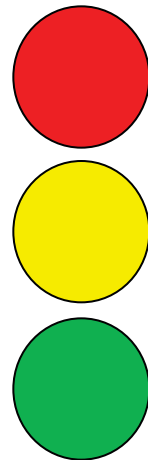


City of Mesa , Arizona

# Traffic Signal Design Manual



City of Mesa Transportation Department  
October 2009



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# INTRODUCTION

## Purpose

The first edition of the City of Mesa Traffic Signal Design Manual expands upon existing guidelines to more completely identify guidelines, practices, and standards for the design of traffic signals within the City of Mesa. Roadway lighting requirements are addressed only to the extent that intersection lighting is provided at signalized intersections. The purpose of this manual is to provide direction to designers, contractors and City of Mesa Transportation Department staff in the development of traffic signal plans.

## Application of 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, drafting guidance and standard notes. City of Mesa staff can also reference this manual during the construction of traffic signals. Designers and contractors 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 such as 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 are also encouraged to suggest changes to this manual. Suggestions should be submitted in written or diagram form to the City of Mesa – Transportation Department. City of Mesa Transportation staff will review and provide a response to any suggestion. If the suggested changes are accepted, they will be included in the next revision.

Should questions arise in the use of this manual, users are referred to the City of Mesa Traffic Engineering Division.



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10-9-09  
Date

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# **Chapter 1 – Project Start-Up**

There are several recommended activities that a traffic signal designer may consider before starting a traffic signal design for the City of Mesa. Additionally, 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.

The City of Mesa Engineering Department manages public projects. Therefore, any overall project schedule or coordination issues will be handled through the designated Engineering 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 Building Safety forwards the plans.

## **Section 101 - Meeting with City of Mesa Transportation Department**

101.1 Although it is not required, a traffic signal designer may meet with City of Mesa staff prior to beginning the project. Meeting with the Transportation Department 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:

101.1.1. Current design standards.

101.1.2. The project's design speed and posted speed limits.

101.1.3. The project limits.

101.1.4. Primary City of Mesa and design team contacts for the project.

101.1.5. The overall project schedule.

101.2 Also at this meeting, City of Mesa staff will identify any special or unusual issues that will need to be addressed during the design of the project. This may include project phasing, unique lane layouts, adjacent intersections or pedestrian concerns.

## Section 102 - Post Meeting Communications

102.1 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 Building Safety.

## Section 103 - Field Visit

103.1 A field visit is recommended before starting any traffic signal design. The traffic signal designer should visit the project site to inventory and identify physical features that may impact the traffic signal design.

103.2 The designer should locate all existing roadway and geometric conditions within a minimum 150' 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 not be limited to the following:

103.2.1. Posted speed limit.

103.2.2. Existing lane configurations, width and lengths (i.e. turn lanes).

103.2.3. Median configuration (i.e. raised or painted), and dimensions.

103.2.4. Driveway locations and operations of driveways (i.e. full access, limited access, right-in/right-out, etc.).

103.2.5. Pavement markings.

103.2.6. Roadway curvature and existing vegetation that may impact sight distance and signal head visibility.

103.2.7. Curbs, gutters and sidewalks.

103.2.8. Drainage ditches and irrigation structures

103.3 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.

103.4 An inventory may include but not be limited to the following existing items:

103.4.1. Traffic signal pole locations.

103.4.2. Traffic signal heads & locations (i.e. pole or mast arm mount).

103.4.3. Pedestrian signal heads & types.

- 103.4.4. Pull Boxes locations and sizes.
- 103.4.5. Controller cabinet location.
- 103.4.6. Power source location.
- 103.4.7. Overhead and underground utilities and poles.
- 103.4.8. Existing detection including video and in-ground loops.
- 103.4.9. Existing communications cable and infrastructure.
- 103.4.10. Spare tenons on mast arms.
- 103.4.11. Streetlights, street name signs and emergency pre-emption devices.
- 103.4.12. Conduits and conductors.

