Town of

Queen Creek

Traffic Signal Design Criteria

July, 2016

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1. Introduction:

This document describes the design criteria for traffic signals located within the Town of Queen Creek's jurisdiction. Traffic signals on the boundary of Queen Creek's jurisdiction, or traffic signals located on facilities maintained by other agencies, such as the Arizona Department of Transportation (ADOT) or Pinal County, shall be determined by the Town of Queen Creek's Transportation Engineer ("Town TE" within this document) as to which agency's standards shall apply. The Traffic Signal Design Engineer ("Designer" within this document) shall be responsible for obtaining specific direction from the Town, prior to initiating the design process, in order that the correct applicable standards are applied. The Designer shall identify any conflicts between direction given by the Town TE and any other involved entities, and seek guidance from the Town TE in resolving conflicting direction.

While every effort has been made to ensure the accuracy and completeness of these guidelines, it shall be the sole responsibility of the Designer to ensure proper design and accuracy, and the completeness of construction documents containing that Professional Engineer's seal.

Recognizing the liability implications associated with traffic signal design and operations, all traffic signal designs for traffic signals that will be the operational responsibility of the Town of Queen Creek should be conducted by professionals experienced in the design of traffic signals. Such individuals shall be a or directly supervised by a currently Registered Professional Engineer (Civil Engineer or Electrical Engineer) in the State of Arizona, and should be a Registered Professional Traffic Operations Engineer (PTOE), as granted by the Institute of Transportation Engineers.

These design criteria are intended to be "directions to the Designer". The Designer, in turn, will develop plans, specifications, special provisions and other associated documents as "directions to the contractor" or other parties deemed responsible for execution and implementation of the resulting project documents, resulting in a complete, operational traffic signal system.

A traffic signal design project may involve the design of a complete new traffic signal system where none previously existed, modifications to an existing signal or communications system, removal or replacement of existing components, addition of new components, and associated pavement markings, signing, establishment of power and/or communications facilities and civil improvements to roadways, curbs, ramps or other features.

Applicable Standards

The following documents represent applicable standards documents, in order of precedence and hierarchy, and should be indicated in the project documents so the contractor has an understanding of which standards or documents apply and supersede other referenced standards.

1. Manual on Uniform Traffic Control Devices (MUTCD), current edition, with all Revisions adopted by the Federal Highway Administration.

2. Arizona Department of Transportation Supplements or Addenda to the ADOT adopted version of the MUTCD.

3. 2010 ADA Standards for Accessible Design, US Department of Justice, Sept 15, 2010.

4. The project Special Provisions.

5. The project plans, inclusive of details.

6. Applicable Town of Queen Creek Standard Details and Standard Specifications.

7. Town of Queen Creek, Traffic Engineering Division, current Approved Materials List (AML) for traffic signal and lighting equipment.

8. Arizona Department of Transportation (ADOT) "Standard Specifications for Road and Bridge Construction", current edition, including any Supplements, Addenda, or applicable stored specifications.

9. Arizona Department of Transportation (ADOT) "Traffic Signals & Lighting Standard Drawings", and "ITS Standard Drawings" current edition, including any Supplements or Addenda.

10. City of Phoenix “Traffic Barricade Manual” for construction zone traffic control, current edition.

Approved Materials List

Designers shall recognize that the Town of Queen Creek Traffic Engineering Division maintains an Approved Materials List (AML) of certain items (controller, cabinet, BBS, LEDs, etc.) specifically preapproved for use on Town of Queen Creek traffic signals. The current AML shall be obtained by the Designer at project initiation. Project documents shall include provisions for the furnishing and installation of items from the AML, unless specific exception has been made by the Town TE.

Federally funded projects do not allow specific brand and model of products unless a Finding in the Public Interest is issued by the FHWA, at the request and justification of the Town. Designers shall seek direction from the Town TE for Federally funded projects.

Items not listed on the Town's AML shall conform to the ADOT AML, if addressed in the ADOT AML by item type or category. Items not listed on either AML shall be subject to submittal by the contractor at the time of construction, as a part of the equipment submittal process and are subject to approval, at the discretion of the Town TE.

2. Traffic Signal Needs Study

All proposed traffic signals shall be justified by a complete and comprehensive Traffic Signal Needs Study, supporting the need for a traffic signal. All Traffic Signal Needs Studies shall be supported by traffic data taken from the site within the last six months for any warrant based on existing traffic or pedestrian volumes. Signal warrants based on future traffic or pedestrian volumes shall be supplied with explanation of the logic by which the traffic volumes were derived.

Spacing between adjacent signals is a concern and shall be analyzed by, and at the cost of, the party proposing any new signal. Typical signal spacing should be no closer than ½ mile (2,640 ft.) between signals. Closer spacing may be proposed with supporting analysis, but are subject to the review and written approval of the Town of Queen Creek Transportation Engineer.

Proposed traffic signals located within ½ mile (2,640 ft.) or less of any adjacent traffic signal, or between any two existing traffic signals operating as part of the Town's coordinated traffic signal system, shall provide a signal coordination analysis showing how the proposed signal will interact with neighboring signals under coordination, and shall incorporate the Town's signal timing policy regarding treatment of pedestrian and clearance timings. This analysis shall provide analysis for the AM, Mid-Day and PM weekday peak periods, based on existing cycle lengths and any proposed changed cycle lengths deemed necessary to suitably operate the new signal in sync with adjacent signals. Proposals to modify existing cycle lengths shall analyze all signals currently in the same geographic control group currently running the same cycle length, acknowledging that a change in cycle length at one location requires a change at all others in the same group.

In cases of commercial development of land uses typical of high weekend peak traffic, analysis periods may include weekend analyses, as directed by the Town TE. The Town of Queen Creek shall establish the time frames and geographic limits of the coordination analysis prior to the analysis being performed. The Designer shall be responsible for obtaining any and all necessary data for this analysis, unless data is available from other sources and approved for use by the Town TE.

All Traffic Signal Needs and any applicable signal coordination analyses shall be submitted to the Town of Queen Creek Transportation Engineer for review and approval, and sealed by an Arizona Registered Professional Engineer experienced in the procedures and application of such procedures, as set forth in the MUTCD.

