

ITS and Traffic Signal Schemes Design and Installation

Guidance for Developers



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Issue History

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1. Introduction

This document provides guidance for developers and other third parties on the design and installation of Intelligent Transportation Systems (ITS) assets. The emphasis of this document is mainly focussed on traffic signal control schemes but developers may be required by provide other ITS assets as part of their highway improvements and which may have additional requirements to those covered in this document.

This document provides details of current Essex Highways (EH) policies and practices applicable to the design and installation of ITS schemes and is intended to enable developers and their representatives to meet EH requirements when submitting schemes for technical approval.

The following is a brief summary of each of the main sections in this document:

CHAPTER 2: POLICIES AND PRACTICES

This chapter details EH policies and practices applying to new ITS assets or modifications to existing assets, including:

- Signal-controlled junctions
- Signal-controlled crossings
- Capacity assessments for signal-controlled junctions
- ITS design and implementation costs
- Commuted maintenance sums

CHAPTER 3: DESIGN CONSIDERATIONS

This chapter focuses on design considerations for Essex ITS schemes and gives specific guidance to designers on meeting EH's requirements to gain technical approval. Relevant national design standards and guidance documents can be found in Appendix A. This chapter also provides details of EH design requirements that supplement national standards and guidance.

CHAPTER 4: EQUIPMENT AND INSTALLATION REQUIREMENTS

This chapter details the types of signal equipment permitted by EH and specific requirements for installation. Requirements for electricity supplies and remote communications are also included.

CHAPTER 5: TESTING AND ACCEPTANCE PROCEDURES

The first part of this chapter specifies the factory acceptance testing (FAT) procedures for verifying that the operation of the traffic signal controller is in accordance with the Controller Works Specification prior to installation on site.

The second part details the processes for site acceptance testing (SAT) of traffic signals and takeover by EH for maintenance and operation.

CHAPTER 6: POST-INSTALLATION REQUIREMENTS

This chapter details procedures to be followed or items that need to be provided by the developer once the ITS asset has been accepted by EH.

2. Policies and practices

2.1 NEW SIGNAL-CONTROLLED JUNCTIONS

A signal-controlled junction may be proposed as a suitable means of access to a development site during the planning process. The Highway Authority will need to be satisfied that traffic signal control is an appropriate solution and that other junction types or control methods are not feasible. The developer will need to demonstrate that they have fully considered the following:-

- Practical Reserve Capacity of the signal-controlled junction(s)
- Impact on existing signal-controlled junctions and/or controlled pedestrian crossings including the need for linking strategies/coordinated control
- Speed limit and measured vehicle speeds and impact on design standards
- Land constraints (including available highway land)
- Junction intervisibility zone
- Recommended visibility distances
- Provision of facilities for non-motorised users (NMU), including facilities for mobility and vision-impaired pedestrians
- Integration with existing active travel provision
- Provision for public transport
- Turning movements of large vehicles
- Safety of maintenance personnel
- Environmental impact and air quality
- Future maintenance and revenue costs

Assessment of the capacity of proposed signal junctions should be undertaken using appropriate modelling software (see section 2.4).

2.2 DEVELOPMENT PROPOSALS AFFECTING EXISTING ITS ASSETS

If a proposed development will adversely impact one or more existing ITS assets the Highway Authority may require the developer to fund or undertake improvements to those assets to offset the impact. This may be, for example, to maintain the reserve capacity of an existing signal-controlled junction with the addition of development traffic, or to provide new or improved crossing facilities at an existing junction. New signals added to an existing network of signal-controlled junctions or crossings will need to be integrated with the existing network control strategy (e.g. UTC/SCOOT).

The developer may be required to undertake all necessary work to modify the existing control strategy within the local network to accommodate new traffic signal assets.

2.3 SIGNAL-CONTROLLED CROSSINGS

A development proposal may generate a need for one or more crossing facilities on a new or existing road. Consideration of whether a signal controlled crossing is appropriate will depend on the following factors:-

- Expected pedestrian flow and 'desire line'
- Provision for cyclists or equestrians
- Traffic volume
- Speed limit and 85th percentile vehicle speed
- Highway alignment
- Intervisibility between drivers and non-motorised users
- Proximity of junctions including other traffic signals
- Safety of maintenance personnel
- Environmental impact
- Future maintenance and revenue costs

Current EH requirements for signal-controlled crossings are detailed below.

Crossing facility within a signal-controlled junction

- Puffin or Toucan nearside signal displays will normally be required as appropriate at all new or modified crossings at a junction. Additional high level repeater displays will be required where a crossing is used by large numbers of pedestrians.
- Far side pedestrian signals will normally only be considered at new or modified traffic signal-controlled junctions if exceptional site circumstances prevent the safe use or accessibility of nearside signals, or if the site is close to other existing sites with far side signals to ensure consistency.

Puffin crossings

- To be provided where the crossing is for use only by pedestrians.
- A Puffin may be installed as a standalone (mid-block) crossing, a dual staggered crossing or as part of a signal-controlled junction (see above)

Toucan crossings

- To be provided where the crossing will be shared by pedestrians and cyclists. The crossing should link shared use surfaces on both sides of a road.
- A Toucan crossing is normally a standalone (mid-block) crossing but may be provided as part of a signal-controlled junction. Staggered Toucan crossings are no longer recommended.
- Nearside signals should be provided at new Toucan crossings.
- If an existing Toucan with far side signals is to be renewed or modified nearside signals should be considered to replace the existing far side signals.
- If a signal-controlled crossing facility is required for equestrians this will normally be provided in parallel a Toucan crossing facility (see below).