## **Section 104 - Standard References for Traffic Signals**

104.1 The following are standard reference documents for the design of traffic signals.

104.1.1. City of Mesa Standard Details, Traffic Signal M-90 series.

104.1.2. Arizona Department of Transportation (ADOT): Standard Specifications for Road and Bridge Construction and General Specifications for Traffic Signals and Highway Lighting; Traffic Signals and Lighting and Signing and Marking – Standard Drawings; Traffic Control Manual for Highway Construction and Maintenance; Manual of Signs Approved for Use on State Highway Systems; Policy, Guide and Procedure Manual.

104.1.3. New or upgraded signal installations should conform to the requirements of the *Manual on Uniform Traffic Control Devices* (MUTCD), current edition as adopted by ADOT.

104.1.4. Equipment, materials and installation procedures should meet or exceed the current City of Mesa Engineering and Design Standards and Details, as well as the Maricopa Association of Governments (MAG) Standard Specifications and Details unless noted otherwise in the construction documents or superseded by direction in this manual.

## **Section 105 - Standard References for Street Lighting at Signalized Intersections**

105.1 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 design guidelines including the Engineering and Design Standards.

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## **Chapter 2 - Traffic Signal Plan Content**

Traffic signal plans shall be developed in accordance with the requirements of the City of Mesa Engineering and Design Standards and Details, and conform to ADOT standard practices. An example of a City of Mesa Traffic Signal Plan Set can be found in the Appendix.

If only part of an intersection or traffic signal is being modified, the entire intersection and all existing traffic signal equipment at the intersection must be shown, even if not impacted by the modification.

### **Section 201 - General Plan Layout:**

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

*Sheet 1:*      Intersection Layout  
                 Pole Schedule  
                 Foundation Schedule  
                 Pull Box Schedule  
                 General Notes  
                 Construction Notes

*Sheet 2:*      Conductor Schedule  
                 Phasing Sequence  
                 Legend  
                 Street Name Signs  
                 City of Mesa Details M-97.3 and M-97.4

201.2 A detailed description of each of these items is found below. General considerations for a typical plan sheet layout are as follows:

201.2.1. Traffic signal plan sheets shall be 36" x 24" and drawn at 1" = 20' scale.

201.2.2. Provide a profile layout when vertical roadway alignment may impact traffic signal visibility requirements, (1" = 40' scale for profile is acceptable).

201.2.3. Refer to the latest Engineering and Design Standards for typical plan sheet borders and title box layouts. The north arrow is located in a title box in the upper right hand corner with north pointing to the top of the page.

201.2.4. Provide details for any items not included in the City of Mesa Standard Details.

**Section 202 - Sheet Number 1** shall contain the following items:

**202.1 - Intersection Layout:**

*202.1.1 General Items*

202.1.1.1. Show a minimum of one hundred and fifty feet (150') of each leg from intersecting centerline, unless curvature, visibility or additional equipment requires information beyond the 150' distance.

202.1.1.2. Show all existing and proposed utilities and traffic signal equipment.

202.1.1.3. Show and dimension all right of way, face of curb and easements for all approaches. All traffic signal equipment must be within public right-of-way or PUFÉ.

202.1.1.4. Show all Monument Lines for offset reference.

202.1.1.5. Show all existing and proposed roadway striping with lane assignment arrows, stop bars, crosswalks and dimensions.

202.1.1.6. Show and label all video detection zones.

202.1.1.7. Show all existing and proposed sidewalks and curb ramps.

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

202.1.1.9. Provide bearings for each leg of the intersection when deflection is greater than 2 degrees. Provide roadway curve data if applicable.

202.1.1.10. Show and specify types of communications.

Figure 2-1 shows an example intersection layout with typical equipment labeling.

*202.1.2 Pole Placement*

202.1.2.1 A typical intersection will have two (2) signal poles per corner, both at end of radius, directly back of 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. See Chapter 3 of this manual for additional information.