Only traffic signal warrant and signal coordination studies approved, in writing, by the Town of Queen Creek Transportation Engineer shall allow the legal installation of a traffic signal. Satisfaction of a signal warrant alone does not justify installation of a traffic signal, as noted in the MUTCD, and is still subject to review and approval.

Approval for traffic signal installation may include additional requirements and agreements such as responsibility for design and constructions costs, installation of associated communications interconnect conduit and cables, roadway and sidewalk improvements necessary to support operation of the traffic signal, improvements necessary to support ADA compliant access to traffic signal features, protection of cabinets or equipment from exposure to traffic or pedestrians, furnishing of spare equipment, coordination with other governmental and utility entities, connection to adjacent railroad control systems and paying of costs associated with the establishment of power service and recurring monthly power costs.

Traffic signals justified or caused by private development, shall be partially or wholly funded, designed and constructed by the Developer, at the discretion of the Town of Queen Creek.

3. Signing & Striping

Typically, each approach to a new traffic signal shall have a new stop line and new crosswalk. Plan notes shall indicate that new stop lines shall not be installed until immediately prior to signal activation, so as not to mislead the public into believing the new signals are malfunctioning.

All new signals as well as existing signals being modified with a different sequence of operation (typically the addition of arrows) shall include provisions for a "TRAFFIC CONTROL CHANGE" sign, with flags, on each approach for a minimum of 30 days.

Locations where a right turn arrow is used shall have mast arm mounted "NO U-TURN" signs for the complimentary left turn movements. For example, if eastbound traffic is served by a right turn arrow, northbound traffic shall have a "NO U-TURN" sign to prevent a conflict between a northbound U-turn and eastbound right turn.

4. Signal Phasing & Timing

Only approved phasing, standardized by direction and as approved by the Town TE shall be utilized. Existing signals being modified shall be converted to standard phasing directions as part of the overall modifications, if not in presently in compliance.

Standard Phasing Orientation

The Designer shall use the vehicular and pedestrian phasing orientations depicted in the Town of Queen Creek Standard Detail. The Designer shall note the specific channel assignments for the associated emergency vehicle preemption directions, and call out wiring to each in a manner consistent with the phase and channel assignment directions.

For intersections where ambiguity may exist in interpretation of directionality (skew intersections, diagonally oriented streets, intersections with more than 4 approaches, etc.), odd geometrics resulting in non-standard phasing arrangements, or the use of phase overlaps, the Designer shall consult the Town TE for special designations applicable to the specific location.

Left Turn Arrows

Left turn arrows consume portions of the signal timing cycle, and should be used only when justified due to volume or safety considerations, after proper analysis. Use of left turn arrows based on the desire to facilitate easy access to a commercial site is not, in itself, an engineering-based justification for the use of arrows.

The Designer shall apply the analysis procedures of the current version of the ADOT Traffic Engineering Guidelines and Processes (TGP) 612, "Left Turn Signal Phasing" to evaluate the potential need for left turn arrows. Approval of use and type of left turn arrow treatments shall be only upon written approval of the analysis presented by the Designer to the Town TE.

The signal sequence shall be designed to be safe, and avoid trapping left turn vehicles who may believe it is safe to turn on a yellow display, when oncoming through traffic still has a green indication (the “trap” condition).

The use of protected-permissive left turn phasing is preferred, as it allows vehicles to turn on the green ball as well as during the arrow display.

Protected-only phasing shall be used for any approach that provides two or more left turn maneuver lanes, or if the oncoming traffic being observed by the left turn traffic is on an approach with three or more through lanes, and has an approach speed limit of 45 MPH or more, or if protected-permissive left turn phasing has not adequately reduced left turn accidents below the analysis threshold.

T-intersections may require protected-only or special treatments/locations of pedestrian crossings, depending on concentration of volumes per maneuver, in the interest of enhancing capacity by removing pedestrian crossing interference. Designers shall confirm pedestrian crossing paths with the Town TE.

Right Turn Arrows

Right turn arrows, overlapping with adjacent street left turn arrows, shall be used whenever an exclusive right turn lane exists on an approach and left turn arrows are used on the adjacent street for a compatible movement. For example, a northbound approach with an exclusive right turn lane shall have a right turn arrow overlapped with a westbound left turn arrow, if a left turn arrow is used for westbound.

Overlaps shall be defined logic overlaps, output by the controller unit based on overlap phase definition, and not achieved by connecting the field wires from a right turn arrow to the load switch outputs of the compatible left turn GREEN ARROW and YELLOW ARROW.

Other Phasing Cases

It is recognized that a variety of other cases may manifest themselves in the way of arrow combinations, phasing, and preemption needs. Any and all proposed phasing sequences shall be supported by analysis, be shown on the plans, reviewed and approved by the Town of Queen Creek Transportation Engineer prior to construction and implementation.

Railroad preemption sequences shall be shown, by sequence step, on the project plans, and reviewed and approved by the affected railroad operator.

Designers shall avoid the use of split-phasing, wherever possible, as split-phasing is derogatory to efficient signal operations and coordination timing.

Signal Timing

Traffic signal timing shall be developed by the Designer in support of the signal design and submitted to the Town TE for review. The Designer shall be responsible for obtaining any necessary current traffic data in support of timing schemes, and shall confirm timing methodology and presentation format with the Town TE prior to development of timing.

Signals along existing coordinated corridors shall be discussed with the Town TE at project initiation to determine the extent of responsibility, if any, of the Designer for coordination plan development and/or revisions. Coordination corridors may, at the discretion of the Town TE, require consideration of timing plan revisions for multiple intersections, beyond the new or upgraded signal, acknowledging that coordination is a system of multiple signals working in concert.

5. Signal Preemption

Emergency Vehicle Preemption

All new traffic signals, and all existing traffic signals being modified that currently do not have emergency vehicle preemption for all approaches, shall be designed to provide emergency vehicle signal preemption for all approaches.

Preemption shall be through the use of infrared devices, such as a strobe light on the approved emergency vehicle, light-sensitive sensors at the traffic signal (typically mounted on the mast arm or other location offering suitable visibility) and phase selector interface card(s) in the controller cabinet.

