =62" Cable
84 =84" Cable
96 =96" Cable
110" =110" Cable
120" =120" Cable
132 =132" Cable
144 =144" Cable

Coating:
PNC =Process No Color
P_ _ =Paint

Note:
Stainless steel upgrade available; includes stainless cable.
Specify by including -SS in the part number, i.e., AB-3009-62-SS-PNC.

Astro-Brac Clamp Kit, Free-Swinging, Cable Mount

AB-3014 - [Cable Length] - [Coating]

Cable Length:
62 =62" Cable
84 =84" Cable
96 =96" Cable
110" =110" Cable
120" =120" Cable

Coating:
PNC =Process No Color
P_ _ =Paint

Note:
Stainless steel upgrade available; includes stainless cable.
Specify by including -SS in the part number, i.e., AB-3014-62-SS-PNC.

Note: 1. All assemblies are supplied standard with stainless steel fasteners.
2. See Reference Section for clamp kit pole diameters.
3. See Reference Section for available paint colors.

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ASTRO-BRAC

NEW Astro-Brac Atlas
Pelco's Large Capacity Traffic Mounting System

Pelco's Astro-Brac Atlas Large Capacity Mounting System is made to the same quality and attention to detail as the traditional Astro-Brac Mounting System.

The Astro-Brac Atlas features an extended lower cover that allows for larger bend radius as well as a new UV-resistant snap-in large capacity insert and tube closure cover cap for easier installation.

The Original Astro-Brac

Introduced in 1968, the Astro-Brac family of signal, sign, and camera mounts has proven to be the most versatile mounting system ever designed. Available in band or cable, the Astro-Brac can mount to any size and shape of mast arm or pole.

The Astro-Brac, in it's various configurations, provides a universal system for mounting signs, cameras, and any size or combination of signals to any size and shape of mast arm or pole. Complete adjustability is only possible with the Astro-Brac mounting system. You will undoubtedly find that the Astro-Brac can solve many, if not all of your mounting problems!

Features
- Completely Adjustable
- 3 Axis of Rotation
- Band, Cable or Tenon Mount
- Quick Easy Installation
- Secure Mounting Method

Mounting Applications
- Any combination of signal heads
- Optically Programmed Signals
- Pedestrian Signals
- Internally Illuminated Signs
- Flat Sheet Signs
- Sensor & Camera Mounts

Stellar Series Astro-Brac
Pelco's newest addition to the Astro-Brac line, the Astro-Stellar 2-piece clamp features a stronger clamping method with quicker and easier installation. Available with band or cable mount.

Astro Mini-Brac
This smaller version of the Astro-Brac was designed to fit small diameter (2-3/8" OD) tubes as well as large diameter mast arms. Ideally suited for Emergency Traffic Signal Sensors or Confirmation Lights.

Mast Arm Mounted Camera Bracket
Designed to mount traffic monitoring cameras, this bracket represents just one of the many possibilities for camera and sensor mounting applications in today's complex and increasingly crowded streets and intersections.

\

Astro-Brac Atlas Brochure (PDF)

Astro-Brac Brochure (PDF)

Installation Instructions

Astro-Brac Cable Clamp Kit Installation Instructions (PDF)
Astro-Brac Band Mount Installation Instructions (PDF)
Astro-Brac Mini-Brac Installation Instructions (PDF)
Stellar Cable Clamp Installation Instructions (PDF)
Stellar Band Mount Installation Instructions (PDF)
Stellar Tenon Mount Installation Instructions (PDF)
Triton Cable Clamp Installation Instructions (PDF)
Triton Band Mount Installation Instructions (PDF)
Talon Cable Clamp Installation Instructions (PDF)
Ty-Back/Restraining Clamp for Cable Mount Installation Instructions (PDF)

Specifications

Mast Arm Mount Signal Bracket 1-Way Stainless Steel Band Mount (PDF)
Mast Arm Mount Signal Bracket 1-Way Stainless Steel Cable Mount (PDF)

Pelco Products, Inc. has the most extensive line of traffic products anywhere. For more information, call (405) 340 3434. You can also email us at sales@pelcoinc.com

INSTALLATION INSTRUCTIONS

ASTRO-BRAC CLAMP ASSY
3/16" Cable

Tools Required: 1/2" & 11/16" Sockets & Ratchets or Box End Wrenches (approx. 7" length)
3/8" Open End Wrench or Equivalent (approx. 7" length)
Torque Wrench or equivalent
Hack Saw

Attaching Clamp Kit to Mast Arm

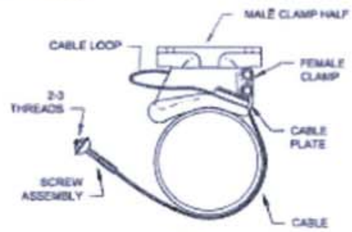


Figure 1

1. Place Female Clamp Half on mast arm as shown in Figure 1. Leave two to three (2-3) threads exposed above the nut on the Cable Screw Assembly as shown.
2. Place Cable Screw Assembly in casting pawl of the Female Clamp as shown in Figure 2. Loosen four (4) 5/16" Bolts on Cable Plate. Pull cable loop to tighten cable on the mast arm. To secure cable with cable plate, tighten four (4) 5/16" bolts to 15-18 ft. lbs. of torque. ***DO NOT OVERTIGHTEN.***
3. Repeat Step 2 for second Cable Plate.
4. Back off nut on both Cable Screw Assemblies to loosen cable. Rotate Clamp Kit on mast arm to desired signal position (Figure 3). Snug nut on both Cable Screw Assemblies just enough to hold Clamp Kit in position. When tightening Cable Screw Assembly, hold hex portion with 3/8" Open End Wrench or equivalent. ***DO NOT ALLOW CABLE TO TWIST OR TURN WHEN TIGHTENING. DO NOT TIGHTEN TO FINAL TORQUE UNTIL STEPS 5-7 BELOW ARE COMPLETED.***

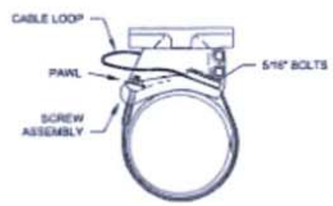


Figure 2

Attaching Signal and Tube Assembly to Clamp Kit

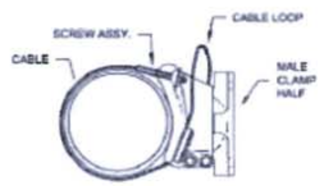


Figure 3

5. Position tube into Male Half of Clamp Kit (Figure 4). Insert V-Bolts as shown and attach with lockwashers and nuts.
6. With signal properly positioned to the desired height and direction, tighten nuts on two (2) V-bolts to 12-15 ft. lbs. of torque. ***DO NOT OVERTIGHTEN.***
7. Plumb or level signal and tighten two (2) 5/16" hex bolts on Female Half of Clamp Kit to 20-22 ft.lbs. of torque. ***DO NOT OVERTIGHTEN.***
8. Use 3/8" Open End Wrench to hold Cable Screw and tighten both Cable Screw Assembly Nuts to 20-22 ft.lbs. of torque, using a 11/16" Box End Wrench or Ratchet (Figure 4). Note: Tightening the Cable Screw Assembly Nuts firmly with a 7" Wrench will produce approximately 20 ft. lbs. of torque. ***DO NOT OVERTIGHTEN.***
9. Install cable Ty-Back/Restraining Clamp (AB-0506) per separate instruction Bulletin No. 2037. Clamp will provide neater cable appearance and a positive cable restraint.

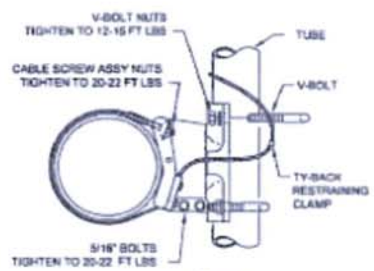


Figure 4

INSTALLATION INSTRUCTIONS

ASTRO-BRAC CLAMP ASSY
3/16" Cable

For All Arm and Tube Kits:

Gusseted and **Solid**

1. Mount lower arm to bottom of signal. Position arm so that tube boss will be centered in back of signal. (Figure 1). Using the hardware kit without rubber gasket, secure arm to signal.
2. Screw tube into lower arm, being sure to stop at a point where the channel (if using a gusseted tube) is at the back, facing directly away from the signal. Slide upper arm down over top of tube and secure to signal, using hardware kit with rubber gasket. Hardware kit should be installed against the inside top of signal. (Figure 2).
3. After upper and lower arms are secure, and tube channel (if gusseted tube) is centered at back of tube, tighten setscrews in upper and lower arms. This will prevent rotation of tube after installation. (Figure 3).
4. Using hack saw, cut off any excess tube which may protrude above the upper arm. (Figure 4).
5. Finished assembly is now ready for installation on Clamp Kit. (Figure 5).

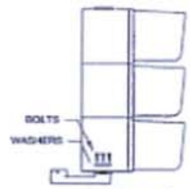


Figure 1

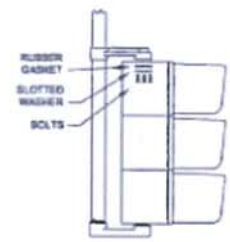


Figure 2

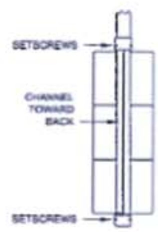


Figure 3

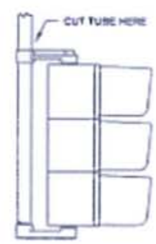


Figure 4

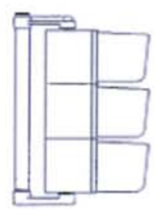
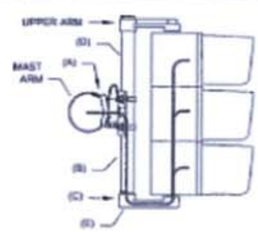


Figure 5

COVERED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS 3586280, 3764090, 3854685, 4659046. OTHERS PENDING.

How To Wire When Using The Astro-Brac

1. Wiring from inside the MastArm should be fed through field drilled hole in the arm and brought through Clamp Kit (A) to extruded Aluminum Support Tube (B) to Lower Arm (C) and to signal connections.
2. After running wire, cut Vinyl Insert to size and insert in Support Tube (D).
3. Slide in Bottom Cover (E) and snap into place.



No Other Adjustable Bracket Gives You...
COMPLETELY CONCEALED WIRING!

The Astro-Brac provides the most versatile mounting system available!

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PELCO PRODUCTS, INC.

Bulletin No. 2005 - Yellow

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Revised 04/03/12

APPENDIX Q

Yellow Trap Guidelines

Main Street Operations:

Scenario 1:
Protected left-turns {normally Ø1 & Ø5}

- No trap possible, no special sequence omit necessary
- Preempt settings:
    - Emergency = Ø1+ Ø6 or Ø2+ Ø5
    - Transit = Ø2+Ø6

Scenario 2:
Permissive left-turns using flashing red arrow, current operation

- No trap possible, no special sequence omit necessary
- Preempt settings:
    - Emergency = Ø1+ Ø6 or Ø2+ Ø5
    - Transit = Ø2+Ø6

Scenario 3:
Permissive left-turns (5-section display) both directions {normally Ø1 & Ø5}

- Special sequence omit needed to prevent yellow trap for Ø1 & Ø5
    - Special sequence omit for Ø1 to be set to Ø2
    - Special sequence omit for Ø5 to be set to Ø6
    - OCAL function is available for special circumstances
- Preempt settings:
    - Emergency = Ø2+Ø6
    - Transit = Ø2+Ø6

Scenario 4:
One protected left-turn & one permissive left-turn (5-section display) {Ø1 protected and Ø5 permissive}

- Special sequence omit needed to prevent yellow trap for phase 5
    - Special sequence omit for Ø1 to be set to Ø2
    - OCAL for Ø1 to be set to phase 4 (or the last phase used in Ring 1)
- Preempt settings:
    - Emergency = Ø2+Ø6 (for protected direction); Ø2+Ø5 for permissive direction
    - Transit = Ø2+Ø6

Scenario 5:
One protected left-turn & one permissive left-turn (5-section display) {Ø5 protected and Ø1 permissive}

- Special sequence omit needed to prevent yellow trap for phase 1
    - Special sequence omit for Ø5 to be set to Ø6
    - OCAL for Ø5to be set to phase 4 (or the last phase used in Ring 1)
- Preempt settings:
    - Emergency = Ø2+Ø6 (for protected direction); Ø1+Ø6 for permissive direction
    - Transit = Ø2+Ø6

Scenario 6:
One permissive left-turn & one un-signalized permissive left-turn (left-turn from through movement) {Ø1 signalized permissive left-turn (5-section)}

- Special sequence omit needed to prevent yellow trap for un-signalized movement
    - Special sequence omit Ø1 to be set to Ø2
    - If no side street, OCAL to dummy phase may be necessary
- Preempt settings:
    - Emergency = Ø2+Ø6
    - Transit = Ø2+Ø6

Main Street Operations (continued):

Scenario 7:
One permissive left-turn & one un-signalized permissive left-turn (left-turn from through movement) {Ø5 signalized permissive left-turn (5-section)}

- Special sequence omit needed to prevent yellow trap for un-signalized movement
    - Special sequence omit Ø5 to be set to Ø6
    - If no side street, OCAL to dummy phase may be necessary
- Preempt settings:
    - Emergency = Ø2+Ø6
    - Transit = Ø2+Ø6

Scenario 8:
One protected left-turn & one un-signalized permissive left-turn (left-turn from through movement) {Ø1 signalized protected left-turn}

- Trap possible for un-signalized movement
    - Special Sequence omit Ø1 to be set to Ø2
    - OCAL for Ø1 to be set to phase 4 (or last phase in Ring 1)
- Preempt settings:
    - Emergency = Ø2+Ø6
    - Transit = Ø2+Ø6

Scenario 9:
One protected left-turn & one un-signalized permissive left-turn (left-turn from through movement) {Ø5 signalized protected left-turn}

- Trap possible for un-signalized movement
    - Special Sequence omit Ø5 to be set to Ø6
    - OCAL for Ø5 to be set to phase 4 (or last phase in Ring 1)
- Preempt settings:
    - Emergency = Ø2+Ø6
    - Transit = Ø2+Ø6

LEAD/LAG Operations:

Scenario 10: (LEAD/LAG operations)
Protected left-turns in both directions {phases unknown}

- No trap possible, no special sequence omit necessary
- Preempt settings:
  - Emergency = main street through phase and associated left-turn phase for each direction
  - Transit = main street through phases only

Scenario 11: (LEAD/LAG operations)
Permissive left-turns (5-section display) both directions {phases unknown}

- Must hang sign for LEAD left-turn *"ON COMING TRAFFIC MAY HAVE EXTENDED GREEN"*
- Special Sequence omit LEAD left turn phase to be omitted by opposite through movement phase
- Preempt settings:
  - Emergency = main street through phases only
  - Transit = main street through phases only
- OCAL function is available for special circumstances

Scenario 12: (LEAD/LAG operations)
Protected left-turn LEAD / permissive left-turn LAG (5-section) {phases unknown}

- Special Sequence omit LEAD left-turn phase to be omitted by opposite through movement phase
  - OCAL for LEAD left-turn phase to be set to last phase in Ring 1
- Preempt settings:
  - Emergency = main street through phase for approach with protected left-turn phase; main street through plus left for approach with permissive left-turn phase
  - Transit = main street through phase

Scenario 13: (LEAD/LAG operations)
Permissive left-turn LEAD (5-section) / protected left-turn LAG {phases unknown}

- Must hang sign for LEAD left-turn *"ON COMING TRAFFIC MAY HAVE EXTENDED GREEN"*
- Preempt settings:
  - Emergency = main street through phase and associated left-turn phase for each direction
  - Transit = main street through phase

Scenario 14: (LAG Operation)
One LAG permissive left-turn & one un-signalized permissive left-turn (left-turn from through movement)

- Must hang sign for un-signalized left-turn *"ON COMING TRAFFIC MAY HAVE EXTENDED GREEN"*
- Preempt setting:
  - Emergency = main street through phase
  - Transit = main street through phase

Side Street Operations:

Scenario 1:

Protected left-turns {normally Ø3 & Ø7}

- No trap possible, no special sequence omit necessary
- Preempt settings:
    - Emergency = Ø3+ Ø8 or Ø4+ Ø7
    - Transit = Ø4+Ø8

Scenario 2:

Permissive left-turns (5-section display) {normally Ø3 & Ø7}

- Trap possible in preemption only due to main street recalls
- Preempt settings:
    - Emergency = Ø4+ Ø8
    - Transit = Ø4+Ø8

Scenario 3:

One protected left-turn & one permissive left-turn (5-section display) {Ø3 protected and Ø7 permissive}

- Trap possible in preemption only due to main street recalls
- Preempt settings:
    - Emergency = Ø4+Ø8 (for protected direction); Ø4+Ø7 for permissive direction
    - Transit = Ø4+Ø8

Scenario 4:

One protected left-turn & one permissive left-turn (5-section display) {Ø7 protected and Ø3 permissive}

- Trap possible in preemption only due to main street recalls
- Preempt settings:
    - Emergency = Ø4+Ø8 (for protected direction); Ø3+Ø8 for permissive direction
    - Transit = Ø4+Ø8

Scenario 5:

One permissive left-turn & one un-signalized permissive left-turn (left-turn from through movement) {Ø3 signalized permissive left-turn}

- Trap possible in preemption only due to main street recalls
- Preempt settings:
    - Emergency = Ø4+Ø8
    - Transit = Ø4+Ø8

Scenario 6:

One permissive left-turn & one un-signalized permissive left-turn (left-turn from through movement) {Ø7 signalized permissive left-turn}

- Trap possible in preemption only due to main street recalls
- Preempt settings:
    - Emergency = Ø4+Ø8
    - Transit = Ø4+Ø8

Scenario 7:

One protected left-turn & one un-signalized permissive left-turn (left-turn from through movement) {Ø3 signalized protected left-turn}

- Trap possible in preemption only due to main street recalls
- Preempt settings:
    - Emergency = Ø4+Ø8
    - Transit = Ø4+Ø8

Side Street Operations (continued):

Scenario 8:
One protected left-turn & one un-signalized permissive left-turn (left-turn from through movement)
{Ø7 signalized protected left-turn}

- Trap possible in preemption only due to main street recalls
- Preempt settings:
  - Emergency = Ø4+Ø8
  - Transit = Ø4+Ø8

APPENDIX R

Traffic Signal Preemption at Highway –Rail Grade Crossings Guidance

INSTRUCTIONS

for the

GUIDE FOR DETERMINING TIME REQUIREMENTS FOR TRAFFIC SIGNAL PREEMPTION AT HIGHWAY-RAIL GRADE CROSSINGS

USING THESE INSTRUCTIONS

The purpose of these instructions is to assist TxDOT personnel in completing the 2003 Guide For Determining Time Requirements For Traffic Signal Preemption At Highway-Rail Grade Crossings*, also known as the Preemption Worksheet. The main purpose of the Preemption Worksheet is to determine if additional time (advance preemption) is required for the traffic signal to move stationary vehicles out of the crossing before the arrival of the train.*

If you have any questions about completing the Preemption Worksheet, please contact the Mr. David Valdez in the Traffic Operations Division at telephone 512-416-2642 or email DVALDEZ@dot.state.tx.us. For any feedback on the Draft version of the Worksheet or Instructions, please contact Mr. Roelof Engelbrecht from the Texas Transportation Institute at 979-862-3559 or roelof@tamu.edu.

SITE DESCRIPTIVE INFORMATION:

Enter the location for the highway-rail grade crossing including the (nearest) **City**, the **County** in which the crossing is located, and the Texas Department of Transportation (TxDOT) **District** name. When entering the District name, do not use the dated district numbering schema; use the actual district name.

Next, enter the **Date** the analysis was performed, your (the analyst's) name next to "**Completed by**," and the status of the **District Approval** for this crossing.

To complete the reference schematic for this site, place a **North Arrow** in the provided circle to correctly orient the crossing and roadway. Record the name of the **Parallel Street** and the **Crossing Street** in the spaces provided, and remember to include any "street sign"/local name for the streets as well as any state/US/Interstate designation (i.e., "FM 1826," "SH 71," "US 290," "Interstate 35 [frontage]"). You may wish to note other details on the intersection/crossing diagram as well, including the number of lanes and/or turn bays on the intersection approach crossing the tracks and any adjacent land use.

Enter the **Railroad** name, **Railroad Contact** person's name, and **Phone** number for the responsible railroad company and its equipment maintenance and operations contractor (if any). Finally, record the unique 7-character **Crossing DOT#** (6 numeric plus one alphanumeric characters) for the crossing.

Note that this guide for determining (warning) time requirements for traffic signal preemption requires you to input many controller unit timing/phasing values. To preserve the accuracy of these values, record all values to the next highest tenth of a second (i.e., record 5.42 seconds as 5.5 seconds).

SECTION 1: RIGHT-OF-WAY TRANSFER TIME CALCULATION

Preempt Verification and Response Time

Line 1. The **preempt delay time** is the amount of time, in seconds, that the traffic signal controller is programmed to wait from the initial receipt of a preempt call until the call is "verified" and considered a viable request for transfer into preemption mode. Preempt delay time is a value entered into the controller unit for purposes of preempt call validation, and may not be available on all manufacturer's controllers.

Line 2. Unlike preempt delay time (Line 1), which is a value entered into the controller, **controller response time to preempt** is the time that elapses while the controller unit electronically registers the preempt call (i.e., it is the controller's equipment response time for the preempt call). The controller manufacturer should be consulted to find the correct value (in seconds) for use here. For future reference, you may wish to record the controller type in the **Remarks** section to the right of the controller response time to preempt value. However, note that the manufacturer's given response time may be unique for a controller unit's model and software generation; other models and/or software generations may have different response times.

Line 3. The sum of Line 1 and Line 2 is the **preempt verification and response time**, in seconds. It represents the number of seconds between the receipt at the controller unit of a preempt call issued by the railroad's grade crossing warning equipment and the time the controller software actually begins to respond to the preempt call (i.e., by transitioning into preemption mode).

Worst-Case Conflicting Vehicle Time

Line 4. Worst-case conflicting vehicle phase number is the number of the controller unit phase which conflicts with the phase(s) used to clear the tracks—the track clearance phase(s)—that has the longest sum of minimum green (if provided), other (additional) green time (if provided), yellow change interval, and red clearance interval durations that may need to be serviced during the transition into preemption. Note that all of these time elements are for vehicular phases only; pedestrian phase times will be assessed in the next part of the analysis. The worst-case vehicle phase can be any phase that conflicts with the track clearance phase(s); it is not restricted to only the phases serving traffic parallel to the tracks.

Line 5. Minimum green time during right-of-way transfer is the number of seconds that the worst-case vehicle phase (see Line 4 discussion) must display a green indication before the controller unit will terminate the phase through its yellow change and red clearance intervals and transition to the track clearance green interval. The minimum green time during right-of-way transfer may be set to zero to allow as rapid a transition as possible to the track clearance green interval. However, local policies will govern the amount of minimum green time provided during the transition into preemption.

Line 6. If any additional green time is preserved beyond the preempt minimum green time for the worst-case vehicle phase (line 4), it should be entered here as **Other green time during right-of-way transfer**. Given the time-critical nature of the transition to the track clearance green interval during preempted operation, this value is usually zero except in unusual circumstances. One situation where other green time may be present is when a trailing green overlap is used on the worst-case vehicle phase, and the controller unit is set up to time out the trailing green overlap on entry into preemption.

Line 7. Yellow change time is the required yellow change interval time for the worst-case vehicle phase (line 4) given prevailing operating conditions. Yellow change time for the phase under preemption is usually the same value, in seconds, programmed for the phase under normal operating circumstances. Section 4D.13 of the *Texas Manual on Uniform Traffic Control Devices* (*MUTCD*) states that the normal yellow change interval shall not be shortened or omitted during the transition into preemption control. Guidance on setting the yellow change interval can be found in the Institute of Transportation Engineer's *Determining Vehicle Signal Change and Clearance Intervals*.

Line 8. Red clearance time is the required red clearance interval for the worst-case vehicle phase (line 4) given prevailing operating conditions. Red clearance time for the phase under preemption is usually the same value, in seconds, programmed for the phase under normal operating circumstances. Section 4D.13 of the *Texas MUTCD* states that the normal red clearance interval shall not be shortened or omitted during the transition into preemption control. Guidance on setting the red clearance interval can be found in the Institute of Transportation Engineer's *Determining Vehicle Signal Change and Clearance Intervals*.

Line 9. Worst-case conflicting vehicle time is the sum of lines 5 through 8. It will be compared with the worst-case conflicting pedestrian time to determine whether vehicle or pedestrian phase times are the most critical in their impact on warning time requirements during the transition to the track clearance green interval.

Worst-case Conflicting Pedestrian Time

Line 10. Worst-case pedestrian phase number is the pedestrian phase number (referenced as the vehicle phase number that the pedestrian phase is associated with) that has the longest sum of walk time, pedestrian clearance (i.e., flashing don't walk) times, and associated vehicle clearance times that have to be provided during the transition into preemption. The worst-case pedestrian phase is not restricted to pedestrian phases running concurrently with vehicle phases that serve traffic parallel to the tracks. The vehicle phase associated with the worst-case pedestrian phase may even be one of the track clearance phases if the pedestrian phase is not serviced concurrently with the associated track clearance phase.