*202.1.3 Traffic Signal Heads*

202.1.3.1 For traffic signal head placement see the current edition of the Manual on Uniform Traffic Control Devices (MUTCD), as adopted by ADOT. Additionally, see Chapter 4 of this manual for more information.

## LEGEND

|                                                                                   |                                    |
|-----------------------------------------------------------------------------------|------------------------------------|
|  | Underground Conduit and Conductors |
|  | Traffic Signal Pull Box            |
|  | Control Cabinet and Foundation     |
|  | Metered Service Pedestal           |
|  | Pole on New Foundation             |
|  | SRP Point of Electrical Service    |
|  | Uninterruptible Power Supply       |
|  | Loop Stub Out                      |
|  | Denotes New Conduit Run            |
|  | Denotes New Traffic Signal Pole    |
|  | Denotes New Junction Box           |

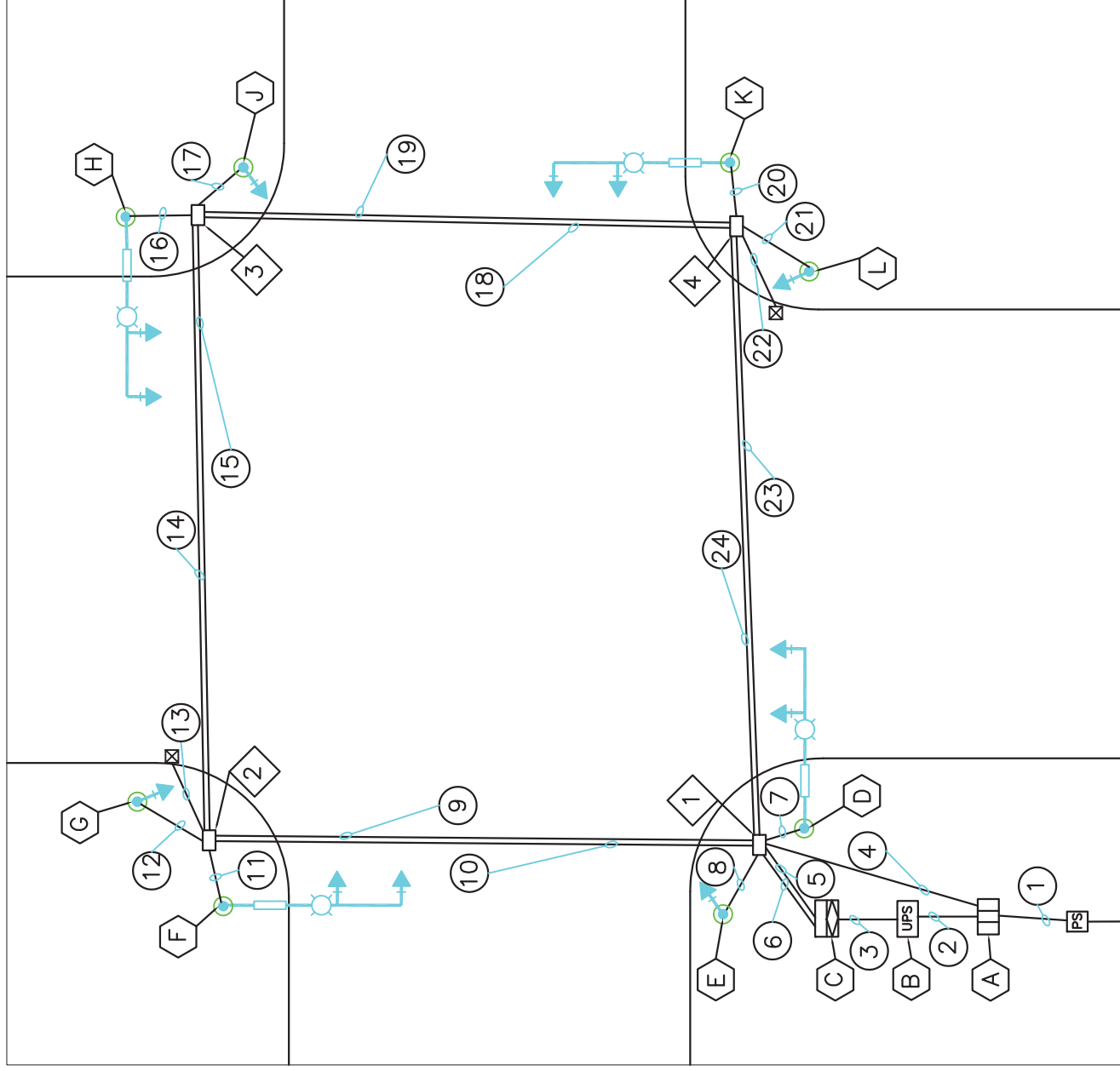


Figure 2-1: Traffic Signal Plan Equipment Labeling

202.1.3.2 City of Mesa general guidelines for traffic signal head placement:

202.1.3.2.1. For Arterial Street, use four (4) Type F heads:

- a. One (1) head on side of pole for curb lane (far right – pole mount)
- b. Two (2) mast arm heads with heads centered in through lanes
- c. One (1) far left head for left turn bay (far left – pole mount)

202.1.3.2.2. For Minor Street, use three (3) Type F heads

- a. One (1) head on side of pole for curb lane (far right – pole mount)
- b. One (1) mast arm head preferably centered over a through lane
- c. One (1) far left head (pole mount)

202.1.3.2.3. For Left-turn Control:

- a. Use an outboard head for left-turn lanes per Section 402 of this manual, and as shown on Figures 3-1 through 3-2, and Figure 4-1.

202.1.3.2.4. Provide phase numbers next to corresponding signal and pedestrian indications.

*202.1.4 Controller, Power Service and UPS Cabinets*