Equipment shall be as approved on the Town's Approved Materials List (AML). In the event of modification of an existing signal, the Designer shall determine specific equipment in place and provide for replacement of any existing components with which new components cannot be compatible with, resulting in a fully functioning system for the new condition. An example would be the addition of a 4th approach to an existing T-intersection that presently does not provide enough channels for preemption with 4 approaches, requiring additional phase selector modules. New modules shall be from the AML and be compatible with the existing cabinet and controller or new items shall be furnished to allow the overall system to function per the designated channel assignments. Only existing modules or devices known to be fully compatible with the proposed new equipment will be allowed to remain.

Emergency vehicle preemption shall be designed such that any approach's through plus left turn phases (when left turn phases are used) typically are activated simultaneously to display GREEN plus GREEN ARROW (where left turn phases are used) upon the approach of an emergency vehicle, while all other vehicular directions display RED indications.

In cases of vertical and horizontal curvature, preemption sensors may need to be mounted on additional poles located upstream from the traffic signal. The desirable unobstructed preemption visibility distance for optically activated systems shall be 1,800 feet, unless dealing with an approach (such as a development driveway) with limited length.

Preemption cable shall be per the AML, and shall run unspliced from the sensor, to the controller cabinet terminals.

Railroad Preemption

According to Section 8C.09 of the MUTCD, traffic signals located within 200 feet of any at-grade rail crossing with a flashing-light signal system should provide railroad preemption. Providing railroad preemption for other situations and distances are subject to evaluation of the safety aspects of providing preemption on a case by case basis, and subject to the discretion of the Town TE, and all proposed preemption operations shall comply with the provisions of the MUTCD.

The Designer shall be responsible for coordinating with the railroad, and provide all documentation required by the railroad, including railroad approval and identification and coordination of permits, as well as complying with the requirement of Section 8C.09 of the MUTCD.

The Designer shall coordinate with and make all arrangements with the railroad, including specifics on how and where any interfaces shall occur, determine what documentation must be submitted on behalf of the Town for approvals, and circuit type. Any relays, panels, special cabling required to support proper preemption operation shall be identified by the Designer and shown in the project plans as provided and included as part of the project.

Preemption operation shall be provided by the Town's standard traffic signal controller without the use of special equipment or external "black box" logic, and should provide for continued limited signal operation for directions and movement combinations that are not in conflict with the rail crossing during the preemption event. Any termination panels, interface devices or cables necessary within the cabinet in support of railroad preemption shall be identified, shown on the project plans, and furnished by the contractor as part of the project.

Each step of the preemption sequence(s) shall be shown on the plans. Rail crossings on multiple approaches of through the middle of the intersections shall require multiple sequences and additional equipment.

Rail preemption sequences shall typically allow limited service to phases and movements that may occur without conflict with the rail crossing, in the presence of a train.

Internally illuminated NO RIGHT TURN signs shall be utilized, in conformance with the provisions of the MUTCD.

All traffic signal plans with railroad preemption shall contain a note indicating the railroad agency contact person and telephone number, as well as any specific coordination elements and permits necessary for the Contractor, on the plan sheets.

Transit Priority

The Town of Queen Creek does not presently provide transit priority features at traffic signals. Any proposals for transit priority shall be submitted to, and approved by the Town TE.

6. Plans

All traffic signal plans shall be developed in computer-generated CADD, utilizing current ADOT Traffic Engineering CADD Standards, color table and levels.

The standard size of full-size plan sheets for the Town of Queen Creek traffic signals shall typically be 22” x 34”, allowing half-size 11" x 17" to be printed to true half scale.

The Designer shall submit 1 PDF set of 22" x 34" and one half-size PDF set of 11” x 17” plans at the 60%, 95% and 100% stages to the Town TE for review and comment, unless the traffic signal plans are a part of a capital improvement project plan set, in which case submittal to the Town's project manager for the capital improvement project, conforming to the required submittal quantity, format and size would apply.

A submittal package shall consist of a complete set of plans, Special Provisions covering any items deviating from referenced standard specifications, the Signal Needs Study, left turn arrow analysis (if applicable), railroad preemption analysis documentation (if applicable), conduit capacity calculations (only if requested by the Town) and an Engineer’s Estimate.

Final approved plans shall be sealed and signed by a Registered Professional Engineer (Civil or Electrical) of the State of Arizona. Final sealed plans shall be submitted to the Town in both full-size and half-size true scale PDF format, for reproduction.

At the end of the design project, CADD files shall be submitted to the Town on CD ROM, DVD, thumb drive or by a form of file transfer protocol (ftp). Bid stage specifications and Special Provisions shall be provided in Microsoft Word and PDF formats. Engineer’s Estimates shall be provided in either Microsoft Word or Excel formats, and PDF format. The Engineer's seal shall be removed from the CADD files.

Sample plans of recent Town-approved traffic signals may be requested from the Town TE as a guide, but the Designer must recognize the possibility of recent revisions to the design criteria or that site-specific alternatives may be necessary.

Designers shall obtain the current Town of Queen Creek standard notes for the traffic signal plan sheet, pole schedule, conductor schedule and ITS notes (if applicable), and insure they are placed on the plans with appropriate project-specific notes.

Designers shall acknowledge that the plans hold superior precedence over other documents and references. As such, care and skill shall be exercised in development and content. The Town of Queen Creek reserves the right to reject and suspend review of plans that do not exhibit an acceptable level of detail, content accuracy or compliance to the directions set forth herein.

A typical stand-alone traffic signal plan set shall consist of the following sheets with typical content:

1. Face Sheet (minimum requirements):
   - Project Title (indicating "Traffic Signal Construction"),
   - Location (street names of intersection),
   - Project Number (if applicable),
   - Designer's name, PE seal and expiration date,
   - Firm name, logo and contact information,
   - Town logo,
   - Blue Stake number/information,
   - Vicinity map showing project location(s) relative to entire Town, and
   - Approval Signature block as specified by the Town of Queen Creek Transportation Engineer.

2. Signing & Striping Plan View Sheet:
   - Scale shall be 1" = 20' or 1"=40', as necessary to provide proper detail and readability;
   - Use exploded views or blowups of specific areas, as necessary, to enhance clarity of information,
   - Obtain latest Signing & Striping General Notes from Town, and add/delete/revise notes to serve specific project under design,
   - ADOT Traffic Engineering CADD layers, colors and ADOT symbology shall be used,
   - Use English units,

   - Show "Existing" features that are to remain unchanged as dashed, and in light pen weight (Color=169):
     1. Curb & gutter/edge of road,
     2. Lane dimensions of existing to remain,
     3. Sidewalk & ramps,
     4. Bus Stops,
     5. Striping & Signing, including dimensions of lane widths,
     6. Street names,
     7. North Arrow, and
     8. Scale of drawing.