Line 11. Minimum walk time during right-of-way transfer (seconds) is the minimum pedestrian walk time for the worst-case pedestrian phase (line 10). The *Texas MUTCD* permits the shortening (i.e. truncation) or complete omission of the pedestrian walk interval. A zero value allows for the most rapid transition to the track clearance green interval. However, the minimum pedestrian walk time is typically set based on local policies, which may or may not allow truncation and/or omission.

Line 12. Pedestrian clearance time during right-of-way transfer (seconds) is the clearance (i.e., flashing don't walk) time for the worst-case pedestrian phase. The *Texas MUTCD* permits the shortening (i.e. truncation) or complete omission of the pedestrian clearance interval. A zero value allows for the most rapid transition to the track clearance green interval. However, the pedestrian clearance time is typically set based on local policies, which may or may not allow truncation and/or omission.

Line 13. Enter a **Yellow change time** if the pedestrian clearance interval does not time simultaneously with the yellow change interval of the vehicular phase associated with your worst-case pedestrian phase; enter zero if does. Local policies will determine if this is allowed. Simultaneous timing of the pedestrian clearance interval and the yellow change interval (i.e. a zero value on line 13) allows for the most rapid transition to the track clearance green interval. If a non-zero value is entered, make sure to enter the yellow change time of the vehicular phase associated with your worst-case pedestrian phase. This value may not be the same value you enter on Line 7, since the worst-case pedestrian phase may not be the same as the worst-case vehicular phase.

Line 14. Enter a **Red clearance time** if the pedestrian clearance interval does not time simultaneously with the red clearance interval of the vehicular phase associated with your worst-case pedestrian phase; enter zero if does. Local policies will determine if this is allowed. Also, note than not all traffic signal controllers allow simultaneous timing of the pedestrian clearance interval and the red clearance interval. Simultaneous timing of the pedestrian clearance interval and the red clearance interval (i.e. a zero value on line 14) allows for the most rapid transition to the track clearance green interval. If a non-zero value is entered, make sure to enter the red clearance time of the vehicular phase associated with your worst-case pedestrian phase. This value may not be the same value you enter on Line 8, since the worst-case pedestrian phase may not be the same as the worst-case vehicular phase.

Line 15. Add lines 11 through 14 to calculate your **Worst-case conflicting pedestrian time**. This value will be compared to the worst-case conflicting vehicle time to determine whether vehicle or pedestrian phase times are the most critical in their impact on warning time requirements during the transition to the track clearance green interval.

Worst-case Conflicting Vehicle or Pedestrian Time

Line 16. Record the **Worst-case conflicting vehicle or pedestrian time** (in seconds) by comparing lines 9 and 15 and writing the larger of the two as the entry for line 16.

Line 17. Calculate the **Right-of-way transfer time** by adding lines 3 and 16. The right-of-way transfer time is the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval.

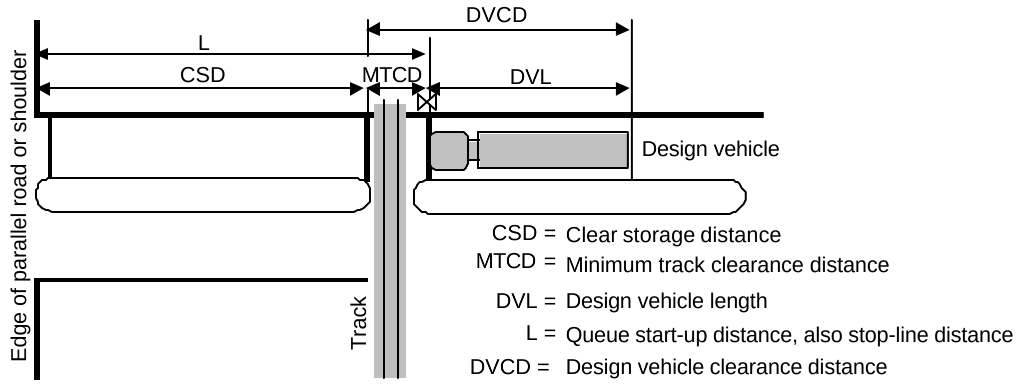


Figure 1 Queue clearance distances.

SECTION 2: QUEUE CLEARANCE TIME CALCULATION

Line 18. Record the **Clear storage distance** (CSD in Figure 1), in feet, as the shortest distance along the crossing street between the edge of the grade crossing nearest the signalized intersection—identified by a line parallel to the rail 6 feet (2 m) from the rail nearest to the intersection—and the edge of the street or shoulder of street that parallels the tracks. If the normal stopping point on the crossing street is significant different from the edge or shoulder of parallel street, measure the distance to the normal stopping point. For angled (i.e., non-perpendicular) railroad crossings, always measure the distance along the inside (centerline) edge of the leftmost lane or the distance along the outside (shoulder) edge of the rightmost lane, as appropriate, to determine the <u>shortest</u> clear storage distance and record that value.

Line 19. Minimum track clearance distance (MTCD in Figure 1), in feet, is the length along the highway at one or more railroad tracks, measured from the railroad crossing stop line, warning device, or 12 feet (4 m) perpendicular to the track centerline—whichever is further away from the tracks, to 6 feet (2 m) beyond the tracks measured perpendicular to the far rail. For angled (i.e., non-perpendicular) railroad crossings, always measure the distance along the inside (centerline) edge of the leftmost lane or the distance along the outside (shoulder) edge of the rightmost lane, as appropriate, to determine the <u>longest</u> minimum track clearance distance and record that value.

Line 20. Design vehicle length (DVL in Figure 1), in feet, is the length of the design vehicle, the longest vehicle permitted by road authority statute on the subject roadway. In the **Remarks** section to the right of the data entry box for Line 20, note the design vehicle type for ease of reference. Some design vehicles from the *AASHTO Green Book (A Policy on Geometric Design of Highways and Streets)* are given in Table 1. Note that Texas legal size and weight limits for non-permit vehicles allow a maximum semitrailer length of 59 feet, resulting in a design vehicle length of 79.5 feet when combined with a conventional long-haul tractor.

Table 1. AASHTO Design vehicle lengths and heights.

Design Vehicle Type	Symbol	Length (ft)
Passenger Car	P	19
Single Unit Truck	SU	30
Large School Bus	S-BUS 40	40
Intermediate Semi-Trailer	WB-50	55

Line 21. Queue start-up distance (L in Figure 1), in feet, is the maximum length over which a queue of vehicles stopped for a red signal indication at an intersection downstream of the crossing must get in motion so that the design vehicle can move out of the railroad crossing prior to the train's arrival. Queue start-up distance is the sum of the clear storage distance (Line 18) and minimum track clearance distance (Line 19).

Line 22. Time required for the design vehicle to start moving (seconds) is the time elapsed between the start of the track clearance green interval and the time the design vehicle, which is located at the edge of the railroad crossing on the opposite side from the signalized intersection, begins to move. This elapsed time is based on a "shock wave" speed of 20 feet per second and a 2 second start-up time (the additional time for the first driver to recognize the signal is green and move his/her foot from the brake to the accelerator). The time required for the design vehicle to start moving is calculated, in seconds, as 2 plus the queue start-up distance, L (Line 21) divided by the wave speed of 20 feet per second. The time required for the design vehicle to start moving is a conservative value taking into account the worst-case vehicle mix in the queue in front of the design vehicle as well as a limited level of drive inattentiveness. This value may be overridden by local observation, but care must be taken to identify the worst-case (longest) time required for the design vehicle to start moving.

Line 23. Design vehicle clearance distance (DVCD in Figure 1) is the length, in feet, which the design vehicle must travel in order to enter and completely pass through the railroad crossing's minimum track clearance distance (MTCD). It is the sum of the minimum track clearance distance (Line 19) and the design vehicle's length (Line 20).

Line 24. The **Time for design vehicle to accelerate through the design vehicle clearance distance (DVCD)** is the amount of time required for the design vehicle to accelerate from a stop and travel the complete design vehicle clearance distance. This time value, in seconds, can be found through local observation or by using by Figure 2. If local observation is used, take care to identify the worst-case (longest) time required for the design vehicle to accelerate through the DVCD. If Figure 2 is used to estimate the time for the design vehicle to accelerate through the DVCD, locate the DVCD from Line 23 on the horizontal axis of Figure 2 and then draw a line straight up until that line intersects the acceleration time performance curve for your design vehicle. Then, draw a horizontal line from this point to the left until it intersects the vertical axis, and record the appropriate acceleration time. Round up to the next higher tenth of a second. For example, with a DVCD of 80 feet and a WB-50 semi-trailer design vehicle on a level surface, the time required for the design vehicle to accelerate through the DVCD will be 12.2 seconds.

If your design vehicle is a WB-50 semi-trailer, large school bus (S-BUS 40), or single unit (SU) vehicle, you may need to apply a correction factor to estimate the effect of grade on the acceleration of the vehicle. Determine the average grade over a distance equal to the design vehicle clearance distance (DVCD), centered around the minimum track clearance distance (MTCD). If the grade is 1% uphill (+1%) or greater, multiply the acceleration time obtained from Figure 2 with the factor obtained from Table 2 and round up to the next higher tenth of a second to get an estimate of the acceleration time on the grade. For example, with a DVCD of 80 feet and a WB-50 semi-trailer design vehicle on a 4% uphill, the (interpolated) factor from Table 2 is 1.30. Therefore, the estimated time required for the design vehicle to accelerate through the DVCD will be 12.2 x 1.30 = 15.86 seconds, or 15.9 seconds rounded up to the next higher tenth of a second.

If you selected a design vehicle different from those listed in Figure 2 and Table 2, you may still be able to use Figure 2 and Table 2 if you can match your design vehicle to the weight, weight-to-power ratio, and power application characteristics of the design vehicles in Figure 2 and Table 2. The WB-50 curve and grade factors are based on an 80,000 lb vehicle with a weight-to-power ratio of 400 lb/hp accelerating at 85% of its maximum power on level grades and at 100% of its maximum power on uphill grades, and may therefore be representative of any heavy tractor-trailer combination with the same characteristics. The school bus curve and grade factors are based on a 27,000 lb vehicle with a weight-to-power ratio of 180 lb/hp accelerating at 70% of its maximum power on level grades and at 85% of its maximum power on uphill grades. The SU curve and grade factors are based on a 34,000 lb vehicle with a weight-to-power ratio of 200 lb/hp accelerating at 75% of its maximum power on level grades and at 90% of its maximum power on uphill grades.

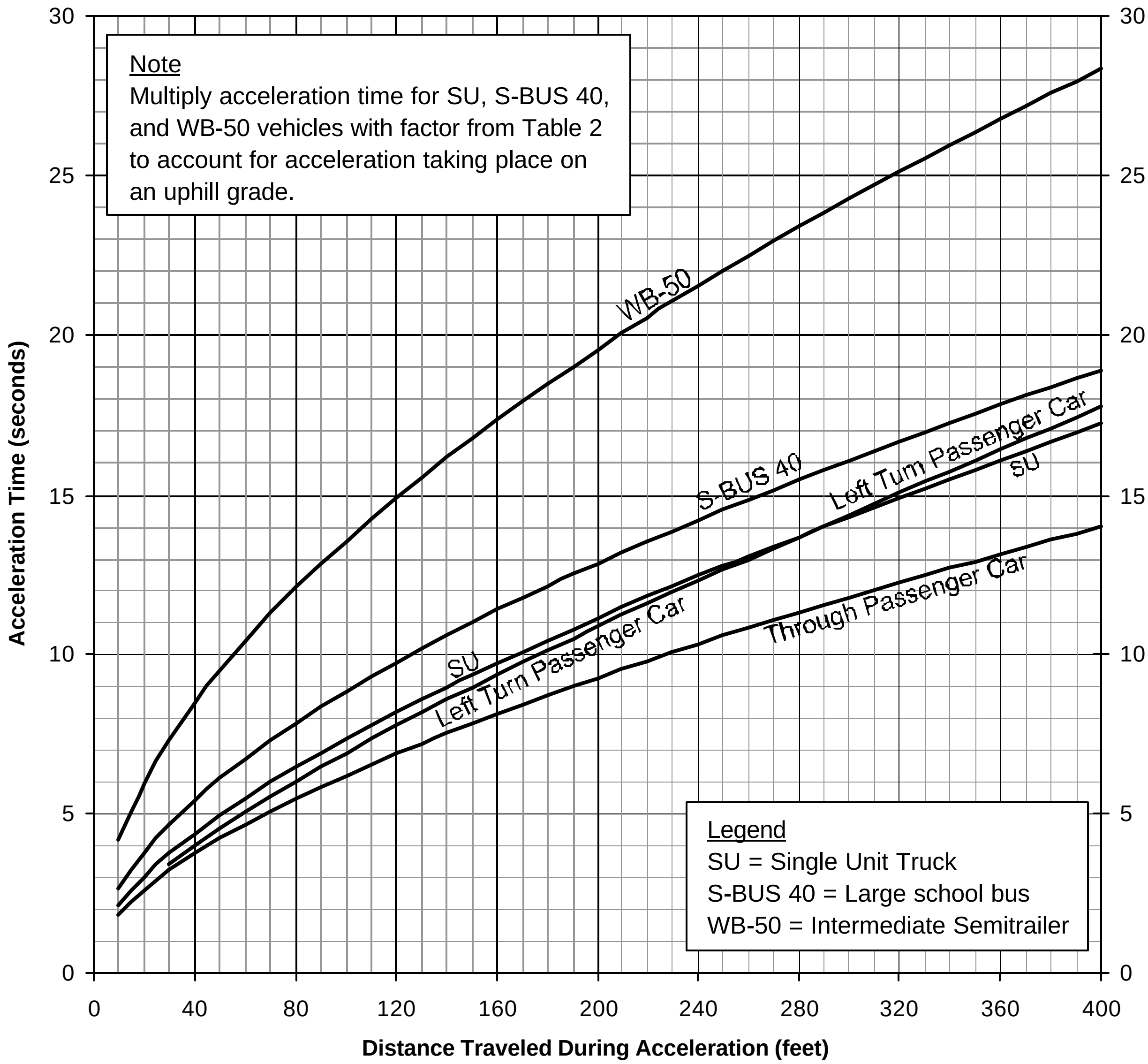


Figure 2 Acceleration time over a fixed distance on a level surface.

Table 2. Factors to account for slower acceleration on uphill grades. Multiply the appropriate factor (depending on the design vehicle, grade, and acceleration distance) with the acceleration time in Figure 2 to obtain the estimated acceleration time on the grade.

Acceleration Distance (ft)	Design Vehicle and Percentage Uphill Grade													
	Single Unit Truck (SU)				Large School Bus (S-BUS 40)					Intermediate Tractor-Trailer (WB-50)				
	0-2%	**4%**	**6%**	**8%**	**0-1%**	**2%**	**4%**	**6%**	**8%**	**0%**	**2%**	**4%**	**6%**	**8%**
25	1.00	1.06	1.13	1.19	1.00	1.01	1.10	1.19	1.28	1.00	1.09	1.27	1.42	1.55
50	1.00	1.09	1.17	1.25	1.00	1.01	1.12	1.21	1.30	1.00	1.10	1.28	1.44	1.58
75	1.00	1.10	1.19	1.29	1.00	1.02	1.13	1.23	1.33	1.00	1.11	1.30	1.47	1.61
100	1.00	1.11	1.21	1.32	1.00	1.02	1.14	1.25	1.35	1.00	1.11	1.31	1.48	1.64
125	1.00	1.12	1.23	1.34	1.00	1.03	1.15	1.26	1.37	1.00	1.12	1.32	1.50	1.66
150	1.00	1.12	1.24	1.37	1.00	1.03	1.16	1.28	1.40	1.00	1.12	1.33	1.52	1.68
175	1.00	1.13	1.25	1.38	1.00	1.03	1.17	1.29	1.42	1.00	1.12	1.34	1.53	1.70
200	1.00	1.13	1.26	1.40	1.00	1.04	1.17	1.30	1.43	1.00	1.13	1.35	1.54	1.72
225	1.00	1.14	1.27	1.42	1.00	1.04	1.18	1.32	1.45	1.00	1.13	1.35	1.56	1.74
250	1.00	1.14	1.28	1.43	1.00	1.04	1.19	1.33	1.47	1.00	1.13	1.36	1.57	1.76
275	1.00	1.14	1.29	1.44	1.00	1.05	1.20	1.34	1.49	1.00	1.14	1.37	1.58	1.77
300	1.00	1.14	1.30	1.46	1.00	1.05	1.20	1.35	1.50	1.00	1.14	1.37	1.59	1.79
325	1.00	1.15	1.30	1.47	1.00	1.05	1.21	1.36	1.52	1.00	1.14	1.38	1.60	1.81
350	1.00	1.15	1.31	1.48	1.00	1.05	1.22	1.37	1.54	1.00	1.15	1.39	1.61	1.82
375	1.00	1.15	1.31	1.49	1.00	1.06	1.22	1.38	1.55	1.00	1.15	1.39	1.62	1.84
400	1.00	1.15	1.32	1.50	1.00	1.06	1.23	1.40	1.57	1.00	1.15	1.40	1.63	1.85

For design vehicle clearance distances greater than 400 feet, use Equation 1 to estimate the time for the design vehicle to accelerate through the design vehicle clearance distance or any other distance:

$$T = e^{\left[a - b\sqrt{c + \frac{2}{b}\ln\left(\frac{d}{X}\right)}\right]} \qquad (1)$$

where

T = time to accelerate through distance X, in seconds;
X = distance over which acceleration takes place, in feet;
ln = natural logarithm function;
e = 2.17828, the base of natural logarithms; and
a, b, c, and d = calibration parameters from Table 3.

Note: To interpolate between grades, do not interpolate the parameters in Table 3. The correct way to interpolate is to calculate the acceleration time *T* using Equation 1 for the two nearest grades and then interpolate between the two acceleration times.

Line 25. Queue clearance time is the total amount of time required (after the signal has turned green for the approach crossing the tracks) to begin moving a queue of vehicles through the queue start-up distance (L, Line 21) and then move the design vehicle from a stopped position at the far side of the crossing completely through the minimum track clearance distance (MTCD, Line 19). This value is the sum of the time required for design vehicle to start moving (Line 22) and the time for design vehicle to accelerate through the design vehicle clearance distance (Line 24).

Table 3. Parameters to estimate vehicle acceleration times over distances greater than 400 feet using Equation 1.

Design Vehicle	Grade	*a*	*b*	*c*	*d*
Through Passenger Car	Level	7.75	3.252	5.679	2.153
Left Turning Passenger Car	Level	10.29	5.832	3.114	5.090
Single Unit Truck (SU)	Level to 2%	8.16	3.624	5.070	2.018
	4%	10.39	4.865	4.560	1.739
	6%	9.52	4.542	4.393	1.700
	8%	9.38	4.597	4.165	1.668
Large School Bus (S-BUS 40)	Level to 1%	10.02	4.108	5.95	0.885
	2%	11.51	5.254	4.801	1.300
	4%	10.79	5.042	4.577	1.266
	6%	10.61	5.101	4.329	1.253
	8%	11.84	6.198	3.652	1.554
Intermediate Semi-Trailer (WB-50)	Level	17.75	7.984	4.940	0.481
	2%	10.26	4.026	6.500	0.249
	4%	9.39	3.635	6.670	0.193
	6%	9.38	3.732	6.310	0.188
	8%	10.31	4.515	5.219	0.265

SECTION 3: MAXIMUM PREEMPTION TIME CALCULATION

Line 26. Right-of-way transfer time, in seconds, recorded on Line 17. The right-of-way transfer time is the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval.

Line 27. Queue clearance time, in seconds, recorded on Line 25. Queue clearance time starts simultaneously with the track clearance green interval (i.e. after right-of-way transfer), and is the time required for the design vehicle stopped just inside the minimum track clearance distance to start up and move completely out of the minimum track clearance distance.

Line 28. Desired minimum separation time is a time “buffer” between the departure of the last vehicle (the design vehicle) from the railroad crossing (as defined by the minimum track clearance distance) and the arrival of the train. Separation time is added for safety reasons and to avoid driver discomfort. If no separation time is provided, a vehicle could potentially leave the crossing at exactly the same time the train arrives, which would certainly lead to severe driver discomfort and potential unsafe behavior. The recommended value of four (4) seconds is a based on the minimum recommended value found in the Institute of Transportation Engineer’s *ITE Journal* (in an article by Marshall and Berg in February 1997).

Line 29. Maximum preemption time is the total amount of time required after the preempt is initiated by the railroad warning equipment to complete right-of-way transfer to the track clearance green interval, initiate the track clearance phase(s), move the design vehicle out of the crossing’s minimum track clearance distance, and provide a separation time “buffer” before the train arrives at the crossing. It is the sum of the right-of-way transfer time (Line 26), the queue clearance time (Line 27), and the desired minimum separation time (Line 28).

SECTION 4: SUFFICIENT WARNING TIME CHECK

Line 30. Minimum time (seconds) is the least amount of time active warning devices shall operate prior to the arrival of a train at a highway-rail grade crossing. Section 8D.06 of the *Texas MUTCD* requires that flashing-light signals shall operate for at least 20 seconds before the arrival of any train, except on tracks where all trains operate at less than 32 km/h (20 mph) and where flagging is performed by an employee on the ground.

Line 31. Clearance time (seconds), typically known as CT, is the additional time that may be provided by the railroad to account for longer crossing time at wide (i.e., multi-track crossings) or skewed-angle crossings. You must obtain the clearance time from the railroad responsible for the railroad crossing. In cases where the minimum track clearance distance (Line 19) exceeds 35 feet, the railroads' *AREMA Manual* requires clearance time of one second be provided for each additional 10 feet, or portions thereof, over 35 feet. Additional clearance time may also be provided to account for site-specific needs. Examples of extra clearance time include cases where additional time is provided for simultaneous preemption (where the preemption notification is sent to the signal controller unit simultaneously with the activation of the railroad crossing's active warning devices), instead of providing advance preemption time.

Line 32. Minimum warning time (seconds) is the sum of the minimum time (Line 30) and the clearance time (Line 31). This value is the actual minimum time that active warning devices can be expected to operate at the crossing prior to the arrival of the train under normal, through-train conditions. The term "through-train" refers to the case where trains do not stop or start moving while near or at the crossing. Note that the minimum warning time, does not include buffer time (BT). Buffer time is added by the railroad to ensure that the minimum warning time is always provided despite inherent variations in warning times; however, it is not consistently provided and cannot be relied upon by the traffic engineer for signal preemption and/or warning time calculations.

Line 33. Advance preemption time (seconds), if provided, is the period of time that the notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly prior to activating the railroad active warning devices. Only enter advance preemption time if you can verify from the railroad that advance preemption time is already being provided for your site. If you are determining whether or not you need advance preemption time, enter zero for the advance preemption time in Line 33.

Line 34. Warning time provided by the railroad is the sum of the minimum warning time (Line 32) and the advance preemption time (Line 33), in seconds. This value should be verified with the railroad, and should not include buffer time (BT).

Line 35. Additional warning time required from railroad is the additional time needed (if any), in seconds, that is required to provide safe preemption in the worst case (the maximum preemption time on Line 29), given the warning time provided by the railroad (Line 34). The additional warning time required is calculated by subtracting the warning time provided by the railroad (Line 34) from the maximum preemption time (Line 29). If the result of the subtraction is equal to or less than zero, it means that sufficient warning time is available, and you should enter zero (0) on Line 35. However, keep in mind that highly negative (-10 or less) subtraction results may indicate the potential for operational problems due to insufficient track clearance green time. Section 5 of the worksheet contains a methodology for calculating sufficient track clearance green time.

If the additional warning time is greater than zero (0), it means that the warning time provided by the railroad is insufficient, and additional warning time has to be requested from the railroad to ensure safe operation. The railroad can provide additional warning time either by providing additional clearance time (CT) (Line 30), or by providing or increasing advance preemption time (Line 33).

As an alternative, it may be possible to reduce the maximum preemption time (Line 29). To reduce the maximum preemption time, you can reduce either the preempt delay time (Line 1), if this is possible; reduce preempt minimum green time (Line 5) or other green time (Line 6), as long as you do not violate local policies for signal timing; or, reduce yellow change time (Line 7) or red clearance time (Line 8) as long as adequate and appropriate yellow change and red clearance intervals are provided as per the *Texas MUTCD* Section 4D.10 and applicable guidelines such as the Institute of Transportation Engineers' *Determining Vehicle Signal Change and Clearance Intervals*.

If pedestrian rather than vehicular phasing controls warning time requirements for preemption, it may be possible to reduce the minimum walk time (Line 11) and/or pedestrian clearance time (Line 12) as long as you do not violate local policies for signal timing. You can also let the pedestrian clearance time (flashing don't walk) time simultaneous with vehicular yellow change and red clearance and so reduce the values on Line 13 (yellow change time) and Line 14 (red clearance time) to zero (0). If local policies do not currently allow simultaneous clearance for pedestrian and vehicular phasing, you may want to consider allowing this type of operation to reduce your worst-case conflicting pedestrian time.

Once you have made all of the possible adjustments to the warning time, recompute the totals in Lines 3, 9, 15, 16, 17, 26, 29, and 35. If Line 35 remains greater than zero, then you will have to request additional warning time from the railroad, as described above, to ensure safe preemption of the adjacent signalized intersection.

SECTION 5: TRACK CLEARANCE GREEN TIME CALCULATION (OPTIONAL)

Note: This section is optional and is used to calculate the duration of the track clearance green interval. If this worksheet is only used to determine if additional warning time has to be requested from the railroad, this section need not be completed.