202.1.4.1 Cabinets go on same corner as electric point of service. See chapter 7 of this manual for additional information.

*202.1.5 Conduit Layout and Pull Boxes*

202.1.5.1. Reference City of Mesa Detail M-93.5 for roadway conduit and pull box layout.

202.1.5.2. Use # 7 pull boxes on all corners and medians (City of Mesa Detail M-93.1, Sheet 1 of 2).

202.1.5.3. All Type J, K, Q and R poles get a 3" conduit from pole base to pull box.

202.1.5.4. All Type A and Streetlight poles (only Streetlight poles with Traffic Signal equipment on them) get a 2" conduit from pole base to pull box.

202.1.5.5. Use 2" conduit for in-ground loops when used for detection.

202.1.5.6. Use 2 ½" conduit from Service Cabinet to point of service drop.

202.1.5.7. Use 2" conduit for the UPS Cabinet from the Service Cabinet, and to the Controller Cabinet.

202.1.5.8. Use 3" conduit from the Controller Cabinet to the first pull box.

See Chapter 10 of this manual for additional information.

### *202.1.6 Labeling Protocols – See Figure 2-1*

#### 202.1.6.1 Signal Pole and Cabinets:

202.1.6.1.1. Use Alphabetical letters in a hexagon symbol for both

202.1.6.1.2. Start with the Meter Service Cabinet for A, UPS Cabinet is B, Controller Cabinet is C, and then Signal pole is D. Continue clockwise around intersection. If there is no UPS at the location, the Controller Cabinet is labeled B, and so forth. See Figure 2-1.

#### 202.1.6.2 Conduits:

202.1.6.2.1. Use numbers in a circle symbol, with 1 as point of service, 2 ½" conduit. Number all conduits on the controller cabinet corner, and then continue clockwise around intersection.

#### 202.1.6.3 Pull Boxes:

202.1.6.3.1. Use numbers in diamond symbol, with 1 for controller cabinet corner, and then continue clockwise around intersection.

### **202.2 - Pole Schedule:**

202.2.1. Use the standard format for pole schedules as shown in the example in the Appendix. The schedule should include the pole letter and a diagram of the layout. The pole list should be in sequential order.

