

Traffic Signal Design Manual

November 2014



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Introduction

Purpose

The second edition of the City of Mesa Traffic Signal Design Manual is an update to the first edition which was originally issued in October 2009. The second edition supersedes and replaces the first edition in its entirety.

The purpose of the Traffic Signal Design Manual is to expand upon and identify guidelines, practices and standards that should be applied during the design of a traffic signal within the City of Mesa, Arizona. Roadway lighting requirements are addressed only to the extent that intersection lighting is provided at signalized intersections.

The intended audience of this manual is design consultants, contractors, developers, and City of Mesa staff including those in the Transportation Department, the Engineering Department and the Development & Sustainability Department.

Application of the Manual

This manual assembles information developed by the City of Mesa regarding typical traffic signal design and construction. It is meant to help with the production and review of plans by providing equipment selection, layout and placement guidelines, as well as plan formatting instructions and standard notes. Contractors and City of Mesa staff can also reference this manual during the construction of traffic signals. Designers should be able to use the information presented in this manual to develop plans consistent with City of Mesa standards, as well as national standards including the Manual on Uniform Traffic Control Devices (MUTCD). Users of this manual are encouraged to use engineering judgment when site specific conditions exist that are not addressed in this manual.

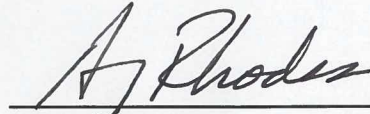
Revision Process

All users of this manual are encouraged to suggest changes that would improve the manual. Suggestions should be submitted in written or diagram form to the City of Mesa Transportation Department's ITS Group.

Questions

If the user encounters an error or ambiguity or conflict with other standards within this manual, the user is encouraged to contact the City of Mesa ITS Engineer to resolve the situation.

Approvals



Avery Rhodes, P.E.
ITS Engineer
City of Mesa



Date



V. Alan Sanderson, P.E.
Deputy Transportation Director-Traffic Engineer
City of Mesa



Date

Revision History

Date: December 10, 2014

Location: Page 32, Chapter 7: Cabinets, Section: Equipment Requirements.

Description: Clarified responsibility of ordering a new point of service for developer initiated signals.

Chapter 1: Starting a New Project

There are several recommended activities that a traffic signal designer may consider before starting a traffic signal design for the City of Mesa. It should be understood that there are two general realms under which a project can be managed: public or private. Both types of plans should follow these guidelines. Public projects refer to traffic signal construction that is initiated by the City. Private projects refer to those which are initiated by a developer.

The City of Mesa Engineering Department manages public projects. Therefore, any overall project schedule or coordination issues will be handled through the designated Engineering Project Manager. Overall project plans are submitted to Engineering, and then traffic signal plans are reviewed by the City of Mesa Transportation Department once the plans are forwarded by Engineering.

The City of Mesa Development & Sustainability Department coordinates private project plan development. Similar to the public plan review, private development plans will be submitted to the Development & Sustainability Department, and then traffic signal plans are reviewed by the City of Mesa Transportation Department once Development & Sustainability forwards the plans.

Meeting with the Transportation Department

Although it is not required, a traffic signal designer may meet with City of Mesa staff prior to beginning the design. Meeting with the Transportation Department, the Engineering Department and/or Development and Sustainability is especially important for those designers who have not designed a project for the City of Mesa. This discussion can address all applicable traffic signal related items for the project such as:

- existing record drawings;
- current design standards;
- the project's design speed and posted speed limits;
- scope of the project;
- primary City of Mesa and design team contacts; and
- project schedule.

City of Mesa staff will identify any special or unusual issues they are aware of that will need to be addressed during the design of the project. This may include construction phasing, left-turn operations, pedestrian features, connection to the City's ITS fiber system, interaction with adjacent intersections, utility conflicts and other issues as appropriate.

CHAPTER 1: STARTING A NEW PROJECT**Post Meeting Communications**

The City of Mesa Transportation Department welcomes any meetings or correspondence that may be necessary after the initial meeting once the project is underway. However, any meetings, correspondence, issues or modifications will be shared with the managing department – Engineering or Development & Sustainability.

Field Visit

A field visit is strongly recommended before starting any traffic signal design. Although the designer should obtain any record drawings that are related to the intersection, such drawings may not always be accurate and up to date, therefore it is imperative that existing conditions be verified in the field. The traffic signal designer should visit the project site to inventory and identify physical features that may impact the traffic signal design.

The designer should locate all existing roadway and geometric conditions within approximately 250' of the intersection. The amount of roadway required to be shown depends on factors such as curves and adequate visibility. An inventory may include but is not limited to the following:

- Posted speed limit.
- Existing lane configurations, width and lengths (i.e. turn lanes).
- Median configuration (i.e. raised or painted), and dimensions.
- Driveway locations and operations of driveways (i.e. full access, limited access, right-in/right-out, etc.).
- Pavement markings.
- Roadway horizontal or vertical curvature and existing vegetation that may impact sight distance and signal head visibility.
- Curbs, gutters, sidewalks and ramps.
- Bus stops and/or shelters.
- Drainage ditches and irrigation structures.
- Utility boxes, cabinets or marked underground infrastructure.
- Overhead utility lines.
- Type and condition of existing pavements.

If the project is an upgrade to an existing traffic signal then the designer should obtain a copy of the record drawings for the existing traffic signal to help determine existing equipment. As previously mentioned, record drawings do not always accurately reflect field conditions, it is the responsibility of the designer to verify field conditions. An inventory of an existing traffic signal may include but is not limited to the following existing items:

- Traffic signal pole locations and types.

CHAPTER 1: STARTING A NEW PROJECT

- Traffic signal pole finish (i.e. galvanized, painted hunter green, etc.)
- Traffic signal foundation types
- Traffic signal heads and locations (i.e. pole or mast arm mount).
- Signal mast arm lengths.
- Luminaire mast arm lengths.
- Pedestrian signal heads and locations.
- Pedestrian detector types (accessible pedestrian signal vs standard) and locations.
- Pull Box locations and sizes.
- Controller cabinet location.
- Controller cabinet type.
- Power source location.
- Existing detection including video and/or in-ground loops.
- Existing communications cable and infrastructure.
- Existing and spare tenons on mast arms, if any.
- Street name sign types (i.e. internally illuminated vs. reflectorized aluminum)
- Emergency pre-emption devices.
- Conduits and conductors.
- Blank out signs.
- Other traffic control devices mounted to signal poles and/or mast arms.

Base Mapping

Detailed topographic mapping may or may not be required. This should be discussed with the City of Mesa project manager. Once a base map has been generated, a field visit with ITS staff is highly recommended as the major design elements can be determined in the field and sketched onto the base map. The designer should consider the potential for conflicts with existing utilities or other infrastructure for the specific intersection and scope of proposed traffic signal improvements when determining the need for topographic survey and mapping.

Standard Reference Documents for Traffic Signal Design

The following section describes some of the reference documents that will be useful when designing a traffic signal.

CHAPTER 1: STARTING A NEW PROJECT

2010 Americans with Disabilities Act Standards for Accessible Design

<http://www.ada.gov/regs2010/2010ADASTandards/2010ADAstandards.htm>

City of Mesa Standard Details

The City of Mesa Standard Details are available at the following address:

<http://www.mesaaz.gov/engineering/mesastandardandspecs.aspx>

Traffic signal details are in the M-90 series and fiber optic details are in the M-66 series.

http://www.mesaaz.gov/engineering/pdf/2014_Mesa_Standard_Details_and_Specifications/2014FOandTrafficSignalsDetailsOnly.pdf

The Standard Details are typically updated annually therefore it is important for the designer to make sure that they are using and referencing the most recent version of the Standard Details. It is not necessary to copy any of the Standard Details into the design plans; however, each standard detail should be referenced by drawing number in the design plans when appropriate. The designer should indicate on the plans which version of the details was used during design so that the contractor knows which version they will be required to use.

City of Mesa Engineering Procedure Manual: Engineering & Design Standards

<http://www.mesaaz.gov/engineering/pdf/EngineeringDesignStandards2012.pdf>

Equipment, materials and installation procedures should meet or exceed the current City of Mesa Engineering and Design Standards and Details unless noted otherwise in the construction documents or by direction in this manual.

Maricopa Association of Governments (MAG)

http://www.azmag.gov/communications/Specs_and_Details/

Equipment, materials and installation procedures should meet or exceed the current MAG standards unless noted otherwise in the construction documents or by direction in this manual.

City of Mesa Street Lighting

http://www.mesaaz.gov/engineering/pdf/2014_Mesa_Standard_Details_and_Specifications/2014LightingDetailsOnly.pdf

<http://www.mesaaz.gov/engineering/pdf/EngineeringDesignStandards2012.pdf>

While this manual is not intended to be a street lighting design manual, intersection lighting is included in traffic signal design. For this reason, street lighting should meet current City of Mesa street lighting details.

CHAPTER 1: STARTING A NEW PROJECT**Arizona Department of Transportation (ADOT) Documents**

The City of Mesa Standard Details make reference to the ADOT Standard Specifications and ADOT Signals and Lighting Standard Drawings for a number of items, such as signal faces, mounting assemblies, and other details, that the designer will also need to be familiar with.

ADOT Standard Specifications for Road and Bridge Construction

<http://www.azdot.gov/docs/business/2008-standards-specifications-for-road-and-bridge-construction.pdf>

ADOT Signals and Lighting Standard Drawings

<http://www.azdot.gov/business/engineering-and-construction/traffic/signals-and-lighting-standard-drawings/current>

ADOT Traffic Policies, Guides and Procedures

[http://www.azdot.gov/business/engineering-and-construction/traffic/policies-guidelines-and-procedures-\(pgp\)](http://www.azdot.gov/business/engineering-and-construction/traffic/policies-guidelines-and-procedures-(pgp))

Chapter 2: Plan Content

General Plan Layout

Traffic signal plans shall be developed in accordance with the requirements of the City of Mesa Engineering and Design Standards and Details.