The objective of the section is to calculate the duration of the track clearance green interval to ensure safe and efficient operations at the crossing and adjacent traffic signal.

The Preempt Trap Check section (lines 36 to 44) focuses on safety by calculating the minimum duration of the track clearance green interval to ensure that the track clearance green does not terminate before the gates block access to the crossing. If the gates do not block access to the crossing before the expiration of the track clearance green, it is possible that vehicles can continue to cross the tracks and possibly stop on the tracks. However, the track clearance green interval has already expired and there will be no further opportunity to clear. This potentially hazardous condition is called the "preempt trap" and is described in more detail in TxDOT Project Bulletin 1752-9: The Preempt Trap: How to Make Sure You Do Not Have One.

The Clearing of Clear Storage Distance section (lines 45 to 50) focuses on efficiency by calculating duration of the track clearance green interval that is needed to clear the clear storage distance (CSD in Figure 1), or a specific portion thereof.

Preempt Trap Check

Line 36. Advance preemption time provided is the duration (in seconds) the preempt sequence is active in the highway traffic signal controller before the activation of the railroad active warning devices. If Line 35 is zero (i.e. no additional warning time is required from the railroad), the value on Line 33 can be used. In other cases, use the actual value of the advance preemption time (APT) provided by the railroad. If no APT is provided, enter zero on Line 36.

Line 37. Multiplier for maximum APT due to train handling is a value that relates the maximum duration of the advance preemption time (APT) to the minimum value guaranteed by the railroad. Although the railroad guarantees a minimum duration for the APT, it is probable that in most cases the actual duration of the APT will be longer than the guaranteed duration. This variability in APT occurs due to "train handling", which a term that describes the acceleration and deceleration of trains on their approach to the crossing. If a train accelerates or decelerates while approaching to the crossing, the railroad warning system cannot estimate the arrival time of the train at the crossing accurately, resulting in variation in the actual duration of APT provided. This variation needs to be taken into account to ensure safe operation.

To make sure that the preempt trap does not occur we need to determine the maximum value of the APT so that a sufficiently long track clearance green interval can be provided to ensure that the gates block access to the crossing before the track clearance green ends. The maximum APT can be estimated by multiplying the advance preemption time provided (and guaranteed) by the railroad (Line 36) with the multiplier for maximum APT due to train handling. This value is only significant if the value for APT on Line 36 is non-zero. If APT is zero, continue to line 38.

In the case where APT is provided, the difference between the minimum and maximum values of APT is termed excess APT. Excess APT usually occurs when the train decelerates on the approach to the crossing, or where train handling affects the accuracy of the estimated time of train arrival at the crossing so that the preempt sequence is activated earlier than expected. The amount of excess APT is increased by the following conditions:

- Increased variation in train speeds, since more trains will be speeding up and slowing down;
- Lower train speeds, since a fixed deceleration rate has a greater effect on travel time at low speeds than at higher speeds; and
- Longer warning times, because more time is available for the train to decelerate on the approach to the crossing.

The multiplier for maximum APT can be determined from field measurements as the largest advance preemption time observed (or the 95th percentile, if enough observations are available) divided by the value on Line 36. If no field observations are available, the multiplier for maximum APT can be estimated as 1.60 if warning time variability is high or 1.25 if warning time variability is low. High warning time variability can typically be expected in the vicinity of switching yards, branch lines, or anywhere low-speed switching maneuvers takes place. According to Section 16.30.10 of the *AREMA Signal Manual* the railroad can provide a "timer for constant time between APT and CWT." The effect of such a "not to exceed" timer is to eliminate excess APT, and if provided, the multiplier on Line 37 can be set to 1.0.

Line 38. Maximum APT is largest value (in seconds) of the advance preemption time that can typically be expected, which corresponds to the earliest possible time the preemption sequence in the traffic signal controller will be activated before the activation of the railroad grade crossing warning system (flashing lights and gates). It is the calculated by multiplying the APT provided by the railroad (Line 36) with the multiplier for maximum APT due to train handling (Line 37).

Line 39. Minimum duration for the track clearance green is the minimum duration (in seconds) of the track clearance green interval to ensure that the gates block access to the crossing before the track clearance green expires in the case where no advance preemption time is provided. It is necessary to block access to the crossing before the track clearance green expires to ensure that vehicles do not enter the crossing after the expiration of the track clearance green and so be subject to the preempt trap (described in the introduction to Section 5).

The 15 seconds minimum duration for the track clearance green interval is calculated from Federal regulations and requirements of the *Texas MUTCD*. Section 8D.06 of the *Texas MUTCD* requires that flashing-light signals shall operate for at least 20 seconds before the arrival of any train (with certain exceptions), while Section 8D.04 requires that the gate arm shall reach its horizontal position at least 5 seconds before the arrival of the train. For simultaneous (non-advance) preemption, the preemption sequence starts at the same time as the flashing-light signals, so to ensure that the preempt trap does not occur, a track clearance green interval of at least 15 seconds is required.

Line 40. Gates down after start of preemption is the maximum duration (in seconds) from when the preempt is activated in the highway traffic signal controller until the gates reach a horizontal position. Calculate this value by adding the maximum advance preemption time on Line 38 to the minimum duration for the track clearance green interval on Line 39.

Line 41. Preempt verification and response time, recorded on Line 3, is the number of seconds between the receipt at the controller unit of a preempt call issued by the railroad's grade crossing warning equipment and the time the controller software actually begins to respond to the preempt call.

Line 42. Best-case conflicting vehicle or pedestrian time (in seconds) is the minimum time from when the preempt starts to time in the controller (i.e. after verification and response) until the track clearance green interval can start timing. In most cases, this value is zero, since the controller may already be in the track clearance phase(s) when the preempt starts timing, and therefore the track clearance green interval can start timing immediately. The best-case conflicting vehicle or pedestrian time may be greater than zero if the track clearance green interval contains phases that are not in normal operation (and conflicts with the normal phases), or where another phase or interval always has to terminate before the track clearance green interval can start timing.

Line 43. Minimum right-of-way transfer time is the minimum amount of time needed for the best case condition, prior to display of the track clearance green interval. Calculate the minimum right-of-way transfer time by adding lines 41 and 42.

Line 44. Calculate the M**inimum track clearance green time** by subtracting Line 43 from Line 40. This yields the minimum time that the track clearance green interval has to be active to avoid the preempt trap.

Clearing of Clear Storage Distance

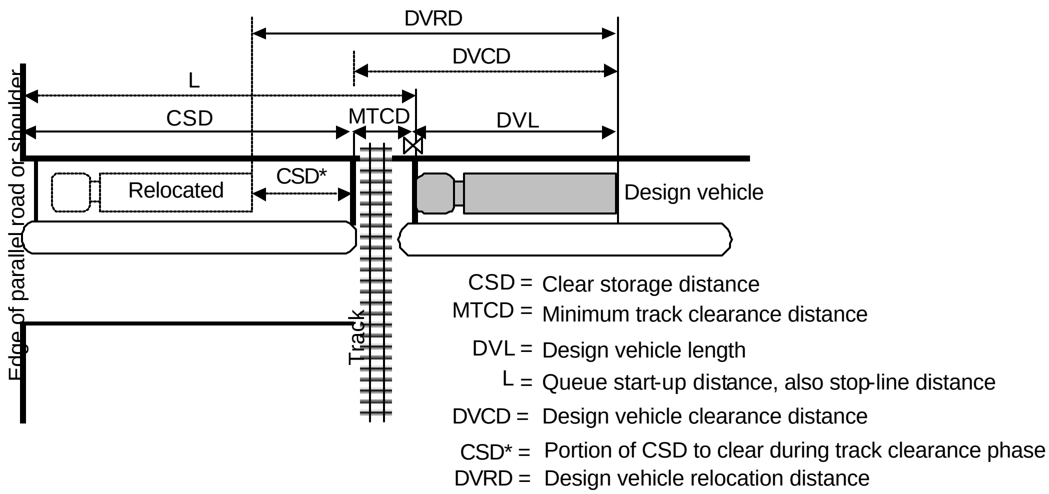


Figure 3 Relocation distances during the track clearance green interval.

Line 45. Time required for design vehicle to start moving, recorded on Line 22, is the number of seconds that elapses between the start of the track clearance green interval and the time the design vehicle, which is located at the edge of the railroad crossing on the opposite side from the signalized intersection, begins to move.

Line 46. Design vehicle clearance distance (DVCD in Figure 3) is the length, in feet, which the design vehicle must travel in order to enter and completely pass through the railroad crossing's minimum track clearance distance (MTCD). This is the same value as recorded on Line 23.

Line 47. Portion of CSD to clear during track clearance, (CSD* in Figure 3) is the portion of the clear storage distance (CSD), in feet, that must be cleared of vehicles before the track clearance green interval ends. For intersections with a CSD greater than approximately 150 feet it is desirable—but not necessary—to clear the full CSD during the track clearance green interval. In other words, it is desirable to set Line 47 to the full value of CSD (Line 18). If the full CSD is <u>not</u> cleared, however, vehicles will be stopped in the CSD during the preempt dwell period, and if not serviced during the preempt dwell period, will be subject to unnecessary delays which may result in unsafe behavior. For CSD values less than 150 feet the full CSD is typically cleared to avoid the driver task of crossing the tracks followed immediately by the decision to stop or go when presented by a yellow signal as the track clearance green interval terminates.

Line 48. Design vehicle relocation distance (DVRD in Figure 3) is the distance, in feet, that the design vehicle must accelerate through during the track clearance green interval. It is the sum of the design vehicle clearance distance (Line 46) and the portion of CSD to clear during the track clearance green interval (Line 47).

Line 49. The **Time required for design vehicle to accelerate through DVRD** is the amount of time required for the design vehicle to accelerate from a stop and travel the complete design vehicle relocation distance (DVRD). This time value, in seconds, can be found by locating your design vehicle relocation distance from Line 48 on the horizontal axis of Figure 2 and then drawing a line straight up until that line intersects the acceleration time performance curve for your design vehicle. For a WB-50 semi-trailer, large school bus (S-BUS 40), or single unit (SU) vehicle, multiply the acceleration time with a correction factor obtained from Table 2 to estimate the effect of grade on the acceleration of the vehicle. Use the average grade over the design vehicle relocation distance. For design vehicle relocation distances greater than 400 feet, use Equation 1 with the appropriate parameters listed in Table 3.

Line 50. Time to clear portion of clear storage distance, in seconds, is the total amount of time required (after the signal has turned green for the approach crossing the tracks) to begin moving a queue of vehicles through the queue start-up distance (L in Figure 3) and then move the design vehicle from a stopped position at the far side of the crossing completely through the portion of clear storage distance that must be cleared (CSD* in Figure 3). This value is the sum of the time required for design vehicle to start moving (Line 45) and the time for the design vehicle to accelerate through the design vehicle relocation distance, DVRD (Line 49).

Line 51. The **Track clearance green interval** is the time required, in seconds, for the track clearance green interval to avoid the occurrence of the preempt trap <u>and</u> to provide enough time for the design vehicle to clear the portion of the clear storage distance specified on Line 47. The track clearance green interval time is the maximum of the minimum track clearance green time (Line 44) and the time required to clear a portion of clear storage distance (Line 50).

SECTION 6: VEHICLE-GATE INTERACTION CHECK (OPTIONAL)

Note: This section is optional and is used to calculate the required advance preemption time to avoid the automatic gates descending on a stationary or slow moving design vehicle as it moves through the minimum track clearance distance (MTCD). If this worksheet is only used to determine if additional warning time has to be requested from the railroad to ensure that vehicles have enough time to clear the crossing before the arrival of the train, this section need <u>not</u> be completed.

Line 52. Right-of-way transfer time, in seconds, recorded on Line 17, is the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval.

Line 53. Time required for design vehicle to start moving, recorded on Line 22, is the time (in seconds) elapsed between the start of the track clearance green interval and the time the design vehicle, which is located at the edge of the railroad crossing on the opposite side from the signalized intersection, begins to move.

Line 54. Time required for design vehicle to accelerate through the design vehicle length, DVL, is the time required for the design vehicle to accelerate through its own length. The design vehicle length is recorded on Line 20. This time value, in seconds, can be read from Figure 2 and Table 2 or looked up in Table 4 for standard design vehicles. For a WB-50 semi-trailer, large school bus, or single unit (SU) truck use the average grade over the design vehicle length at the far side of the crossing.

Line 55. Time required for design vehicle to clear the descending gates, in seconds, is the sum of the right-of-way transfer time on Line 52, the time required for design vehicle to start moving on Line 53, and the time required for design vehicle to accelerate through the design vehicle length on Line 54.

Line 56. Duration of flashing lights before gate descent start, in seconds, is the time the railroad warning lights flash before the gates start to descend. This value typically ranges from 3 to 5 seconds and must be obtained from the railroad. The value obtained from the railroad may be verified using field observation.

Table 4. Time required for the design vehicle to accelerate through the design vehicle length.

Design Vehicle	Design Vehicle Length (feet)	Grade	Acceleration Time (seconds)
Through Passenger Car	19	Level	2.6
Left Turning Passenger Car	19	Level	2.7
Single Unit Truck (SU)	30	Level to 2%	3.8
		4%	4.0
		6%	4.3
		8%	4.6
Large School Bus (S-BUS 40)	40	Level to 1%	5.5
		2%	5.5
		4%	6.1
		6%	6.6
		8%	7.0
Intermediate Semi-Trailer (WB-50)	55	Level	10.0
		2%	11.0
		4%	12.8
		6%	14.4
		8%	15.8

Line 55. Time required for design vehicle to clear the descending gates, in seconds, is the sum of the right-of-way transfer time on Line 52, the time required for design vehicle to start moving on Line 53, and the time required for design vehicle to accelerate through the design vehicle length on Line 54.

Line 56. Duration of flashing lights before gate descent start, in seconds, is the time the railroad warning lights flash before the gates start to descend. This value typically ranges from 3 to 5 seconds and must be obtained from the railroad. The value obtained from the railroad may be verified using field observation.

Line 57. Full gate descent time, in seconds, is the time it takes for the gates to descend to a horizontal position after they start their descent. This value must be obtained from the railroad and may be verified using field observation. In the case where multiple gates descend at different speeds, use the descent time of the gate that reaches the horizontal position first.

Line 58. The **Proportion of non-interaction gate descent time** is the decimal proportion of the full gate descent time on Line 57 during which the gate will not interact with (i.e. not hit) the design vehicle if it is located under the gate. This value depends on the design vehicle height, h, and the distance from the center of the gate mechanism to the nearest side of the design vehicle, d, as shown in Figure 4. Figure 5 can be used to determine the proportion of non-interaction gate descent time. Select the distance from the center of the gate mechanism to the nearest side of the design vehicle, d, on the vertical axis of Figure 5, draw a horizontal line until you reach the curve that represents the design vehicle, and then draw a vertical line down to the horizontal axis and read off the value of the proportion of non-interaction gate descent time.

Line 59. Non-interaction gate descent time is time (in seconds) during gate descent that the gate will not interact with (i.e. not hit) the design vehicle if it is located under the gate. In other words, it is the time that expires after the gate starts to descend until it hits the design vehicle if it is located under the gate. This value is calculated by multiplying the full gate descent time on Line 57 with the proportion of non-interaction gate descent time on Line 58.

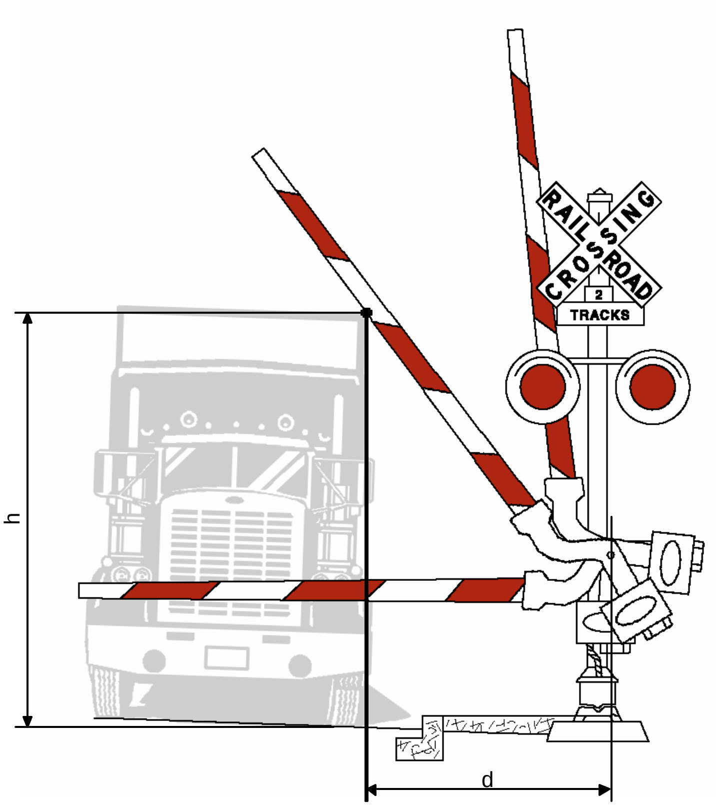


Figure 4 Gate interaction with the design vehicle.

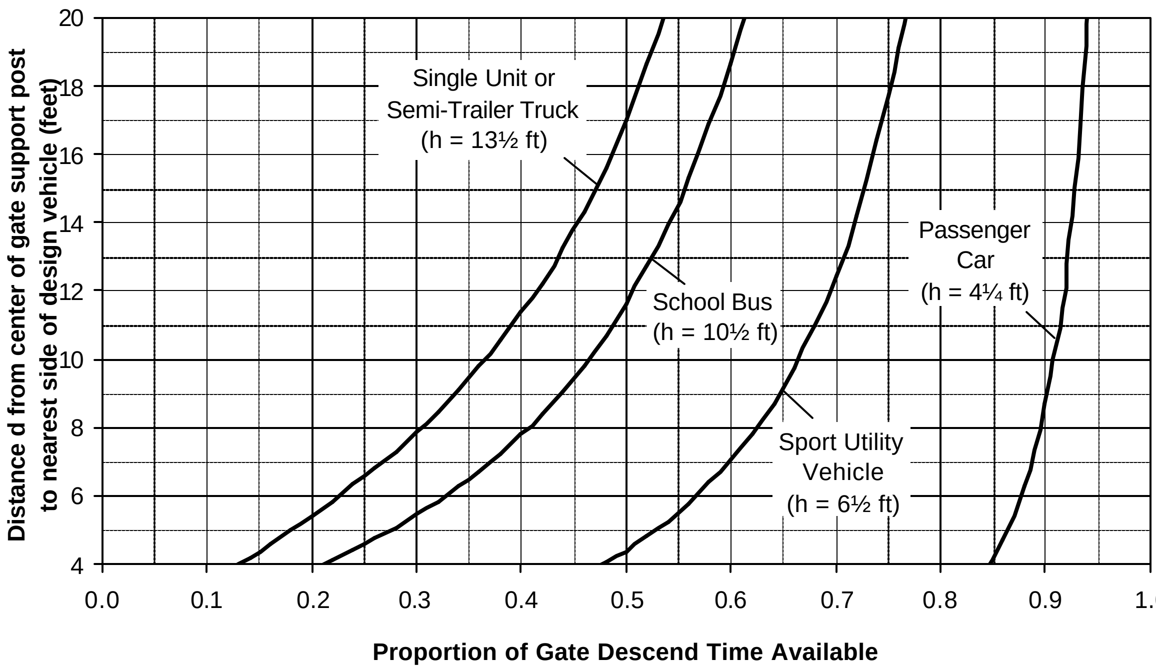


Figure 5 Proportion of gate descent time available as a function of the design vehicle height and the distance from the center of the gate mechanism to the nearest side of the design vehicle.

Line 60. Time available for design vehicle to clear descending gate, in seconds, is the time, after the railroad warning lights start to flash, that is available for the design vehicle to clear the descending gate before the gate hits the vehicle. It is the sum of the duration of the flashing lights before gate descent start (Line 56) and the non-interaction gate descent time (Line 59).

Line 61. Advance preemption time required to avoid design vehicle-gate interaction, in seconds, is calculated by subtracting the time available for the design vehicle to clear descending gate (Line 60) from the time required for the design vehicle to clear descending gate (Line 55). The result is the amount of advance preemption time that is required to avoid the gates descending on a stationary or slow-moving design vehicle. If the result of the subtraction is equal to or less than zero, it means that sufficient time is available, and you should enter zero (0) on Line 61. If the result is greater than the amount of advance preemption time provided by the railroad, as given on Line 36, there is a possibility that the gates could descend on a stationary or slow-moving design vehicle. To avoid this situation, additional advance preemption time should be requested from the railroad.

It should be kept in mind that on its own, gates descending on a vehicle is not a critical safety failure, because enough time still exists to clear the crossing before the arrival of the train, if the advance preemption time on Line 36 is provided. Therefore, local policies may vary on whether additional advance preemption time (over and above that on Line 36) should be requested solely for the purpose of prohibiting gates descending on vehicles.

If additional advance preemption time is provided to avoid design vehicle-gate interaction, Line 33 of this Worksheet has to updated, and Lines 34 and 35 recomputed. Section 5 also needs to be recomputed to calculate the track clearance green time.

REFERENCES

The following references were used in the development of the *2003 Guide For Determining Time Requirements For Traffic Signal Preemption At Highway-Rail Grade Crossings* and these accompanying Instructions.

Texas Department of Transportation. *Texas Manual on Uniform Traffic Control Devices (MUTCD)*. 2003. On the Internet at http://www.dot.state.tx.us/TRF/mutcd.htm. Link valid May 2003.

Institute of Transportation Engineers (ITE). *Determining Vehicle Signal Change and Clearance Intervals*. An Informational Report prepared by ITE Technical Council Task Force 4TF-1, August 1994.

American Association of State Highway & Transportation Officials (AASHTO). *A Policy on Geometric Design of Highways and Streets*. (Green Book). 2001.

Marshall, P.S. and W.D. Berg. *Design Guidelines for Railroad Preemption at Signalized Intersections*. In ITE Journal Volume 67, Number 2, February 1997, pp. 20-25.

American Railway Engineering and Maintenance-of-Way Association (AREMA). *Manual of Recommended Practices-Signals*. 2000.

Engelbrecht, R.J., S. Sunkari, T. Urbanik, and K. Balke. *The Preempt Trap: How to Make Sure You do Not Have One*. Texas Department of Transportation Project Bulletin 1752-9, October, 2000. On the Internet at http://tti.tamu.edu/product/catalog/ reports/1752-9.pdf. Link valid May 2003.

APPENDIX S

Timing Guidelines for Countdown Pedestrian Signals

INTERSECTION TIMING STANDARD:
PEDESTRIAN CROSSWALKS

The MUTCD requires as a "shall condition" any signalized crosswalk using a countdown display cannot display a flashing don't walk indication during the yellow change interval; however, the yellow change and red clearance interval may be used as part of the overall pedestrian clearance time. This restriction could result in short countdown intervals displayed to the public and could create public concern over a short countdown time displayed to a pedestrian in a crosswalk. The Department will adopt a standard that will display a minimum countdown interval of 7 seconds. The table below reflects the minimum crosswalk distance the standard will cover utilizing the yellow change and red clearance intervals:

Minimum Countdown Display	Yellow Change Interval	Red Clearance Interval (2.0 sec)	Crosswalk Distance (in feet)
7 seconds	3.0 seconds	2.0 seconds	42
7 seconds	4.0 seconds	2.0 seconds	45.5
7 seconds	5.0 seconds	2.0 seconds	49
7 seconds	5.5 seconds	2.0 seconds	50.75
Minimum Countdown Display	Yellow Change Interval	Red Clearance Interval (3.0 sec)	Crosswalk Distance (in feet)
7 seconds	3.0 seconds	3.0 seconds	45.5
7 seconds	4.0 seconds	3.0 seconds	49
7 seconds	5.0 seconds	3.0 seconds	52.5
7 seconds	5.5 seconds	3.0 seconds	54.25

The pedestrian timing can be reflected as follows:

Walk Display	Flashing Don't Walk	Yellow Change	Red Clearance
Walk Interval 7"	Pedestrian Clearance time (curb to curb)		

Crosswalks longer than those noted in the table above will display countdown indications equal to the pedestrian clearance time minus the yellow change and red clearance intervals.