- Show “New” features solid, in bold pen weight:
    1. New signing & striping,
    2. Lane and distance dimensions of new,
    3. Callouts for new and removals,
    4. Images and sign identifiers of new signs, and
    5. Notes.

3. Removals Sheet (Optional):
    - Scale appropriate for purpose,
    - Indicate items to be removed and/or salvaged, and
    - Notes regarding disposition of removed/salvaged items and any restrictions, coordination requirements or time constraints.

4. Signal Plan View Sheet:
    - Scale shall be 1” = 20’ or 1"=10', as necessary to provide proper detail and readability,
    - Use exploded views or blowups of specific areas, as necessary, to enhance clarity of information,
    - Obtain latest Traffic Signal General Notes from Town and add notes or revisions specific for project under design,
    - Indicate name and telephone number of electrical service contact, and service address to be used in arranging service with the utility,
    - Blue Stake number/information,
    - ADOT Traffic Engineering CADD layers, colors and ADOT symbology shall be used,
    - Use English units,
    - Show “Existing” features dashed, and in light pen weight (Color=169):
        1. Centerline,
        2. Curb & gutter/edge of road,
        3. Sidewalk & ramps,
        4. Utilities – Overhead and underground identified by type, manhole covers, valves, hydrants,
        5. Bus stops,
        6. Striping & signing unchanged by this project,
        7. Right-of-Way lines (Existing & Proposed), including dimensions from face of curb,
        8. Easements,
        9. Existing traffic signal features (signal poles, conduits, pull boxes, & detection),
        10. Street names, and
        11. North Arrow, indicating scale of drawing.

- Show “New” features solid, in bold pen weight:
  1. New centerline (if applicable),
  2. New signing & striping,
  3. Signal poles & callouts,
  4. Town of Queen Creek's Traffic Signal General Notes & project-specific notes,
  5. Vehicle signals,
  6. Vehicle signal phase designation,
  7. Pedestrian signals with phase designation,
  8. Luminaires,
  9. Cabinets & callouts,
  10. Electric service cabinets & callouts,
  11. Pull boxes,
  12. Conduit & callouts, and
  13. Detection (loops or video zones).

5. Schedule Sheet:
   - Use ADOT layout format,
   - Distinguish between existing and new equipment and conductors by using dash symbology and light pen weight for existing and solid symbology and bolder pen weight for new equipment and conductors, per ADOT symbology,
   - Distinguish between existing and new by using “existing” and “new” callouts in the Schedules,
   - Indicate locations by station and offset or “To Be Field Located” for all signal poles, cabinets and poles that are not tied to survey data,
   - Provide elevation data for pole and cabinet bases,
   - Indicate length of any Type A poles, when used,
   - Show specific quadrant to which signal mounts will attach to pole shafts,
   - Indicate locations of tenons along the length of the signal mast arm,
   - Show any internally illuminated street name signs or static signs,
   - Show specific quadrant to which pedestrian push buttons are intended to be attached, and show arrow to indicate direction of arrow on placard,
   - Town of Queen Creek's Traffic Signal Pole Schedule Notes, Traffic Signal Conductor Schedule Notes & project-specific notes,
   - In areas where signal poles are placed in areas of future development, indicate elevation of signal pole base so structure elevation is compatible with future grades, and
   - Include IMSA cable color code and conductor assignment by phase and circuit type, per the Town of Queen Creek Standard Detail.

6. Detail Sheets:
   - Include sheets showing all of the applicable Town of Queen Creek Standard Details, as part of the plan set (verify current versions),
   - Additional project-specific details shall be created and used in plan sets as needed or required by project needs, and
   - Scale of drawings shall be sufficient for their purpose.

7. Electrical Service

All electrical services and modifications to existing electrical service resulting from relocation, reconstruction or additional loads being added shall be closely coordinated with the power provider by the Designer.

All traffic signal installations shall provide a backup power system (UPS). Manufacturers of meter pedestal and UPS systems approved for use in Queen Creek are listed in the AML.

The UPS must provide sufficient power, including future signal loads, to operate the traffic signal in a cycling mode for a minimum of 4 hours. The Designer shall indicate on the plans, the size (amp-hour rating) and quantity of batteries needed to meet this minimum specification.

The Designer shall insure that the specific proposed meter pedestal is acceptable to the utility company. This generally entails coordination during the negotiation of the power service location with the utility representative.

Typically, the controller cabinet and electrical service should reside on the same corner or quadrant of the intersection. Design shall route conduit from service pedestal directly to the controller cabinet.

Plans shall contain the name, company and telephone number of the electrical service utility company contact. Any specific instructions from the utility company regarding service installation shall be clearly shown on the plans, on the signal plan view sheet. The Designer shall determine the complete service process in discussions with the utility and identify and constructions costs anticipated to be paid to the utility company for establishing service, and seek direction from the Town TE as to who will pay what costs, and reflect those responsibilities in the construction documents. Items that may cause construction costs may include extension of power lines to the desired service locations, setting of transformer pads or pole-mounted transformers, permits, inspections, or equipment and boxes required by the utility company.

Plans shall indicate the service address, as assigned through the Town of Queen Creek, so contractor's permit corresponds to correct service address and does not conflict with other Town-assigned addresses in the area.

The Designer shall be responsible for verifying the size of conduit to the utility source (pole, transformer base, etc.) and exact process and materials the Contractor will be expected to provide (conduit stubbed out of pedestal foundation, conduit sweep at base of service pole, quadrant of pole for conduit attachment, trench only requirements, depth of conduit, inspection procedures, required pull ropes/mule tape, who is to supply/pull service conductors etc.) with the utility company. Such processes shall be detailed in the Special Provisions and/or plan notes.

The Designer shall be responsible for providing the power company with any required load calculations as part of the service arrangement process.

Meter Method

Typically, located as close to the service point as allowed by the utility company, 5-foot minimum clear distance, within Town right-of-way. This approach minimizes the distance uncontrolled by the meter pedestal breakers. Placement of meter pedestals or conduit in easements is typically not allowed, unless specifically approved by the Town TE.