A typical City of Mesa traffic signal plan set consists of two sheets as follows:

Sheet 1:

- General Notes
- Construction Notes
- Intersection Layout
- Pole Schedule
- Foundation Schedule
- Pull Box Schedule
- Painting Notes (if applicable)

Sheet 2:

- Conductor Schedule
- Street Name Sign Layout
- Legend
- Phase Layout and Phase Diagram
- Signal Spacing Diagram
- Details for any items not included in standard details (may be placed on additional sheet(s) as required). For example, certain utility companies may require supplemental details depicting minimum clearance requirements.

Traffic signal plan sheets shall be 36 inches x 24 inches and be drawn at a scale of 1 inch equals 20 feet. A larger scale of 1 inch equals 30 feet or 1 inch equals 40 feet may be used if absolutely necessary.

Provide a profile layout when vertical roadway alignment may impact traffic signal visibility requirements, (1 inch equals 40 feet scale for profile is acceptable).

Refer to the latest Engineering and Design Standards for typical plan sheet and title box requirements. The north arrow is typically in the upper right hand corner of the plan sheet with north pointing to the top (preferred) or right of the page. The City will provide the nearest suitable elevation benchmark which should also be placed in the upper right hand corner for reference. City benchmarks are typically located at land section corners and thus will be at most arterial/arterial signalized intersections; otherwise reference the nearest benchmark.

CHAPTER 2: PLAN CONTENT

Each of the following sections describes each element of the plan sheets in detail and contains an example of the element from a sample design. The complete design which is composed of the examples in this chapter is included as an appendix at the end of this document.

General Notes (Sheet 1)

General Notes are used to convey important information about the design and construction of the traffic signal. The notes below may be used as a starting point. The designer must tailor the general notes to the specific signal under design. The example notes shown below may need to be modified or amended, or notes may even be deleted if they do not relate to the specific project.

1. The City of Mesa requires at least one International Municipal Signal Association (IMSA) Level I and one level II certified traffic signal technician on site during all phases of any traffic signal work. It will be the responsibility of the contractor to provide verification of certification. If a job site is inspected and certified technician is not on site, a stop work order will be issued. Temporary and contract employees do not satisfy this requirement; they must be full-time permanent employees.
2. All traffic signal equipment and construction shall conform to the City of Mesa standard specifications, drawings and procedures (current version) supplemented by ADOT specifications and standard drawings.
3. Location of utilities shown on this plan are for reference only, the engineer does not guarantee these locations nor the fact that some may be left out. It is the responsibility of the contractor to contact Arizona Blue Stake and all involved agencies prior to construction.
4. Top of signal pole foundations and pull boxes shall be at the same elevation as the back of sidewalk per M-92.03 & M-93.01.
5. New conduit under roadway shall be placed by jacking or boring method (M-18). Contractor shall not trench existing pavement without prior approval of engineer.
6. Contact appropriate utilities for utility location prior to start of construction:

Southwest Gas	Gas	City of Mesa	Water
City of Mesa	Sewer	City of Mesa	Street lights
City of Mesa	Storm drain	City of Mesa	Electricity
Cox	Cable TV	SRVWUA	Irrigation
Salt River Project	Electricity	Century Link	Telephone
Arizona Blue Stake	(602) 263-1100		
7. All new vehicle and pedestrian indications shall have LED indications. All new pedestrian indications shall be countdown type. Specifications for LED modules are available at: http://www.mesaaz.gov/transportation/Traffic_Signals_Specifications.aspx.
8. Contractor shall provide ADA access pad to pedestrian push buttons to meet all ADA accessibility requirements (M-44.01.1 and M-44.01.2).

CHAPTER 2: PLAN CONTENT

9. Mounting location and orientation of all pedestrian indications and side mount signal indications shall be confirmed with the traffic signal inspector in the field prior to drilling poles.
10. Existing vehicle detection shall be restored within two weeks of its removal or damage. Longer outages or exceptions will require special approval from the City.
11. Contractor is responsible for obtaining construction and temporary traffic control permits from the City of Mesa, from the Arizona Department of Transportation (if applicable) and from the Maricopa County Department of Transportation (if applicable).

GENERAL NOTES

1. THE CITY OF MESA REQUIRES AT LEAST ONE INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION (IMSA) LEVEL I AND ONE LEVEL II CERTIFIED TRAFFIC SIGNAL TECHNICIAN ON SITE DURING ALL PHASES OF ANY TRAFFIC SIGNAL WORK. IT WILL BE THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE VERIFICATION OF CERTIFICATION. IF A JOB SITE IS INSPECTED AND A CERTIFIED TECHNICIAN IS NOT ON SITE, THE JOB WILL BE SHUT DOWN.
2. ALL TRAFFIC EQUIPMENT AND CONSTRUCTION SHALL CONFORM TO THE CITY OF MESA STANDARD SPECIFICATIONS, DRAWINGS AND PROCEDURES SUPPLEMENTED BY ADOT SPECIFICATIONS AND STANDARD DRAWINGS.
3. LOCATION OF UTILITIES SHOWN ON THIS PLAN ARE FOR REFERENCE ONLY. THE ENGINEER DOES NOT GUARANTEE THESE LOCATIONS NOR THE FACT THAT SOME MAY BE LEFT OUT. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO CONTACT BLUE STAKE AND ALL INVOLVED AGENCIES PRIOR TO CONSTRUCTION.
4. TOP OF SIGNAL POLE FOUNDATIONS SHALL BE AT THE SAME ELEVATION AS THE BACK OF SIDEWALK (M-92.03).
5. NEW CONDUIT UNDER ROADWAY SHALL BE PLACED BY JACKING OR BORING METHOD (M-18). CONTRACTOR SHALL NOT TRENCH EXISTING PAVEMENT WITHOUT PRIOR APPROVAL OF ENGINEER.
6. CONTACT APPROPRIATE UTILITIES FOR UTILITY LOCATION PRIOR TO START OF CONSTRUCTION:

Figure 1: Example General Notes

Construction Notes (Sheet 1)

Construction notes are used to convey additional information about items in the intersection layout and/or pole schedule. The notes are identified with a numbered square which can then be used to point to specific items on the intersection layout or pole schedule. Some common construction notes that have been used on past projects are included below. The items in this list are by no means exhaustive, exclusive or mandatory. The designer must decide which notes are needed and modify and/or develop new notes if required.

1

CHAPTER 2: PLAN CONTENT

Example Construction Note 1: Remove conductors from existing conduit runs & dispose of properly. Remove & dispose of existing pull box. Remove conduit sweeps & dispose of properly. Abandon existing horizontal runs in place.

Example Construction Note 2: After new traffic signal system is completely operational, contractor shall remove existing traffic signal pole and/or equipment and return to the City of Mesa Transportation Department. Contact signal inspector for location to return equipment; make arrangements 48 hours in advance. Completely remove existing pole foundation & dispose of properly. Backfill & compact per MAG specifications.

Example Construction Note 3: Pull un-spliced Opticom cable from controller cabinet to the red section of the outboard head. Leave 3 feet of cable coiled in the red section of signal head and 10 feet inside controller cabinet.

Example Construction Note 4: Use extreme caution when excavating for this foundation due to close proximity of underground utility.

Example Construction Note 5: Dig down and intercept existing conduit and route to new #9 pull box.

CONSTRUCTION NOTES

- 1 DEMOLISH AND REMOVE EXISTING DIAGONAL SIDEWALK RAMPS AND CONSTRUCT NEW TYPE D RAMP PER MESA STD. DETAIL M-44.05, MODIFIED AS INDICATED.
- 2 CONSTRUCT NEW TYPE D RAMP PER MESA STD. DETAIL M-44.05.
- 3 CONSTRUCT NEW TYPE C RAMPS PER MAG STD. DETAIL 235-2.
- 4 NEW SIDEWALK RAMPS ON THE SE CORNER WILL BE CONSTRUCTED BY SAVE THE FAMILY.

Figure 2: Example Construction Notes

Intersection Layout (Sheet 1)

The intersection layout is the main part of a signal design which shows existing and proposed features. The layout is drawn at a scale of 1 inch equals 20 feet. Other elements of the intersection layout are described in the paragraphs below.

Show a minimum of two hundred and fifty feet (250') of each leg from intersecting centerline, unless curvature, visibility or additional equipment requires information beyond the 250' distance.

Show all existing and proposed utilities.

CHAPTER 2: PLAN CONTENT

Show all existing and proposed traffic signal equipment including the signal cabinet, conduits, poles, lighting mast arms, signal mast arms, signal heads, pedestrian heads, pedestrian detectors, preemption devices, video detection cameras, CCTV cameras, and blank-out signs.

Show the existing or proposed power service and connection to the traffic signal cabinet or uninterruptable power supply.

Show and label all video detection zones. Show and label all loop detectors.

Show connection between the signal cabinet and the City's fiber optic system, if applicable.

Show and dimension all right-of-way lines, face of curb and easements on all approaches. All proposed traffic signal equipment must be confirmed to be in the right-of-way or in an easement. If equipment must be placed outside of the right-of-way, the City of Mesa Engineering Department should be notified immediately for resolution.

Show all monument lines for offset reference.

Show all existing and proposed roadway striping with lane assignment arrows, stop bars, crosswalks and dimensions on all four approaches. Refer to Chapter 2 of the Engineering & Design Standards Manual and the Mesa Standard Details (e.g. M-46 & M-47 series) for additional guidance. If the necessary roadway striping extends beyond the intersection layout (traffic signal plan) sheet limits, then a specific striping plan sheet may need to be prepared.

Show all existing and proposed sidewalks and curb ramps. If the traffic signal is part of a larger project that includes civil plans, proposed sidewalk and curb modifications should also be shown on the civil plans.

Show existing vegetation which could be in conflict with any proposed equipment locations or that could impact required signal visibility distances.

Include boxed numbers to point to elements on the plan view that relate to the construction notes.