APPENDIX T

Sample Plan – Fiber Pathway

THE STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION

U.S. CUSTOMARY UNITS

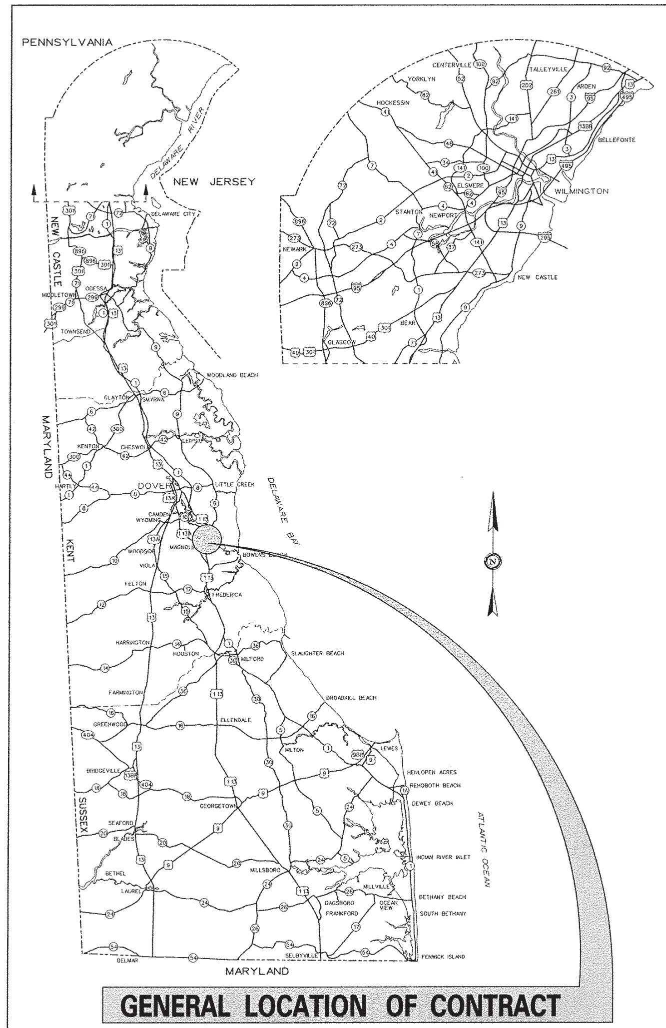
CONSTRUCTION PLANS FOR:

ITMS INTERCONNECT
SR1, SR9 TO LITTLE HEAVEN

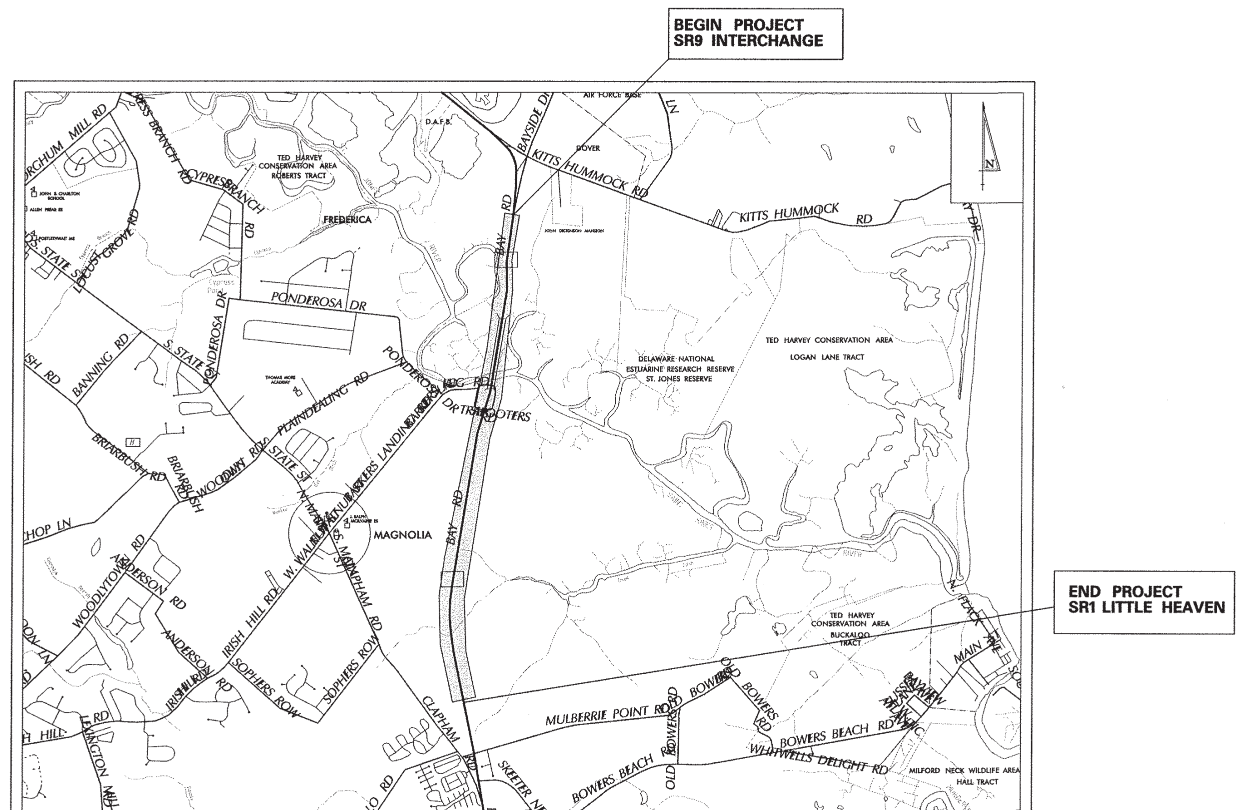
CENTURY AGREEMENT NUMBER: 1486

CONTRACT NUMBER: T2012047404

ROADWAY LENGTH: 12,419 ± **FEET =** 2.35 ± **MILES**



GENERAL LOCATION OF CONTRACT



PROJECT LOCATION
NOT TO SCALE

INDEX OF SHEETS

TOTAL SHEETS: 10

APPROVED DESIGN EXCEPTIONS

DESIGN PARAMETER	REQUIRED	PROVIDED	DATE

ADDENDA & REVISIONS

DESCRIPTION	NAME & DATE

PREPARED BY
THE CONSULTING FIRM OF

CENTURY ENGINEERING, INC.
4134 N. DUPONT HWY.
DOVER, DE 19901
(302) 734-9188

RECOMMENDED 10/11/2011
DATE

RECOMMENDED

TRAFFIC DESIGNER DATE

ASSISTANT CHIEF TRAFFIC ENGINEER 10/13/11 DATE

CHIEF TRAFFIC ENGINEER 10/13/11 DATE

FINAL PLANS
OCTOBER 2011

GENERAL NOTES:

1. ALL CONSTRUCTION AND MATERIALS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE DELAWARE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION DATED AUGUST 2001 AND ANY ADDENDA THERETO AND THE MOST CURRENT VERSION OF THE DELDOT MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD).

2. ALL DISTURBED AREAS WITHIN THE STATE RIGHT-OF-WAY, BUT NOT IN THE PAVEMENT, SHALL BE TOPSOILED (6" MINIMUM), FERTILIZED, SEEDED AND MULCHED.

3. MISS UTILITY OF DELMARVA SHALL BE NOTIFIED THREE (3) CONSECUTIVE WORKING DAYS PRIOR TO EXCAVATION, AT 1-800-282-8555.

4. EXISTING UTILITIES ARE SHOWN IN ACCORDANCE WITH THE BEST AVAILABLE INFORMATION. COMPLETENESS OR CORRECTNESS THEREOF IS NOT GUARANTEED. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO CONTACT THE UTILITY COMPANIES INVOLVED IN ORDER TO SECURE THE MOST ACCURATE INFORMATION AVAILABLE AS TO UTILITY LOCATION AND ELEVATION. NO CONSTRUCTION AROUND OR ADJACENT TO UTILITIES SHALL BEGIN WITHOUT NOTIFYING THEIR OWNERS AT LEAST 48 HOURS IN ADVANCE. THE CONTRACTOR SHALL TAKE THE NECESSARY PRECAUTIONS TO PROTECT THE EXISTING UTILITIES AND MAINTAIN UNINTERRUPTED SERVICE AND ANY DAMAGE DONE TO THEM DUE TO HIS/HER NEGLIGENCE SHALL BE IMMEDIATELY AND COMPLETELY REPAIRED AT THE CONTRACTOR'S EXPENSE. TO LOCATE EXISTING UTILITIES IN THE FIELD PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL CONTACT MISS UTILITY OF DELMARVA (SEE NOTE #3).

5. ANY DAMAGE TO ITEMS THAT ARE REQUIRED TO BE RELOCATED OR RESET BY THE CONTRACTOR SHALL BE REPAIRED AND/OR REPLACED IN KIND AT THE CONTRACTOR'S EXPENSE.

6. IF THIS PROJECT EXTENDS OVER A WINTER PERIOD ANY SNOW REMOVAL ALONG THE STATE MAINTAINED ROAD WILL BE HANDLED BY STATE FORCES. FOLLOWING THE SNOW REMOVAL OPERATION, ANY MAINTENANCE OF TRAFFIC CONTROL DEVICES SHALL BE PERFORMED BY THE CONTRACTOR.

7. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER.

8. ALL PROPOSED MAIN LINE TRENCHED CONDUIT SHALL BE 4 INCH PVC WITH 4-1" SMOOTH WALL HDPE. ALL BORING SHALL BE 4" HDPE.

9. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND /OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.

10. ROADWAY GEOMETRY IS BASED OFF AERIAL PHOTOS. A DETAILED FIELD SURVEY WAS NOT CONDUCTED.

11. CONDUIT SHALL BE A MINIMUM OF 24 INCHES BELOW GRADE.

12. TYPE 4 JUNCTION WELLS SHALL BE NO MORE THAN 600 FEET APART, TYPE 7 JUNCTION WELLS SHALL BE NO MORE THAN 2,400 FEET APART.

13. WORK SHALL BE PERFORMED IN A MANNER THAT WILL ENSURE THE LEAST PRACTICAL OBSTRUCTION TO THE TRAVELING PUBLIC, CONSISTENT WITH SAFETY STANDARDS AND SHALL COMPLY WITH THE REQUIREMENTS OF THE 2007 DELAWARE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD) PART 6, HEREIN REFERRED TO AS THE TRAFFIC CONTROL MANUAL (INCLUDING REVISIONS IN EFFECT AT THE TIME OF THE ADVERTISEMENTS OF BIDS).

14. MAINTENANCE OF TRAFFIC DURING LANE CLOSURES AND LANE SHIFTS SHALL CONFORM TO CASE 3 OF THE TRAFFIC CONTROL MANUAL.

15. ACCESS TO ALL BUSINESSES AND RESIDENCES WITHIN THE PROJECT LIMITS SHALL BE MAINTAINED THROUGHOUT THE DURATION OF THIS CONTRACT. ANY TEMPORARY CLOSURE OF A DRIVEWAY FOR TIE-IN PURPOSES SHALL BE COORDINATED WITH THE ENGINEER AND/OR PROPERTY OWNER IN ADVANCE OF THE CLOSURE.

16. ALL SIGNING AND MAINTENANCE OF TRAFFIC IS THE CONTRACTOR'S RESPONSIBILITY AND SHALL FOLLOW THE GUIDELINES SHOWN IN DELAWARE DEPARTMENT OF TRANSPORTATION MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD) FOR STREETS AND HIGHWAYS.

17. ALL TRAFFIC CONTROL DEVICES SHALL BE IN NEW OR REFURBISHED CONDITION, SHALL COMPLY WITH THE TRAFFIC CONTROL MANUAL, AND SHALL BE NCHRP-350 APPROVED AND SHALL BE APPROVED BY THE ENGINEER PRIOR TO INSTALLATION. TRAFFIC CONTROL DEVICES SHALL BE MAINTAINED IN GOOD CONDITION FOR DURATION OF USE.

18. WITHIN THE CONSTRUCTION AREA, UTILITY WORK - 1500FT, 1000FT, 500FT AND END OF WORK PERMANENT SIGNS SHALL BE PLACED WHENEVER POSSIBLE. IF THE ABOVE DISTANCES ARE NOT APPLICABLE, A "UTILITY WORK AHEAD" PERMANENT SIGN SHALL BE PLACED, AS DIRECTED BY THE SOUTH DISTRICT INSPECTOR. AN "END OF UTILITY WORK" PERMANENT SIGN SHALL BE PLACED ON THE RIGHT SIDE, 500FT FROM THE WORK ZONE. ALL DIMENSIONS ARE APPROXIMATE AND MAY BE ADJUSTED TO MEET FIELD CONDITIONS AS APPROVED BY THE DISTRICT INSPECTOR . ALL PERMANENT TRAFFIC CONTROL SIGNS SHALL BE SEVEN FEET FROM THE BOTTOM OF THE SIGN TO THE TOP OF THE GROUND.

19. MAINTENANCE OF TRAFFIC MAY BE REQUIRED FOR THE INSTALLATION OF CONDUIT, FIBER OR DEVICES. TRAFFIC CONTROLS FOR STREET AND HIGHWAY CONSTRUCTION, DELDOT MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES SHALL BE ADHERED TO FOR THE SHOULDER CLOSURE MAINTENANCE OF TRAFFIC OPERATION (CONTRACTOR SHALL COORDINATE WITH SAFETY OFFICER).

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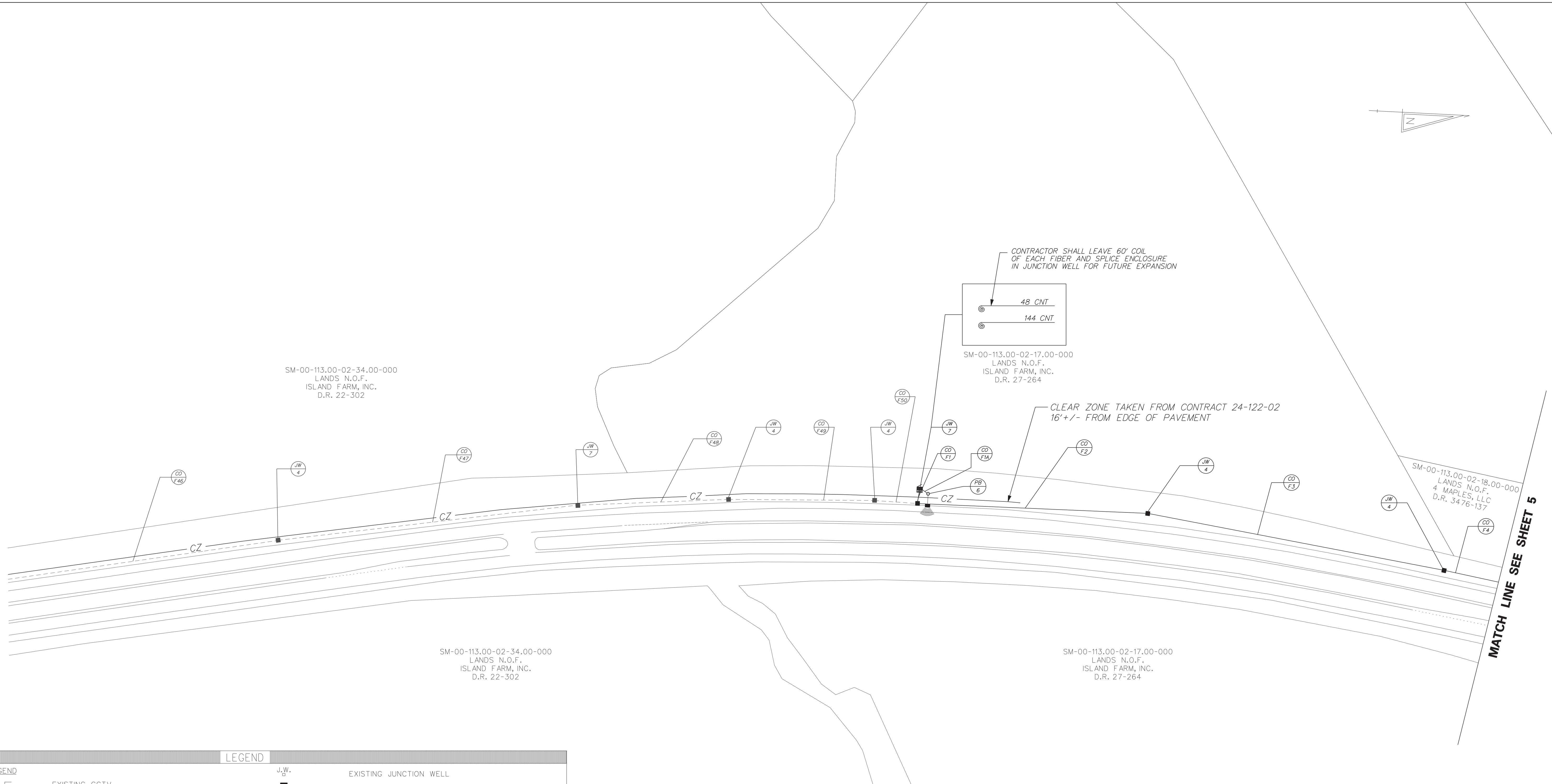
DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 1000 2000 3000 FEET	ITMS INTERCONNECT (SR1, SR9 TO LITTLE HEAVEN)	CONTRACT NO. T201204704 COUNTY KENT	PERMIT NO. - DESIGNED BY: DLD CHECKED BY: BAM	ITMS INDEX PLAN	SHEET NO. 3 TOTAL SHTS. 10



LEGEND

LEGEND			
	EXISTING CCTV	J.W.	EXISTING JUNCTION WELL
	PROPOSED CCTV		PROPOSED JUNCTION WELL
JW X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)		PROPOSED JUNCTION WELL FROM PREVIOUS CONTRACT
CO X	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)		PROPOSED CONDUIT RUN FROM PREVIOUS CONTRACT
	EXISTING RIGHT OF WAY LINE	JW X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
	EXISTING PROPERTY LINE	CO X	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
	EXISTING MICROWAVE DETECTION		STORM SEWER
	PROPOSED MICROWAVE DETECTION	CNT SM	COUNT, SINGLEMODE FIBER OPTICS
	PROPOSED POLE (TYPE 6)		EXISTING ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
	PROPOSED CABINET (TYPE M)		PROPOSED ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
			EXISTING GUARDRAIL

ITMS GENERAL NOTES:

1. CONDUIT RUNS F46, F47, F48, F49, F50 AND ASSOCIATED JUNCTION WELLS OBTAINED FROM CONTRACT NO. 24-122-02, SR1 LITTLE HEAVEN GRADE SEPARATED INTERSECTION, FISCAL YEAR 2015.
2. POLE BASE, 32' POLE AND RADAR SHALL BE INSTALLED UNDER THIS CONTRACT.
3. INITIAL POWER FOR THE PROPOSED MICROWAVE DETECTION TO BE SOLAR. POWER WILL BE ESTABLISHED THROUGH CONTRACT NO. 24-122-02.
4. DETECTION UNIT TO BE MOUNTED AT MIN MOUNTING HEIGHT OF 20' AND MAX MOUNTING HEIGHT OF 41' WITH A MANUFACTURER RECOMMENDED MOUNTING HEIGHT OF 30'. FIELD ADJUST MOUNTING HEIGHT AS REQUIRED TO ACHIEVE MAXIMUM DATA OUTPUT. DETECTOR WILL COMMUNICATE WITH THE TMC VIA A CDMA WIRELESS CONNECTION.

CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/WIRE
F1	1	4.0"	20'	T	12 CNT SINGLE MODE
F1A	1	4.0"	15'	T	12 CNT SM
F2	1	4.0"	508'	T	144 CNT SM, 48 CNT SM
F3	1	4.0"	600'	T	144 CNT SM, 48 CNT SM
F4	1	4.0"	110'	T	144 CNT SM, 48 CNT SM

* DENOTES EXISTING

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

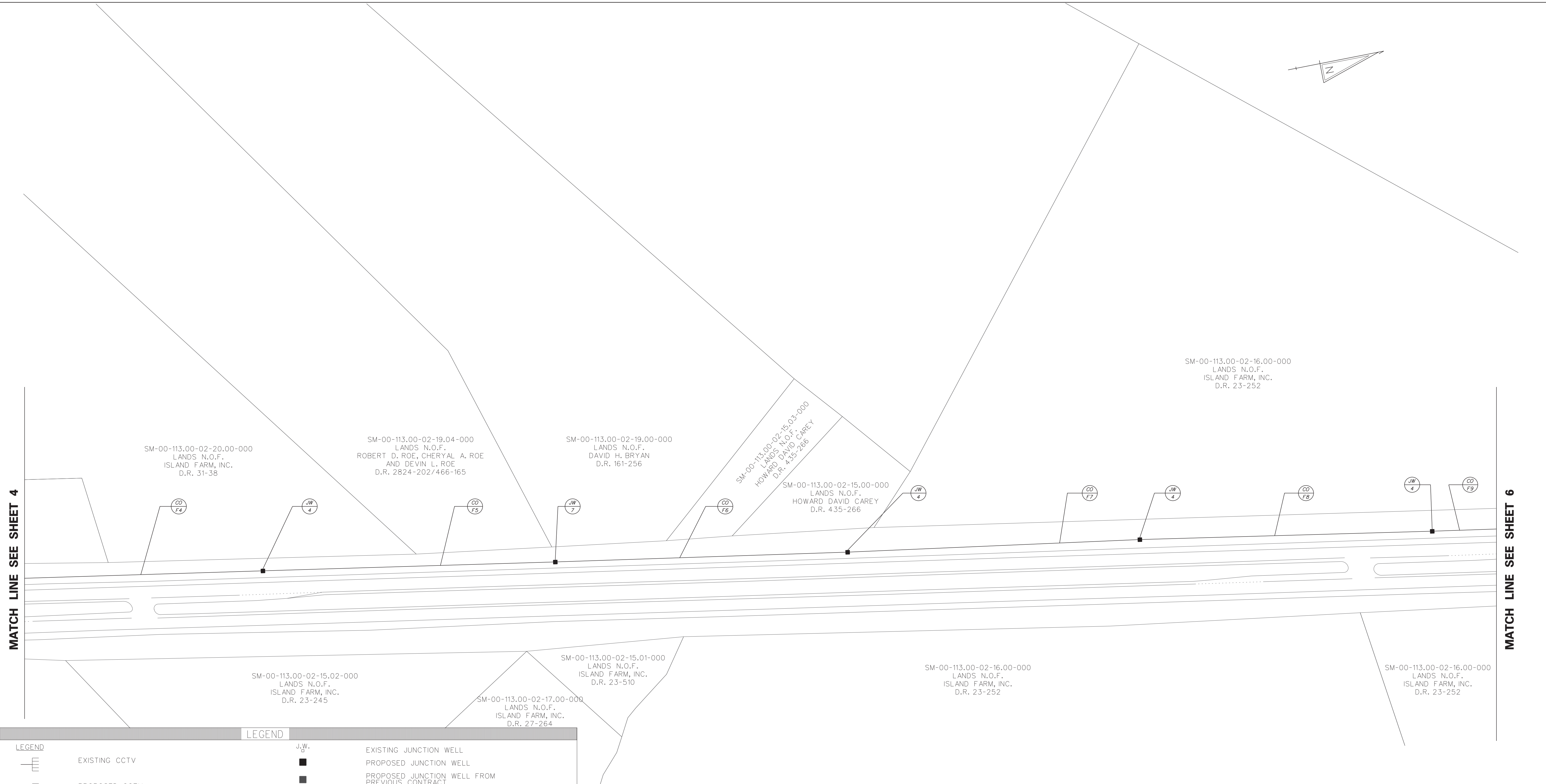
SCALE 0 100 200 300 FEET

ITMS INTERCONNECT (SR1, SR9 TO LITTLE HEAVEN)

CONTRACT NO.	T201204704	PERMIT NO.	-
COUNTY	KENT	DESIGNED BY:	DLD
		CHECKED BY:	BAM

ITMS CONDUIT PLAN

SHEET NO. 4
TOTAL SHTS. 10



LEGEND

LEGEND

- EXISTING CCTV
- PROPOSED CCTV
- PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- PROPOSED CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)
- EXISTING RIGHT OF WAY LINE
- EXISTING PROPERTY LINE
- EXISTING MICROWAVE DETECTION
- PROPOSED MICROWAVE DETECTION
- PROPOSED POLE (TYPE 6)
- PROPOSED CABINET (TYPE M)
- J.W. EXISTING JUNCTION WELL
- PROPOSED JUNCTION WELL
- PROPOSED JUNCTION WELL FROM PREVIOUS CONTRACT
- PROPOSED CONDUIT RUN FROM PREVIOUS CONTRACT
- EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- EXISTING CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)
- STORM SEWER
- CNT SM — COUNT, SINGLEMODE FIBER OPTICS
- EXISTING ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
- PROPOSED ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
- EXISTING GUARDRAIL

CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/WIRE
F4	1	4.0"	490'	T	144 CNT SINGLE MODE, 48 CNT SINGLE MODE
F5	1	4.0"	600'	T	144 CNT SM, 48 CNT SM
F6	1	4.0"	600'	T	144 CNT SM, 48 CNT SM
F7	1	4.0"	600'	T	144 CNT SM, 48 CNT SM
F8	1	4.0"	600'	T	144 CNT SM, 48 CNT SM
F9	1	4.0"	132'	T	144 CNT SM, 48 CNT SM