Typical traffic signal service shall be 100 amp, 120/240 volt, 3-wire, single-phase.

Breakers shall be labeled as to what they serve.

If located in an area where vehicles may come into contact with the meter pedestal and UPS, use guard posts to protect the cabinet location.

8. Signal Poles

The Town of Queen Creek utilizes tapered galvanized steel poles conforming to and approved by ADOT. The only exception to the tapered requirement is for pedestrian push button posts. All Type A poles shall be tapered.

The use of span wire supports, for temporary or permanent signal installations shall be used only when specifically approved or directed by the Town of Queen Creek Transportation Engineer.

Signal poles designed for an interim condition shall be located in their ultimate location, whenever possible, to minimize relocation and modification upon future widening, but within Town right-of-way or legally documented traffic control easement. The Designer is cautioned to verify ground elevations for the present and future conditions so signal poles located to accommodate future conditions are not too low or too high when the ultimate widening or improvement is provided.

ADA access requirements demand that any pole with a pedestrian push button provide a flat paved concrete, asphalt sidewalk or walkway up to the face of the structure, and has specific requirements for size of flat area in proximity to the pedestrian push button. All structures with pedestrian pushbuttons must account for this requirement, including those adjusted in response to field conditions during construction.

Designers are cautioned to carefully evaluate placement of poles outside of the clear zone for locations with no vertical curb or other protective barriers. Barrier systems are required if poles cannot be placed outside the clear zone in such cases as well as cases where a pole foundation protrudes above the ground line more than 6 inches.

9. Signal Heads

Traffic signal heads shall be 12-inch lens diameter, LED, conforming to the Town of Queen Creek Approved Materials List, and compliant to ITE specifications.

Designers shall attempt to align the end of the mast arm head with the center of the left turn lane as much as possible. Recognizing that the mast arms are in 5-foot increments, if perfect alignment is not possible, shorten the arm to the next 5-foot interval so the head aligns somewhere between the center of the left turn lane and the projection of the left turn lane line.

Provide one mast arm signal head per through lane, aligned over the center of the lane.

Designs that are intended to be temporary on roadways known to be widened and improved in the known future shall incorporate the head and pole placement policies described herein, or otherwise approved for deviation by the Town TE on a case by case basis. The intent is to minimize future relocation and modifications of costly signal poles and components.

One “far-right-hand" side and one “far-left-hand" side signal face shall be provided for all approaches, in addition to mast arm displays.

Approaches with dual left turn lanes shall have two mast arm left turn heads in addition to the far-left head.

Approaches with right turn overlap arrows shall typically provide a near-right and far-right indication containing the right turn arrows in addition to the associated through phase indications in a 5-section signal face.

All signal heads shall have 5-inch louvered backplates.

All signal displays and placement shall comply with the MUTCD.

10. Pedestrian Features

All traffic signals shall provide man/hand symbol countdown LED pedestrian signals and ADA-compliant pedestrian pushbuttons, as listed on the Town of Queen Creek AML.

Typically, all corners will be connected with crosswalks unless specifically directed otherwise by the Town TE. Designers shall seek project specific direction if an approach is a private driveway.

The use of pedestrian equipment to facilitate actuation by the handicapped are required by the ADA.

Designers should evaluate the need for any special accommodations needed for bicyclists and provide associated features as approved by the Town TE.

The design and installation of stand-alone pedestrian crosswalks (unsignalized intersection) with electrical devices to control or warn oncoming traffic of pedestrians are required to be reviewed and approved in accordance with the procedures set forth in these guidelines, including justification by an approved engineering study.

The use of audible pedestrian signals and/or push buttons is allowed only when approved by the Town TE in response to site specific needs or circumstances.

Designers shall comply with the pedestrian push button placement requirements of the MUTCD and evaluate placement based on MUTCD and ADA provisions. Some locations may require additional pedestrian push button posts to accommodate these accessibility requirements. Designers are encouraged to arrange poles to reduce the number of obstacles to vision impaired users, where possible.

11. Detection

The Town of Queen Creek utilizes video detection, as shown on the AML.

Designers shall indicate detection zones on the plans, by phase, so Town staff can subsequently set up the video detection as intended.

Cables from the video detection sensors (cameras) shall be compatible with the system being used, and be installed unspliced from sensor to the traffic signal control cabinet.

Video detection sensors shall be typically located on the street light mast arm, to allow a more vertical view of oncoming traffic. Locations without available street light mast arms may utilize a riser pole attached to the signal mast arm. Placement of any video detection sensor must take into consideration the field of view from the proposed mounting location and elevation, and account for approach curvature and vegetation growth obscuring the line of sight.

One spare video detection camera with mounting bracket shall be provided, as a spare, to the Town in addition to the camera, mounting bracket, cables, surge protection and interface to be used in the field.

12. CCTV

All new signals shall provide a pan-tilt-zoom CCTV camera complying with the AML. Existing signalized intersections being modified as part of a project, that presently do not have CCTV shall add CCTV as part of the project.

CCTV cameras shall be placed at a minimum 28’ height on one corner (typically the controller corner), with associated connections to the traffic signal controller cabinet. The Designer shall verify adequate fiber connectivity and switch capacity within the cabinet and specify provisions for any additional equipment necessary to result in the ability to communicate with the traffic signal controller and the CCTV through the controller cabinet equipment.

Camera location shall be coordinated with and approved by the Town TE, and shall be placed to offer the best visibility for traffic observation, without interference from trees, buildings or roadway curvature.

One spare camera with mounting bracket shall be provided, as a spare, to the Town in addition to the camera, mounting bracket, cables, surge protection and interface to be used in the field.

13. Lighting

Street lighting shall be provided, typically on each “far side” corner, as a component of the signal pole. Wide arterial to arterial intersections may be directed by the Town TE to be provided with two street light fixtures, one at the beginning of radius, and one at the end of radius.

Some situations, such as a T intersection, will require a Type G pole to support a street light on a corner that otherwise does not have a traffic signal mast arm pole.

Lighting shall typically be 250 W/120 VAC horizontal cutoff HPS fixtures, conforming to the Town of Queen Creek AML.