Include circled numbers to point to conduits on the plan view that correspond to the conduits identified in the conductor schedule.

Include letters in a hexagon that correspond to items in the foundation and pole schedules and point to those features on the plan drawing.

Include numbers in diamonds that correspond to pull boxes in the pull box schedule and use them to point to the pull boxes on the plan drawing.

CHAPTER 2: PLAN CONTENT

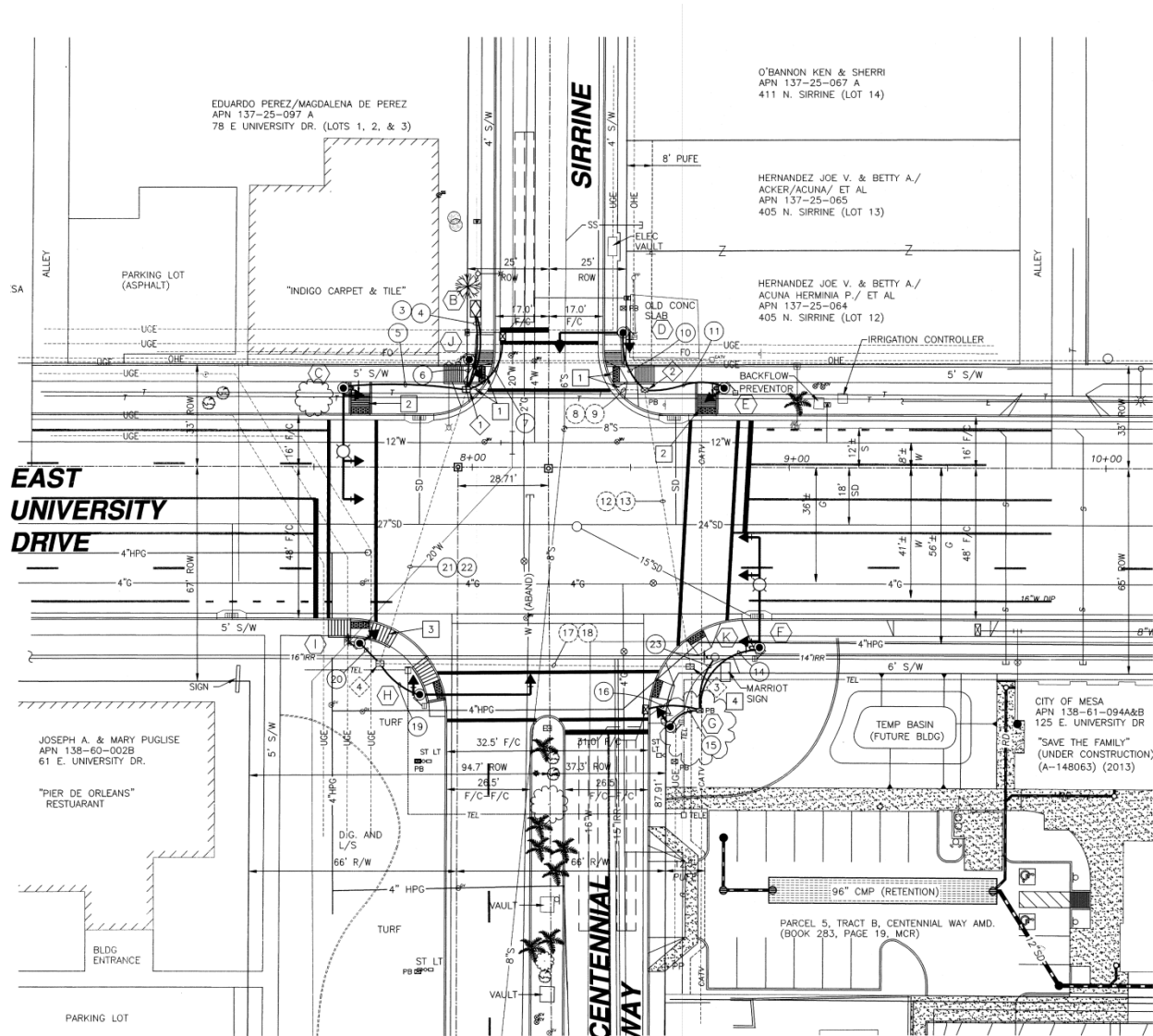


Figure 3: Example Intersection Layout

Pole Schedule (Sheet 1)

Poles are identified by a letter enclosed in a hexagon. Typically the service and cabinet are designated as A and B respectively. The poles are then typically numbered in a clockwise fashion beginning on the cabinet corner.

The pole schedule contains the pole identifier and information about the pole including type, mast arm length, luminaire mast arm and luminaire information if applicable, type and location of traffic signal heads, location of pedestrian signal heads, type of signal mounts, pedestrian push button locations and informational signs, blank out signs if applicable, video detection if applicable, internally illuminated street name signs (IISNS) if applicable, and any other relevant information including standard detail references or construction notes.



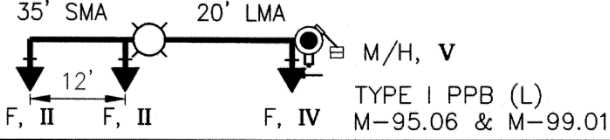
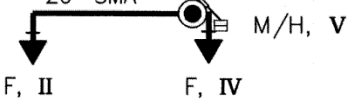
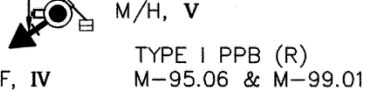
POLE SCHEDULE	
NO.	POLE LAYOUT
A	NEW/TBD 100 AMP SERVICE PEDESTAL (M-91.02) (CITY OF MESA ELECTRIC POWER SERVICE) 
B	NEW TYPE V CONTROL CABINET ON TYPE V FOUNDATION WITH PORCH SLAB (M-92.01) 
C	NEW COM TYPE Q POLE 35' (M-94.04, 05 & 06) WITH 35' SIGNAL MAST ARM, 20' LMA 400W HPS. 
D	NEW COM TYPE J POLE 22' (M-94.04, 05 & 06) WITH 20' SIGNAL MAST ARM. 20' SMA 
E	COM TYPE A POLE, 10' (M-94.03) 

Figure 4: Example Pole Schedule

Foundation Schedule (Sheet 1)

Foundations are also identified by a letter enclosed in a hexagon. The foundation schedule should correspond to the poles in the pole schedule. In other words, each foundation is directly associated with a pole in the pole foundation and therefore they should share the same letter designation. For example, pole E is set on foundation E.

The foundation schedule should indicate the foundation identifier, the type of foundation, the station and offset of the center of the foundation from the middle line of each roadway to the center of the foundation.

FOUNDATION SCHEDULE			
NO.	TYPE	FROM M _L OF SIRRINE	FROM Q _L OF UNIVERSITY DR
A	SERVICE PEDESTAL (M-91.02)	55.4' E	25.0' N
B	CONTROLLER CABINET TYPE V (M-92.01)	23.0' W	50.0' N
C	Q POLE (M-94.08)	65.0' W	25.0' N
D	J POLE (M-94.05)	23.5' W	42.6' N
E	A POLE (M-94.03)	55.4' E	25.0' N

Figure 5: Example Foundation Schedule

Offset distances (in both directions) from the monument lines can often be used as indicated in the above foundation and pull box schedule examples. Stationing along one or both monument lines is also acceptable, and may be particularly advantageous at mid-block locations. The use solely of state plane coordinates, even when verified by GPS methods, in foundation and pull box schedules is prohibited; station and offset information must also be shown.

Pull Box Schedule (Sheet 1)

Pull boxes are identified with a numeral inside of a diamond.

The pull box schedule should indicate the pull box identifier, the type of pull box, the station and offset of the center of the pull box or the offset from the middle line of each roadway to the center of the pull box. Pull boxes are numbered in a clockwise fashion beginning on the cabinet corner.

PULL BOX SCHEDULE (M-93.01)			
NO.	TYPE	FROM M _L OF SIRRINE	FROM C _L OF UNIVERSITY DR
1	NEW #8 PULLBOX	26.0' W	24.6' N
< 2 >	EXIST #7 BOX	30.4' E	24.5' N
< 3 >	EXIST #7 BOX	44.4' E	62.5' S
< 4 >	EXIST #7 BOX	53.6' W	61.8' S

Figure 6: Example Pull Box Schedule

Painting Note (Sheet 1)

Some locations feature painted signal poles. In these cases it is necessary to specify the finish color and the approved paint products. Approved painting products are shown at the following location:

<http://www.mesaaz.gov/transportation/pdf/ITS/ApprovedTrafficSignalPolePaintingMaterial.pdf>

PAINTING NOTE

ALL NEW & EXISTING SIGNAL POLES SHALL BE PRIMED AND PAINTED USING ONE OF THE FOLLOWING CITY OF MESA APPROVED POLYURETHANE PAINT PRODUCTS:

- A. TNEMEC SERIES UVX 740
 - B. CARBOLINE CARBOTHANE 134HG
 - C. PPG PITTHANE UG 95-812
 - D. SHERWIN WILLIAMS HI SOLIDS POLYURETHANE B65-350 SERIES B60V30
- FINISH COLOR SHALL BE QUARTZ GREY RAL 7039.

Figure 7: Example Painting Note

CHAPTER 2: PLAN CONTENT

Conductor Schedule (Sheet 2)

The conductor schedule is a table used to indicate the type and number of cables that are in each conduit. The conduit sizes are also indicated in this table. The wire size (AWG) and type of wire is included and the conductor schedule is populated with numbers to indicate the number of each type of cable that is in each individual conduit. Additional information about the conductor schedule can be added in notes below the conductor schedule if necessary.