Pegasus (Equestrian) crossings

- This type of crossing should be provided where ridden horses are to be accommodated, usually where a bridleway crosses a major route and an uncontrolled crossing is not appropriate.
- Pegasus crossings should allow users to cross a road in a single stage; staggered crossings are not recommended for equestrian use. A Pegasus crossing may also be provided as part of a signal-controlled junction.
- Nearside equestrian signals are to be used in preference to far side signals.
- An equestrian crossing will normally be provided in parallel with a Toucan crossing to allow pedestrians and cyclists using the bridleway or any adjacent footways to cross independently of equestrians.

Pelican crossings

- Pelican crossings may no longer be installed following the enactment of the Traffic Signs Regulations and General Directions (TSRGD) 2016.
- Where a signal-controlled crossing is for pedestrians only a Puffin crossing should be provided.
- Existing Pelican crossings affected by a developer scheme will need to be replaced by a Puffin, Toucan or equestrian crossing as appropriate.

2.4 JUNCTION CAPACITY ASSESSMENT

Capacity assessments will be required for all new or existing signal-controlled junctions forming part of a development proposal.

For isolated junctions, a network of linked junctions and multi-node signalised roundabouts use of appropriate modelling software should be agreed with the Highway Authority. Modelling will be required for the AM and PM weekday peak periods but other peak periods may need to be assessed. The capacity assessment should be based on a junction cycle time not exceeding 120 seconds.

The modelling results should typically include the optimised cycle time, degree of saturation (DoS) and predicted queue lengths on each lane, which should not exceed available lane length. The reserve capacity of each junction modelled should be indicated. A network layout diagram identifying all nodes, lanes and traffic flows should be provided.

2.5 ITS DESIGN AND IMPLEMENTATION COSTS

Developers will be responsible for meeting all costs associated with the design and implementation of traffic signals and other ITS equipment required as part of a scheme, including the following requirements:

- Technical review and approval of the ITS design documentation.

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- Attendance by EH's ITS engineer at factory acceptance testing (FAT) and site acceptance testing (SAT) of the traffic signals or other ITS equipment installation(s).
 - For schemes involving traffic signals within a UTC/SCOOT region, all work necessary to update the UTC/SCOOT database and to test and validate the operation of UTC/SCOOT control including peak period validation.
 - For traffic signals operating under MOVA control, all work necessary to design, configure, test and undertake validation of MOVA operation during peak periods.
 - For non-UTC installations supply and installation of all necessary equipment to add the installation to EH's Remote Monitoring System.
 - Monitor traffic flows at junctions following commissioning and make adjustments to timings as necessary. Make permanent any revised timings or other data changes to the control equipment, normally within 12 months of commissioning the signals.

2.6 COMMUTED MAINTENANCE SUMS

The Developer will be required to provide a commuted maintenance sum to EH in respect of new signal installations to offset future operational costs. The sum will be for a period of 15 years from the date of acceptance of the signals by EH. The value of this sum will be calculated based on the costs to EH of maintaining the signal equipment, energy consumption and communications costs associated with remote monitoring or UTC equipment.

Further advice on commuted sums for ITS installations can be found in the document 'The Essex County Council Developers' Guide to Infrastructure Contributions'.

3. Design considerations

3.1 STANDARDS AND GUIDANCE DOCUMENTS

Appendix A gives an overview of the key design standards, guidance documents and legislation relevant to the design and installation of traffic control schemes. This is not intended to be an exhaustive list and it is the designer's responsibility to ensure any ITS design complies with the current relevant standards and guidance.

3.2 ESSEX HIGHWAYS SPECIFIC DESIGN REQUIREMENTS

This section includes details of specific EH design requirements where these may differ from national standards and guidance listed in Appendix A. This section is not a 'design guide' as such but is provided to highlight the most common design issues applying to signal control schemes.

a) Stop lines

Stop lines should be located 2.6m from the centre line of the primary signal pole where a crossing is located immediately forward of the stop line. The stop line should be located 3.0m from the nearest pedestrian crossing studs. Where no crossing is present the distance from the stop line to the primary signal pole should be 2.5m. Any departure from the above requirements should be agreed with EH.

Whilst TSM Chapter 6 recommends 300mm wide stop lines at high speed sites, EH require any stop line to be 300mm wide.

b) Crossing widths

The recommended crossing width between studs is 2.8m for Puffin crossings and pedestrian-only crossings at junctions and 4.0m at Toucan crossings. It may be necessary to increase these minimum widths where pedestrian/cyclist volumes are expected to be high.

c) Audible and tactile indicators

All signal-controlled crossings will require indicators for mobility-impaired pedestrians accompanying the green 'invitation to cross' signal. Audible 'bleepers' and/or tactile rotating cone signals are provided within the pushbutton units for this purpose. The type of indicators provided will depend upon site considerations but the following are general requirements:

- Single stage standalone crossings (except equestrian crossings) will normally have audible indicators fitted. For safety reasons audible indicators must not

be fitted at staggered (two stage) crossings, or at any standalone crossing which is close to another signal-controlled crossing where the audible indication could mislead pedestrians.