120 volt LED lighting may be used, if approved by the Town TE, only in isolated areas with no adjacent lighting where color rendition from competing types of lighting sources would be an issue. Designer shall seek direction from the Town TE if the AML does not list an LED fixture suitable for the application at hand.

Lighting shall be controlled by a photocell mounted on top of the traffic signal controller cabinet, and a magnetic contactor mounted inside of the traffic signal controller cabinet.

The Designer shall verify and account for any overhead obstructions, and resolve such obstructions as necessary to obtain appropriate clearance distance or approved alternative lighting arrangements. The Designer shall provide a minimum 12' radial clearance from most energized overhead lines encountered in an urban electrical distribution system. High voltage lines (usually above 13.5 Kv) require larger distances, based on voltage of the line.

14. Controller Assembly

A new traffic signal controller assembly shall be furnished for all new traffic signal installations and comply with the Town of Queen Creek AML. Cabinets shall be furnished with all load switch sockets, input card rack slots, flasher pack sockets, and flash transfer relay sockets occupied with components, regardless of intersection configuration.

Existing signals being modified shall have any and all additional or modified controller cabinet equipment identified in the project plans, and furnished by the project. The Designer shall obtain direction from the Town TE regarding any requirements for any data transfer devices to be furnished as part of a project.

A Type IV controller cabinet, on concrete foundation, shall typically be used, unless directed otherwise by the Town of Queen Creek. Elevator bases are not used in Queen Creek.

Typically, locate the controller cabinet and foundation in a safe location that offers reasonable access and good visibility of the displays for maintenance personnel, is not in a low area where water will collect, away from sprinklers, does not obscure visibility to drivers observing oncoming traffic, and is protected from collision but not a safety nuisance to pedestrians or others.

The controller cabinet should typically be located on the same corner as the electrical service source, but not at the expense of the other factors listed above, or pedestrian safety.

Designers shall use guard posts to protect the cabinet location if placed in any area subject to vehicular contact, such as at edge of a parking lot, close to a curb radius, open are with no curb, etc.

Controller cabinets shall not be painted or have decorative design overlays or decals, unless specifically approved or directed by the Town TE.

15. Conduits

Material

PVC conduits, of adequate size, shall be used for all underground electrical raceway installations.

Conduits above ground or otherwise exposed to weather or sunlight shall be rigid galvanized conduit to the end of the first conduit section or sweep that is below ground, at which point a rigid-to-PVC adapter may be used to convert to a PVC run underground. Intermediate metallic conduit (IMC) shall not be used.

Conduit required for connecting signal mountings and equipment on wood poles used for a span wire signal, may be PVC-coated flexible conduit.

Any new conduits installed and scheduled to be unoccupied by cables or conductors shall be furnished and installed with a 2,500-pound detectable mule tape. Detectable elements shall be connected together and/or to the ground wire in each pull box, resulting in a continuous detectable circuit. Existing conduits with existing mule tape, scheduled to be occupied with new cables or conductors as part of the project may be used as a mechanism for pulling in new cables and conductors if a detectable element (new mule tape, tracer or ground conductor) are being installed.

Installation Method

Conduits under any existing paved or concrete areas (streets, driveways, sidewalks, parking areas, paved alleys) that would otherwise not be disturbed by associated street improvements shall be bored, or directional driller, as required by the ADOT Standard Specifications.

Trenching shall be allowed only in unpaved areas, unless otherwise preapproved, in writing, by the Town of Queen Creek TE. Trench warning tape, conforming to ADOT specifications and placement shall be utilized when conduit is installed in open trench.

Designers are encouraged to consider the use of directional drilling for conduit necessary for long runs, parallel to the street (interconnect conduit, as example) to avoid disturbing established landscape features and irrigation systems.

Conduit crossing or placed within 5 feet of any underground utility shall require potholing of the utility to determine exact location, depth and composition. The Town requires the use of vacuum excavation or other approved non-destructive methods for potholing as a means of providing a higher level of safety to workers and reducing the potential for damage.

Size

Conduits shall utilize sizes in ½ inch increments, and shall be sized such that no more than 40% of the cross sectional area conduit capacity is utilized. Calculations of conduit capacity may be requested by the Town of Queen Creek TE with the 60% submittal, in situations where capacity may be an issue.

Street crossing conduits shall consist of a minimum of two 3-inch conduits. Generally, one conduit should be used for electrical circuits (IMSA cables, lighting, common, bond, etc.), and one for non-electrical circuits (video detection, interconnect cables, preemption cables), assuming the above stated capacity constraints can be met.

Conduits between the controller cabinet and first pull box on the controller cabinet corner shall typically be three 3" PVC conduits, with one containing IMSA and other electrical circuits, one for interconnect cables/fiber, and the other containing video detection and non-electrical circuits.

The controller cabinet shall also have a 1” PVC sleeve in the foundation, vertically, for installation of a ground rod, and a separate 2 ½” conduit for electrical service conductors routed from the meter pedestal/UPS.

The meter pedestal shall have typically a 2 ½” conduit to the service pole/transformer, and a 2 ½” conduit to the controller cabinet.

Conduits into Type J, K, Q, R, V and W signal poles shall be 3-inch PVC conduits, assuming the above capacity constraints can be met. Conduit into Type A poles shall be 2-inch PVC.

16. Pull Boxes

Size

All traffic signal electrical pull boxes shall conform to the Town of Queen Creek AML, and provided with locking devices and appropriate wording on lids (TRAFFIC SIGNAL).

A No. 7 size pull box with 24" depth shall be utilized on the controller cabinet corner. At locations where an existing signal is being modified, replacement of the controller corner pull box to comply with this provision is required. Replacement may require adjustment of existing conduits to allow the conduit to route under the extension unit and up into the box appropriately.

A No. 7 pull box shall be utilized on each remaining corner/quadrant. No pull boxes should be placed in medians.

No. 5 and No. 3 ½ pull boxes are typically not be used, unless directed by the Town TE for a project specific purpose.

No. 9 pull boxes, per the latest ADOT ITS Standard Drawings, shall be used as a fiber splice point box when installing fiber interconnect. This box will house the fiber splice closure and coiled fiber cable and allows entry on any of the four box walls, and has a lockable lid to discourage vandalism and theft.

Location

Locate pull boxes out of areas subject to vehicle travel. Places where the entire area is subject to vehicular traffic, and no reasonable location otherwise exists, the use of heavy duty boxes and traffic-rated lids shall be required and indicated on the plans.