202.2.2. Typical placement is upper right hand corner of first plan sheet.

202.2.3. Reference current ADOT Standard Details for Traffic Signal Faces and for Traffic Signal Mounts. Reference City of Mesa Details M-90 series for poles, mast arms, and pedestrian push buttons.

202.2.4. Layout diagrams should be shown so that the arrows representing signal faces point to the bottom of the plan sheet.

202.2.5. Locate and specify the source of electric service. City of Mesa ITS group must be provided written confirmation.

See Chapters 3 and 4 of this manual for additional information.

### **202.3 - Foundation Schedule:**

202.3.1. Use the standard format for foundation schedules as shown in the example in the Appendix. The schedule should include the foundation numbers, equipment types and offset dimensions. The foundation list should be in sequential order.

202.3.2. Offsets shall be referenced off monument lines.

202.3.3. The foundation schedule is typically placed in the lower left-hand corner of the plan sheet.

See Chapters 3 and 7 of this manual for additional information.

### **202.4 - Pull Box Schedule:**

202.4.1. Use the standard format for pull box schedules as shown in the example in the Appendix. The schedule should include the pull box number, type, size and offset dimensions. Schedule list should be in sequential order.

202.4.2. Offsets shall be referenced off monument lines.

202.4.3. Include Electric Power Point of Service.

202.4.4. The pull box schedule is typically placed in the lower left-hand corner of the plan sheet.

See Chapter 10 of this manual for additional information.

### **202.5 - General Notes:**

Use the following notes for all traffic signal plans.

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. Locations 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-92.3).
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          |
| Cox                | Cable TV     |
| City of Mesa       | Water        |
| SRVWUA             | Irrigation   |
| City of Mesa       | Sewer        |
| Salt River Project | Electricity  |
| City of Mesa       | Streetlights |
| Blue Stake         | 602-263-1100 |
| City of Mesa       | Storm Drain  |
| Qwest              | Telephone    |

## 202.6 - Construction Notes:

202.6.1 Exceptions or additions to general notes for a specific intersection design should be listed as construction notes. Typically, construction notes are listed with numbered boxes. The box and number are then located on the intersection layout where relevant.

## Section 203 - Sheet Number 2 shall contain the following items:

### 203.1 Conductor Schedule:

203.1.1. Use the standard format for conductor schedules as shown in the example in the Appendix. The schedule should include the conduit run number, size and conductor type. Conductor list should be in the following order: IMSA cable, Detection, Street Lighting, Illuminated Signs, Commons, Bond Wire, Fire Pre-Emption, Communications, and Power.

203.1.2. Conductor legend should identify specific types of conductor and should be placed directly under the conductor schedule.

203.1.3. See COM Detail M-97.4 for IMSA Cable Conductors in Traffic Signal Poles.

203.1.4. Provide emergency vehicle signal pre-emption cabling for all approaches, using detector cable (COM Detail M-97.0).

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203.1.5. The conductor schedule is typically placed in the upper left-hand corner of the plan sheet.

See Chapter 9 of this manual for additional information.

### **203.2 Phasing Sequence:**

203.2.1. Provide a phasing diagram for initial signal operation and ultimate 8-phase operation depicting the operational sequence of the traffic signal phases. Clearly define any overlaps and pedestrian phases with phase numbers shown adjacent to the corresponding phase arrows.

203.2.2. North should always be to the top of the sheet for phase movements.

203.2.3. The City of Mesa uses standard NEMA dual quad 8-phase with Ph 8=northbound through. This phasing diagram is shown on Figure 2-2.

### **203.3 Legend:**

203.3.1 Figure 2-3 shows the CADD symbols that may be shown on construction documents using the actual legend symbols from the ADOT, Traffic Signals & Lighting, Standard Drawings, drawing no. 0-1. The designer may add additional legends for unique intersection design.

### **203.4 Internally Illuminated Street Name Signs (IISNS) or Conventional Metros:**

203.4.1 Use the standard format for the street name sign layout as shown on the example in the appendix and per City of Mesa Details M-23.8, M-98.2 and M-98.3. The street name sign layout is typically placed in the center of the plan sheet. See Chapter 11 of this manual for additional information.