* DENOTES EXISTING

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

SCALE 0 100 200 300 FEET

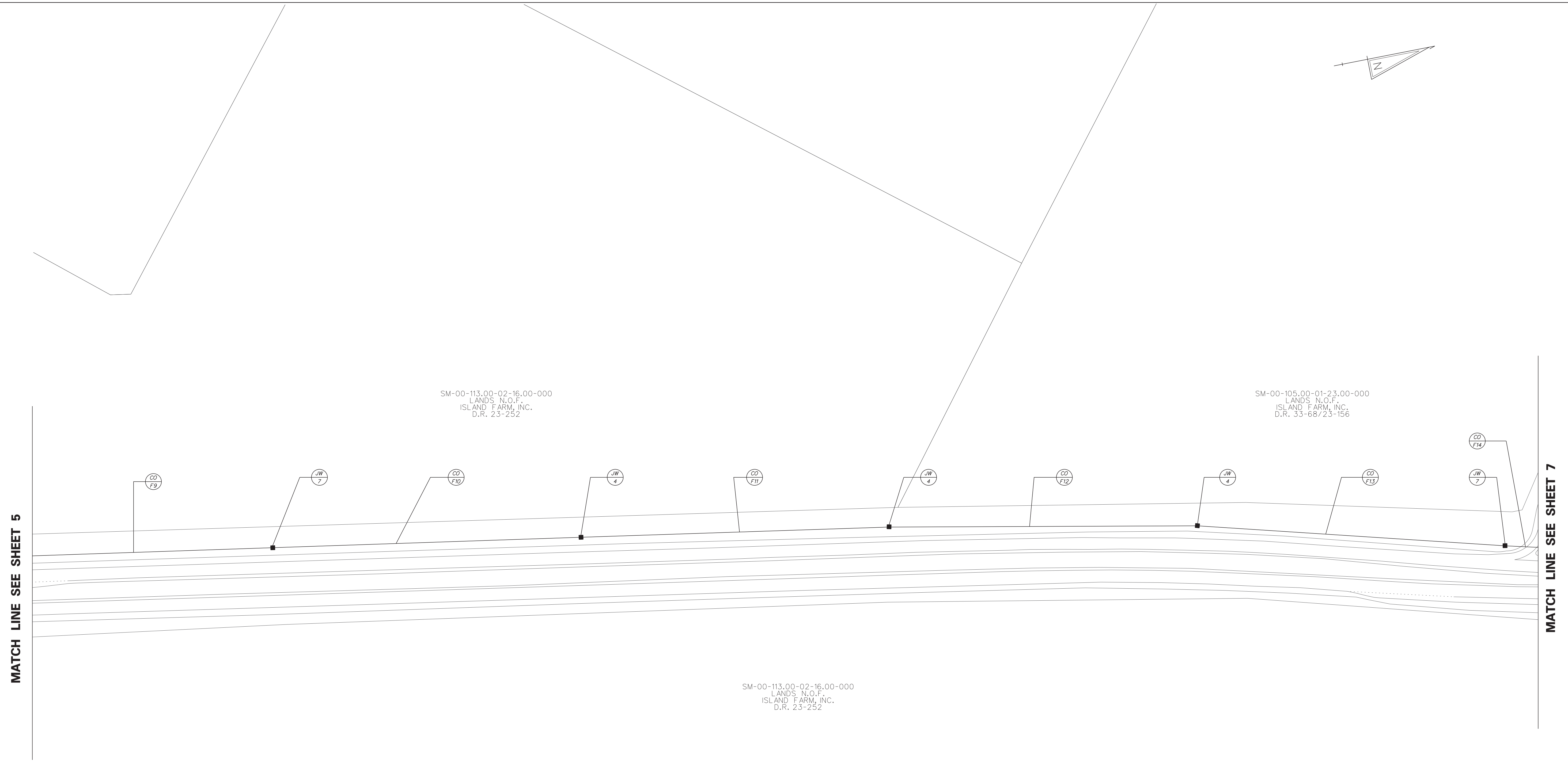
ITMS INTERCONNECT (SR1, SR9 TO LITTLE HEAVEN)

CONTRACT NO.	T201204704	PERMIT NO.	-
COUNTY	KENT	DESIGNED BY:	DLD
		CHECKED BY:	BAM

ITMS CONDUIT PLAN

SHEET NO. 5

TOTAL SHTS. 10



LEGEND

LEGEND			
	EXISTING CCTV	J.W.	EXISTING JUNCTION WELL
	PROPOSED CCTV		PROPOSED JUNCTION WELL
			PROPOSED JUNCTION WELL FROM PREVIOUS CONTRACT
			PROPOSED CONDUIT RUN FROM PREVIOUS CONTRACT
JW X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	JW X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
CO X	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)	CO X	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
	EXISTING RIGHT OF WAY LINE		STORM SEWER
	EXISTING PROPERTY LINE	CNT SM	COUNT, SINGLEMODE FIBER OPTICS
	EXISTING MICROWAVE DETECTION		EXISTING ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
	PROPOSED MICROWAVE DETECTION		PROPOSED ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
	PROPOSED POLE (TYPE 6)		EXISTING GUARDRAIL
	PROPOSED CABINET (TYPE M)		

CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/WIRE
F9	1	4.0"	468'	T	144 CNT SINGLE MODE,48 CNT SINGLE MODE
F10	1	4.0"	600'	T	144 CNT SM,48 CNT SM
F11	1	4.0"	600'	T	144 CNT SM,48 CNT SM
F12	1	4.0"	600'	T	144 CNT SM,48 CNT SM
F13	1	4.0"	600'	T	144 CNT SM,48 CNT SM
F14	1	4.0"	65'	B	144 CNT SM,48 CNT SM

* DENOTES EXISTING

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DELAWARE
DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

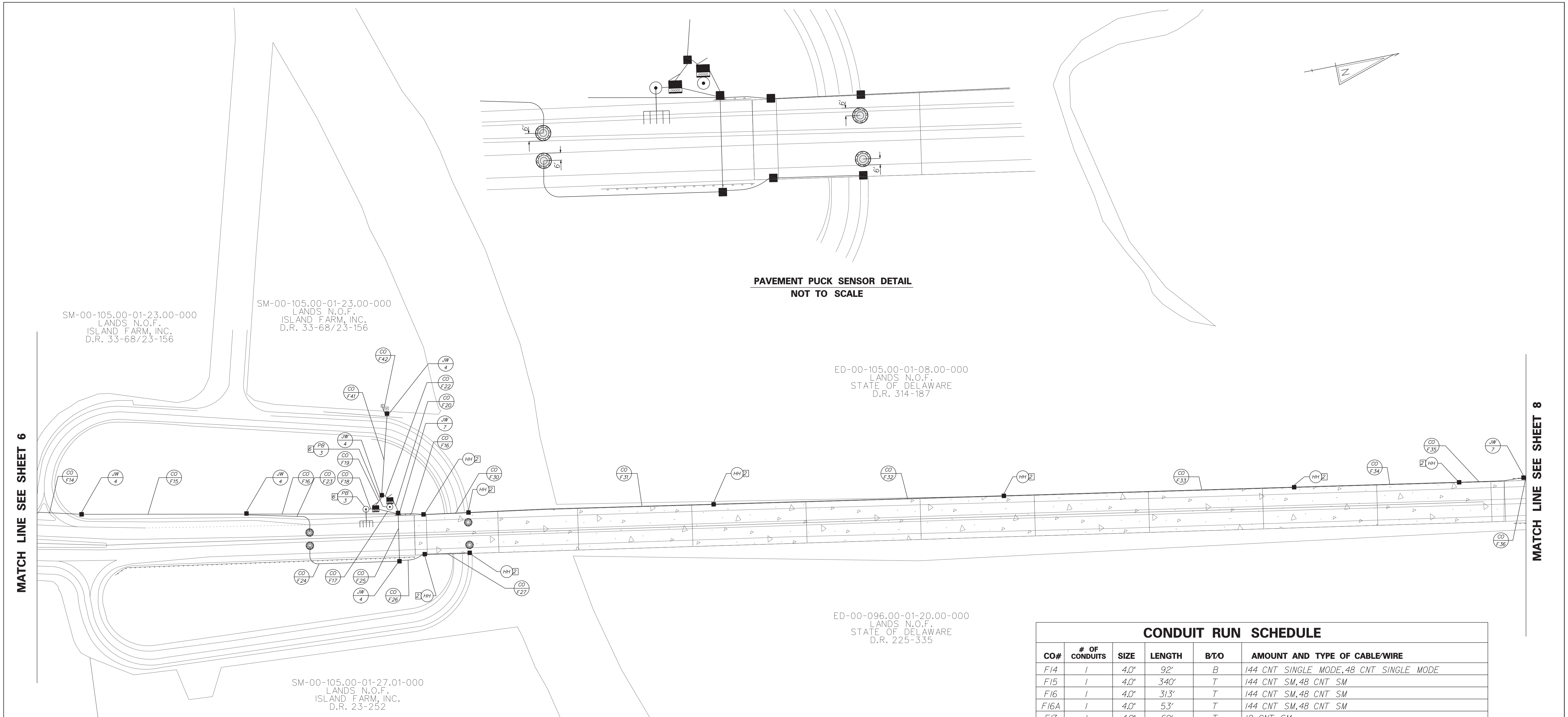
SCALE 0 100 200 300 FEET

ITMS INTERCONNECT
(SR1, SR9 TO LITTLE HEAVEN)

CONTRACT NO.	T201204704	PERMIT NO.	-
COUNTY	KENT	DESIGNED BY:	DLD
		CHECKED BY:	BAM

ITMS CONDUIT PLAN

SHEET NO. 6
TOTAL SHTS. 10



LEGEND

LEGEND		J.W.	
	EXISTING CCTV		EXISTING JUNCTION WELL
	PROPOSED CCTV		PROPOSED JUNCTION WELL
			PROPOSED JUNCTION WELL FROM PREVIOUS CONTRACT
			PROPOSED CONDUIT RUN FROM PREVIOUS CONTRACT
JW X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	JW X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
CO X	PROPOSED CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)	CO X	EXISTING CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)
	EXISTING RIGHT OF WAY LINE		STORM SEWER
	EXISTING PROPERTY LINE	CNT SM	COUNT, SINGLEMODE FIBER OPTICS
	EXISTING MICROWAVE DETECTION		EXISTING ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
	PROPOSED MICROWAVE DETECTION		PROPOSED ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
	PROPOSED POLE (TYPE 6)		EXISTING GUARDRAIL
	PROPOSED CABINET (TYPE M)		

ITMS GENERAL NOTES

1 CCTV AND RWIS STATION SERVICE FEED SHALL BE COORDINATED WITH LOCAL ELECTRIC COMPANY.

2 3'x3'x6" HAND HOLE ATTACHED TO THE PARAPET WALL.

3 ALL PAVEMENT PUCK SENSORS SHALL BE INSTALLED APPROXIMATELY 4 FEET FROM THE EDGE OF THE TRAVEL LANE AS SHOWN (SEE DETAIL THIS SHEET).

4 SENSOR CABLE TYPE 11A SHALL BE INSTALLED IN ½" x 1 ½" SAWCUT IN PAVEMENT. THE SAWCUT SHALL BE FILLED WITH 3M LOOP DETECTOR SEALANT.

5 ALL PAVEMENT PUCK SENSOR HEADS SHALL BE INSTALLED FLUSH WITH FINISHED PAVEMENT SURFACE.

6 POLE BASE TYPE 3 SHALL BE A 75' POLE FOR CAMERA AND 25' FOR WEATHER.

7 RWIS ASSEMBLY SHALL BE MOUNTED ON THE RWIS POLE.

8 THE COMMUNICATION MEDIA FOR THE RWIS ASSEMBLY SHALL BE FIBER OPTIC. (CDMA COMMUNICATIONS SHALL BE USED IF FIBER IS NOT ACTIVATED PRIOR TO COMPLETION OF THE PROJECT).

CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/WIRE
F14	1	4.0"	92'	B	144 CNT SINGLE MODE,48 CNT SINGLE MODE
F15	1	4.0"	340'	T	144 CNT SM,48 CNT SM
F16	1	4.0"	313'	T	144 CNT SM,48 CNT SM
F16A	1	4.0"	53'	T	144 CNT SM,48 CNT SM
F17	1	4.0"	60'	T	12 CNT SM
F18	1	2.0"	10'	T	12 CNT SM
F19	1	4.0"	25'	T/B	2/*8 U.F.w/GROUND
F20	1	4.0"	25'	T	(6) SENSOR HOMERUN CABLE
F22	1	2.0"	10'	T/B	2/*8 U.F.w/GROUND
F23	1	4.0"	85'	T	(1) SENSOR HOMERUN CABLE
F24	1	4.0"	30'	B	(1) SENSOR HOMERUN CABLE
F25	1	4.0"	95'	T	(5) SENSOR HOMERUN CABLE
F26	1	4.0"	50'	T	(4) SENSOR HOMERUN CABLE
F27	1	4.0"	85'	**	(4) SENSOR HOMERUN CABLE
F30	1	4.0"	85'	**	144 CNT SM,48 CNT SM,(1) SENSOR HOMERUN CABLE
F31	1	4.0"	500'	**	144 CNT SM,48 CNT SM
F32	1	4.0"	600'	**	144 CNT SM,48 CNT SM
F33	1	4.0"	600'	**	144 CNT SM,48 CNT SM
F34	1	4.0"	341'	**	144 CNT SM,48 CNT SM
F35	1	4.0"	134'	**	144 CNT SM,48 CNT SM
F36	1	4.0"	1'	T	144 CNT SM,48 CNT SM
F41	1	2.0"	165'	T/B	2/*8 U.F.w/GROUND
F42	1	2.0"	15'	T	2/*8 U.F.w/GROUND

* DENOTES EXISTING
** DENOTES ATTACHMENT TO BRIDGE

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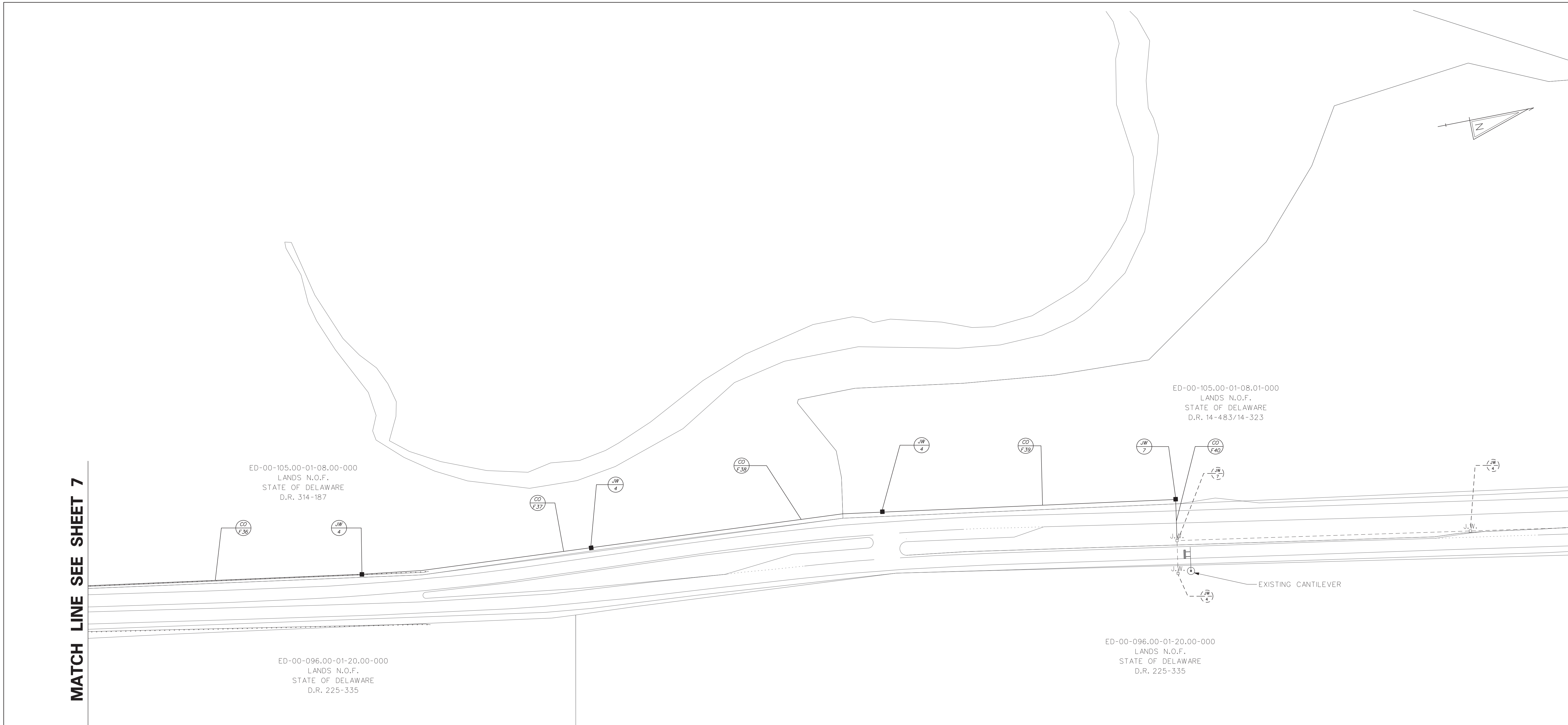
DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 100 200 300 FEET	ITMS INTERCONNECT (SR1, SR9 TO LITTLE HEAVEN)	CONTRACT NO. T201204704	PERMIT NO. -	ITMS CONDUIT PLAN	SHEET NO. 7
				COUNTY KENT	DESIGNED BY: DLD / CHECKED BY: BAM		TOTAL SHTS. 10



LEGEND

LEGEND

- EXISTING CCTV
- PROPOSED CCTV
- PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- PROPOSED CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)
- EXISTING RIGHT OF WAY LINE
- EXISTING PROPERTY LINE
- EXISTING MICROWAVE DETECTION
- PROPOSED MICROWAVE DETECTION
- PROPOSED POLE (TYPE 6)
- PROPOSED CABINET (TYPE M)
- J.W. EXISTING JUNCTION WELL
- PROPOSED JUNCTION WELL
- PROPOSED JUNCTION WELL FROM PREVIOUS CONTRACT
- PROPOSED CONDUIT RUN FROM PREVIOUS CONTRACT
- EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- EXISTING CONDUIT RUN IDENTIFIER (* OF CONDUIT RUN)
- STORM SEWER
- CNT SM — COUNT, SINGLEMODE FIBER OPTICS
- EXISTING ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
- PROPOSED ROAD WEATHER INFORMATION SYSTEM (RWIS) PUCK SENSOR
- EXISTING GUARDRAIL

GENERAL NOTE:

1. *EXISTING JUNCTION WELLS AND CONDUIT RUNS OBTAINED FROM CONTRACT NO. 24-122-04, SR1, SR9 GRADE SEPARATED INTERSECTION.*

CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/WIRE
F36	1	4.0"	565'	T	144 CNT SINGLE MODE,48 CNT SINGLE MODE
F37	1	4.0"	472'	T	144 CNT SM,48 CNT SM
F38	1	4.0"	600'	T	144 CNT SM,48 CNT SM
F39	1	4.0"	600'	T	144 CNT SM,48 CNT SM
F40	1	4.0"	134'	B	144 CNT SM,48 CNT SM

* DENOTES EXISTING

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

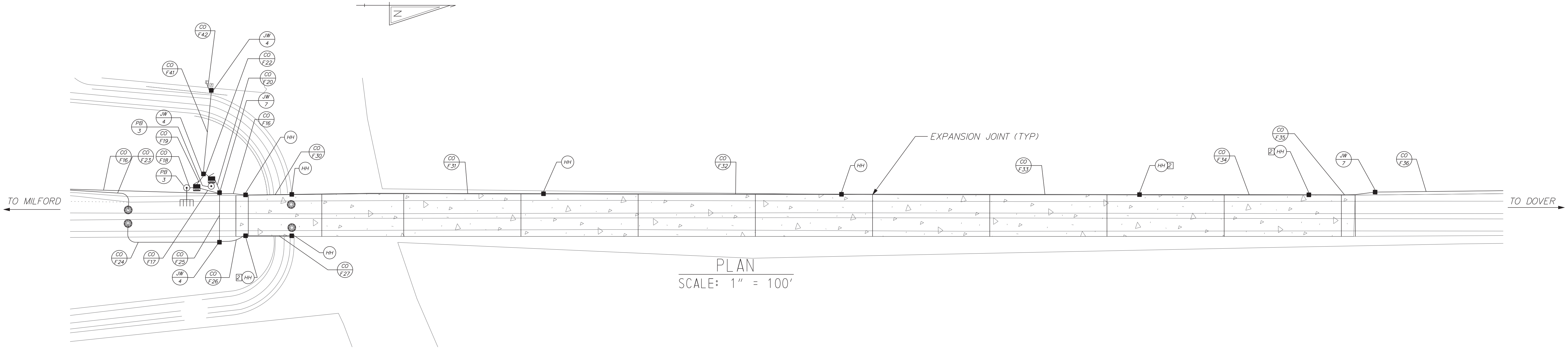
SCALE 0 100 200 300 FEET

ITMS INTERCONNECT (SR1, SR9 TO LITTLE HEAVEN)

CONTRACT NO.	T201204704	PERMIT NO.	-
COUNTY	KENT	DESIGNED BY:	DLD
		CHECKED BY:	BAM

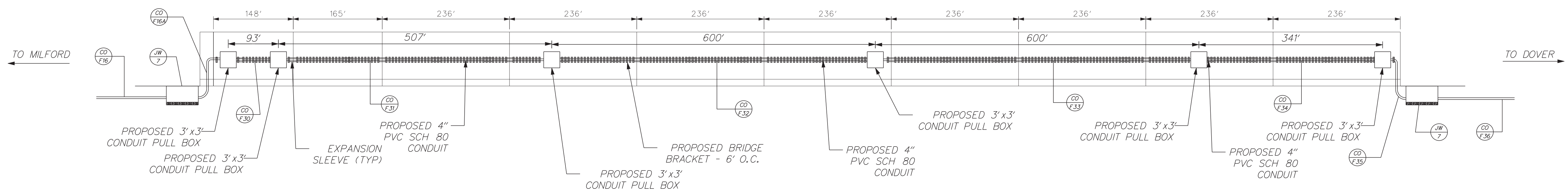
ITMS CONDUIT PLAN

SHEET NO. 8
TOTAL SHTS. 10



PLAN

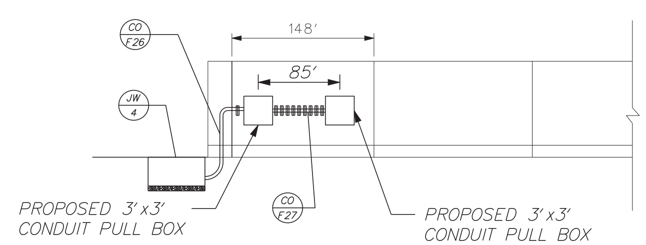
SCALE: 1" = 100'



BRIDGE ELEVATION - SOUTH BOUND SIDE

SCALE: N.T.S.

(MIRROR IMAGE OF SECTION USED FOR INSTALLATION CLARITY)



BRIDGE ELEVATION - NORTH BOUND SIDE

SCALE: N.T.S.

NOTE:

1. PVC CONDUIT THAT WILL BE EXPOSED TO ELEMENTS (INSTALLED ON PARAPET WALL) WILL BE INSTALLED WITH EXPANSION SLEEVES. THE CONTRACTOR SHALL ENSURE THE PLACEMENT OF EXPANSION SLEEVES AT A MAXIMUM OF 100 FEET.

2. ALL CONDUIT SWEEPS INTO BRIDGE PARAPET SHALL BE A MINIMUM OF 24" RADIUS.

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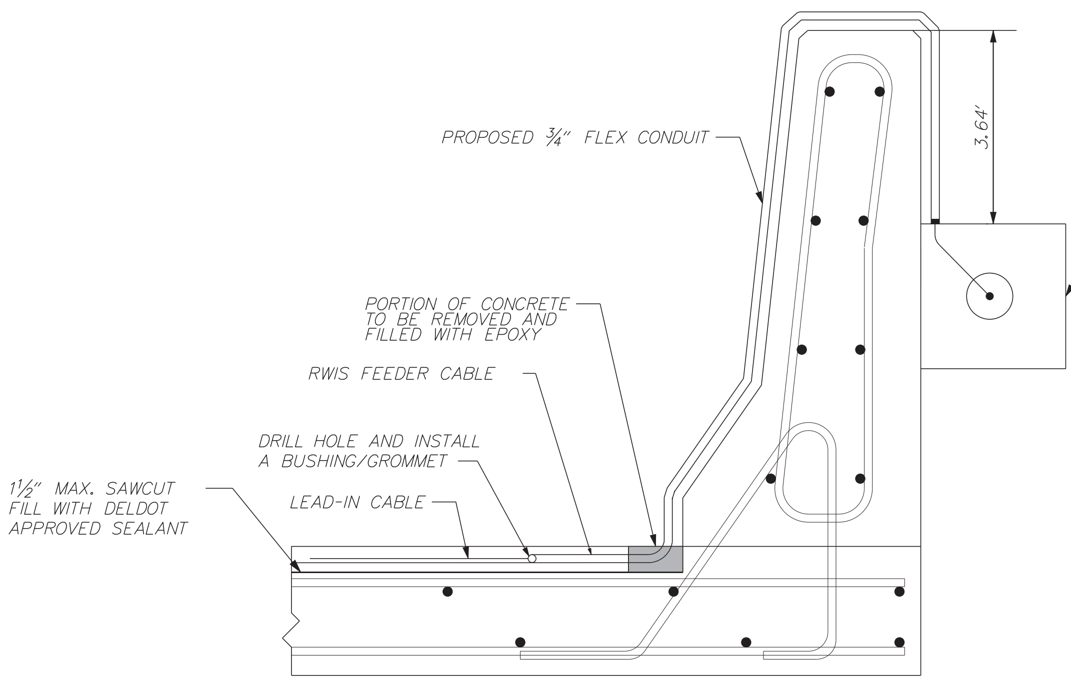
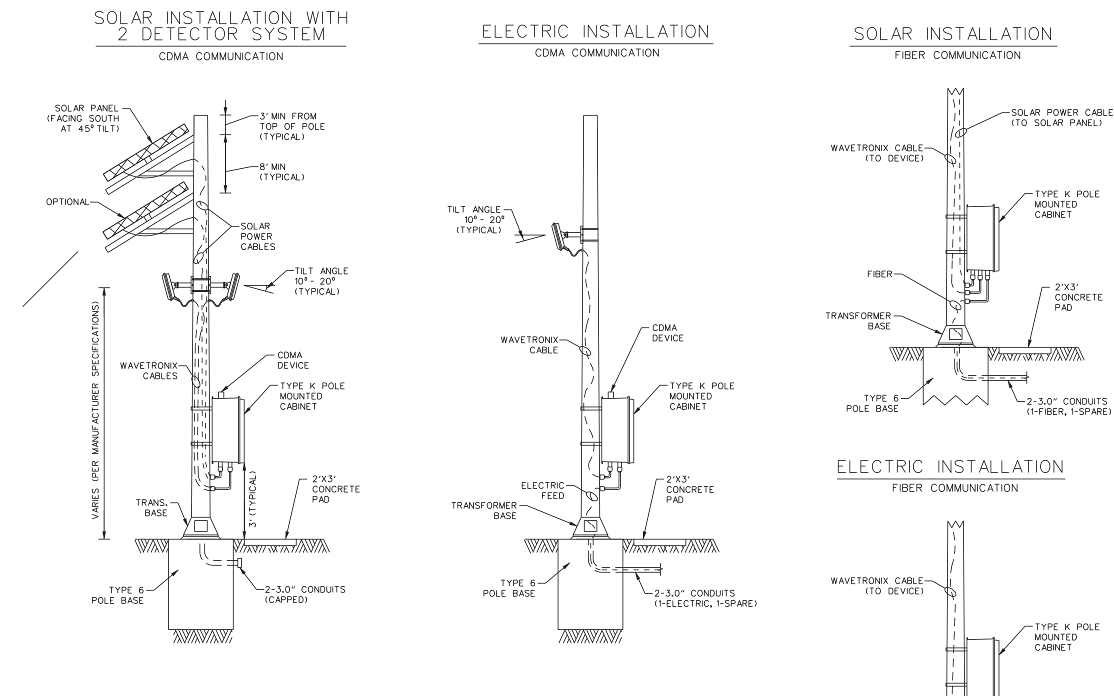
DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 100 200 300 FEET	ITMS INTERCONNECT (SR1, SR9 TO LITTLE HEAVEN)	CONTRACT NO. T201204704	PERMIT NO. -	ITMS CONDUIT PLAN	SHEET NO. 9
				COUNTY KENT	DESIGNED BY: DLD / CHECKED BY: BAM		TOTAL SHTS. 10



TYPICAL PARAPET CONDUIT DETAILS (N.T.S.)