- Crossings forming part of a signal-controlled junction should only have audible indicators fitted if all traffic movements are stopped at a red signal (i.e. there is an 'All Red' pedestrian stage). At junctions where a crossing phase runs alongside a traffic phase at green ('walk-with' crossing) audible indicators must not be fitted to any crossing.
- Audible indicators should be timetabled to switch off overnight to reduce disturbance to nearby residential properties.
- Tactile rotating cone indicators should be fitted to all pushbuttons at standalone crossings and at crossings forming part of a signal-controlled junction. Pushbutton units specifically for equestrian users do not require tactile indicators.

d) Pedestrian crossing detection

Above-ground kerbside detectors are normally required to detect waiting pedestrians/cyclists at Puffin and Toucan crossings with nearside signals and cancel the demand if users leave the kerbside wait area. They are normally installed on the same pole as the nearside signal display/pushbutton unit. Should the width of the wait area exceed the detection zone 'footprint' of the unit, an additional kerbside detector will be required at the opposite end of the wait area to ensure waiting users are detected.

Kerbside detection is not required at standalone crossings operating in Pre-timed maximum mode. EH expectation is that kerbside detection is omitted at crossings with a consistently high volume of pedestrians and where pedestrians are unlikely to have an opportunity to cross in gaps in traffic.

On-crossing detection is normally required at Puffin and Toucan crossings to detect pedestrians crossing within the all red period following the green man. Sufficient on-crossing detectors will be required to ensure adequate coverage of the crossing area. The standard starting value for on-crossing detector extensions in junction controller specifications or crossing controller timings is 2.0 seconds.

Kerbside and on-crossing detection may also be required at Puffin or Toucan crossings installed as part of a traffic signal junction. Requirements will vary according to design considerations, such as provision of UTC/SCOOT or MOVA control and will need to be agreed with EH at the detail design stage.

e) Provision for maintenance vehicle parking

Parking provision for maintenance vehicles will need to be considered as part of the signal design. Wherever possible a parking facility should be provided in a safe location near to the signal controller. The parking bay should have a suitable surface material that will discourage indiscriminate parking by other users. Typically, a grass paving system within a grass verge has been successful at many sites. A dropped or splay kerb should be provided to allow safe access and egress from the road carriageway.

f) Skid resistant surfacing

Skid-resistant surfacing is required at standalone crossings and on all approaches to a traffic signal junction with a crossing facility immediately ahead of the stop line.

The type of skid-resistant surfacing will depend on site factors but will consist of either an overlaid high friction surfacing (typically of a contrasting colour) or an inlaid wearing course with a Polished Stone Value (PSV) of 68 or greater. The type of surface material should be agreed with EH on a site-by-site basis.

The minimum length of skid-resistant surfacing measured from the stop line should be 50m. For high-speed locations the length of skid resistant surfacing should increase in accordance with the 85th percentile traffic speed having regard to the following minimum guideline values:

- 30mph: - 50m FSL
- 40mph: - 60m FSL
- 50mph: - 70m FSL
- 60mph: - 80m FSL

FSL = from stop line

Skid-resistant surfacing is also required between the stop line and the first row of pedestrian crossing studs. For sites without crossing facilities, it will be necessary to review requirements for skid-resistant surfacing on a site-specific basis having regard to the factors detailed below.

Skid-resistant surfacing may be required on approaches where there is a significant downward gradient or poor horizontal alignment or visibility, irrespective of the approach speeds.

Furthermore, the approach speed, accident record, average queue length, proximity of side roads and proportion of large vehicles are all relevant when

determining the type and length of skid-resistant surfacing. Any of these factors may result in an increase beyond the minimum length specified above.

g) Vehicle speed detection equipment

It will be necessary for the Designer to undertake a speed survey to determine the 85th percentile traffic speed on each approach to a traffic signal junction or crossing. The speed survey should meet the requirements of CA 185 *Vehicle speed measurement* using appropriate speed measurement equipment.

Where vehicle approach speeds are 35mph or greater appropriate high-speed vehicle detection should be installed in accordance with TSM Chapter 6 and MCE0108C.

For sites with MOVA control an additional vehicle speed survey should be undertaken in accordance with MCH1542C *Installation Guide for MOVA* to determine the mean cruise speed on each approach and ensure the correct placement of detector loops.

h) Clearance to equipment

All traffic signal equipment should have a minimum clearance of 460mm from the carriageway edge including at traffic islands. This distance may need to be increased where the road carriageway has an adverse camber, or greater setback of equipment is required to accommodate turning vehicle movements.

i) Street lighting at signal-controlled crossings

Street lighting is to be provided at all signal-controlled crossings, including pedestrian facilities at signal controlled junctions and should comply with BS 5489-1:2020 and current EH lighting requirements. The lighting design will need to be included in the crossing detailed design and will be subject to review by EH's lighting team.

j) Signal Timings

EH require proof of calculations for intergreens and pedestrian timings to be provided e.g. distances from stop lines to conflict points, diagrams showing conflict points, application of the TSM Chapter 6 requirements and any adjustments for speed or other physical factors.

k) Right Turn Indicative Green Arrow

Right Turn Indicative Green Arrow phases are not permitted on roads with a speed limit above 30mph. Where Right Turn Indicative Green arrows are proposed on roads with a speed limit of 30mph or less, the recorded 85th percentile traffic speeds, accident records, road layout and vehicle counts should be carefully considered to determine suitability.