Pull boxes shall avoid placement in sidewalk areas, where possible, and no pull boxes shall be located in a wheelchair ramp area designed for wheelchair travel (such as the ramp itself).

Pull boxes and conduit placement in existing concrete areas shall require removal and replacement of complete slabs to existing joints. No slot cutting or saw cutting of areas inconsistent with original slab joint design shall be allowed.

Care shall be exercised in respecting existing landscaping to the extent possible in locating pull boxes and conduits, to minimize disruption to existing facilities where possible. Pull boxes shall not be placed in areas subject to frequent moisture, such as low areas or within the reach of sprinklers.

Modifications to Existing Intersections

Any intersection with an existing traffic signal being modified, pull boxes affected by the modification shall be examined in the field prior to design. The Designer shall be responsible for verifying that all conduits, wiring, poles, cabinets and equipment are documented based on actual conditions, and not rely solely on record drawings as the basis of design or current conditions. This requirement includes coordinating with the Town's TE in advance, and opening every pull box and documenting the size and contents of all wiring, documenting the quadrant of signal and pedestrian button attachments, and documenting the size and type of signal and pedestrian heads as well as lighting fixtures.

Boxes with cracked lids, or boxes being entered for wiring purposes that do not comply with the size provisions shown above, shall be designed to be replaced with appropriate sized box. In such cases, plan notes and Special Provisions shall clearly indicate that new stone sump shall be used.

Any existing pull box that is proposed to have new conduit(s) entering the box shall be removed and replaced with a new pull box and completely new stone sump and bricks, and so noted on the plans.

Pull boxes located in existing concrete shall require the complete slab to be removed and replaced. No “slot” saw cutting shall be planned in any design.

17. Conductors

Where indicated that the conductors are to be sized for associated loads/uses (typically applicable to long distances, unusual loads and power runs), load and voltage drop calculations shall be performed by the Designer and provided to the Town with the 60% review submittal package. The maximum tolerable voltage drop between the controller cabinet and field device shall not exceed 3%. Typically, assuming the use of LED indications, #14 AWG IMSA cable is sufficient.

Splicing of electrical conductors for street lighting and commons shall occur only in pull boxes and cabinets. IMSA cables, CCTV cables, preemption cables and interconnect cables shall run unspliced from controller cabinet to device. Under no circumstances will splicing be allowed within any conduit.

IMSA Multi-Conductor Cable

IMSA (refers to International Municipal Signal Association specifications) multi-conductor cable shall be used to provide electrical circuits to all traffic signals, advance flashers, blank-out signs, pedestrian signals and pedestrian pushbuttons. IMSA cable may be used to provide linkage to other electrical circuits, such as railroad cabinets, beacons, internal to structures, etc.

Conductor size and number of conductors per cable shall be appropriate for the intended number of displays, associated electrical loads, plus future left and right turn arrow phases per each signal pole. Minimum size of conductor shall be #14 AWG, and all IMSA cable conductors shall be solid conductors, not stranded.

Designers shall minimize the variety of IMSA cable sizes, and shall utilize the common cable sizes of 4-, 7- and 25-conductor sizes. Typically, a 25-conductor IMSA cable is sufficient for most applications (inclusive of "future" phases), unless unique signal arrangements are used.

Two 25-conductor IMSA cables shall be routed from the controller cabinet to the pull box on the controller corner, then around 3 crossings of the intersection to connect all 4 corners. One crossing, to the farthest corner diagonally opposite of the controller corner, will not be occupied by 25-conductor IMSA cable. In each corner pull box, only the conductors serving that corner shall be spliced, leaving all others unspliced and uncut. Designers shall insure that the cable color code, per the Town of Queen Creek, is included in the plans.

Between a corner pull box and the pole, a 7-conductor cable shall run unspliced from the pull box, where spliced to the appropriate 25-conductor cable, to a the signal head at the end of the mast arm. Similar 7-conductor cable applications apply to any 4-section or 5-section signal heads as well as to locations of any future 4 or 5-section signal head (typically future left turn phases).

Between a corner pull box and the pole, a 4-conductor cable shall run unspliced from the pull box, where spliced to the appropriate 25-conductor cable, to remaining 3-section signal heads, pedestrian signal heads or pedestrian push buttons. If more than one pedestrian push button occupies a pole, one 4-conductor cable shall be run to each button from the pull box.

Street Lighting & Internally Illuminated Street Name Signs

All lighting conductors shall consist of two individual conductors, XHHW insulation, black and white in color, of adequate size to accommodate at least four 120 volt luminaires at each intersection, sized considering voltage drop over the distances to the street lights.

Separate watertight in-line fuses shall be provided in the pull box closest to any pole that has a luminaire or internally illuminated street name signs.

Signal Common

One signal common of adequate size (#8 AWG minimum size) to accommodate the electrical load of the installed signals shall run from the controller cabinet, around the intersection to each corner pull box, usually in the same conduit occupied by the IMSA cables. This conductor shall be stranded, with white insulation.

This signal common conductor is connected to the individual 4 and 7-conductor cables in the corner pull box, with a split-bolt connector.

Pedestrian Pushbutton Common

The pedestrian pushbutton common shall be contained within the IMSA cables to each pole, and connected to the ped button common of the 25-conductor IMSA cable.

Video Detection Cables

Video detection cables shall be compatible with the video detection system being installed, comply with the Town of Queen Creek AML, and shall run unspliced from the loop pull box, to the controller cabinet.

Any proposed signal modifications that disturb any conduits containing video detection cables (rerouting conduits, as example) shall require installation of new cable from the cabinet, back to the affected devices to accomplish the above requirement.

Absolutely NO SPLICES are allowed in video detection cables!

Emergency Vehicle Preemption Cable

Emergency vehicle preemption cable shall be per the Town of Queen Creek AML, and shall run unspliced from the controller cabinet to the sensor.

Any proposed signal modifications that disturb any conduits containing emergency vehicle preemption cables (rerouting conduits, as example) will require installation of new cable from the cabinet, back to the affected preemption sensors to accomplish the above requirement.

Absolutely NO SPLICES are allowed in preemption cables!

In the controller cabinet, the Designer shall arrange for appropriate terminal strips/panels, interface cards and connectors, and identify same on the project plans.