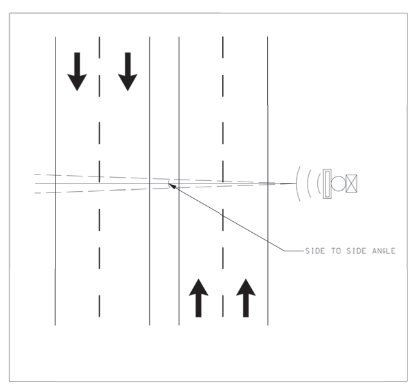
NOTES:
1. SEE PLAN SHEETS FOR DETECTOR MOUNTING HEIGHTS.
2. CONDUIT BODIES USED FOR POLE TO CABINET CONNECTIONS SHALL BE LIQUID TIGHT.
3. DETECTOR POLE SHALL HAVE A HEIGHT OF 40'.
4. CONTRACTOR SHALL INSTALL A 2' X 3' CONCRETE PAD IN FRONT OF CABINET DOOR TO FACILITATE CABINET ACCESS. CONCRETE PAD SHALL BE PAID FOR UNDER ITEM 705001.
5. CABINET SHALL BE PROVIDED WITH SURGE PROTECTOR, CDMA/FIBER COMMUNICATION (AS REQUIRED) AND SOLAR/ELECTRIC EQUIPMENT (AS REQUIRED).
6. BATTERY BACKUP FOR SOLAR INSTALLATIONS SHALL CONSIST OF 4-12V BATTERIES CONNECTED IN PARALLEL.
7. FOR NON-ELECTRIC 2 DETECTOR SYSTEMS, DEVICES SHALL BE POWERED BY 2 SOLAR PANELS.

MICROWAVE DETECTOR TYPICAL

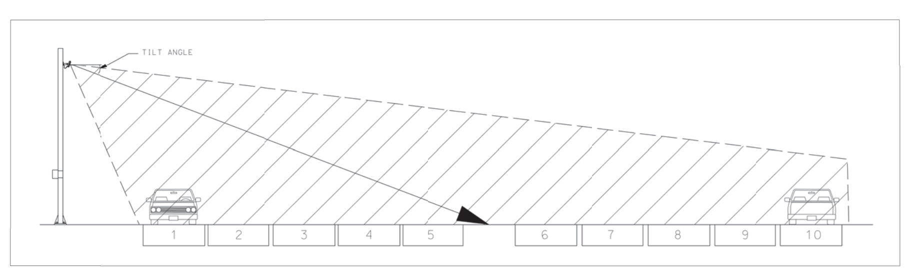
Detector Mounting Height Guidelines

Offset From First Detection Lane (feet)	Recommended Mounting Height (feet)	Minimum Mounting Height (feet)	Maximum Mounting Height (feet)
6	12	9	19
7	12	9	19
8	12	9	20
9	12	9	21
10	12	9	22
11	12	9	23
12	13	10	24
13	13	11	25
14	14	11	26
15	15	12	26
16	15	12	27
17	16	13	28
18	17	14	29
19	17	14	30
20	18	15	30
21	19	15	31
22	20	16	31
23	22	16	32
24	24	16	33
25	26	17	33
26	26	17	34
27	27	18	35
28	27	18	35
29	27	18	36
30	29	19	37
31	29	19	37
32	29	19	38
33	30	19	39
34	30	19	39
35	30	20	40
36	30	20	41
37	31	20	41
38	31	21	42
39	33	21	43
40	33	22	43
41	34	22	44
42	34	22	44
43	35	22	45
44	35	23	46
45	36	23	46
46	36	23	47
47	36	24	48
48	38	24	48
49	38	24	49
50-230	39	25	Must be ≤ Offset

RECOMMENDED OFFSETS



PLAN VIEW



PROFILE VIEW

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DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 100 200 300 FEET	ITMS INTERCONNECT (SR1, SR9 TO LITTLE HEAVEN)	CONTRACT NO. T201204704	PERMIT NO. -	PARAPET DETAIL
				COUNTY KENT	DESIGNED BY: DLD	SHEET NO. 10
					CHECKED BY: BAM	TOTAL SHTS. 10

APPENDIX U

Sample Plan – RTMS Design

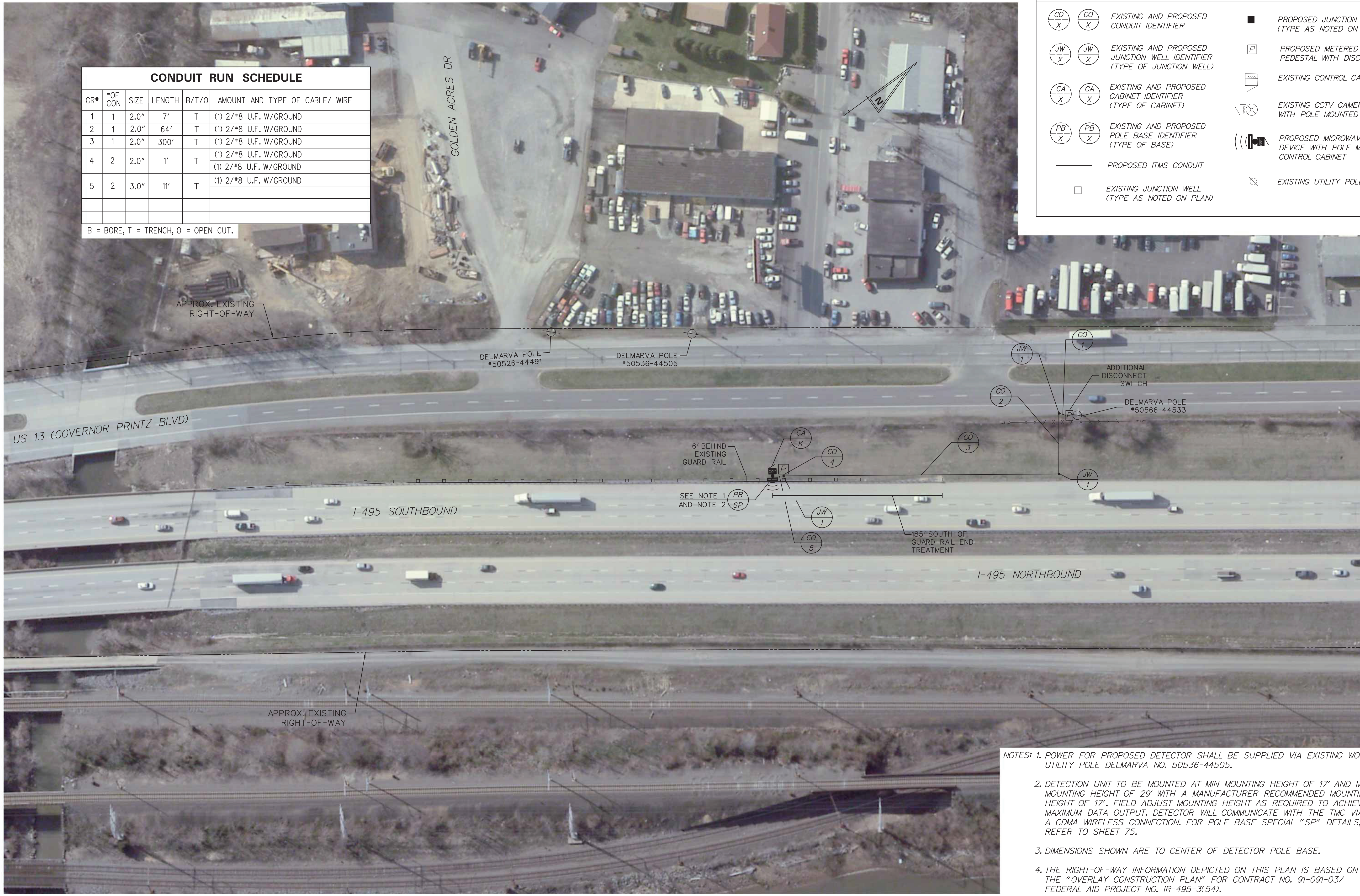
CONDUIT RUN SCHEDULE

CR#	#OF CON	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1	1	2.0"	7'	T	(1) 2/#8 U.F. W/GROUND
2	1	2.0"	64'	T	(1) 2/#8 U.F. W/GROUND
3	1	2.0"	300'	T	(1) 2/#8 U.F. W/GROUND
4	2	2.0"	1'	T	(1) 2/#8 U.F. W/GROUND (1) 2/#8 U.F. W/GROUND
5	2	3.0"	11'	T	(1) 2/#8 U.F. W/GROUND

B = BORE, T = TRENCH, O = OPEN CUT.

LEGEND

CO X — EXISTING AND PROPOSED CONDUIT IDENTIFIER	PROPOSED JUNCTION WELL (TYPE AS NOTED ON PLAN)
JW X — EXISTING AND PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	P — PROPOSED METERED SERVICE PEDESTAL WITH DISCONNECT SWITCH
CA X — EXISTING AND PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	EXISTING CONTROL CABINET
PB X — EXISTING AND PROPOSED POLE BASE IDENTIFIER (TYPE OF BASE)	EXISTING CCTV CAMERA WITH POLE MOUNTED CABINET
PROPOSED ITMS CONDUIT	PROPOSED MICROWAVE DETECTION DEVICE WITH POLE MOUNTED CONTROL CABINET
EXISTING JUNCTION WELL (TYPE AS NOTED ON PLAN)	EXISTING UTILITY POLE



NOTES:
1. POWER FOR PROPOSED DETECTOR SHALL BE SUPPLIED VIA EXISTING WOOD UTILITY POLE DELMARVA NO. 50536-44505.
2. DETECTION UNIT TO BE MOUNTED AT MIN MOUNTING HEIGHT OF 17' AND MAX MOUNTING HEIGHT OF 29' WITH A MANUFACTURER RECOMMENDED MOUNTING HEIGHT OF 17'. FIELD ADJUST MOUNTING HEIGHT AS REQUIRED TO ACHIEVE MAXIMUM DATA OUTPUT. DETECTOR WILL COMMUNICATE WITH THE TMC VIA A CDMA WIRELESS CONNECTION. FOR POLE BASE SPECIAL "SP" DETAILS, REFER TO SHEET 75.
3. DIMENSIONS SHOWN ARE TO CENTER OF DETECTOR POLE BASE.
4. THE RIGHT-OF-WAY INFORMATION DEPICTED ON THIS PLAN IS BASED ON THE "OVERLAY CONSTRUCTION PLAN" FOR CONTRACT NO. 91-091-03/ FEDERAL AID PROJECT NO. IR-495-3(54).

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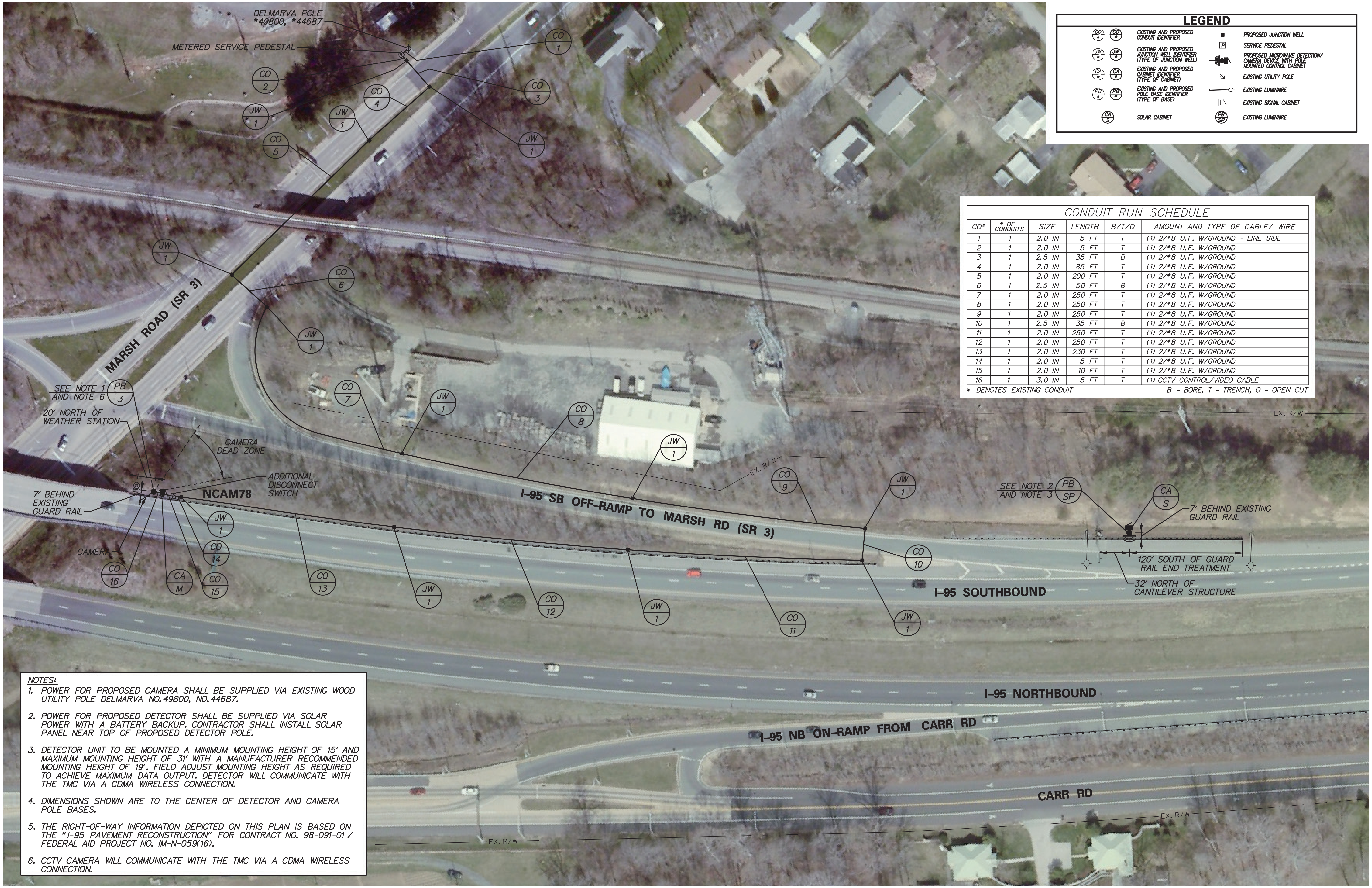
DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

SCALE 0 50 100 150 FEET

FREEWAY DETECTION INSTALLATION PROJECT

CONTRACT T201204701	DETECTOR NO. ND0138	SITE #16	SHEET NO. 17
COUNTY NEW CASTLE	DESIGNED BY: SM / CHECKED BY: JCR		TOTAL SHTS. 75



LEGEND

EXISTING AND PROPOSED CONDUIT IDENTIFIER	PROPOSED JUNCTION WELL
	SERVICE PEDESTAL
EXISTING AND PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)	PROPOSED MICROWAVE DETECTION/ CAMERA DEVICE WITH POLE MOUNTED CONTROL CABINET
EXISTING AND PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)	EXISTING UTILITY POLE
EXISTING AND PROPOSED POLE BASE IDENTIFIER (TYPE OF BASE)	EXISTING LUMINAIRE
	EXISTING SIGNAL CABINET
SOLAR CABINET	EXISTING LUMINAIRE

CONDUIT RUN SCHEDULE

CO#	# OF CONDUITS	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1	1	2.0 IN	5 FT	T	(1) 2/#8 U.F. W/GROUND - LINE SIDE
2	1	2.0 IN	5 FT	T	(1) 2/#8 U.F. W/GROUND
3	1	2.5 IN	35 FT	B	(1) 2/#8 U.F. W/GROUND
4	1	2.0 IN	85 FT	T	(1) 2/#8 U.F. W/GROUND
5	1	2.0 IN	200 FT	T	(1) 2/#8 U.F. W/GROUND
6	1	2.5 IN	50 FT	B	(1) 2/#8 U.F. W/GROUND
7	1	2.0 IN	250 FT	T	(1) 2/#8 U.F. W/GROUND
8	1	2.0 IN	250 FT	T	(1) 2/#8 U.F. W/GROUND
9	1	2.0 IN	250 FT	T	(1) 2/#8 U.F. W/GROUND
10	1	2.5 IN	35 FT	B	(1) 2/#8 U.F. W/GROUND
11	1	2.0 IN	250 FT	T	(1) 2/#8 U.F. W/GROUND
12	1	2.0 IN	250 FT	T	(1) 2/#8 U.F. W/GROUND
13	1	2.0 IN	230 FT	T	(1) 2/#8 U.F. W/GROUND
14	1	2.0 IN	5 FT	T	(1) 2/#8 U.F. W/GROUND
15	1	2.0 IN	10 FT	T	(1) 2/#8 U.F. W/GROUND
16	1	3.0 IN	5 FT	T	(1) CCTV CONTROL/VIDEO CABLE

* DENOTES EXISTING CONDUIT   B = BORE, T = TRENCH, O = OPEN CUT

NOTES:

1. POWER FOR PROPOSED CAMERA SHALL BE SUPPLIED VIA EXISTING WOOD UTILITY POLE DELMARVA NO.49800, NO.44687.
2. POWER FOR PROPOSED DETECTOR SHALL BE SUPPLIED VIA SOLAR POWER WITH A BATTERY BACKUP. CONTRACTOR SHALL INSTALL SOLAR PANEL NEAR TOP OF PROPOSED DETECTOR POLE.
3. DETECTOR UNIT TO BE MOUNTED A MINIMUM MOUNTING HEIGHT OF 15' AND MAXIMUM MOUNTING HEIGHT OF 31' WITH A MANUFACTURER RECOMMENDED MOUNTING HEIGHT OF 19'. FIELD ADJUST MOUNTING HEIGHT AS REQUIRED TO ACHIEVE MAXIMUM DATA OUTPUT. DETECTOR WILL COMMUNICATE WITH THE TMC VIA A CDMA WIRELESS CONNECTION.
4. DIMENSIONS SHOWN ARE TO THE CENTER OF DETECTOR AND CAMERA POLE BASES.
5. THE RIGHT-OF-WAY INFORMATION DEPICTED ON THIS PLAN IS BASED ON THE "I-95 PAVEMENT RECONSTRUCTION" FOR CONTRACT NO. 98-091-01 / FEDERAL AID PROJECT NO. IM-N-059(16).
6. CCTV CAMERA WILL COMMUNICATE WITH THE TMC VIA A CDMA WIRELESS CONNECTION.

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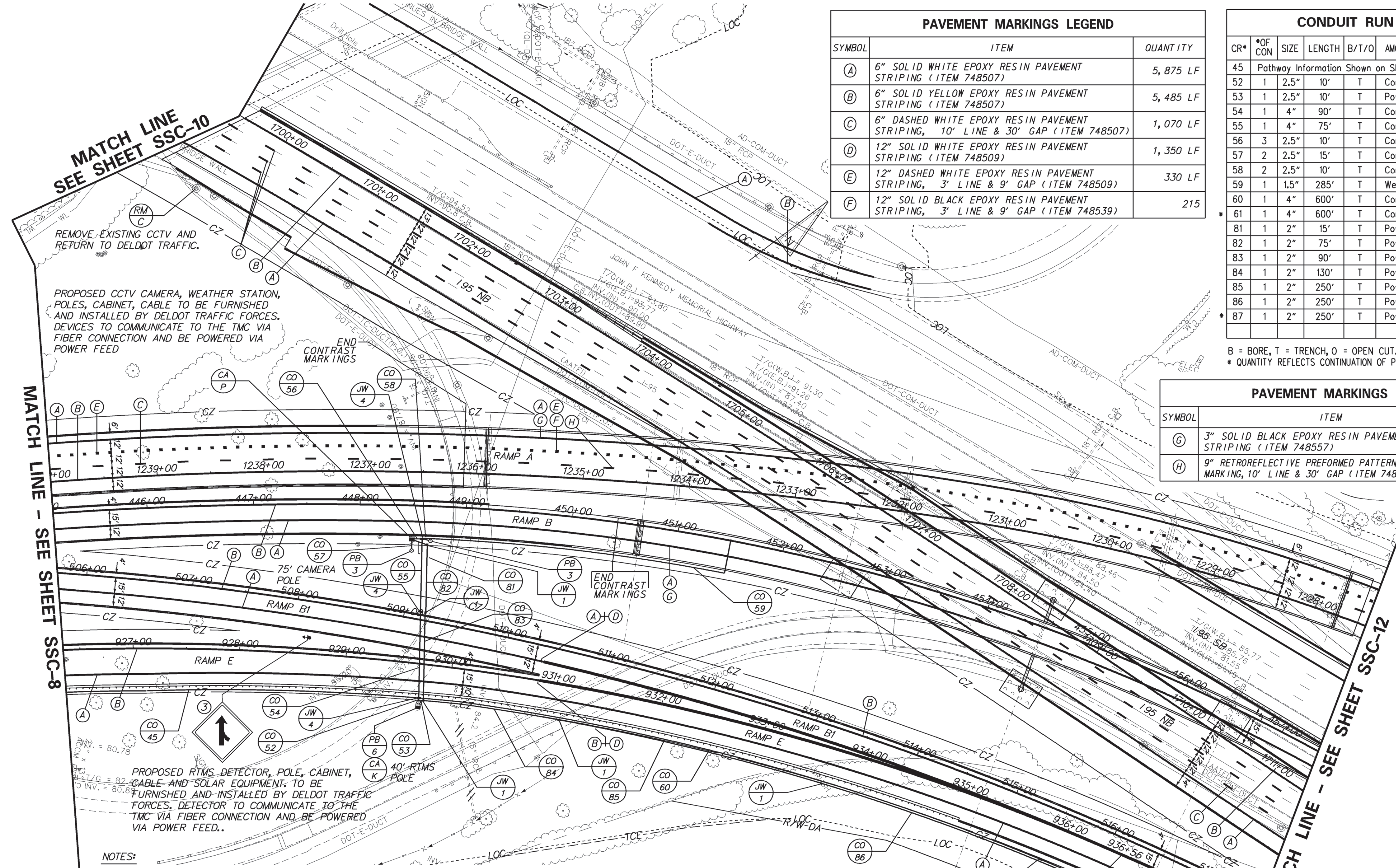
DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUM / REVISIONS	SCALE 0 50 100 150 FEET	FREEWAY DETECTION INSTALLATION PROJECT	CONTRACT T201204701 COUNTY NEW CASTLE	DETECTOR NO. ND0096 DESIGNED BY: L.F.W. (WR&A) CHECKED BY: N.M.L. (WR&A)	SITE H	SHEET NO. 53 TOTAL SHTS. 75