3.3 CONTROL STRATEGIES FOR SIGNAL-CONTROLLED JUNCTIONS AND CROSSINGS

For all new or modified signal-controlled junctions the following control strategy requirements will apply:

- a) For isolated junctions the method of control will normally be vehicle actuation (VA), however MOVA may be required if the junction has high-speed approaches and/or is likely to become congested at peak times. For MOVA sites the fall-back mode in the event of loss of MOVA control is to be VA using the MOVA detector loops.
- b) New junctions or crossings which are to be located close to or within an existing UTC/SCOOT region will need to be added to the region and configured to operate under UTC/SCOOT control, with all necessary equipment provided to allow integration within EH's UTC/SCOOT system.

MOVA control may be considered as a method linking closely-spaced signal sites in some circumstances (e.g. a signal-controlled roundabout) both outside of a UTC/SCOOT region and as a 'fallback' method of control within a UTC/SCOOT region.

For new or modified standalone signal-controlled crossings the following control strategy requirements will apply:

- c) Puffin and Toucan crossings with an 85th percentile approach speed below 35mph and speed limit of 30mph or less will normally require pre-timed maximum mode unless the site is heavily congested. Sites with approach speeds above this value will require appropriate speed detection equipment (see section 3.2 g) and will operate in VA mode.
- d) Crossings situated within a UTC region will need to operate with UTC as the primary control strategy.
- e) Where UTC/SCOOT or MOVA control facilities are provided at new or existing traffic signal sites the developer will be required to appoint a competent and experienced engineer to undertake the design, configuration and validation of the control facilities to the satisfaction of EH's representative (see also section 6.3).

The impact on nodes in the same region in terms of fallback modes and scope of subsequent validation must be agreed prior to detailed design commencing. This will also apply to any schemes where a site is to be removed from the UTC network.

The SCN for any new UTC site (s) will be provided by EH UTC Team.

The UTC control/reply bit pattern for any new site(s) will need to be submitted to the EH UTC Team for approval in addition to the general traffic signal approval process.

3.4 REMOTE MONITORING FACILITIES

EH requires that all traffic signal sites are remotely monitored to enable faults to be reported to the EH Term Signal Maintenance Contractor for prompt action. Consequently, all sites outside of a UTC/SCOOT region are to be provided with suitable outstation equipment to enable communication with EH's Remote Monitoring System (RMS). The method of communication currently used is 4G mobile communications. See section 4.12 for further details.

3.5 UTC/SCOOT CONTROL

Where UTC/SCOOT control is to be used 4G mobile communications will be required between each signal controller and EH's UTC Instation. See also Section 4.12.

3.6 TECHNICAL APPROVAL OF TRAFFIC SIGNAL SCHEMES

- a) To enable technical review and approval of traffic control schemes the scheme designer should provide the following minimum documentation to EH:
- A Signal Approval Drawing showing the signal equipment layout, method of control details, road markings, signing and associated works. The standard requirements for items to be included on signal approval drawings are detailed in **Appendix B**.
 - A Controller Works Specification conforming to TOPAS 2500 for all junction controllers. The use of the MCH1827B blank specification forms is preferred for this purpose.
 - A Traffic Signal Installation Specification incorporating MCHW Appendix 12/5 requirements. This document should specify all traffic signal equipment to be installed, including provision of electricity supply and communications equipment, and factory and site acceptance testing procedures.
- b) The above design documents will be reviewed by EH.

When the signal design is considered satisfactory with regard to technical requirements and a Stage 2 Road Safety Audit has been completed with all issues closed out formal approval will be sought from the EH Head of Network and Safety. Once this is completed the Developer will be notified in writing.

3.8 RISK ASSESSMENTS AND CDM

For all ITS and traffic signal schemes the designer should carry out a risk assessment to identify all risks associated with the system throughout its complete life cycle, from construction, installation and testing to operation, maintenance and decommissioning.

The designer will need to consider if any traffic signal equipment (or other ITS equipment) should be passively safe. A Passive Safety assessment should be carried out in accordance with BS EN: 12767:2019 (UK National Annex) and submitted as part of the design submission.

The designer will also have responsibilities under the CDM 2015 Regulations to assess, eliminate and control risks associated with the design and construction of the works.

4. Equipment and installation requirements

4.1 APPROVAL OF TRAFFIC SIGNAL EQUIPMENT

All traffic signal equipment must be registered with TOPAS (Traffic Open Products and Specifications) and, where appropriate, conform to the Traffic Signs Regulations and General Directions 2016.

4.2 TRAFFIC SIGNAL CONTROLLERS

- a) All traffic signal controllers for junctions and standalone crossings should conform TOPAS 2500B. Controllers should be of extra low voltage (ELV) type and all other traffic signal equipment should be ELV type.
- b) The traffic signal controller cabinet should be specified as grey in colour, unless the scheme is located in a conservation area where it should be specified as black.

4.3 TRAFFIC SIGNAL HEADS

- a) All vehicle and pedestrian signals should have light emitting diode (LED) aspects and should operate at extra low voltage (ELV). The LED aspects should be central light source (CLS) type.
- b) All signal heads are to be fitted with backing boards incorporating white reflective border strips. Reflective border strips should be provided for green arrow aspects and regulatory box signs mounted adjacent to signal heads.

4.4 PEDESTRIAN FACILITIES

- a) Where pedestrian crossing signals are provided red lamp monitoring will be required to meet the requirements of TOPAS 2500B. Configuration details for red lamp monitoring should be specified within the controller Works Specification document.
- b) Audible indicators are to incorporate a means of adjusting their volume.
- c) The controller configuration should include a timetabled facility to allow audible indicators to be disabled overnight at sites close to residential properties. Tactile rotating cone indicators must not be disabled overnight.
- d) Pedestrian kerbside detectors should use optical technology where the detection zone 'footprint' is configured using a handheld device.