CONDUIT RUN NO.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
CONDUIT SIZE IN INCHES		3	2	3	3	3	2	2	3	3	3	2	3	3	3	2	2	3	3	3	2	3	3	2	2	
AWG	CIRCUIT PHASE	NUMBER OF WIRES																								
#16 IMSA 19-1	CABLE #1 25 CONDUCTOR CABLE	1						1					1						1					1		
	CABLE #2 25 CONDUCTOR CABLE	1						1				1						1					1			
	7 CONDUCTOR CABLE			1	1					1	1			1	1					1	1					
	5 CONDUCTOR CABLE			3	1					2	1			3	1					2	1					
*	2 CONDUCTOR CABLE			1							1										1			1		
#18 SHIELDED PAIR CABLE, STRANDED	DETECTION #4			●1				▲2																		
	DETECTION #8			●2					●2				●2							▲1						
#10 XHHW	LIGHTING	2				2			2						2				2							
#8	GREEN, THHN/THWN																									
	STRANDED BOND WIRE																									
◆	OPTICOM PRE-EMPT CABLE			2	1					1				1	1											
FO	FIBER OPTIC CABLE																									
#10 XHHW	BLACK (POWER RUN)																								1	
	WHITE (POWER RUN)																								1	

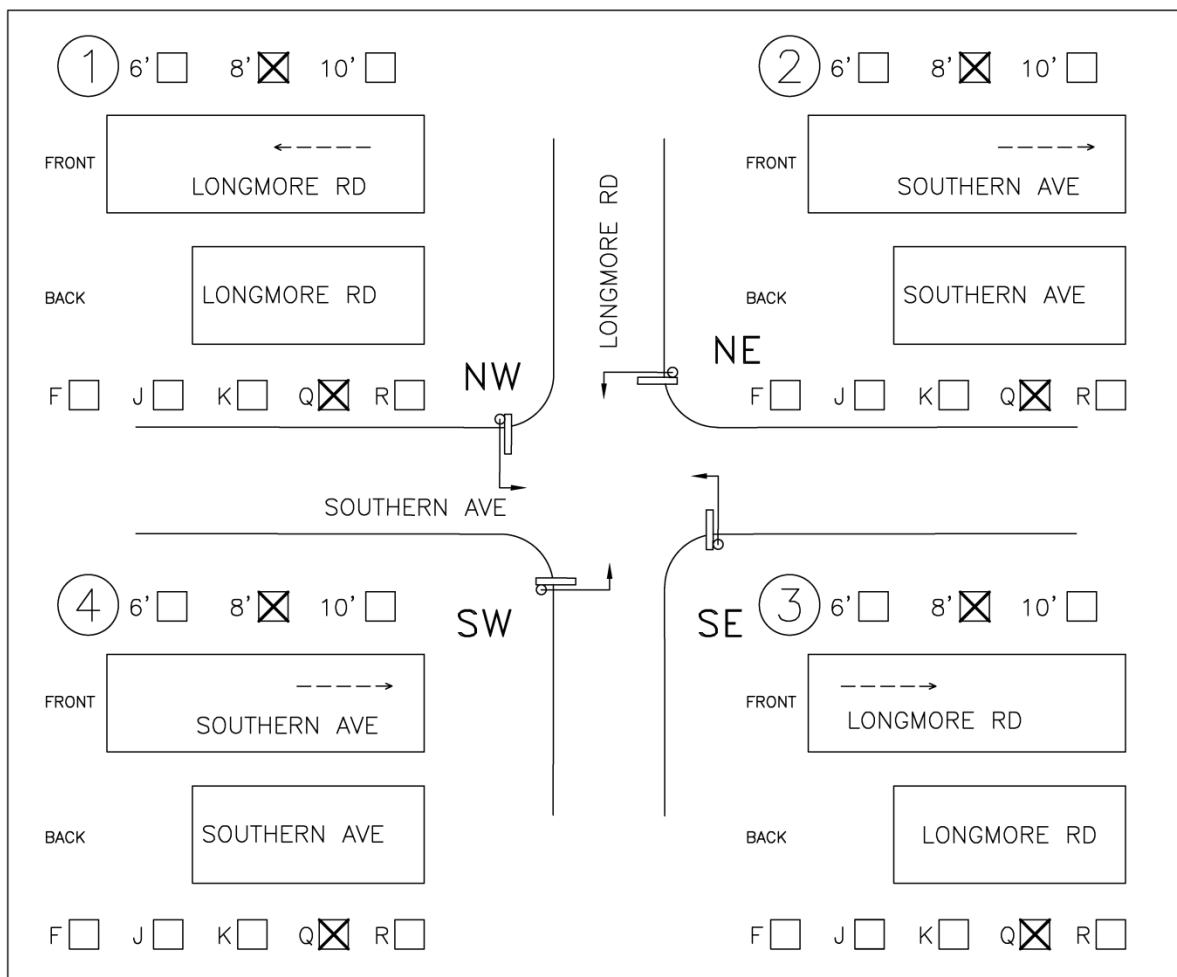
ALL TRAFFIC SIGNAL & FIBER OPTIC CABLES SHALL BE FURNISHED IN ACCORDANCE WITH THE CITY OF MESA TRANSPORTATION/ITS STANDARD SPECIFICATIONS, MOST CURRENT EDITION

- * SIGNAL CABLE: C.O.M. CABLE 19-1, #16 AWG 2, 5, 7, & 25 CONDUCTOR, STRANDED COPPER, 90C HI-TEMP
- ▲ DETECTOR LOOP WIRE: #16 AWG, I.M.S.A. SPEC. 51-5-1984, TUBE COLOR: ORANGE
- DETECTOR LOOP LEAD-IN CABLE: #18 AWG, STRANDED 4 CONDUCTOR WITH SHIELD AND GEL WATER BLOCK (ADHESIVE BLOCK NOT PERMITTED)
- ◆ FIRE PRE-EMPTION CABLE: 20 AWG, 3 CONDUCTOR, STRANDED, BLUE/ORANGE/YELLOW WITH DRAIN WIRE SRP 2.5" RED CONDUIT. DEPTH PER SRP REQUIREMENTS. WIRE SIZE/QUANTITIES PER SRP SPECIFICATIONS
- FO FIBER OPTIC COMMUNICATIONS CABLE: 4-STRAND GATOR PATCH BRANCH CABLE,

Figure 8: Example Conductor Schedule

Street Name Sign Layout (Sheet 2)

The street name sign layout shows the general layout of the internally illuminated street name sign (IISNS), if applicable. IISNS are typically only used in special districts within the City and are not required on every project.



INTERNALLY ILLUMINATED STREET NAME SIGN LAYOUT

NOTE: SIGN FACES SHALL BE FIESTA DISTRICT STYLE

Figure 9: Example Internally Illuminated Street Name Sign Layout

For conventional sign metros, reference to City Std. Detail M-21.05 will usually be sufficient. The City Sign Shop will fabricate and install standard sign metros, which must be in place before the new signal is energized and placed in service.

Legend (Sheet 2)

Any symbols used on the plan view of sheet 1 should be identified in the legend.

LEGEND

<u>PROPOSED</u>	<u>EXISTING</u>	
-----	- - - - -	UNDERGROUND CONDUIT
□	□	NO. 5 PULL BOX
□	□	NO. 7 PULL BOX
⊠	⊠	NO. 7 PULL BOX WITH EXTENSION
⊠	⊠	NO. 8 PULL BOX
⊠	⊠	METERED SERVICE PEDESTAL
⊠	⊠	CONTROL CABINET AND FOUNDATION
●	○	TRAFFIC SIGNAL FOUNDATION
⊠	⊠	TRAFFIC SIGNAL LOOP STUB OUT
⊠	⊠	TRAFFIC SIGNAL LOOP
→	→	TRAFFIC SIGNAL INDICATION
→	→	PEDESTRIAN INDICATION
→	→	PEDESTRIAN PUSH BUTTON
⊙	⊙	HPS LUMINAIRE
◀	◀	VIDEO DETECTION
⊙	⊙	PRE-EMPTION
⊠	⊠	ILLUMINATED STREET NAME SIGN (IISNS)
⊠	⊠	STREET NAME SIGN
①	①	CONDUIT RUN NUMBER TAG
⊠	⊠	TRAFFIC SIGNAL POLE TAG

Figure 10: Example Legend

Phase Layout (Sheet 2)

The phase layout is used to show the signal phases at the intersection including vehicle and pedestrian phases. A generic schematic of an intersection can be used and the direction of each vehicle and pedestrian phase should be clear. The phase layout does not have to be drawn to scale but it should include a north arrow. The phase diagram shows all possible combinations of compatible phases.

8-PHASE SEQUENCE

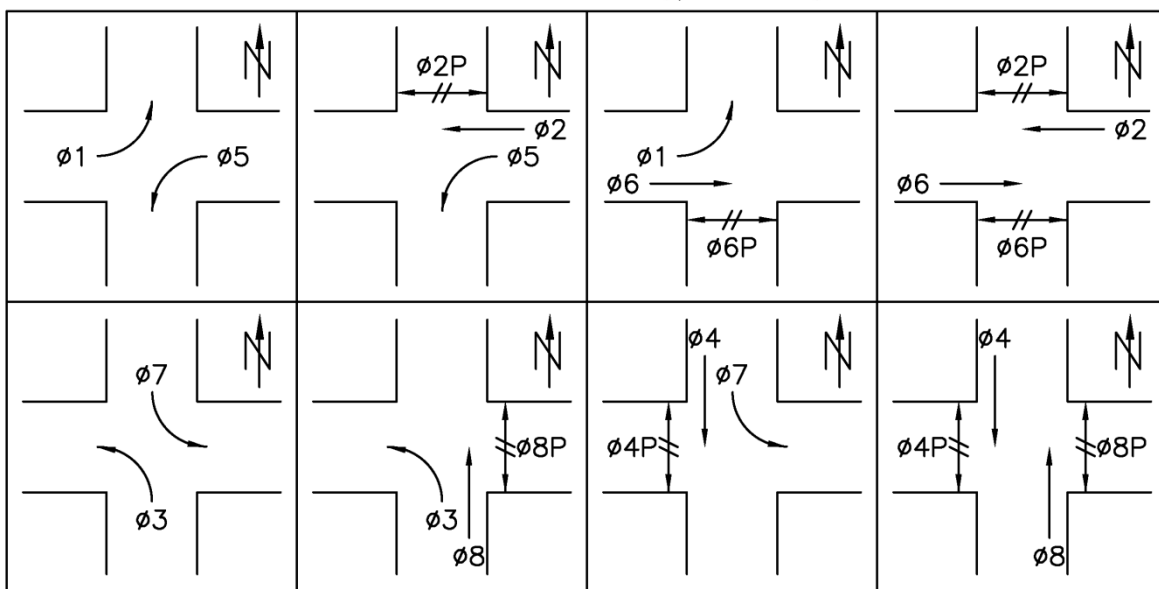


Figure 11: Example Phase Layout

Signal Spacing Diagram (Sheet 2)

The signal spacing diagram is used to show the position of the signal under design relative to other signals in the area. The signal spacing diagram is a stick map and should include at least all of the signalized intersections within a mile upstream or downstream of the signal under design. The distances between each signal on the map should be shown. This diagram is used to show where the signal under design is located to determine if it needs to be coordinated with adjacent signals and to determine whether programmable heads are necessary to control visibility of signal heads to prevent driver confusion at closely spaced intersections.