### **203.5 CADD Level Structures and Symbols**

203.5.1 Refer to the latest City of Mesa Engineering and Design Standards. Typical CADD symbols are shown on Figure 2-3.

### **203.6 Other Related Studies**

203.6.1 A Lighting Report may be required.

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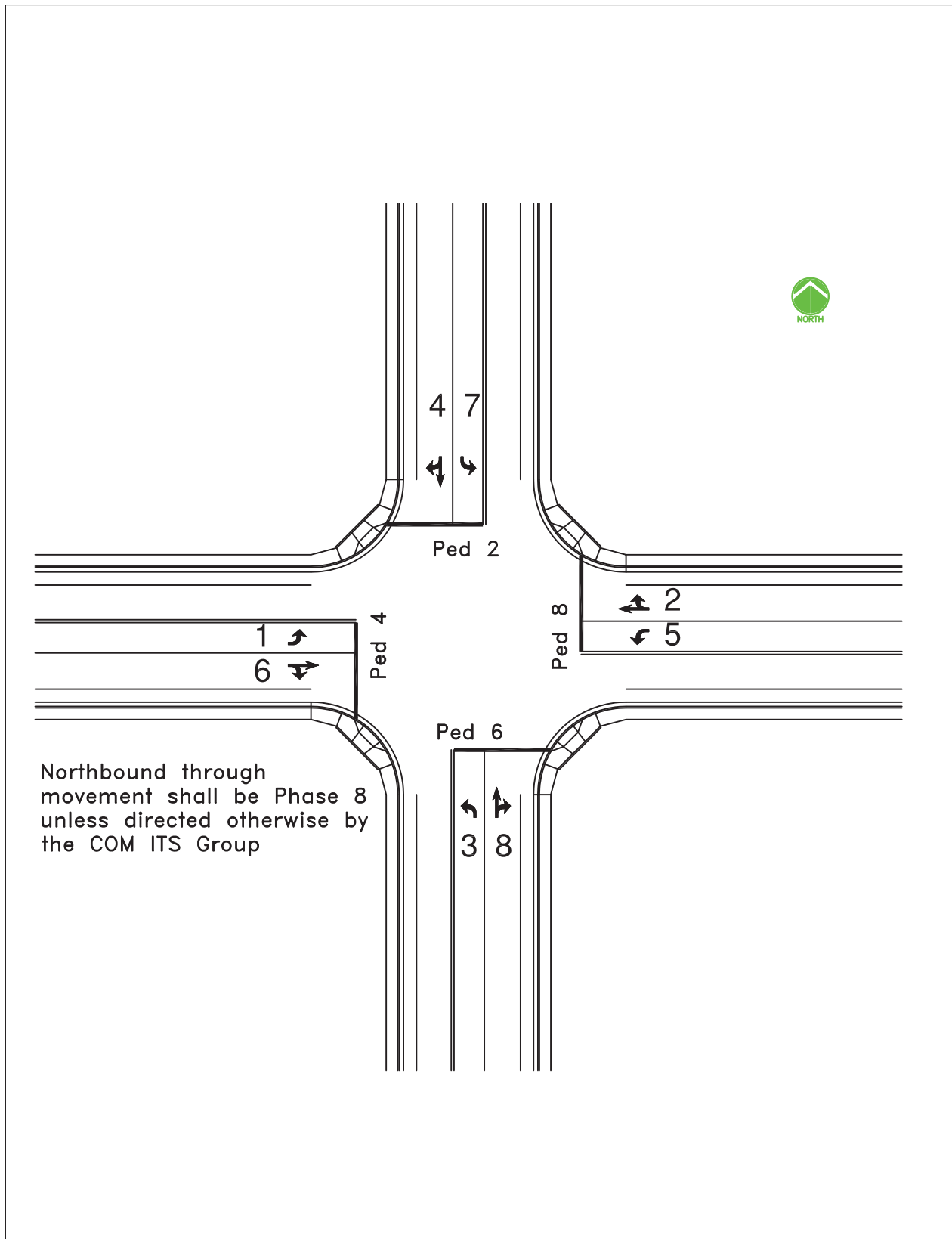