4.5 TRAFFIC SIGNAL POLES

- a) Traffic signal poles should be 114mm in diameter, hot-dip galvanised steel, protected with a coloured plastic coating. Passively safe signal poles may vary, details of which should be provided as part of the design submission. Traffic signal poles should be grey in colour unless the scheme is located in a conservation area where it should be specified as black.
- b) All poles should have low-level terminations accessible from ground level. The access door should not face the carriageway.
- c) Cranked offset poles, where required, are to be of the “swan neck” or “formed” type with no internal welds.
- d) Each signal pole is to be installed within a NAL RS115 pole retention socket (or equivalent) fitted with a lockable anti-rotation device. Larger diameter poles, for example for passive safety, will require suitable pole retention sockets. The sockets should be installed in accordance with the manufacturer’s instructions, adhering to a single continuous pour process for the concrete foundation.
- e) The designer will need to consider if passively safe signal poles are required due to traffic speeds (refer to section 3.8). As part of this process consideration should be given to the risk of secondary collisions as well as the risks to non-motorised users.
- f) Where passively safe traffic signal poles are required, they should be of a construction that meets the requirements of the BS EN 12767.
- g) Tall poles (of 5m length or greater) may need to be considered on approaches to junctions or crossings where visibility of the signal heads may be compromised. This includes locations with adverse horizontal or vertical road alignment, or on approaches with multiple traffic lanes where high-sided vehicles in one lane may obstruct visibility of the signals to drivers in other lanes.
- h) Where tall poles (of 5m length or greater) are specified, details regarding the type of pole and its foundation, including retention socket, should be provided on as part of the design submission. The mounting height of signal heads above carriageway level when mounted on tall poles should be clearly shown.
- i) Where passively safe signal poles are provided an electrical disconnection system should be installed to disconnect the power to the pole in the event of a vehicle collision. Details of the proposed electrical disconnection system should be provided as part of the design submission to EH for approval.
- j) Each signal pole installed within a NAL RS115 pole retention socket (or equivalent) in verge should be installed with a suitably sized hardstanding surround to accommodate maintenance engineer’s ladders.

4.6 CONTROLLER ACCESS

- a) A concrete hardstanding at least 1 metre wide is to be provided adjacent to the front door of the controller and to a width of at least 0.5 metres at the sides and rear, where the controller is not already located within a paved area.
- b) A maintenance vehicle parking bay should be provided close to the controller wherever possible to allow safe off-road parking of a maintenance engineer's vehicle (refer to Section 3.2 e).

4.7 CABLE DUCTING & INSPECTION CHAMBERS

- a) All cable ducting and inspection chambers are to be installed in accordance with the relevant EH folio drawings and the manufacturer's instructions.

Cable ducts should meet the following requirements:-

- All ducts are to be of medium/high density polyethylene, orange in colour and have the legend "Traffic Signals" imprinted on the duct.
 - All ducts should have a smooth internal bore.
 - Flexible 100mm diameter ducts are to be used between pole retention sockets and the nearest inspection chamber and from the controller base to the nearest inspection chamber.
 - Single or multiple sections of rigid 100mm diameter ducting are to be used between inspection chambers.
 - A minimum of 2 no. 100mm diameter ducts are to be provided on all road crossings, increasing as necessary depending on number of cables to be installed.
 - 50mm diameter flexible 'underkerb' ducting is to be used between loop joint chambers and the kerb edge to enable connection of detector loop cables.
 - A 50mm diameter flexible orange-coloured duct is to be used for the incoming power cable connection between the electricity feeder pillar and the controller.
- b) Inspection chambers and loop joint chambers should meet the following requirements:-
 - 600mm x 450mm inspection chambers are to be installed along the duct route linking the controller to each signal pole. A 600mm x 450mm inspection chamber is required at each end of all carriageway crossing ducts.
 - An inspection chamber of minimum 600mm x 450mm size should be provided close to the controller.

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- 450mm x 450mm joint chambers are to be installed where feeder cables are jointed to detector loops.
 - All signal chambers in verge to be surrounded by at least 150mm concrete, and to have a suitably deep frame to ensure the concrete surround does not break up.
 - Any signal chamber that is designed in a location at risk of vehicle overrun should be specified as having a minimum 25 tonne vertical load capacity.
 - The maximum length of duct runs between chambers should not exceed 50m and intermediate chambers should be installed to ensure this length is not exceeded.
 - The maximum length of flexible duct between pole retention sockets and the nearest inspection chamber should not exceed 4m. Intermediate chambers should be installed to ensure this length is not exceeded.
- c) Draw cords are to be installed in all ducts and are to remain or be replaced after cables have been installed.

4.8 SLOT CUTTING AND INDUCTIVE LOOP INSTALLATION

- a) The minimum dimensions for slot cutting loops in asphalt road surfaces should be 8.0mm wide by 92.5mm in depth for the actual loop perimeter and for the 'cut back' for single and double loop tails. Where three pairs of loop tails share a single 'cut back' slot the depth should be increased to 110mm. In concrete road surfaces the depths specified may be reduced by 30mm.
- b) All loops should be cut individually in each lane but may be jointed together at the nearest loop joint chamber if a single detector is required across multiple lanes. Loop tails for multiple loops may share the same slot cut. Tails of loops cut across other lanes should be twisted together in the slot.
- c) Slot cutting is to take place outside of restricted hours on traffic sensitive roads. The permitted times for undertaking slot cutting works will need to be determined in liaison with the EH Permit Team.
- d) The backfill for the loop cable should be a one-part process, comprising of a layer of hot pour bitumen.
- e) Carriageway loop boxes are not to be used in Essex unless the road construction (or other surface in which a loop is to be cut) will not permit the use of underkerb ducting (refer to section 4.7 a).