PAVEMENT MARKINGS LEGEND

SYMBOL	ITEM	QUANTITY
A	6" SOLID WHITE EPOXY RESIN PAVEMENT STRIPING (ITEM 748507)	5,875 LF
B	6" SOLID YELLOW EPOXY RESIN PAVEMENT STRIPING (ITEM 748507)	5,485 LF
C	6" DASHED WHITE EPOXY RESIN PAVEMENT STRIPING, 10' LINE & 30' GAP (ITEM 748507)	1,070 LF
D	12" SOLID WHITE EPOXY RESIN PAVEMENT STRIPING (ITEM 748509)	1,350 LF
E	12" DASHED WHITE EPOXY RESIN PAVEMENT STRIPING, 3' LINE & 9' GAP (ITEM 748509)	330 LF
F	12" SOLID BLACK EPOXY RESIN PAVEMENT STRIPING, 3' LINE & 9' GAP (ITEM 748539)	215

CONDUIT RUN SCHEDULE

CR*	# OF CON	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
45	Pathway Information Shown on Sheet SSC-8				
52	1	2.5"	10'	T	Comm. Cable
53	1	2.5"	10'	T	Power
54	1	4"	90'	T	Comm. Cable
55	1	4"	75'	T	Comm. Cable
56	3	2.5"	10'	T	Comm. Cable
57	2	2.5"	15'	T	Comm. Cable
58	2	2.5"	10'	T	Comm. Cable
59	1	1.5"	285'	T	Weather Sensor
60	1	4"	600'	T	Comm. Cable
* 61	1	4"	600'	T	Comm. Cable
81	1	2"	15'	T	Power
82	1	2"	75'	T	Power
83	1	2"	90'	T	Power
84	1	2"	130'	T	Power
85	1	2"	250'	T	Power
86	1	2"	250'	T	Power
* 87	1	2"	250'	T	Power

B = BORE, T = TRENCH, O = OPEN CUT.
* QUANTITY REFLECTS CONTINUATION OF PATHWAY SHOWN ON SHEET SSC-12

PAVEMENT MARKINGS LEGEND

SYMBOL	ITEM	QUANTITY
G	3" SOLID BLACK EPOXY RESIN PAVEMENT STRIPING (ITEM 748557)	850 LF
H	9" RETROREFLECTIVE PREFORMED PATTERNED CONTRAST MARKING, 10' LINE & 30' GAP (ITEM 748547)	215 LF

NOTES:

1. ALL PROPOSED ITMS CONNECTIONS AND TERMINATIONS SHALL BE COMPLETED BY DELDOT FORCES. THE CONTRACTOR SHALL CONTACT DELDOTS SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 TEN (10) DAYS PRIOR TO REQUIRED WORK
2. ALL UNDERGROUND ITMS FACILITIES TO BE INSTALLED BY THE CONTRACTOR. PRIOR TO COMPLETION OF UNDERGROUND FACILITIES THE CONTRACTOR SHALL CONTACT DELDOT'S SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 TEN (10) DAYS PRIOR TO COMPLETION OF FACILITY.
3. ALL PROPOSED ITMS DEVICE TO BE FURNISHED AND INSTALLED, AND BY DELDOT TRAFFIC FORCES. UPON CONTACT BY THE CONTRACTOR DELDOT TRAFFIC FORCES WILL DEVELOP A SCHEDULE OF WHEN WORK CAN BE PERFORMED AVOIDING CONFLICT WITH THE CONTRACTORS SCHEDULE.
4. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL INSTALLATION AND REMOVAL OF ALL PROPOSED, TEMPORARY AND EXISTING STRIPING AS REQUIRED. ALL PROPOSED MARKINGS SHALL TIE INTO EXISTING MARKINGS IN ACCORDANCE WITH THE MUTCD AND AS DIRECTED BY THE DELDOT'S CONSTRUCTION ENGINEER.
5. THE CONTRACTOR SHALL INSTALL AND REMOVE THE REGULATORY, WARNING, AND SPECIAL SIGNS AND POSTS WITHIN THE CONTRACT LIMITS, AS SHOWN. DELDOT SHALL FABRICATE AND SUPPLY THE REGULATORY, WARNING, AND SPECIAL SIGNS AND POSTS TO THE CONTRACTOR. FOR COORDINATION AND PICK UP OF ALL SIGNS AND POSTS, THE CONTRACTOR SHALL CONTACT DELDOT'S SIGN SHOP AT 302.760.2581. ALLOW FOUR (4) WEEKS FOR DELIVERY. ALL SIGNING MATERIALS REMOVED FROM THIS PROJECT SHALL BE RETURNED TO DELDOT'S SIGN SHOP.
6. CONTRACTOR SHALL INSTALL RAISED PAVEMENT MARKERS IN ACCORDANCE WITH THE MUTCD.

SIGNING LEGEND

1	REMOVE EXISTING SIGN
2	EXISTING SIGN TO REMAIN
3	PLACE NEW SIGN
4	RENEW EXISTING SIGN
5	REPOSITION EXISTING SIGN

SIGN NOTE:
ALL EXISTING REGULATORY, WARNING, AND SPECIAL SIGNS ASSUMED TO BE REMOVED UNLESS OTHERWISE NOTED.

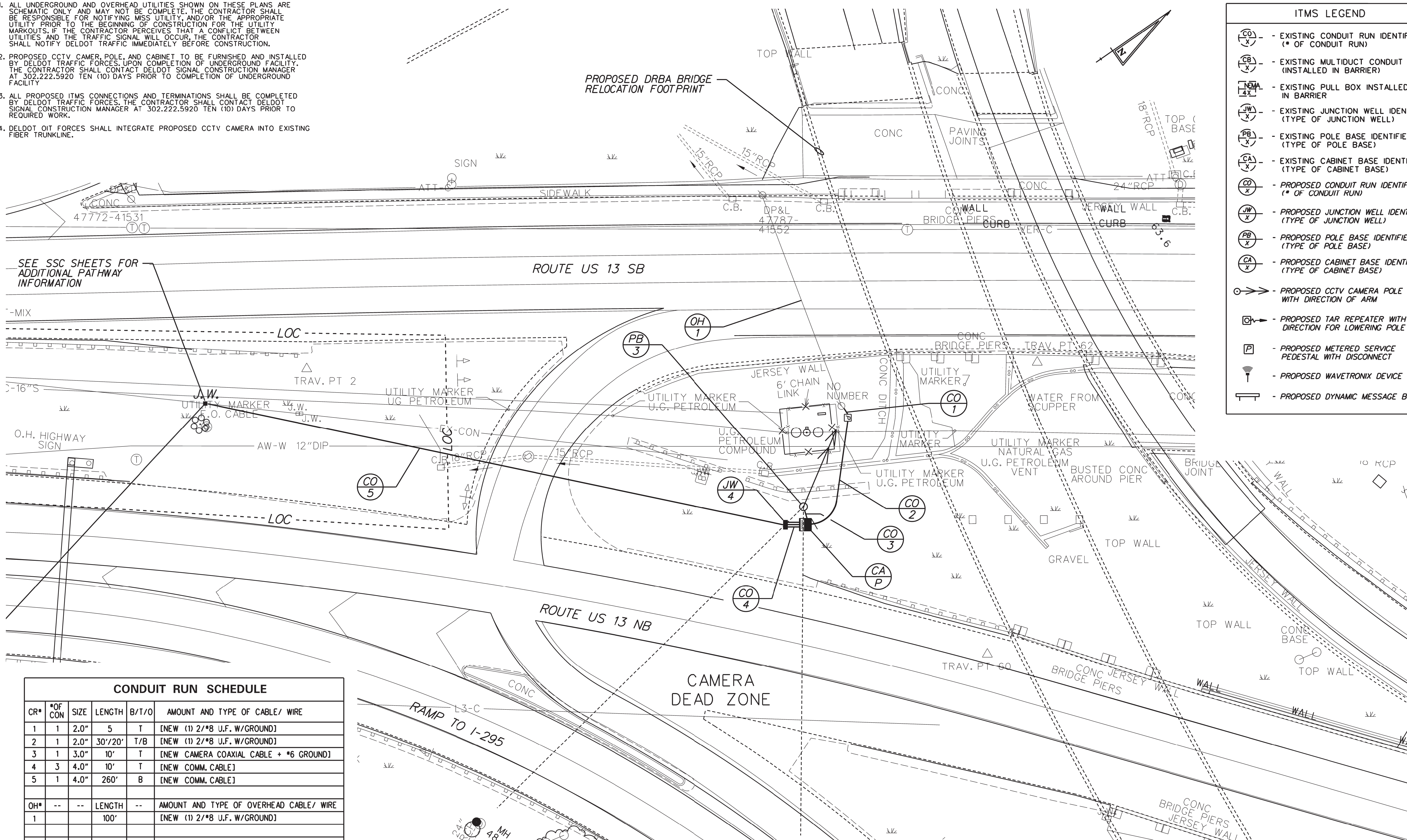
2/16/2011 3:34:54 PM
M:\projects\3*59_deltrnpk\SR\Mall\Cadd\2809003\Plans\cp89_SSC_sr1.dgn

APPENDIX V

Sample Plan – CCTV Camera Design

GENERAL CCTV CAMERA NOTES

1. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
2. PROPOSED CCTV CAMER, POLE, AND CABINET TO BE FURNISHED AND INSTALLED BY DELDOT TRAFFIC FORCES. UPON COMPLETION OF UNDERGROUND FACILITY. THE CONTRACTOR SHALL CONTACT DELDOT SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 TEN (10) DAYS PRIOR TO COMPLETION OF UNDERGROUND FACILITY
3. ALL PROPOSED ITMS CONNECTIONS AND TERMINATIONS SHALL BE COMPLETED BY DELDOT TRAFFIC FORCES. THE CONTRACTOR SHALL CONTACT DELDOT SIGNAL CONSTRUCTION MANAGER AT 302.222.5920 TEN (10) DAYS PRIOR TO REQUIRED WORK.
4. DELDOT OIT FORCES SHALL INTEGRATE PROPOSED CCTV CAMERA INTO EXISTING FIBER TRUNKLINE.



ITMS LEGEND

- CO/X - EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CB/X - EXISTING MULTIDUCT CONDUIT (INSTALLED IN BARRIER)
- NEMA 4X - EXISTING PULL BOX INSTALLED IN BARRIER
- JW/X - EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- PB/X - EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- CA/X - EXISTING CABINET BASE IDENTIFIER (TYPE OF CABINET BASE)
- CO/X - *PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)*
- JW/X - *PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)*
- PB/X - *PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)*
- CA/X - *PROPOSED CABINET BASE IDENTIFIER (TYPE OF CABINET BASE)*
- *PROPOSED CCTV CAMERA POLE WITH DIRECTION OF ARM*
- *PROPOSED TAR REPEATER WITH DIRECTION FOR LOWERING POLE*
- P - *PROPOSED METERED SERVICE PEDESTAL WITH DISCONNECT*
- *PROPOSED WAVETRONIX DEVICE*
- *PROPOSED DYNAMIC MESSAGE BOARD*

CONDUIT RUN SCHEDULE

CR#	#OF CON	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1	1	2.0"	5	T	[NEW (1) 2/#8 U.F. W/GROUND]
2	1	2.0"	30'/20'	T/B	[NEW (1) 2/#8 U.F. W/GROUND]
3	1	3.0"	10'	T	[NEW CAMERA COAXIAL CABLE + #6 GROUND]
4	3	4.0"	10'	T	[NEW COMM. CABLE]
5	1	4.0"	260'	B	[NEW COMM. CABLE]
OH#	--	--	LENGTH	--	AMOUNT AND TYPE OF OVERHEAD CABLE/ WIRE
1			100'		[NEW (1) 2/#8 U.F. W/GROUND]

B = BORE, T = TRENCH, O = OPEN CUT.

RECOMMENDED ______ DATE: ______	RECOMMENDED ______ DATE: ______	RECOMMENDED ______ DATE: ______	APPROVED TRAFFIC ENGINEER ______ DATE: ______

APPROVED FOR INSTALLATION
CHIEF TRAFFIC ENGINEER ______ DATE: ______

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

SCALE 0 20 40 60 FEET

BR 1-665 N&S, US 13 OVER BAYLOR BOULEVARD

CONTRACT	T201107401
COUNTY	NEW CASTLE
PERMIT NO.	
DESIGNED BY:	JCR
CHECKED BY:	MH

CCTV PLAN

SHEET NO.

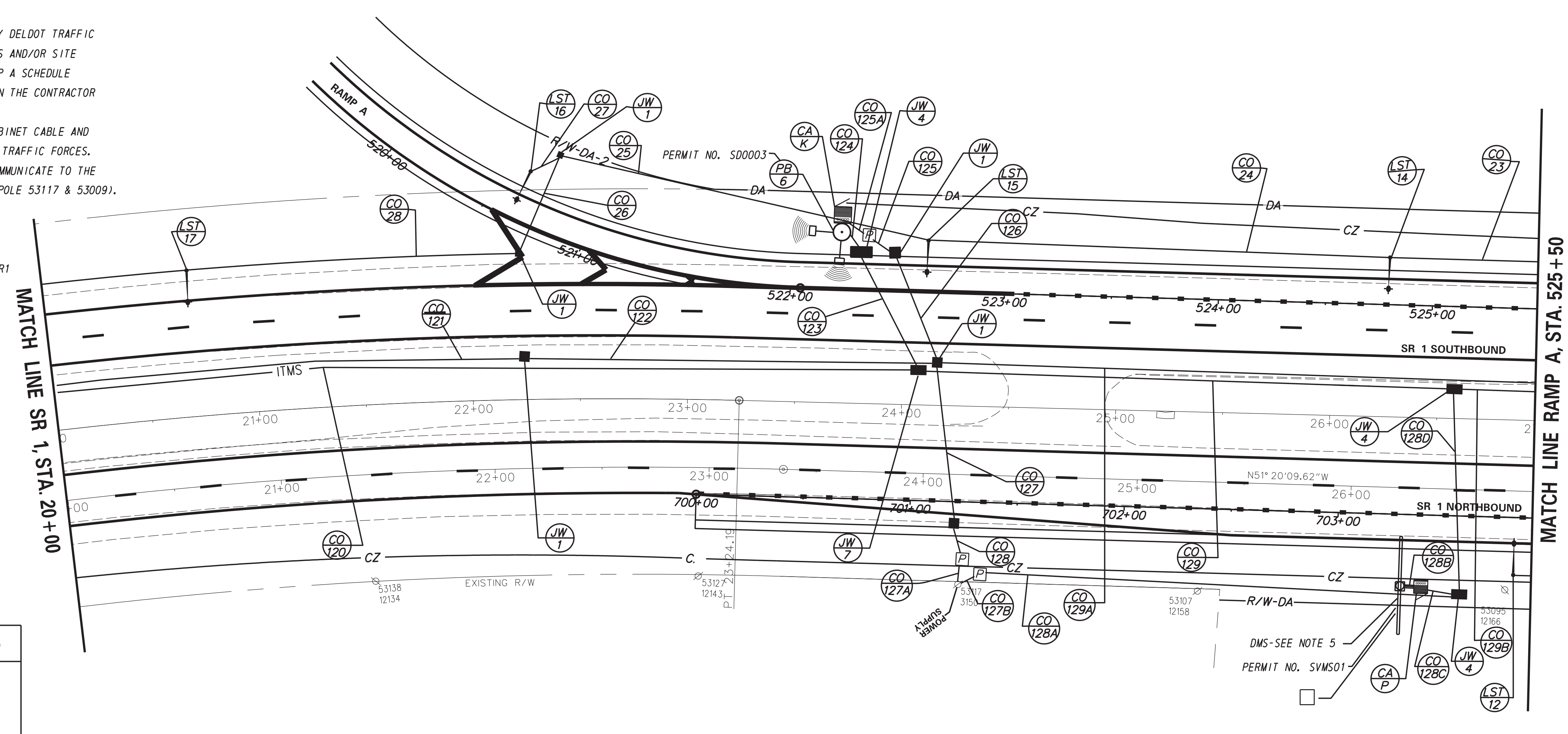
TOTAL SHTS.

APPENDIX W

Sample Plan – Permanently-Mounted CMS Board

NOTES:

1. ALL PROPOSED ITMS CONNECTIONS AND TERMINATIONS SHALL BE COMPLETED BY DELDOT TRAFFIC FORCES. THE CONTRACTOR SHALL CONTACT DELDOT SIGNAL CONSTRUCTION MANAGER AT 302-222-5920 TEN(10) DAYS PRIOR TO ANY REQUIRED CONNECTION AND TERTMINATION WORK.
2. ALL UNDERGROUND ITMS FACILITIES TO BE INSTALLED BY THE CONTRACTOR. PRIOR TO COMPLETION OF UNDERGROUND PATHWAY, FACILITIES AND/OR SITE AREA THE CONTRACTOR SHALL CONTACT DELDOT SIGNAL CONSTRUCTION MANAGER AT 302-222-5920 TEN(10) DAYS PRIOR TO COMPLETION.
3. ALL PROPOSED ITMS DEVICES TO BE FURNISHED AND INSTALLED BY DELDOT TRAFFIC FORCES. UPON NOTIFICATION OF COMPLETION OF ITMS FACILITIES AND/OR SITE AREA BY THE CONTRACTOR, DELDOT TRAFFIC FORCES WILL DEVELOP A SCHEDULE OF WHEN WORK CAN BE PERFORMED TO BOTH AVOID AN WORK WITHIN THE CONTRACTOR PROPOSED SCHEDULE OF WORK.
4. PROPOSED WAVETRONIX, CAMERA, DMS, WEATHER STATION, POLE, CABINET CABLE AND ELECTRIC SERVICE, TO BE FURNISHED AND INSTALLED BY DELDOT TRAFFIC FORCES. CAMERA, WAVETRONIX, DMS AND WEATHER STATION DEVICES TO COMMUNICATE TO THE TMC VIA T1 CONNECTION AND BE POWERD VIA ELECTRIC SERVICE(POLE 53117 & 53009).
5. PRIOR TO STRUCTURE ERECTION, CONTRACTOR SHALL INSTSALL 1.5" FLEXIBLE METALLIC LIQUID TIGHT CONDUIT ALONG FULL LENGTH OF STRUCTURE ARM FOR DELDOT TRAFFIC USE. A 2.5" RISER SHALL ALSO BE INSTALLED ON THE STRUCTURE UP-R1



LIGHTING & ITMS LEGEND

- (LST X) PROPOSED LUMINAIRE IDENTIFIER (#OF LUMINAIRE)
- (CO X) PROPOSED CONDUIT RUN (#OF CONDUIT RUN)
- PROPOSED COBRAHEAD LUMINAIRE, SINGLE DAVIT ARM POLE
- (JW X) PROPOSED JUNCTION WELL TYPE OF JUNCTION WELL
- PROPOSED 277/480V THREE PHASE LIGHTING CONTROL CABINET
- PROPOSED LIGHTING OR ITMS CONDUIT
- PROPOSED JUNCTION WELL
- (P) PROPOSED METERED SERVICE CABINET
- PROPOSED WAVTRONIX DETECTOR
- PROPOSED CCTV CAMERA

ITMS CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/WIRE	INSTALLATION
120	1	4.0"	409'	COMM. CABLE	TRENCH
121	1	3.0"	265'	(2)#2 THWN (1) #6 GRD	TRENCH
122	1	3.0"	188'	(2)#2 THWN (1) #6 GRD	TRENCH
123	1	4.0"	58'	COMM. CABLE	BORE
124	1	4.0"	8'	COMM. CABLE	TRENCH
125	1	2.0"	13'	(2)#8 THWN (1) #6 GRD	TRENCH
125A	1	2.0"	10'	(2)#8 THWN (1)# 6 GRD	TRENCH
126	1	2.0"	51'	(2)#8 THWN (1)# 6 GRD	BORE
127	1	3.0"	72'	(2)#8THWN, (4)#2THWN, (3)#6GRD	BORE
127A	1	2.0"	8'	(2)#2 THWN (1)# 6 GRD	TRENCH
127B	1	2.0"	8'	(2)#2 THWN (1)# 6 GRD	TRENCH
128	1	3.0"	25'	(2)#8THWN, (2)#2THWN, (1)#6GRD	TRENCH
128A	1	3.0"	218'	(2)#8 THWN (1)#6 GRD	TRENCH
128B	1	4.0"	5'	COMM. CABLE	TRENCH
	2	3.0"	5'	(2)#8 THWN (1) #6 GRD	TRENCH
128C	1	4.0"	12'	COMM. CABLE	TRENCH
128D	1	4.0"	93'	COMM. CABLE	BORE
129	1	4.0"	244'	COMM. CABLE	TRENCH
129A	1	3.0"	318'	(2)#2 THWN (1) #6 GRD	TRENCH
129B	1	4.0"	348'	COMM. CABLE	TRENCH

LIGHTING CONDUIT RUN SCHEDULE

CR#	# OF CONDUITS	SIZE	LENGTH	AMOUNT AND TYPE OF CABLE/WIRE	INSTALLATION
23	1	3.0"	145'	(4)#4 AWG (1)#6 GND	TRENCH
24	1	3.0"	216'	(4)#4 AWG (1)#6 GND	TRENCH
25	1	3.0"	176'	(4)#4 AWG (1)#6 GND	TRENCH
26	1	3.0"	50'	(4)#4 AWG (1)#6 GND	TRENCH
27	1	3.0"	15'	(2)#4 AWG (1)#6 GND	TRENCH
28	1	3.0"	155'	(4)#4 AWG (1)#6 GND	TRENCH

LIGHTING STANDARD SCHEDULE

NO.	CIRCUIT NO.	STATION	OFFSET	ARM	LUMINAIRE MOUNTING HEIGHT	POLE BASE	LUMINAIRE
12	A5	703+82.6	27.0' RT	15'	40'	TYPE 6	250W, HPS, TYPE 2, CUTOFF
14	A3	524+79.5	22.3' LT	12'	40'	TYPE 6	250W, HPS, TYPE 2, CUTOFF
15	A5	522+63.9	24.0' LT	12'	40'	TYPE 6	250W, HPS, TYPE 2, CUTOFF
16	A1	520+63.7	24.0' LT	12'	40'	TYPE 6	250W, HPS, TYPE 2, CUTOFF
17	A3	20+64.7	101.3' LT	15'	40'	TYPE 6	250W, HPS, TYPE 2, CUTOFF

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

3 ADED DMS ON THIS SHEET, ADDED PEDESTAL 04/03/13 CBD

SCALE 0 30 60 90 FEET

SR 1, SR 30 GRADE SEPERATED INTERSECTION

CONTRACT T200812201

COUNTY SUSSEX

BRIDGE NO. 3-004

DESIGNED BY: CBD

CHECKED BY: DLH

LIGHTING, ITMS & UTILITY RELOCATION PLANS

SHEET NO. 122

TOTAL SHTS. 133

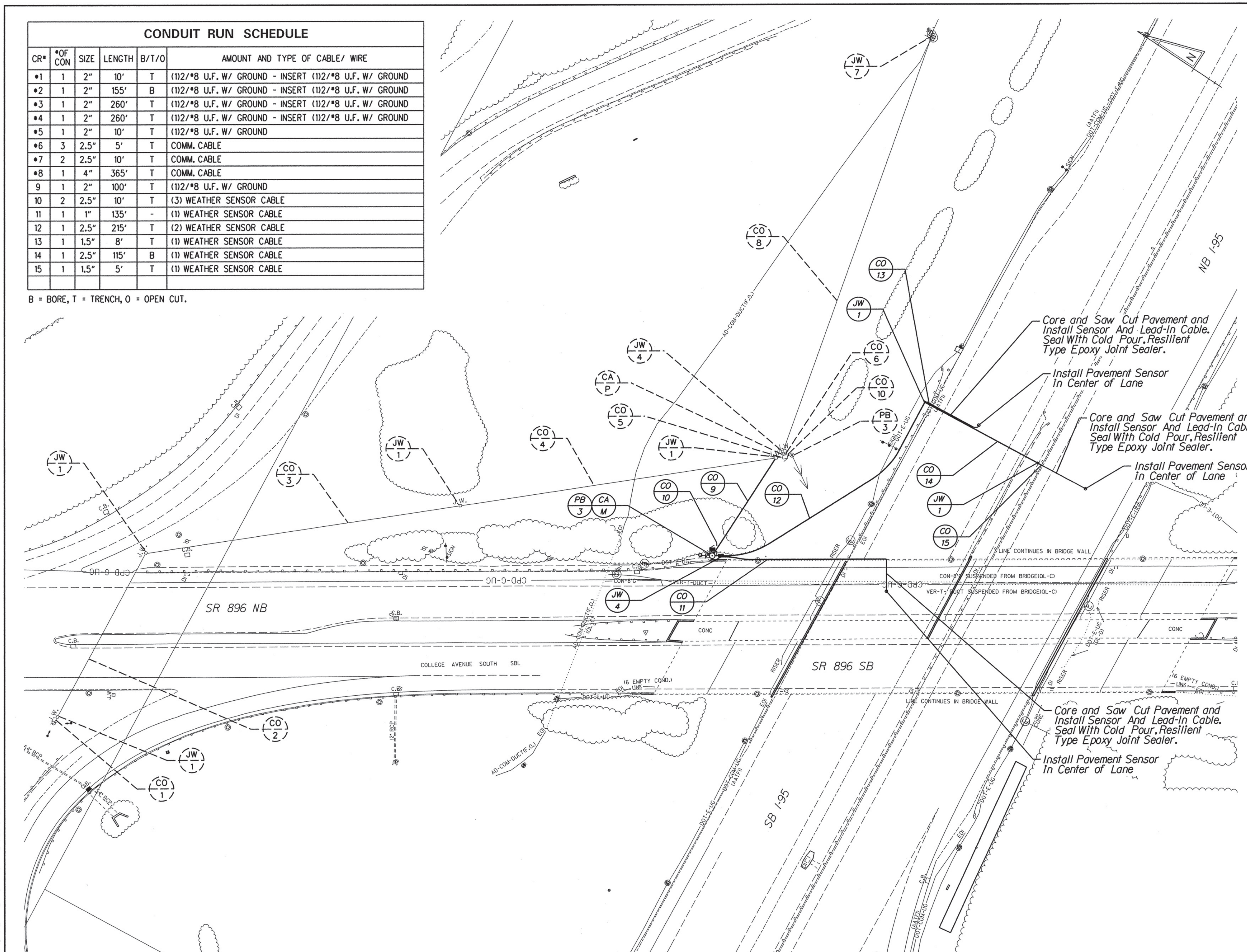
APPENDIX X

Sample Plan – Weather Station

CONDUIT RUN SCHEDULE

CR#	#OF CON	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
•1	1	2"	10'	T	(1)2/#8 U.F. W/ GROUND - INSERT (1)2/#8 U.F. W/ GROUND
•2	1	2"	155'	B	(1)2/#8 U.F. W/ GROUND - INSERT (1)2/#8 U.F. W/ GROUND
•3	1	2"	260'	T	(1)2/#8 U.F. W/ GROUND - INSERT (1)2/#8 U.F. W/ GROUND
•4	1	2"	260'	T	(1)2/#8 U.F. W/ GROUND - INSERT (1)2/#8 U.F. W/ GROUND
•5	1	2"	10'	T	(1)2/#8 U.F. W/ GROUND
•6	3	2.5"	5'	T	COMM. CABLE
•7	2	2.5"	10'	T	COMM. CABLE
•8	1	4"	365'	T	COMM. CABLE
9	1	2"	100'	T	(1)2/#8 U.F. W/ GROUND
10	2	2.5"	10'	T	(3) WEATHER SENSOR CABLE
11	1	1"	135'	-	(1) WEATHER SENSOR CABLE
12	1	2.5"	215'	T	(2) WEATHER SENSOR CABLE
13	1	1.5"	8'	T	(1) WEATHER SENSOR CABLE
14	1	2.5"	115'	B	(1) WEATHER SENSOR CABLE
15	1	1.5"	5'	T	(1) WEATHER SENSOR CABLE

B = BORE, T = TRENCH, O = OPEN CUT.