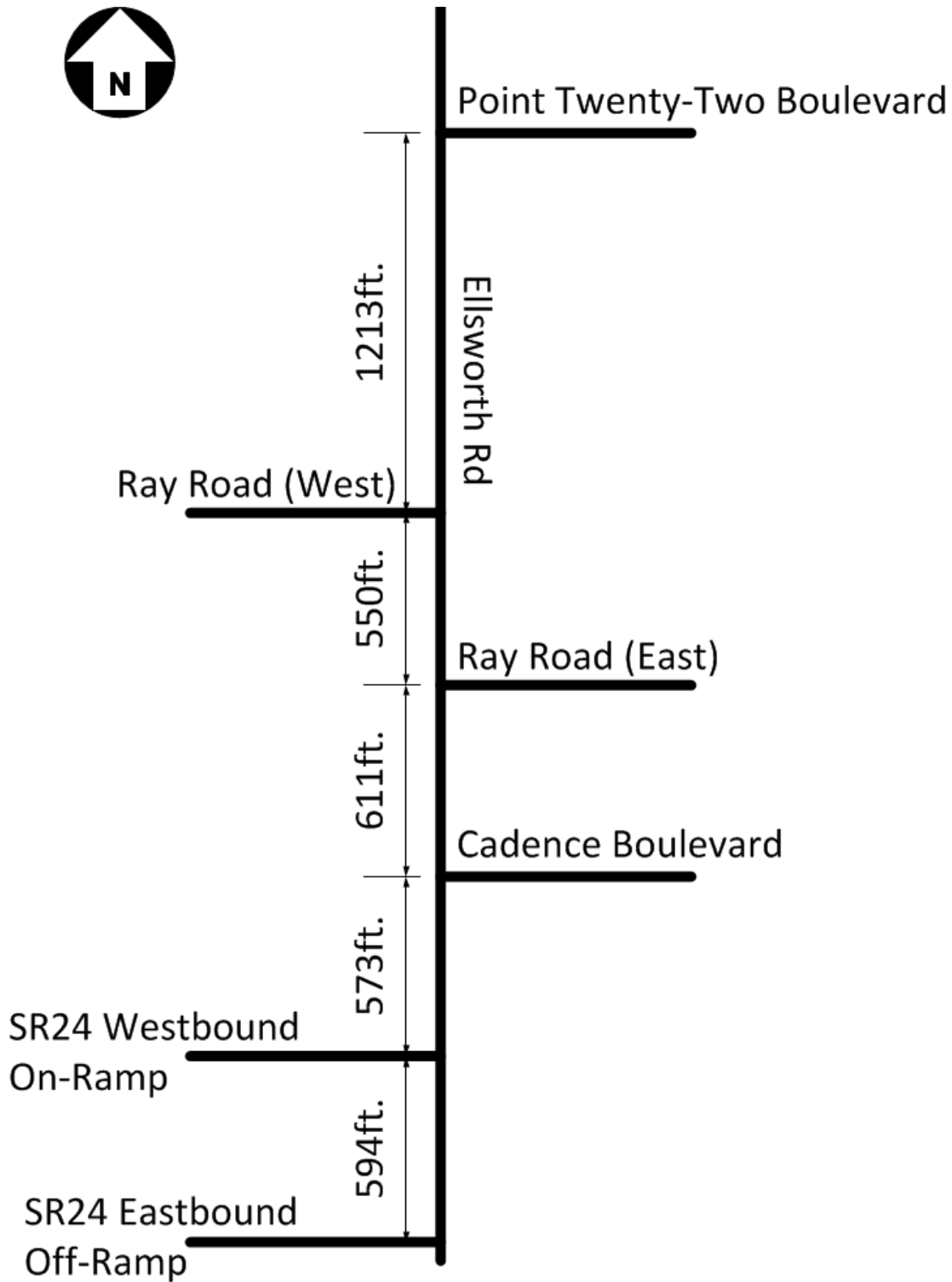


Figure 12: Example Signal Spacing Diagram

Construction Details (Sheet 2 or additional sheets)

In some signal designs it is necessary to provide additional details of items that are not already included in the standard details. This arises when there is something out of the ordinary. A common example is concrete work that must be completed along with the signal construction. If the detail is rather simple it may fit on Sheet 2. If it is not, it may need to be placed on Sheet 3 or on additional sheets as necessary.

It is not necessary to reproduce standard details on the traffic signal plans. They may be referenced by detail number, the year of the standard detail book that the designer is working from and the web address where the standard details can be located.

Chapter 3: Sidewalks and Ramps

Sidewalk Ramp Locations

The Americans with Disabilities Act (ADA) and Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) require sidewalk ramps. These ramps should be provided per City of Mesa Details M-44.02.1 through M-44.05.

Some intersections will require split ramp and crosswalk layouts and the designer should verify this at the outset with the City project manager and Transportation Department. City Standard Details M-44.02.1 through 44.05 are directly applicable to diagonal ramps; therefore, careful review will be needed for split ramp layouts.

For construction of a new traffic signal system at an existing intersection, the location of existing storm drain catch basins can be a significant factor to consider in providing new or upgraded sidewalk ramps. The designer should take this into consideration from the outset and obtain field measurements as needed to confirm suitable locations. Some minor modifications to the City's sidewalk ramp standard may be warranted and will need to be evaluated and approved by the City to ensure that the minimum ADA standards can still be achieved. For major street widening and all-new construction, every effort must be made to provide accessible sidewalk ramps in full compliance with City standard details since associated storm drain laterals, catch basins, and other infrastructure will be new, or relocated on new alignments.

Sidewalk Ramp Landings

Each sidewalk ramp has a flat landing area at the top of the ramp that can be used by a pedestrian to access and activate a pedestrian push button. The landing and ramp slopes should be designed per City of Mesa Details M-44.02.1 through M-44.05. Some recommended push button and ramp configurations are presented in City of Mesa Details M-44.01.1 and M-44.01.2.

In nearly all cases, the landing at the bottom of the ramp is provided by the street pavement. The crosswalk markings need to be designed accordingly to ensure that these landing areas are within the marked crosswalk in all cases (e.g. as indicated on City Std. Detail M-46.07). If older crosswalk markings that do not meet this requirement are encountered revised crosswalk markings must be provided as part of the signal improvements.

In addition, the 2010 ADA and 2011 PROWAG guidelines have criteria for maximum permissible longitudinal gutter gradients for accessibility. The majority of intersections in Mesa conform to the gutter gradient requirements due to the generally flat terrain. This should be

CHAPTER 3: SIDEWALKS AND RAMPS

verified however, particularly for locations in the Desert Uplands Area and elsewhere that have steeper terrain.

Relationship of Curb Access Ramps with Crosswalks and STOP Bars

The location of the curb access ramp determines the location of the marked crosswalks and associated STOP bars. The STOP bars determine the placement of the detection loops or video detection zones and any “near right” poles. Therefore, the type and location of a sidewalk ramp impacts the traffic signal design.

The coordination between intersection corner elements can be managed by referring to several City of Mesa standard details as outlined below:

Determine the type of ramp to be used by referring to City of Mesa ramp details M-44.02.1 through M-44.05. These details contain information explaining when to use each ramp based on type of road and adjacent sidewalk. Factors involved in selection include: number of lanes, corner radius, and alignment of the adjacent sidewalk.

The location of ramps on arterial intersections is shown on City of Mesa M-46 series details.

Crosswalk and STOP bar pavement markings for signalized intersections are shown on City of Mesa Detail M-46.07. Note that when the sidewalks have diagonal ramps, the 15-ft wide marked crosswalk will be offset 5 to 10 feet from centerline of ramp as indicated on City Std. Detail M-46.07. For split ramp layouts using a direct ramp alignment to the crosswalk the markings are centered on the ramp centerline.

Relationship of Curb, Crosswalk and Pedestrian Pushbutton

Pushbuttons should be arranged per Section 4E.08 of the MUTCD. Also see Chapter 6 of this design manual.

Chapter 4: Poles and Mast Arms

Types of Poles

There are several types of standard poles used in the City of Mesa for traffic signals. They are based on ADOT pole designs but are unique to the City of Mesa. Traffic signal poles with mast arms are shown in Details M-94.04 through M-94.06. The types of poles with mast arms are summarized in the following table:

Mast Arm Length (Feet)	Pole Base Size (Inches)	Pole Type without Luminaire	Pole Type with Luminaire
20	18	J	Q
25			
30			
35			
40			
45	23	K	R
50			
55			
60	23	L	S
65			

Table 1: Types of Poles

A Type “A” pole does not have a mast arm and comes in several heights (8, 10, 15, or 18 feet). The Type “A” pole is shown in Detail M-94.03.