4.9 LOOP JOINTS

Re-sealable loop jointing kits (IP68 rated) are to be used for loops at all traffic signal sites installed in Essex.

4.10 SIGNAL LAMP DIMMING

Signal lamp dimming facilities are to be provided in the controller. A photoelectric cell (dimming sensor) should be installed on the nearest pole to the controller where possible, subject to the dimming sensor being positioned a suitable distance from street lighting and other direct lighting sources.

4.11 ABOVE-GROUND DETECTION

- a) Above-ground microwave vehicle detectors (MVDs) may be used in place of inductive loops subject to the requirements of TSM Chapter 6.
- b) All above-ground detectors are to be installed in accordance with the manufacturer's instructions.
- c) Where an above-ground detector is mounted on a pole with no signal heads present the plug and socket connectors on the detector's flying lead are to be mounted within a suitably drilled hole near the top of the pole. It will not be acceptable for the connectors to be removed and the detector hardwired directly into the pole's cable terminations.

4.12 TELECOMMUNICATIONS FOR UTC AND REMOTE MONITORING

- a) All traffic signal sites will require the provision of remote monitoring or UTC/SCOOT facilities using 4G communications in accordance with EH requirements (see Section 3.5).
- b) The appropriate type of UTC/SCOOT or remote monitoring outstation equipment to be installed in the controller(s) is to be agreed at the design stage with EH.
- c) EH will issue a compatible SIM card to the signal installation contractor for all sites with 4G communications. Approximately 4 weeks' notice should be given to EH for procurement of SIM cards. The signal contractor will be responsible for installing the SIM card in the controller. The signal contractor will also be responsible for supplying and installing the appropriate 4G router and antenna equipment to enable reliable communications between the controller and EH's instation equipment.
- d) The signal installation contractor is to supply and install all necessary cabling/interface leads between the outstation equipment and the controller where an integral facility cannot be provided.

4.13 PROVISION OF ELECTRICITY SUPPLY

- a) All traffic signal installations and other ITS equipment installations will require a dedicated electricity supply provided direct from the Distribution Network

Operator's (DNO) network terminated in a dedicated mini feeder pillar located adjacent to the signal controller or other ITS equipment. Provision of an electricity supply from a connection point to the DNO network at a location remote from the controller via a private supply cable will not be acceptable.

- b) All traffic signal installations will require a 230 V 50 Hz electricity supply to the mini feeder pillar incorporating a 25 Amp lockable double pole isolator with single pole fuse. The signal installation contractor is required to install a secondary fused isolator in the feeder pillar rated to provide suitable discrimination between the primary isolator and the signal controller.
- c) The developer or their representative will be responsible for all liaisons with the DNO in the procurement and connection of the electricity supply. The cable connecting the feeder pillar to the controller is to be supplied and installed by the signal installation contractor.
- d) The electricity supply to the traffic signal or ITS equipment feeder pillar must be wholly independent of supplies to other highway electrical equipment such that the isolation of this equipment does not cause the supply to the traffic signals to be interrupted.

5. Testing and acceptance procedures

5.1 FACTORY ACCEPTANCE TESTING

- a) A Factory Acceptance Test (FAT) will be required for all traffic signal controllers including standalone pedestrian crossings.
- b) The developer's signal installation contractor should provide to EH a site specific copy of the controller configuration based on the Controller Works Specification approved by EH at the design stage. EH will require the configuration document at least two weeks before the scheduled FAT date. Following successful site acceptance testing, the signal installation contractor is to supply to EH an electronic copy of the site specific controller configuration data. The contractor should retain sufficient records to provide replacement configurations at reasonable cost, in the event of the configuration becoming corrupted, lost, or requiring modification.
- c) The signal installation contractor should make all necessary arrangements for EH's representative to attend a FAT at the local depot of the Contractor and should give at least three weeks' notice of the proposed FAT date.
- d) The signal installation contractor should ensure that the control equipment on test during the FAT is the actual hardware and software that is to be installed for the site under test. EH's representative reserves the right to uniquely mark parts of the Control equipment (following successful FAT) to ensure this requirement is met.
- e) Should it not be possible during the initial FAT for EH's representative to accept the control equipment due to the failure of facilities/test gear or control equipment supplied by the signal installation contractor, all reasonable costs incurred by EH to attend subsequent FAT(s) may be recovered from the developer or signal installation contractor.

5.2 SITE ACCEPTANCE TESTING

- a) The developer should give EH at least three weeks' notice of the proposed SAT date.
- b) The signal installation contractor is to fully pre-commission the new installation on a day prior to the agreed SAT date. Any faults found at the pre-commissioning including replacing faulty equipment must be resolved before the SAT. For this reason, a pre-commissioning on the day of the SAT will not be accepted.