**Figure 2-2: Standard COM NEMA Phasing Diagram**

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|                                   | Proposed | Existing |
|-----------------------------------|----------|----------|
| Traffic signal pole on foundation |          |          |
| Mast arm                          |          |          |
| Signal head                       |          |          |
| Signal turn head                  |          |          |
| Signal pedestrian head            |          |          |
| Pedestrian push button            |          |          |
| Luminaire                         |          |          |
| Camera                            |          |          |
| Emergency pre-emption device      |          |          |
| Controller cabinet                |          |          |
| Uninterrupted Power Supply        |          |          |
| Metered Service Pedestal          |          |          |
| Pull box                          |          |          |
| Underground conduit               |          |          |
| Loop stub out                     |          |          |
| Loop detector                     |          |          |
| SRP Point of Electrical Service   |          |          |
| Denotes Conduit Run               |          |          |
| Denotes Traffic Signal Pole       |          |          |
| Denotes Junction Box              |          |          |
| Denotes #9 TSFO Pullbox           |          |          |
| Denotes Construction Notes        |          |          |
| Street Light Address              |          |          |

Figure 2-3: CADD Symbols

## **Chapter 3 - Pole Placement Standards and Guidelines**

### **Section 301 - Sidewalk Ramp Locations**

301.1 The Americans with Disabilities Act (ADA) requires sidewalk ramps. These ramps should be provided per City of Mesa Details M-44.2 - 5.

### **Section 302 - Sidewalk Ramp Landings**

302.1 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-44.2-5. Some recommended push button and ramp configurations are presented in City of Mesa Detail M-44.1.

### **Section 303 - Relationship of Curb Access Ramps with Crosswalks and STOP Bars**

303.1 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.

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

303.2.1. Determine the type of ramp to be used by referring to City of Mesa ramp details M-44.2-5. 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.

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

303.2.3. Crosswalk and STOP bar pavement markings for non-arterial roadways are shown on City of Mesa Detail M-46.7.

### **Section 304 - General Considerations for Traffic Signal Pole Locations**

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

304.1.1. Accommodate right-of-way limitations.

304.1.2. Locate signal heads (vehicle and pedestrian heads) to maximize visibility and minimize confusion.

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304.1.3. Accommodate approach lane configuration.

304.1.4. Accommodate alignment of intersecting roadways.

304.1.5. Accommodate approach alignment (horizontal and vertical).

304.1.6. Accommodate bicycle actuation with bike push-button pole placed with consideration of the bike lane and curb ramps per COM Standard Details.

304.1.7. Minimize the number of poles for signal heads, pedestrian buttons, and street lighting without compromising function.

304.1.8. Provide streetlights as necessary.

304.1.9. Account for nearby underground and overhead utilities (existing and proposed).

304.1.10. Account for nearby drainage structures, bridges and embankments.

304.1.11. Account for nearby buildings, walls, fences, and other structures.

304.1.12. Account for nearby trees and other landscaping features.

304.1.13. Use standard mast arm lengths (25 feet to 40 feet for Type Q & J poles, 45 feet to 55 feet for Type K & R poles).