LEGEND

	PROPOSED SIGNAL CABINET	RM/C	REMOVE BY CONTRACTOR
	EXISTING SIGNAL CABINET	RM/O	REMOVE BY OTHERS
	PROPOSED SIGNAL POLE BASE	AB	ABANDON
	EXISTING SIGNAL POLE BASE	PB/X	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
	PROPOSED PEDESTRIAN POLE BASE	PB/X	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
	EXISTING PEDESTRIAN POLE BASE	JW/X	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
	PROPOSED WOOD POLE	JW/X	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
	EXISTING UTILITY POLE	CO/#	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
	PROPOSED JUNCTION WELL	CO/#	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
J.W.	EXISTING JUNCTION WELL	OH/#	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
	PROPOSED SIGNAL HEAD	OH/#	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
	EXISTING SIGNAL HEAD	MA/XX	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
	PROPOSED PEDESTRIAN SIGNAL HEAD	MA/XX	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
	EXISTING PEDESTRIAN SIGNAL HEAD	CA/X	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
	PROPOSED PEDESTRIAN PUSHBUTTON	CA/X	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
	EXISTING PEDESTRIAN PUSHBUTTON		PROPOSED SPAN WIRE
	PROPOSED VIDEO DETECTION	XX	EXISTING SPAN WIRE
	EXISTING VIDEO DETECTION		RIGHT-OF-WAY OR PROPERTY LINE
	PROPOSED MICROWAVE DETECTION		PROPOSED SPAN INSULATOR
	EXISTING MICROWAVE DETECTION		EXISTING SPAN INSULATOR
	OVERHEAD SIGNING	P	SERVICE PEDESTAL
	PROPOSED OPTICOM RECEIVER		
	EXISTING OPTICOM RECEIVER		
	PROPOSED MAST ARM		
	EXISTING MAST ARM		
	PROPOSED LUMINAIRE		
	EXISTING LUMINAIRE		
	PROPOSED LOOP DETECTOR (TYPE 1OR 2)		
	EXISTING LOOP DETECTOR (TYPE 1OR 2)		

GENERAL NOTES

1. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
2. POLE BASES, CABINET BASE AND CONDUIT JUNCTION WELLS TO BE REMOVED IN ACCORDANCE WITH SECTION 201 AND 202 OF THE STANDARD SPECIFICATIONS OR AS DIRECTED BY ENGINEER. EXISTING CONDUIT IS TO BE ABANDONED.
3. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS.SET SCREW, BOLTED, AND COMPRESSION FITTING ARE NOT ACCEPTABLE.
4. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
5. CDMA TECHNOLOGY SHALL BE UTILIZED FOR COMMUNICATION TO THE TMC.

RECOMMENDED [signature] DATE: 3.31.10 | RECOMMENDED ______ DATE: ______ | RECOMMENDED ______ DATE: ______ | APPROVED TRAFFIC ENGINEER [signature] DATE: 3/31/10 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 4/5/10

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUM / REVISIONS

RWIS Station
SR 896 over I-95

CONTRACT	PERMIT NO.	NWMS14
30-047-02	DESIGNED BY: JCR	
COUNTY		
New Castle	CHECKED BY: JCR	

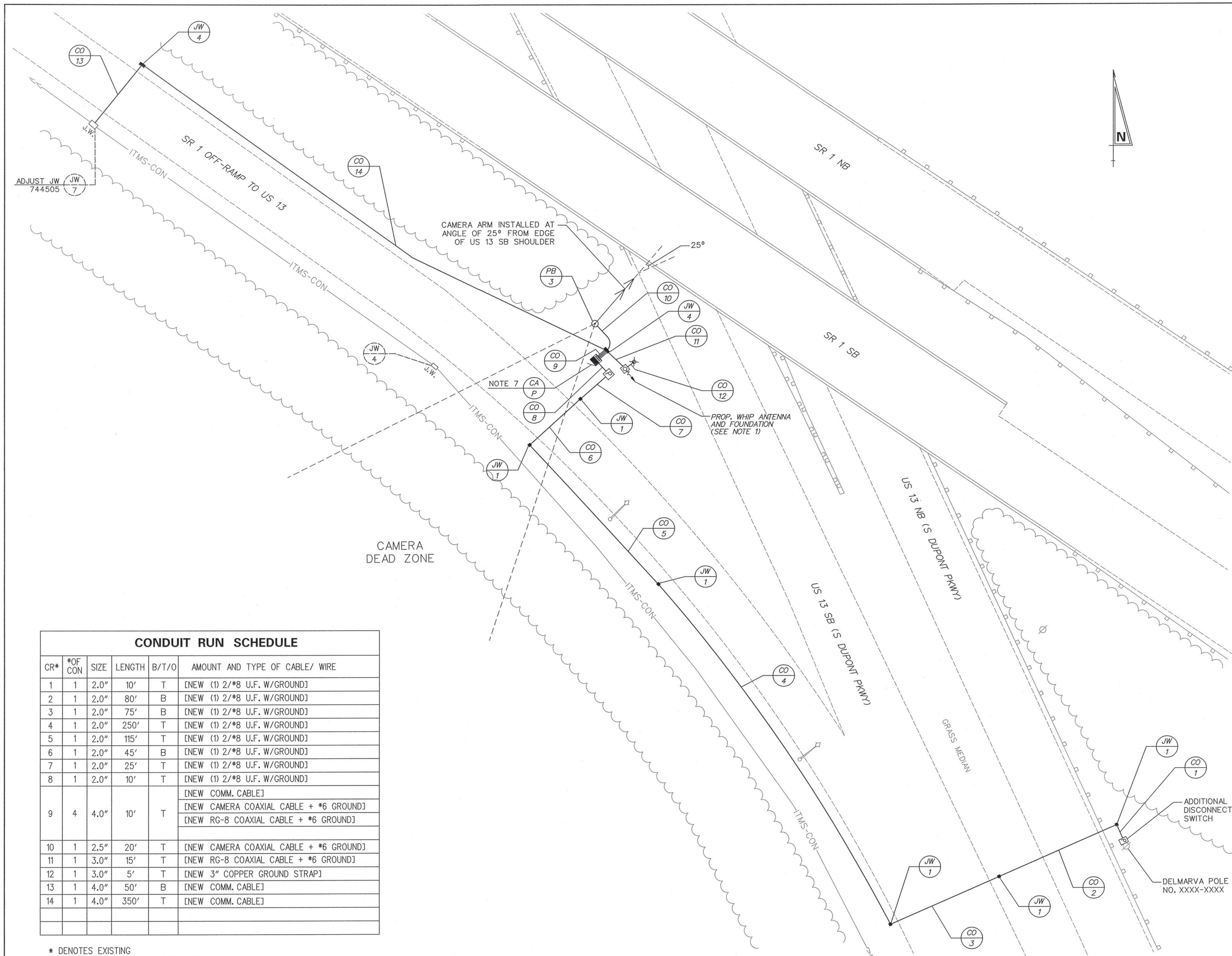
DelTrac
RWIS PLAN

SHEET NO. 1
TOTAL SHTS. 1

Y:\TRAFFIC\USERS\JASON\DELTRAC\WEATHER STATION\RE-DESIGNED\PS_PLAN\NWMS14.DGN

APPENDIX Y

Sample Plan – WTMC Repeater Site



ITMS LEGEND

- CO/X - EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
- CB/X - EXISTING MULTIDUCT CONDUIT (INSTALLED IN BARRIER)
- NEMA 4X - EXISTING PULL BOX INSTALLED IN BARRIER
- JW/X - EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
- PB/X - EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
- CA/X - EXISTING CABINET BASE IDENTIFIER (TYPE OF CABINET BASE)
- CO/X - *PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)*
- JW/X - *PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)*
- PB/X - *PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)*
- CA/X - *PROPOSED CABINET BASE IDENTIFIER (TYPE OF CABINET BASE)*
- *PROPOSED CCTV CAMERA POLE WITH DIRECTION OF ARM*
- *PROPOSED TAR REPEATER WITH DIRECTION FOR LOWERING POLE*
- P - *PROPOSED METERED SERVICE PEDESTAL WITH DISCONNECT*
- *PROPOSED WAVETRONIX DEVICE*
- *PROPOSED DYNAMIC MESSAGE BOARD*

GENERAL REPEATER AND CCTV CAMERA NOTES

1. CONTRACTOR SHALL INSTALL NEW 44′ DELDOT SUPPLIED TAR WHIP ANTENNA ON A MODIFIED TYPE III POLE BASE USING DELDOT SUPPLIED ANCHOR BOLTS (SEE TAR REPEATER CONSTRUCTION DETAILS).
2. CONTRACTOR SHALL AUGER A 10 IN. DIAMETER X 40.5 FT DEEP SHAFT FOR GROUND ROD INSTALLATION. GROUND ROD SHALL NOT BE MORE THAN 5′ FROM EDGE OF REPEATER FOUNDATION.
3. DELDOT SHALL INSTALL TAR TRANSMISSION EQUIPMENT AND PERFORM FINAL TUNING.
4. CONDUIT 13 SHALL BE SDR-13.5 HDPE. ALL OTHER CONDUIT SHALL BE RIGID POLYVINYL CHLORIDE SCHEDULE 80.
5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
6. ALL SIGNAL EQUIPMENT REMOVED FROM THIS PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.
7. INSTALL CCTV EQUIPMENT AND REPEATER EQUIPMENT IN NEW TYPE P CABINET. DELDOT TRAFFIC FORCES TO ADJUST EQUIPMENT AS NEEDED.
8. DELDOT FORCES SHALL INTEGRATE CCTV CAMERA WITH EXISTING FIBER TRUNKLINE.

CONDUIT RUN SCHEDULE

CR#	#OF CON	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1	1	2.0″	10′	T	[NEW (1) 2/#8 U.F. W/GROUND]
2	1	2.0″	80′	B	[NEW (1) 2/#8 U.F. W/GROUND]
3	1	2.0″	75′	B	[NEW (1) 2/#8 U.F. W/GROUND]
4	1	2.0″	250′	T	[NEW (1) 2/#8 U.F. W/GROUND]
5	1	2.0″	115′	T	[NEW (1) 2/#8 U.F. W/GROUND]
6	1	2.0″	45′	B	[NEW (1) 2/#8 U.F. W/GROUND]
7	1	2.0″	25′	T	[NEW (1) 2/#8 U.F. W/GROUND]
8	1	2.0″	10′	T	[NEW (1) 2/#8 U.F. W/GROUND]
9	4	4.0″	10′	T	[NEW COMM. CABLE] [NEW CAMERA COAXIAL CABLE + #6 GROUND] [NEW RG-8 COAXIAL CABLE + #6 GROUND]
10	1	2.5″	20′	T	[NEW CAMERA COAXIAL CABLE + #6 GROUND]
11	1	3.0″	15′	T	[NEW RG-8 COAXIAL CABLE + #6 GROUND]
12	1	3.0″	5′	T	[NEW 3″ COPPER GROUND STRAP]
13	1	4.0″	50′	B	[NEW COMM. CABLE]
14	1	4.0″	350′	T	[NEW COMM. CABLE]

* DENOTES EXISTING
B = BORE, T = TRENCH, O = OPEN CUT.

RECOMMENDED ____ DATE: 6.28.12 | RECOMMENDED ____ DATE: ____ | RECOMMENDED ____ DATE: 7/9/12 | APPROVED TRAFFIC ENGINEER ____ DATE: 7/11/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER ____ DATE: 7/11/12

DELAWARE DEPARTMENT OF TRANSPORTATION

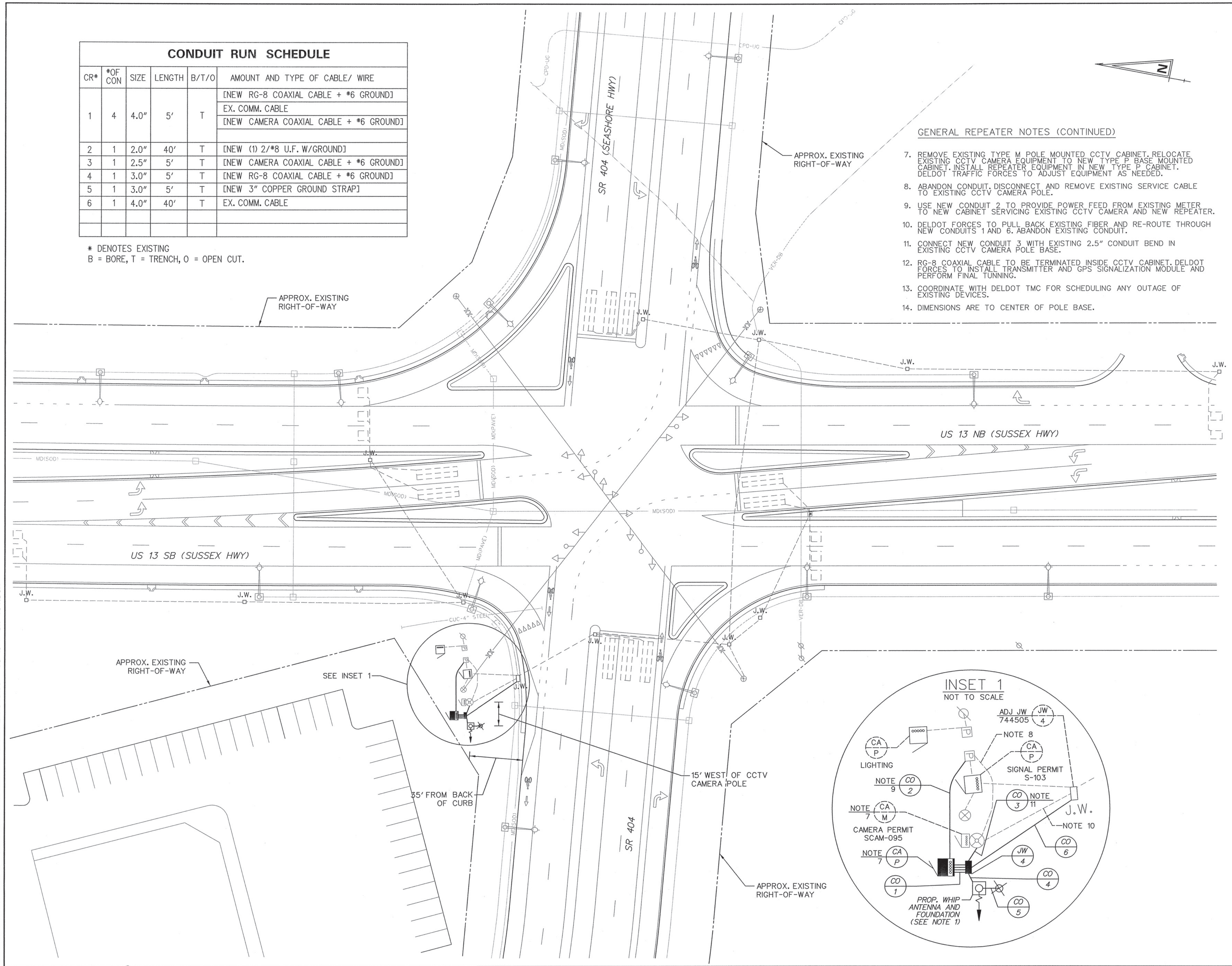
ADDENDUMS / REVISIONS

SCALE 0 30 60 90 FEET

CONTRACT T201304701
COUNTY NEW CASTLE
PERMIT NO. NWTMC07
DESIGNED BY: SM
CHECKED BY: JCR

WTMC REPEATER AND CCTV PLAN SR 1 @ US 13

SHEET NO. 1
TOTAL SHTS. 1



CONDUIT RUN SCHEDULE

CR*	#OF CON	SIZE	LENGTH	B/T/O	AMOUNT AND TYPE OF CABLE/ WIRE
1	4	4.0"	5'	T	[NEW RG-8 COAXIAL CABLE + #6 GROUND]
					EX. COMM. CABLE
					[NEW CAMERA COAXIAL CABLE + #6 GROUND]
2	1	2.0"	40'	T	[NEW (1) 2/#8 U.F. W/GROUND]
3	1	2.5"	5'	T	[NEW CAMERA COAXIAL CABLE + #6 GROUND]
4	1	3.0"	5'	T	[NEW RG-8 COAXIAL CABLE + #6 GROUND]
5	1	3.0"	5'	T	[NEW 3" COPPER GROUND STRAP]
6	1	4.0"	40'	T	EX. COMM. CABLE

* DENOTES EXISTING
B = BORE, T = TRENCH, O = OPEN CUT.

GENERAL REPEATER NOTES (CONTINUED)

7. REMOVE EXISTING TYPE M POLE MOUNTED CCTV CABINET. RELOCATE EXISTING CCTV CAMERA EQUIPMENT TO NEW TYPE P BASE MOUNTED CABINET. INSTALL REPEATER EQUIPMENT IN NEW TYPE P CABINET. DELDOT TRAFFIC FORCES TO ADJUST EQUIPMENT AS NEEDED.
8. ABANDON CONDUIT. DISCONNECT AND REMOVE EXISTING SERVICE CABLE TO EXISTING CCTV CAMERA POLE.
9. USE NEW CONDUIT 2 TO PROVIDE POWER FEED FROM EXISTING METER TO NEW CABINET SERVICING EXISTING CCTV CAMERA AND NEW REPEATER.
10. DELDOT FORCES TO PULL BACK EXISTING FIBER AND RE-ROUTE THROUGH NEW CONDUITS 1 AND 6. ABANDON EXISTING CONDUIT.
11. CONNECT NEW CONDUIT 3 WITH EXISTING 2.5" CONDUIT BEND IN EXISTING CCTV CAMERA POLE BASE.
12. RG-8 COAXIAL CABLE TO BE TERMINATED INSIDE CCTV CABINET. DELDOT FORCES TO INSTALL TRANSMITTER AND GPS SIGNALIZATION MODULE AND PERFORM FINAL TUNNING.
13. COORDINATE WITH DELDOT TMC FOR SCHEDULING ANY OUTAGE OF EXISTING DEVICES.
14. DIMENSIONS ARE TO CENTER OF POLE BASE.

SIGNAL PHASING

SIGNAL HEAD DIAGRAM

LEGEND

PROPOSED SIGNAL CABINET	REMOVE BY CONTRACTOR
EXISTING SIGNAL CABINET	REMOVE BY OTHERS
PROPOSED SIGNAL POLE BASE	ABANDON
EXISTING SIGNAL POLE BASE	PROPOSED POLE BASE IDENTIFIER (TYPE OF POLE BASE)
PROPOSED PEDESTRIAN POLE BASE	EXISTING POLE BASE IDENTIFIER (TYPE OF POLE BASE)
EXISTING PEDESTRIAN POLE BASE	PROPOSED JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
PROPOSED WOOD POLE	EXISTING JUNCTION WELL IDENTIFIER (TYPE OF JUNCTION WELL)
EXISTING UTILITY POLE	PROPOSED CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
PROPOSED JUNCTION WELL	EXISTING CONDUIT RUN IDENTIFIER (# OF CONDUIT RUN)
EXISTING JUNCTION WELL	PROPOSED OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
PROPOSED SIGNAL HEAD	EXISTING OVERHEAD RUN IDENTIFIER (# OF OVERHEAD RUN)
EXISTING SIGNAL HEAD	PROPOSED MAST ARM IDENTIFIER (LENGTH OF ARM)
PROPOSED PEDESTRIAN SIGNAL HEAD	EXISTING MAST ARM IDENTIFIER (LENGTH OF ARM)
EXISTING PEDESTRIAN SIGNAL HEAD	PROPOSED CABINET IDENTIFIER (TYPE OF CABINET)
PROPOSED PEDESTRIAN PUSHBUTTON	EXISTING CABINET IDENTIFIER (TYPE OF CABINET)
EXISTING PEDESTRIAN PUSHBUTTON	PROPOSED SPAN WIRE
PROPOSED VIDEO DETECTION	EXISTING SPAN WIRE
EXISTING VIDEO DETECTION	RIGHT-OF-WAY OR PROPERTY LINE
PROPOSED MICROWAVE DETECTION	SERVICE PEDESTAL
EXISTING MICROWAVE DETECTION	PROPOSED GROUND ROD
OVERHEAD SIGNING	PROPOSED TAR REPEATER
PROPOSED OPTICOM RECEIVER	DIRECTION FOR LOWERING POLE
EXISTING OPTICOM RECEIVER	
PROPOSED MAST ARM	
EXISTING MAST ARM	
PROPOSED LUMINAIRE	
EXISTING LUMINAIRE	
PROPOSED LOOP DETECTOR (TYPE 1 OR 2)	
EXISTING LOOP DETECTOR (TYPE 1 OR 2)	

GENERAL REPEATER NOTES

1. CONTRACTOR SHALL INSTALL NEW 44' DELDOT SUPPLIED TAR WHIP ANTENNA ON A MODIFIED TYPE III POLE BASE USING DELDOT SUPPLIED ANCHOR BOLTS (SEE TAR REPEATER CONSTRUCTION DETAILS).
2. CONTRACTOR SHALL AUGER A 10 IN. DIAMETER X 40.5 FT DEEP SHAFT FOR GROUND ROD INSTALLATION. GROUND ROD SHALL NOT BE MORE THAN 5' FROM EDGE OF REPEATER FOUNDATION.
3. DELDOT SHALL INSTALL TAR TRANSMISSION EQUIPMENT AND PERFORM FINAL TUNING.
4. ALL GALVANIZED CONDUIT (GRC) SHALL BE REAMED AND THREADED. ALL GRC SHALL BE THREADED TOGETHER WITH APPROVED COUPLINGS. SET SCREWS, BOLTS, AND COMPRESSION FITTINGS ARE NOT ACCEPTABLE.
5. ALL UNDERGROUND AND OVERHEAD UTILITIES SHOWN ON THESE PLANS ARE SCHEMATIC ONLY AND MAY NOT BE COMPLETE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING MISS UTILITY, AND/OR THE APPROPRIATE UTILITY PRIOR TO THE BEGINNING OF CONSTRUCTION FOR THE UTILITY MARKOUTS. IF THE CONTRACTOR PERCEIVES THAT A CONFLICT BETWEEN UTILITIES AND THE TRAFFIC SIGNAL WILL OCCUR, THE CONTRACTOR SHALL NOTIFY DELDOT TRAFFIC IMMEDIATELY BEFORE CONSTRUCTION.
6. ALL SIGNAL EQUIPMENT REMOVED FROM A PROJECT IS TO BE RETURNED TO DELDOT TRAFFIC - DOVER, DELAWARE.

RECOMMENDED [signature] DATE: 6.28.12 | RECOMMENDED ______ DATE: ______ | RECOMMENDED [signature] DATE: 7/6/12 | APPROVED TRAFFIC ENGINEER [signature] DATE: 7/11/12 | APPROVED FOR INSTALLATION CHIEF TRAFFIC ENGINEER [signature] DATE: 7/11/12

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

SCALE 0 30 60 90 FEET

CONTRACT	PERMIT NO.	SWTMC08	WTMC REPEATER PLAN US 13 (SUSSEX HWY) @ SR 404 (SEASHORE HWY)	SHEET NO.
T201304701	DESIGNED BY:	SM		1
COUNTY				TOTAL SHTS.
SUSSEX	CHECKED BY:	JCR		1

6/28/2012 9:17:11 AM
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