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- c) The signal installation contractor's engineer will be required to demonstrate to EH's representative the compliance of the installation with the specifications and design documentation in all respects during the SAT. Such testing equipment as may be necessary should be provided by the signal installation contractor.
 - d) A Takeover Certificate will be co-signed by EH's representative and the signal installation contractor's engineer when the installation has been shown to comply with the specifications and design documentation and has successfully passed all required tests.
 - e) The SAT will only take place once all signal equipment, electricity supply, remote communications and all associated civils works including road markings, signing, high friction surfacing and street lighting have been installed and are operational. Incomplete works will result in either the postponement of the SAT, or if agreed appropriate by EH's representative, a partial SAT with the traffic signals left switched off and signal heads bagged over. Should further SAT visits be required the developer will be responsible for the additional costs incurred for EH's representative to complete the SAT process.
 - f) Testing of the UTC or remote monitoring outstation equipment is to be carried out in the presence of EH's representative. Interrogation of the outstation should be demonstrated by the signal installation contractor to the satisfaction of EH's representative by means of a suitable interrogation device.

5.3 EARTH LOOP IMPEDANCE (ELI) TEST CERTIFICATE

Prior to the SAT the traffic signal or other ITS equipment is to be pre-commissioned by the developer's signal installation contractor. As part of this process an Earth Loop Impedance (ELI) test shall be undertaken covering the electricity feeder pillar and the controller in accordance with the requirements of BS 7671. The signal installation contractor shall provide an electrical test certificate to EH's representative at the SAT before any further testing may proceed. Failure to do so will result in EH's representative postponing the SAT until an electrical test certificate is provided.

5.4 CABLE SCHEDULE

The developer's signal installation contractor shall complete a cable schedule for the controller showing the unique identity of each cable, and the location of its terminations. A cable core schedule shall be completed for each cable showing the function of each core within the cable. The completed schedules shall be passed to EH at the SAT.

6. Requirements following site acceptance

6.1 STAGE 3 ROAD SAFETY AUDIT

EH will undertake a Stage 3 Road Safety Audit following the completion of the scheme and site acceptance of the traffic signals. This will consider the safety aspects of the completed and operational signal installation(s) in both daytime and night-time conditions and will make recommendations for any remedial works. EH will require the developer to comply with the recommendations made and undertake additional works if necessary.

6.2 COMPLETION OF OUTSTANDING WORKS

Any outstanding works that are agreed with EH's representative as acceptable to be completed following the SAT must be completed within ten working days.

6.3 VALIDATION OF TRAFFIC SIGNAL TIMINGS AND OPERATION

Following site acceptance the developer will need to appoint a suitably competent and experienced engineer to undertake validation of signal timings during the peak and off-peak periods. If the site(s) include MOVA or SCOOT control as part of their operation then the competent engineer will be required to set up and validate these control methods to the satisfaction of EH's representative.

As part of the validation process sites operating under SCOOT control will require the implementation of cableless linking (CLF) plans in the controller(s) in the event of loss of SCOOT control.

6.4 REVISIONS TO CONTROLLER CONFIGURATIONS

Following the completion of the validation process any changes to timings or other controller parameters will require an updated controller configuration to be completed and installed by the developer's signal installation contractor to make permanent all temporary controller data. The updated configuration data will be provided to the signal installation contractor by the validating engineer or EH's representative as appropriate. The updated configuration will be tested by EH's representative who will then attend site with the signal installation contractor's engineer to oversee the installation of the revised configuration.

Should further controller data changes be required the signal installation contractor is to include for an additional configuration be completed and installed within twelve months of the original SAT with all costs to be borne by the developer. For each controller configuration, the signal installation contractor should supply to EH an electronic copy of the configuration data.

6.5 AS-BUILT DETAILS

Following the installation of traffic signals or other ITS equipment the developer or their representative is to produce an as-built drawing detailing the specific locations of all signal equipment, the associated ducting system and related civils works. Any changes to the installation from the original Signal Approval layout drawing must be captured on the as-built drawing. This as built drawing should be a suitably revised version of the original Signal Approval layout drawing and supplied to EH in electronic format, including AutoCAD files for drawings.

APPENDIX A: DESIGN STANDARDS AND GUIDANCE DOCUMENTS

The following list gives an overview of the key guidance documents, design standards and legislation relevant to the design and installation of traffic signal schemes. The list is not intended to be exhaustive and it is the designer's responsibility to ensure any traffic signal design complies with the current standards and guidance.

Traffic Signs Manual

TSM Chapter 6: Traffic Control

TSM Chapter 5: Road Markings

Design Manual for Roads & Bridges (DMRB)

CD 116 Geometric design of roundabouts

CD 123 Geometric design of at-grade priority and signal-controlled junctions

CA 185 Vehicle speed measurement

TA101 Traffic Signalling Systems

TD101 Traffic Signalling Systems (Design)

TM101 Traffic Signalling Systems (Maintenance and Operation)

TS101 Traffic Signalling Systems (Inspection and Assessment)

Traffic signal control equipment specifications

TOPAS 2500B Specification for traffic signal controller

TOPAS 2505B, TOPAS 2506A, TOPAS 2507A Above ground vehicle and pedestrian detection

TOPAS 2512B Below ground vehicle detection

TOPAS 2511A Nearside signals and demand units

TOPAS 2508C, TOPAS 2509B Audible and tactile indicators

MCE0108C Siting of inductive loops for vehicle detecting equipment at permanent road traffic signal installations

MCH1542C Installation guide for MOVA

Statutory instruments

Traffic Signs Regulations and General Directions 2016

Miscellaneous guidance

Essex County Council Development Construction Manual

Guidance on the use of tactile paving surfaces (DfT)

Manual for Streets and Manual for Streets 2 (DfT)