A Bicycle / Pedestrian pole is a 5.5 foot pole used to get pedestrian detectors and bicycle detectors into the optimal position. It is not always feasible to locate the main signal poles in the ideal position for bicycle / pedestrian detection, and adding a smaller pole is an inexpensive method to get detection in an ideal position without having to move the larger poles around. The bicycle / pedestrian pole is shown in Detail M-94.01.

Pole Placement

A typical intersection will have at least two (2) signal poles per corner, both at end of the radius, directly behind the sidewalk. The poles will generally consist of one mast arm pole and one Type “A” pole or a joint use streetlight pole with signal equipment on it. In many cases, the mast arm pole and the Type “A” pole cannot be located in a position that is ideal for the pedestrian detection. The designer is encouraged to use the bicycle / pedestrian pole in these circumstances so that the pedestrian detection is in compliance with the 2009 MUTCD Figure 4E-3. It is better to add a bicycle / pedestrian pole than to place the mast arm pole or Type “A” pole in an unideal location just to accommodate the pedestrian detector.

CHAPTER 4: POLES AND MAST ARMS

Once the mast arm pole is placed, the type of pole is determined based on the length of mast arm required. The length of mast arm is determined by the head placement which will be discussed in the next chapter.

Traffic signal poles should be located to provide the best visibility of signal faces while balancing the following design issues:

- Accommodate right-of-way limitations.
- Locate signal heads (vehicle and pedestrian heads) to maximize visibility and minimize confusion. Pedestrian signal heads should be located so that they are centered as much as possible between the two crosswalk lines of the crosswalk they serve.
- Accommodate approach lane configuration.
- Accommodate alignment of intersecting roadways.
- Accommodate approach alignment (horizontal and vertical).
- Accommodate bicycle actuation with bike push-button pole placed with consideration of the bike lane and curb ramps per Standard Detail M-94.02.
- Minimize the number of poles for signal heads, pedestrian buttons, and street lighting without compromising function.
- Provide streetlights as necessary.
- Account for nearby underground and overhead utilities (existing and proposed).
- Account for nearby drainage structures, bridges and embankments.
- Account for nearby buildings, walls, fences, and other structures.
- Account for nearby trees and other landscaping features.
- Use standard mast arm lengths (25, 30, 35 and 40 feet for Type Q & J poles, 45, 50 and 55 feet for Type K & R poles, 60 or 65 feet for L & S poles).

While recognizing the above issues, the following signal pole location criteria should also be incorporated:

- The distance between the STOP bar and the mast arm heads shall be at least 60 feet.
- Luminaires should be positioned to light the intersection.
- Avoid placing poles in the medians of divided roadways if possible.
- Poles or posts should not obstruct pedestrian routes. (**DO NOT INSTALL** in curb access ramps or landings. Avoid installing in sidewalks if possible.)

Chapter 5: Indications

Traffic Signal Faces

All traffic signal indications shall use light emitting diodes (LED) per current City of Mesa standards and specifications:

http://www.mesaaz.gov/transportation/Traffic_Signals_Specifications.aspx

Optically programmed or louvered visors may be used if the geometry indicates their use. They should be considered at closely spaced intersections and skewed intersections to prevent drivers from seeing an indication that is not meant for them. The City of Mesa ITS group must approve the use of optically programmed or louvered heads.

The type of left-turn and right-turn phasing shall be determined by the City of Mesa Transportation Department.

Protected/permitted left turn signal faces on new designs are usually Flashing Yellow Arrow type. For the traditional protected/permitted left-turn signal faces, S faces are used on the mast arm while Q faces are used on the pole. Type R faces are used for protected left-turn phasing.

Right turn signal faces shall be Type Q. Right turn signal faces are not necessarily required. The necessity of right turn signal faces shall be determined by the City of Mesa Transportation Department.

The City of Mesa Standard Traffic Signal Faces are shown in Figure 13: Traffic Signal Faces



City of Mesa Standard Traffic Signal Faces

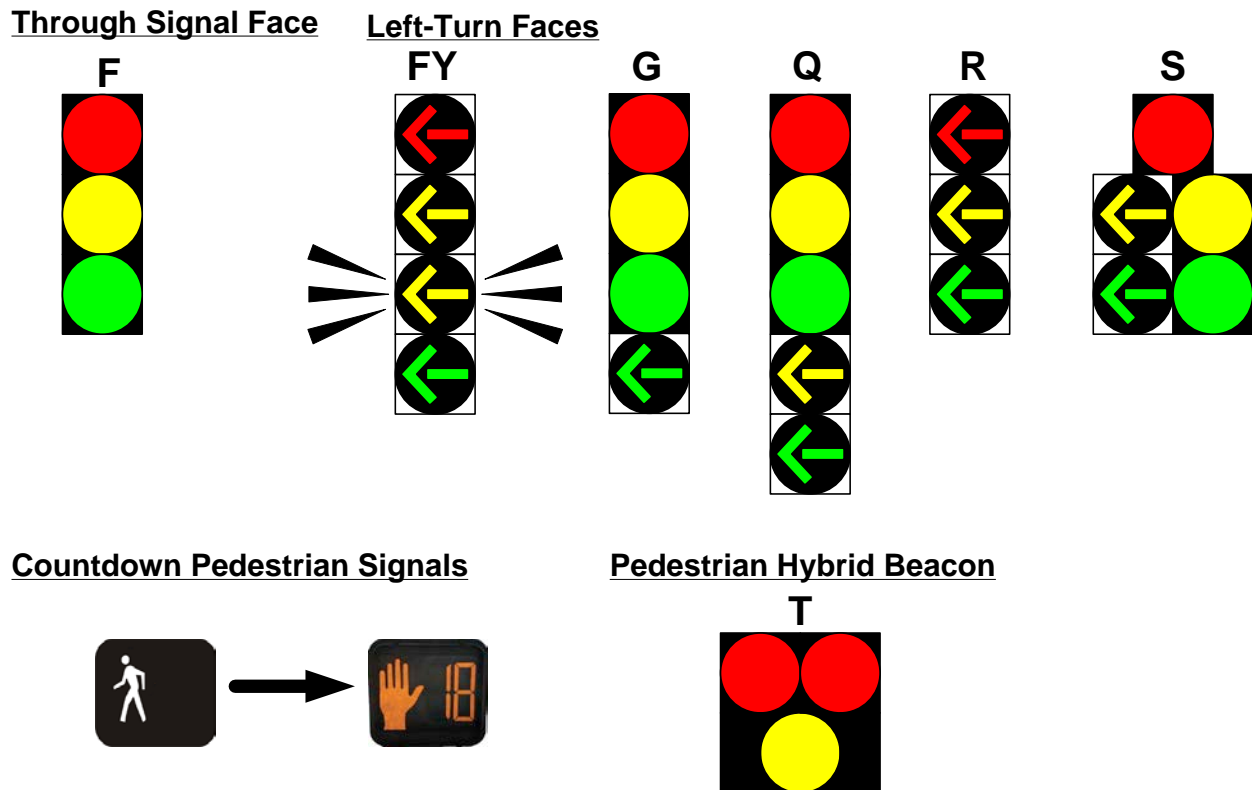


Figure 13: Traffic Signal Faces

Placement Considerations for Traffic Signal Faces

The requirements of MUTCD Sections 4D.11 through 4D.25 shall be satisfied; however, the City of Mesa requires at least 60 feet between the stop bar and the primary signal faces.

Traffic signal faces for one direction of travel should not obstruct the visibility of traffic signal faces for the opposing direction of travel. Left-turns should not overlap as they may obstruct the view of the opposing left-turn faces.

Typically, provide a far left pole mounted indication. This can be either an exclusive left-turn face or a shared signal face.

CHAPTER 5: INDICATIONS

Position overhead signal faces for through movements to align approximately in the middle of the lane or slightly to the driver's side of the lane. Avoid placing the overhead signal face directly over the lane stripes. This allows maintenance vehicles to work on the signals while closing only one travel lane.

City of Mesa signal mast arms only have a tenon for the outboard head, therefore the designer can specify the exact spacing of the signal heads although standard spacings of either 10, 12 or 18 feet are preferred. The spacing should be shown in the pole schedule. The minimum spacing between two signal heads is 8 feet. The mount for a signal head on a mast arm is shown in COM Standard Detail M-94.10.

There should be at least two overhead mast arm heads and one side mounted head for the through movement on each approach. This can include shared heads such as a mast arm mounted S head. For minor street approaches, only one overhead mast arm head is required for the through movement.

On each approach with left-turn phasing, left-turn indications shall be provided with at least one overhead mast arm head and one left far side pole mounted head.

For protected only left-turn phasing or protected-permissive left-turn phasing with a flashing yellow arrow configuration, the overhead mast arm left-turn head should be mounted in the center of the left-turn lane(s). For protected-permissive left-turn phasing (with a Q or S head) the overhead mast arm left-turn head should be mounted just to the right of the lane line separating the through lane(s) from the left-turn lane(s) or in line with the buffer space between the left-turn lane and through lane if applicable. For permissive only left-turn phasing, the shared face should be mounted over the through lanes.

At locations with right-turn phasing there should be at least one near side face on a Type "A" pole or streetlight pole near the stop bar and one far side face mounted on the side of the signal pole for each approach with right-turn phasing.

Additional signal faces may be needed when the view of the typical signal faces are concealed from approaching drivers due to horizontal or vertical alignment or other obstructions. Signal visibility must meet criteria based on approach speed in the 2009 MUTCD, Table 4D-2.

Provide phase numbers next to corresponding signal and pedestrian indications. Phase numbers should be preceded by the Greek letter ϕ .

Traffic Signal Mounting Hardware

All mounting assemblies for traffic signals mounted on mast arms and poles should conform to ADOT Traffic Signals & Lighting Standard Drawings (T.S. 9 Series drawings):

<http://www.azdot.gov/business/engineering-and-construction/traffic/signals-and-lighting-standard-drawings/current>

Type II mounts are used for mast arm mounted heads. Type V mounts are used for pedestrian signal indications and vehicle indications mounted on the side of a pole. Type IV mounts are used to mount signal indications on the top of a Type “A” pole. The various standard mounts are summarized in Table 2.