Interconnect

All traffic signals, including existing signals being modified, shall have interconnect facilities added/included as a part of the design. All associated equipment, such as switches, splice closures, Gator Patches, radios, antennas, all connectors and cables shall be clearly called out in the project plans, including spares, where indicated herein or when directed by the Town TE.

Every new or modified traffic signal cabinet shall be provided with two switches compatible with the media to which they are being connected. One switch is intended for use in the cabinet and the other shall be provided to the Town as a spare.

The Town TE will provide the Designer direction on the extent of the interconnect facilities to be provided on a case by case basis. However, the general practice will be to provide interconnect conduit and cable to any adjacent signal within ½ mile that is owned by the Town of Queen Creek and does not currently have interconnect facilities.

Interconnect cable shall be 144-fiber loose tube, single mode, fiber optic cable in trunk runs between intersections. Runs between splice vaults and the controller cabinet shall be 12-fiber loose tube, single mode, fiber optic cable Gator Patch, with connectors and fiber patch cables connecting to the switch in the controller cabinet.

Plans shall detail all appropriate fusion splicing, enclosures and identify size and locations of splice enclosures and end treatments.

Locations where installation of conduit is determined by the Town TE to be impractical or of limited value, the Designer may be directed to implement a wireless solution, using radios on the Town of Queen Creek AML. In all cases of wireless interconnect, the project plans shall call for two or more radios - even when there may already be an existing radio at one end of the link. One additional radio than needed to complete a wireless link shall be required to be furnished as part of the project, and becomes a "spare" to be provided to the Town.

The design of wireless links requires the Designer to be knowledgeable of wireless technologies and requires site evaluation, including frequency survey, determination of type and size of antenna, determination of bandwidth needs, and line of sight evaluation. Such evaluations shall be documented and provided to the Town as part of the plans submittal process for review and approval.

Devices, such as the traffic signal controller, CCTV and any other devices requiring communications, shall be provided with all appropriate cables and connectors to accomplish all connectivity. Designers are required to specify, in detail on the plans, all required materials and equipment and account for any spares required by the Town TE. The Designer shall consult with the Town of Queen Creek to identify specific fibers to connect in trunk lines to avoid conflicts of fiber assignment.

Grounding

A #8 AWG solid copper conductor, with green insulation, shall be used in all PVC conduits containing voltage circuits, and any otherwise empty conduits. The #8 conductor in empty conduits will be used for locating and future pulling purposes. The #8 conductor in occupied conduit is considered a ground wire. The ground wires are connected together in each pull box and connected to the ground rods to form a continuous grounded system.

Copper-clad ground rods, 5/8" x 10', shall be provided in the base of the meter pedestal, base of the controller cabinet, and in the pull box located on the corner diagonally opposite the controller corner, with the ground wire attached. Plans and bid items shall make note of the extra pull box ground rod.

18. Interconnect

A No. 9 pull box shall be used on all interconnect routes at the corner where the fiber will be spliced to the branch cable entering the signal controller cabinet or other ITS device, as well as between intersections when spaced far enough apart that signal to signal distances are impractical for a fiber pull. No. 7 pull boxes shall be used along the length of a fiber interconnect route, allowing the fiber to be secured within the lockable No. 9 box.

A No. 9 pull box shall also be provided at each traffic signal controller corner, with a 3-inch conduit directly to the controller cabinet, bypassing the No. 7 pull box. The interconnect duct shall then connect to this box, and splice enclosure and coiled fiber cables contained within the No. 9 box. This provision applies even in the event the interconnect conduit is to be installed in the future, with approximately 5 to 10 feet of the interconnect conduit installed in both directions from the box to avoid future disruption of the box when connecting the future interconnect conduit system. (The "future conduit" situation implies the interim use of wireless communication solutions.)

No. 9 pull boxes shall be placed at no more than 1/4 mile intervals, at existing and proposed traffic signal locations and at all one mile existing and future arterial streets.

Lids of No. 9 pull boxes shall have the words "FIBER OPTIC".

The Designer is responsible to determining the specific fibers to be spliced and provide splicing details in the project plans.

19. Removal and Salvage

Any existing traffic signal poles, arms, equipment and cabinets shall be salvaged and transported to the location identified by the Town TE. The project plans shall clearly convey that the contractor is responsible for inventorying, producing a list of items being salvaged, load, transport and unload all salvaged materials and place it where directed by the Town TE. The Town is not to be expected to transport, load or unload any materials.

Existing wiring, trash, debris, excess spoil, concrete boxes, and wood that will not be reused shall be removed by the Contractor, at his expense, and disposed of.

Existing foundations that will not be reused shall be removed or demolished to at least six inches below grade and the ground replaced, compacted and restored to match the surrounding area.

The general project areas is to be left completely clean of evidence of construction, including raking of dirt and decomposed gravel areas, restoration of any damaged landscaping and irrigation systems and sweeping of all concrete and asphalt surfaces.

20. Bid and Construction Phase

Permits

All Permits and acquisition of Standards referred to herein shall be solely the responsibility of the Contractor and the Designer, as applicable. Plan notes or specifications shall clearly convey that the acquisition and payment for any and all permits necessary for the complete and operational traffic signal installation shall be shall be the responsibility of the Contractor, unless otherwise determined by the Town TE. Certain Town issued permits for capital projects may have permit fees waived at the discretion of the Town TE.

Equipment Submittals

All new and modified traffic signals shall bear a note on the plans indicating that the contractor is to provide 1 electronic PDF set of equipment submittals to the Town of Queen Creek Transportation Engineer for review and approval prior to ordering or installing any equipment. Level of detail and procedure of what the material submittals should contain should be the same as the ADOT process.

Anywhere these criteria or the current Town of Queen Creek Approved Materials List specifies a specific brand and model, that brand and model must be provided without exception, unless Federal funding is used or the Town TE waives this requirement.

Record Drawings

All new or modified traffic signal projects shall make provisions for providing the Town TE with a PDF redlined set of plans clearly and legibly indicating deviations from the intended design, in “As-Built” fashion, signed and sealed by an Arizona Registered Professional Engineer. It should be recommended to use a PDF editor, such as Adobe, to insure legibility of text.

No project will be granted Final Acceptance by the Town until record drawings are submitted and approved by the Town TE.