LTN 1/08 Traffic management and streetscape

LTN 1/20 Cycle Infrastructure Design

APPENDIX B: REQUIREMENTS FOR TRAFFIC SIGNAL APPROVAL DRAWINGS

Applicable to all Traffic Signal Approval drawings:

All Traffic Signal Approval drawings will need to include the following details in order to gain technical approval from Essex Highways:

- Layout showing extents of junction or crossing including all signal equipment at 1:500 scale
- A 1:200 scale inset detail of the central section of the junction or crossing. The area of the inset detail should include all stop lines, crossing points and signal poles.
- A key defining all symbols used on the drawing. Traffic signal symbols should be in accordance with TSM Chapter 6, Appendix A2.
- All traffic signal equipment symbols should be clearly shown on the layout. It may be necessary to remove tactile paving infill detail to allow equipment symbols to be clearly shown.
- Cable ducting and access chambers including the size and number of ducts in each run
- Traffic signal poles should be numbered in a clockwise direction starting with the pole nearest to the signal controller.
- All kerb lines and dropped kerbs associated with the signal installation shown in black line type. All old kerb lines, old road markings and survey details not relevant to the final junction layout should be omitted.
- Tactile paving at crossings to be in accordance with the latest version of the DfT document *Guidance on the use of Tactile Paving Surfaces*
- A north point.
- All road markings including stop lines, zigzag markings, lane lines and arrows, lane destination markings, yellow box markings, Keep Clear markings and pedestrian crossing studs.
- All relevant signs including regulatory box signs, advance warning signs, signage and markings for buses when special facilities are provided for them at junctions; signage and road markings for cyclists.

The drawing location in the title block should include a site reference number (to be obtained from EH), road names and road classification numbers, including side roads. The location of all standalone crossings should be referenced to the name of the nearest side road and its compass direction in relation to the crossing (e.g. High Street northwest of Kings Road).

Two boxes for approval stamps are required: One to record the final technical approval and one to record the Essex Highways' Road Safety Audit team's approval. The formal approval meeting that takes place between the EH Design Reviewer and EH Head of Network and Safety requires the design and RSA to have been accepted.

The Traffic Signal Approval drawing to be approved should not differentiate between existing and new details but should show the detail in its completed state. If necessary a separate construction drawing can be issued differentiating between existing and new details.

Applicable to Junction Signal Approval drawings:

- a) Junction Signal Approval drawings should include the following diagrams and tables -
- Phasing and staging diagram
 - Detector Functions table
 - Phase Intergreen table
 - Phase Timings table
 - Permitted stage movements matrix
 - Pole schedule and setting out dimensions
 - Loop setting out details and dimensions
 - MOVA link/lane diagram (where applicable)
- b) Detector loops and above ground detectors should be labelled on the drawing and in the Detector Functions table according to the following conventions:
- System 'D' loop detection: the phase letter should be at the start of the label e.g. AX, AYZ
 - Microwave vehicle detectors: the phase letter should be at the start of the label e.g. AMVD
 - Stop line demand loops: the phase letter should be at the end of the label e.g. DEMA
 - Presence (call/cancel) loops: the phase letter should be followed by the letter 'P', e.g. AP
 - MOVA loops: the phase letter should be followed by the loop type and finally the MOVA detector number, e.g. AIN1, AX2, ASL3.
 - Pedestrian kerbside detectors: the phase letter should be followed by 'PKD' and the pole number e.g. BPKD1.
 - Pedestrian on-crossing detectors: the phase letter should be followed by 'PCD' and the pole number e.g. BPCD1.
- c) The Detector Functions table should include the following columns: detector number; detector label; distance from stop line to detector loop; phase(s) demanded; phase(s) extended; call/cancel timings; loop dimensions.
- d) Junction Signal Approval drawings should include a Phase Intergreens table calculated in accordance with TSM Chapter 6. When SD loops, SA loops and/or

All Red extension detectors are provided the intergreens extended should be identified in a note below or adjacent to the Phase Intergreen table. SD/SA extra clearance period, the All Red extension timing and maximum additional All Red timing should also be included.

- e) The Phase Timings table should include the following details:
- Minimum green timings and phase green extension timings for each phase
 - Where nearside Puffin or Toucan crossing signals are provided the table should include all nearside sequence timing periods in accordance with TSM Chapter 6
 - For junctions with pedestrian facilities the method of calculating the pedestrian timings should be accordance with TSM Chapter 6
 - The table is to include a 'blackout' timing column if far side pedestrian signals are provided at the junction or where nearside signals are located on a central refuge island for a single stage crossing.
 - A column showing the green extension timing for SD/SA loops is required for all relevant phases.

Applicable to Puffin, Toucan and Pegasus crossing Signal Approval drawings:

- a) Standalone crossing Signal Approval drawings should include a timings table with the following details:-
- Nearside sequence timing periods calculated in accordance with TSM Chapter 6. The table should include columns indicating for each period the respective signal to vehicles and pedestrians/cyclists/equestrians with the corresponding duration of the period.
 - For dual (two-stage) crossings a set of timings is to be shown for each crossing point clearly identifying which timing set relates to which crossing point.
- b) The following timings should also be shown where applicable:
- Pedestrian kerbside detection hold period (normally 2 seconds)
 - Pedestrian kerbside detection cancel period (normally 2 seconds)
 - Vehicle green extension period
 - SD/SA vehicle green extension period
 - Maximum vehicle green timings for peak and off peak periods
- c) The following diagrams and tables should also be shown where applicable:
- Detector Functions table
 - Pole schedule and setting out dimensions
 - Loop setting out details and dimensions