Mount Type	Description
I	Not Used
II	Mast Arm Signal Head
III	Pedestrian Head on top of an A pole
IV	Vehicle Head on top of an A Pole
V	Vehicle Head or Pedestrian Head Side Mounted on a pole
VI	Dual heads on an A pole
VII	Dual heads side mounted on a pole
VIII	Not Used
IX	Not Used
X	Head mounted directly to A pole (typically used in medians)

Table 2: Summary of Signal Mounts

Pedestrian Signals

Pedestrian control features shall meet MUTCD accessibility standards for placement (location, height, and reach), pushbutton station signage, and so forth. Refer to Mesa Standard Details M-95.06 and M-99.01 & M-99.02 for the City’s standard pushbutton station layout.

Countdown pedestrian signals (LED type) should be used at all traffic signals.

Pedestrian signal heads should be mounted as close as possible to the center of the crosswalk that it serves, and shall be continuously visible to pedestrians using the crosswalk.. The pedestrian signal head should be placed so that it is not obscured by large vehicles that stop at the traffic signal.

Chapter 6: Detection

Pedestrian Detection

Mount the pedestrian push button adjacent to the landing on the sidewalk area leading to the crosswalk. See City of Mesa Detail M-44.01.1 through M-44.05 and MUTCD Section 4E.08.

Mount the pedestrian push button no further than 5 feet from the extension of the crosswalk lines and within 10 feet of the curb line, unless the curb ramp is longer than 10 feet. See the 2009 MUTCD Figure 4E-3.

Pedestrian detectors should be mounted at least 10 feet apart, if possible.

The control face of the push button should be parallel to the direction of the crosswalk controlled by the push button and no closer than 30 inches from the curb line.

Pedestrian detectors are not required on phases that will be operated in pedestrian recall. Typically, the pedestrian movements that are parallel to an arterial roadway at an arterial-minor intersection are operated in pedestrian recall. Pedestrian push buttons should be included at new arterial-arterial intersections.

Push buttons shall be located to meet Section 308 of the Americans with Disabilities Act Standards for Accessible Design – Reach Ranges.

Accessible Pedestrian Signals

Accessible Pedestrian Signals (APS) may be required at the signal and are determined on a case-by-case basis. Please consult the ITS Engineer on the need for APS. For positioning of APS buttons see MUTCD Section 4E.11.

Bicycle Detection

All approaches to a signalized intersection that have bike lanes or are part of a designated bicycle route shall include bicycle detection. Bicycle detection can be implemented using video detection or a bicycle push button.

Video detection shall be used at locations where there are dedicated right-turn lanes on the approach.

If video detection is not used and there is no right-turn lane on the approach, then a bicycle push button shall be installed per City of Mesa Details M-94.01 and M-94.02.

If the approach will be operated in vehicle or pedestrian recall, bicycle detection is not required.

Vehicle Detection

Detection Types and Considerations

The guidelines below include the use of both in-pavement vehicle detection loops and video detection systems. Typically, standard in-pavement presence loop detectors are used at a signalized intersection of a minor street approach per the guidelines below. Video detection is usually used at intersections of two arterial streets. Video detection may be installed at a major street to major street intersection as part of the new construction of a traffic signal, or added with improvements to an existing traffic signal. If video detection is added to part of an existing traffic signal that has in-ground loops, the remainder of the signal should be upgraded to video. Specifications for video detection systems can be found on the City of Mesa website.

Loop detectors are installed directly in the roadway and the lead in wire runs to a pull box behind the curb. Refer to M-96.04 for details.

Video detection standards are available on the Transportation specifications page: http://www.mesaaz.gov/transportation/Traffic_Signals_Specifications.aspx

Detection Guidelines

Major/ Minor Street Intersection

In-pavement detection loops are usually used at an intersection of this type.

Detection is required on all side street lanes.

Detection is required in left-turn lanes if there is a left-turn phase.

Video detection may be required at Major/Minor Street Intersections where the Transportation Department requires the flexibility to change detector layouts (near a special event venue where lane assignments may change for example).

Video detection may also be used on approaches with decorative pavement, or on approaches that are privately owned.

If video detection is required on one approach to an intersection it should generally be added to the other detected approaches as well.

Generally the video detection cameras will be mounted on signal mast arms, see Std. Detail M-96.05. For special cases, such as T-intersections or locations where mounting on a luminaire mast arm may be more advantageous, the designer should consult with the Transportation Department.

Major/ Major Street Intersection

Use video detection for all approach lanes, including bike lanes.

Detector Sizes

The City of Mesa uses 6 foot by 60 foot detector loops in the through lanes. The left-turn lanes use three 6 foot by 20 foot detector loops. This allows the left-turn to be operated in first car (left-turn is activated by one vehicle) or third car detection (left-turn is activated by approximately three or more vehicles).

Chapter 7: Cabinets

Equipment Requirements

The electric service pedestal installed shall be a 120/240 volt 100 amp fully-metered system per City of Mesa Detail M-91.01 or split-metered system per Detail M-91.02. Fully-metered systems are only used in special circumstances such as at freeway interchanges. Generally a split-metered system (so that the traffic signal circuits are metered and the luminaire circuits are unmetered) should be used, but the designer may check with the ITS group for guidance.

The electric service cabinet must be on the City of Mesa approved product list.

The controller cabinet shall be NEMA TS 2 Type 1, Size 7 cabinet with 16 load bays and include all peripherals for a functional eight-phase traffic signal. Cabinet and controller specifications are available on the City of Mesa website:

http://www.mesaaz.gov/transportation/Traffic_Signals_Specifications.aspx

An Econolite ASC/3-1000 NEMA TS-2 Type 1 traffic signal controller shall be supplied and installed.

A concrete service pad shall be constructed on the door side of the controller cabinet foundation per City of Mesa Detail M-92.1.

For traffic signals that are the responsibility of a developer, it is the responsibility of the developer to order all new points of service from the appropriate power company. The developer is also responsible for all expenses related to the service including utility company design and construction costs. For City constructed signals, the City of Mesa ITS group will order all new points of service from the appropriate power company. Designer is responsible for obtaining the "Meter Spot" from the appropriate power company. The City of Mesa is served by two power companies. Depending on location within the City, it may be Salt River Project (SRP) or City of Mesa Energy Resources.

Uninterruptable Power Supply (UPS) must be provided at all arterial-arterial intersections, pedestrian signals, pedestrian hybrid beacons and light rail intersections.

Placement Requirements

Place the controller cabinet and service pedestals so that a technician working at the cabinet(s) has as good a view of the intersection and signal indications as possible. The cabinet should be placed so it does not block a pedestrian's or driver's view of oncoming traffic. The designer

CHAPTER 7: CABINETS

should refer to the Engineering and Design Standards Simplified Design Guidelines for Sight Triangles (Figure 2.3):

<http://www.mesaaz.gov/engineering/mesastandardandspecs.aspx>

The cabinet should also be located so that it does not block existing signing for adjacent commercial or residential developments.

Electrical meter pedestal goes on the same corner as the electric point of service.

Ideally, the controller cabinet should be placed beyond the returns of the corner radius, behind poles or in other areas that provide protection from vehicular crashes. The door of the cabinet should open toward the street, but not block the sidewalk when open.

Controller cabinets and electrical service pedestals shall not be located in any areas susceptible to water immersion, flooding, or sprinkler spray.

Place the controller cabinet, the electrical service pedestal and UPS cabinet at least ten feet (10') apart from each other.

Chapter 8: Cabling

Traffic Signal Conductors

Wiring for City of Mesa traffic signals shall be designed per City of Mesa Details M-97.01, M-97.02, M-97.03, M-97.04, M-97.05 and M-97.06.

Signal conductors installed shall be multi-conductor cable in 16 AWG stranded 2, 5, 7 and 25 conductor configurations per the most recent traffic signal specifications:

http://www.mesaaz.gov/transportation/Traffic_Signals_Specifications.aspx

Three (3) feet of slack in the conductor cable, measured from the top of the conduit, shall be provided in each pull box.

Two (2) un-spliced COM Hi-Temp (IMSA 19-1 style) 25 conductor cables shall be installed so that the intersection is boxed by each cable. Generally one cable is dedicated to Phases 1 through 4 and the other is assigned to Phases 5 through 8.

From the pull box to the pole an individual cable shall be run to each device according to the following table:

Device	Number of Conductors in Cable
Pedestrian Push Button	2
Single Pedestrian Head on Pole	5
Type F Heads (Inside Mast Arm and Side Mount)	
Light Rail Blank Out Sign	
Single Light Rail Signal Indication on Pole	
Double Pedestrians Heads on Pole	7
Type F Heads (Outside Mast Arm)	
Type Q Heads	
Type S Heads	
Flashing Yellow Arrow (Type FY Heads)	
Double Light Rail Signal Indications on Pole	

Table 3: IMSA Cable Types for Various Displays

Streetlight Conductor Requirements

Intersection streetlight luminaires (120V AC) should be fed from the electrical service pedestal per COM Detail M-91.02.

CHAPTER 8: CABLING

Two (2) #10 XHHW street lighting conductors shall be run from the electric service cabinet to each corner pull box of the signalized intersection, and then from the pull box to the pole handhole. Three (3) #12 AWG THHN/XHHW conductors shall run from the handhole to the luminaire. See City of Mesa Detail M-73.07.

For the 120 volt luminaire connection, use one black, one white, and one green wire up the pole. The luminaire is fused in the handhole with an HEB or LEB type fuse holder and a five amp FNM type fuse.

Internally Illuminated Street Name Sign (IISNS) Conductor Requirements

The IISNS shall be fed from the streetlight circuit portion of the traffic signal.

Three (3) 12 AWG THHN/THWN conductors shall be installed from each IISNS to the pull box adjacent to the pole foundation per City of Mesa Detail M-95.09.

IISNS conductors shall be included in the design and construction regardless of whether IISNS are being installed as part of the current project.

Loop Detector Conductor Requirements

All vehicle roadway detection loop wire and loop detector lead-in-cable shall be as indicated on the approved products list:

<http://www.mesaaz.gov/transportation/pdf/ITS/ITSCableFiberOptic.pdf>

No splices shall be allowed in roadway detection loop cable or lead-in-cable except at the pull box adjacent to the loop.

Loop detector conductors should be in one conduit to the curb line and cross the curb line perpendicularly.

Loop stub out conduit shall be 2" schedule 40 PVC per City of Mesa Detail M-96.04.

Communications Cabling

Every new or existing traffic signal requires communications media. If there is fiber optic conduit nearby, a 2" conduit path will need to be provided from the signal cabinet to the fiber optic conduit system. If there is an existing designated fiber optic communications conduit in the cabinet foundation (or in the case of a new foundation it will include one as shown in City of Detail M-92.01) the conduit will run from the cabinet to the nearby fiber optic pull box. If there is not a designated fiber optic communications conduit in the existing cabinet foundation then the

CHAPTER 8: CABLING

conduit will run from the main traffic signal pull box on the cabinet corner to the nearby fiber optic pull box. A four strand Single Mode Fiber Optic (SMFO) GatorPatch™ cable (<http://www.mesaaz.gov/transportation/pdf/ITS/GatorPatchCable110713.pdf>) shall be installed between the fiber optic trunkline and the traffic signal cabinet.

If a fiber optic connection is not available, the City of Mesa will install wireless communications outside of the project.

Fiber splicing may be handled by the City of Mesa ITS group or it may be required that the contractor perform splicing. In the latter case, the City of Mesa will supply a fiber optic splicing diagram to the contractor during the construction phase.

Emergency Vehicle Pre-Emption Conductor Requirements

Emergency vehicle pre-emption sensor cable shall be run to the red section of the through signal that is approximately centered on the approach. Emergency vehicle pre-emption cable shall be installed regardless of whether emergency vehicle preemption equipment is included in the project. The fire preemption cable is per the approved cable list:

<http://www.mesaaz.gov/transportation/pdf/ITS/ITSCableFiberOptic.pdf>

Video Detection Conductor Requirements

Video detection cable shall be run to each pole that has a video detection unit. Video detection cable is not required at locations that do not have video detection. Video detection cable shall be as recommended by the manufacturer of the video detection equipment. Approved video detection systems are documented at:

http://www.mesaaz.gov/transportation/Traffic_Signals_Specifications.aspx

Summary of Cable Types

Cable Type	Cable Size/Jacket Type	Cable Notes
Signal Cable	#16 AWG	COM Cable 19-1. 2,5, 7 or 25 conductor, Stranded Copper, 90C Hi-Temp
Detector Loop Wire	#16 AWG	IMSA Spec 51-5-1994, Tube Color: Orange.
Detector Loop Lead-In Cable	#18 AWG	Stranded 4 Conductor with Shield and Gel Water Block (Adhesive Block Not Permitted)
Fire Pre-Emption Cable	#20 AWG	3 Conductor, Stranded, Blue/Orange/Yellow with Drain Wire.
Fiber Optic Communication Cable	NA	4-Strand Gator Patch Branch Cable
Video Detection Cable	NA	Per Video Detection Manufacturer's Requirements. (See approved list).
IISNS Cable	#10 AWG	XHHW
Power Cable	#10 AWG	XHHW
Spare Cable	#10 AWG	XHHW
Street Lighting Cable	#10 AWG	XHHW
Street Light Tray Cable	#14 AWG	FRPC 14/3

Table 4: Summary of Cable Types

Additional information including approved cable types and manufacturers are documented on the City's web site: http://www.mesaaz.gov/transportation/Traffic_Signals_Specifications.aspx.

General Requirements

Provide conduit to each corner of the intersection in a ring configuration underneath all intersection approaches per City of Mesa Detail M-93.04.

Provide low-voltage and high-voltage conductors in separate conduits in road crossings per City of Mesa Detail M-93.04.

Low voltage conductors include: emergency vehicle pre-emption sensors, detector cable, video feed back to controller cabinet, and communication cables.

High voltage conductors include signal and street lighting conductors.

Provide fiber optic quad duct per City of Mesa Details M-66.09 and M-66.10.

Conduit Size and Placement

Reference City of Mesa Detail M-93.04 for roadway conduit and pull box layout.

A 3" conduit should be installed in J, K, Q and R pole bases and connected to the pull box on the same corner.

A 2" conduit should be installed in all Type A and Streetlight poles (only Streetlight poles with Traffic Signal equipment on them) to the pull box on the same corner.

Use 2" conduit for loop detectors runs.

Conduit should be bored under existing paved driveways that are not scheduled to be reconstructed as a part of the project unless prior approval from the City of Mesa Engineering Department is obtained.

Pull Box Considerations

Install pull boxes per City of Mesa Details M-93.01.

Use #7 pull boxes on all corners and medians (City of Mesa Detail M-93.04).

Use #8 pull boxes on all corners with controller cabinets (City of Mesa Detail M 93.04).

Use #9 pull boxes on fiber optic quad duct installation.

Use 4'x4' vaults on locations where quad duct runs cross (i.e. four sets of quad duct in the box).

Pull boxes shall not be located in drainage areas susceptible to water immersion or flooding.

CHAPTER 9: CONDUIT & PULL BOXES

Pull boxes shall not be installed within wheelchair ramps. Pull boxes should not be located in sidewalks. In addition, any pull boxes installed beyond curbs shall consider future sidewalk locations.

Any pull boxes installed along an uncurbed roadway should not be within the shoulder (minimum of 10 feet from the pavement edge) if right-of-way permits, and shall be of the traffic rated load bearing type.

CHAPTER 10: OTHER TRAFFIC SIGNAL RELATED ITEMS**Street Lighting at Signalized Intersections**

Intersection lighting is required at most signalized intersections.

The designer should consult with the City project manager and Transportation Department to verify the appropriate lighting design method (typically illuminance criteria), roadway classification and pedestrian conflict classifications, photometric analysis guidelines, and similar key design criteria early in the design development. See Chapter 9 of the Engineering and Design Standards for additional guidance and requirements.

Considerations for Intersection Lighting

When needed, illuminate each approach per City of Mesa Design Standards based on the results of a lighting analysis. If luminaires are required, the traffic signal design should place the luminaires on traffic signal poles. The lighting analysis and design must consider existing street lighting at the traffic signal location.

Only place luminaires on poles that light a road or driveway.

Location of luminaire poles should meet guidance contained in Chapter 3 of this document.

Match existing or planned luminaire mounting heights. Typical heights are 40' to 45' for major streets, 35' to 40' for collector streets, and 35' for local streets.

Lighting design guidelines can be found in Chapter 9 of the City of Mesa Engineering and Design Standards, as well as the Illuminating Engineering Society of North America, ANSI/IESNA RP-8, 2000.

Lighting Requirements for Traffic Signal Installations

Intersection lighting shall use 120 volt, high-pressure sodium luminaires with horizontal cut-off lenses meeting City of Mesa Detail M-70.1 and the City of Mesa Engineering and Design Standards. Streetlights shall be wired to the contactor designated for such as provided in the traffic signal split-meter pedestal.

A street lighting photocell shall be mounted on the luminaire closest to the traffic signal split-meter service pedestal. All other luminaires shall be of the non-photocell type or shall have a shorting cap matching M-70, Note 25.

Wiring from the photocell pole hand hole to the traffic signal split-meter pedestal shall be FRPC 14/3 cable or equivalent. Wiring from the photocell pole hand hole to the photocell terminal block shall be #14 AWG THHN. Insulated, crimp type butt splices are to be used in the hand hole for photocell wiring only.

Power for the street lighting shall come from the traffic signal service pedestal.

CHAPTER 10: OTHER TRAFFIC SIGNAL RELATED ITEMS

If an intersection requires a corner streetlight pole and luminaire to meet lighting requirements, that streetlight pole can be used in place of an A-pole for traffic signal design as described in this manual.

Internally Illuminated Street Name Signs (IISNS)

Internally Illuminated Street Name Signs are provided at some signalized intersections per City of Mesa Details M-95.07, M-95.08 and M-95.09. However, conventional retro-reflective aluminum signs may be preferred on some locations. In general, IISNS are only used within certain designated districts within the City of Mesa.

IISNS will not be typically installed at private driveways unless the nature of the property served is of such interest to the general public that an IISNS would be desirable.

Contact the City of Mesa ITS Group for more information on whether IISNS are required at the location under design.

When IISNS are used, the standard format for the street name sign layout is shown in City of Mesa Details M-21.06, M-21.07 and M-21.08.

Emergency Vehicle Pre-emption Sensors

All City of Mesa traffic signals should include emergency vehicle pre-emption cabling per City of Mesa specifications.

Sensors are typically installed on the top of the signal head closest to the center of the road (outboard). However, sensor location should be coordinated with the City of Mesa ITS group during design.

Closed Circuit Television Cameras

Closed circuit television cameras (CCTV) are installed at select intersections for traffic surveillance purposes. CCTV cable is not required unless a CCTV is also being installed. Several factors should be considered when locating the CCTV camera:

- The CCTV should provide an unobstructed view up each of the four legs of the intersection.
- The length of the CCTV cable should be as short as possible; therefore, the cabinet corner is preferred, although the adjacent corners are frequently used. The corner opposite of the cabinet corner is usually too far of a run. The maximum cable length is 328 feet (100 meters).

CHAPTER 10: OTHER TRAFFIC SIGNAL RELATED ITEMS

- The CCTV should be mounted on a full height pole. If a pole has been shortened at the top to avoid overhead utilities, the pole should not be used for the CCTV camera.
- See Mesa Detail M-95.10 for the City's standard CCTV mounting arrangement.
- See <http://www.mesaaz.gov/transportation/pdf/ITS/CCTVSpec022514.pdf>