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

304.2.1. The distance between the STOP bar and the mast arm heads shall meet current MUTCD recommendations.

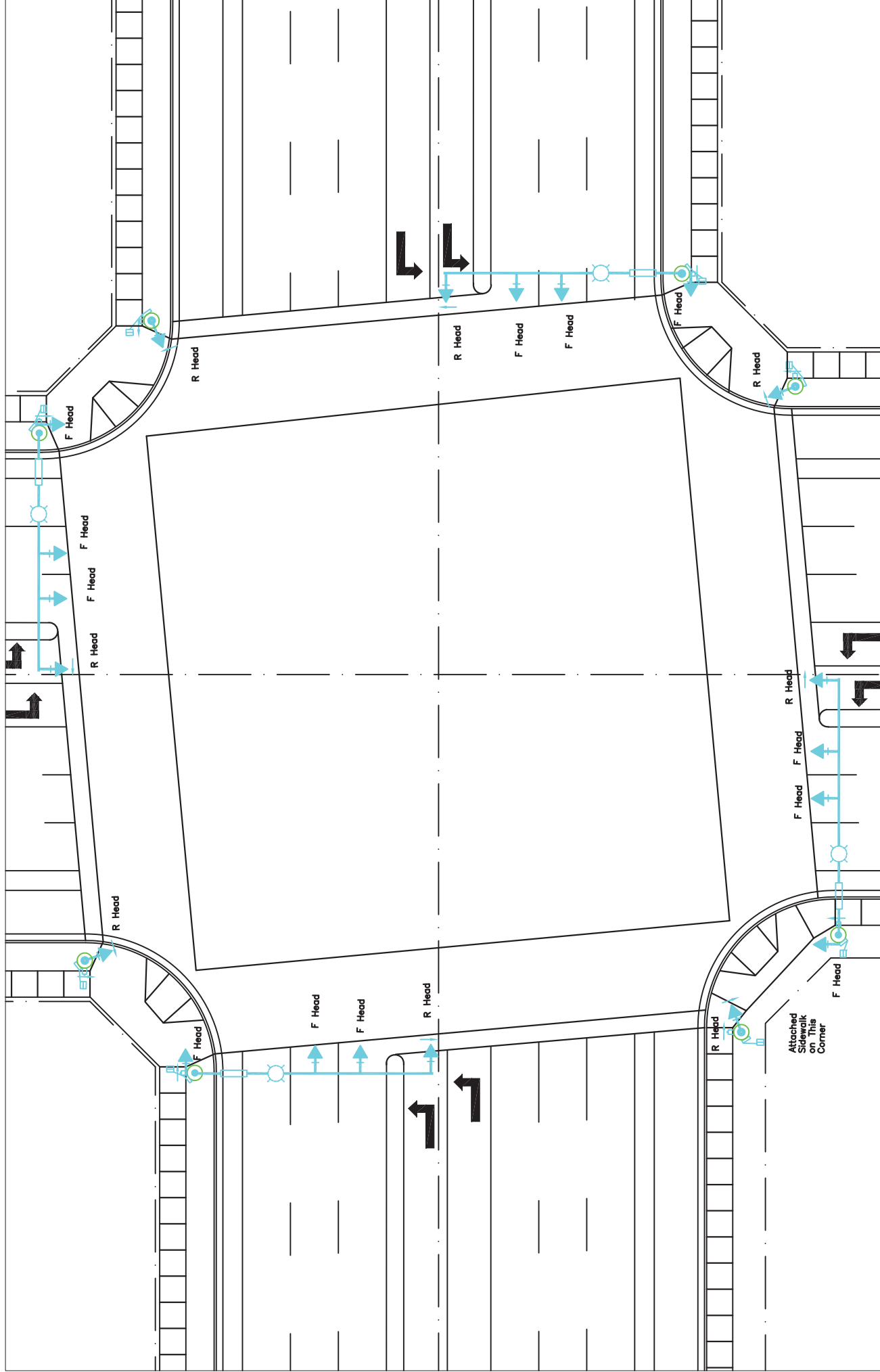
304.2.2. Luminaires should be positioned to light the intersection.

304.2.3. Avoid placing poles in the medians of divided roadways.

304.2.4. Poles or posts should not obstruct pedestrian routes. **(DO NOT INSTALL** in curb access ramps or landings.)

304.2.5. If used, pedestrian bike push buttons for intersecting approaches should be installed per Figure 3-2. See City of Mesa Detail M-94 for additional information.

See Figures 3-1 through 3-3 for sample drawings illustrating common intersection and signal configurations.



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**Figure 3-1: Pole Placement Guidelines for Major to Major Street Intersection**

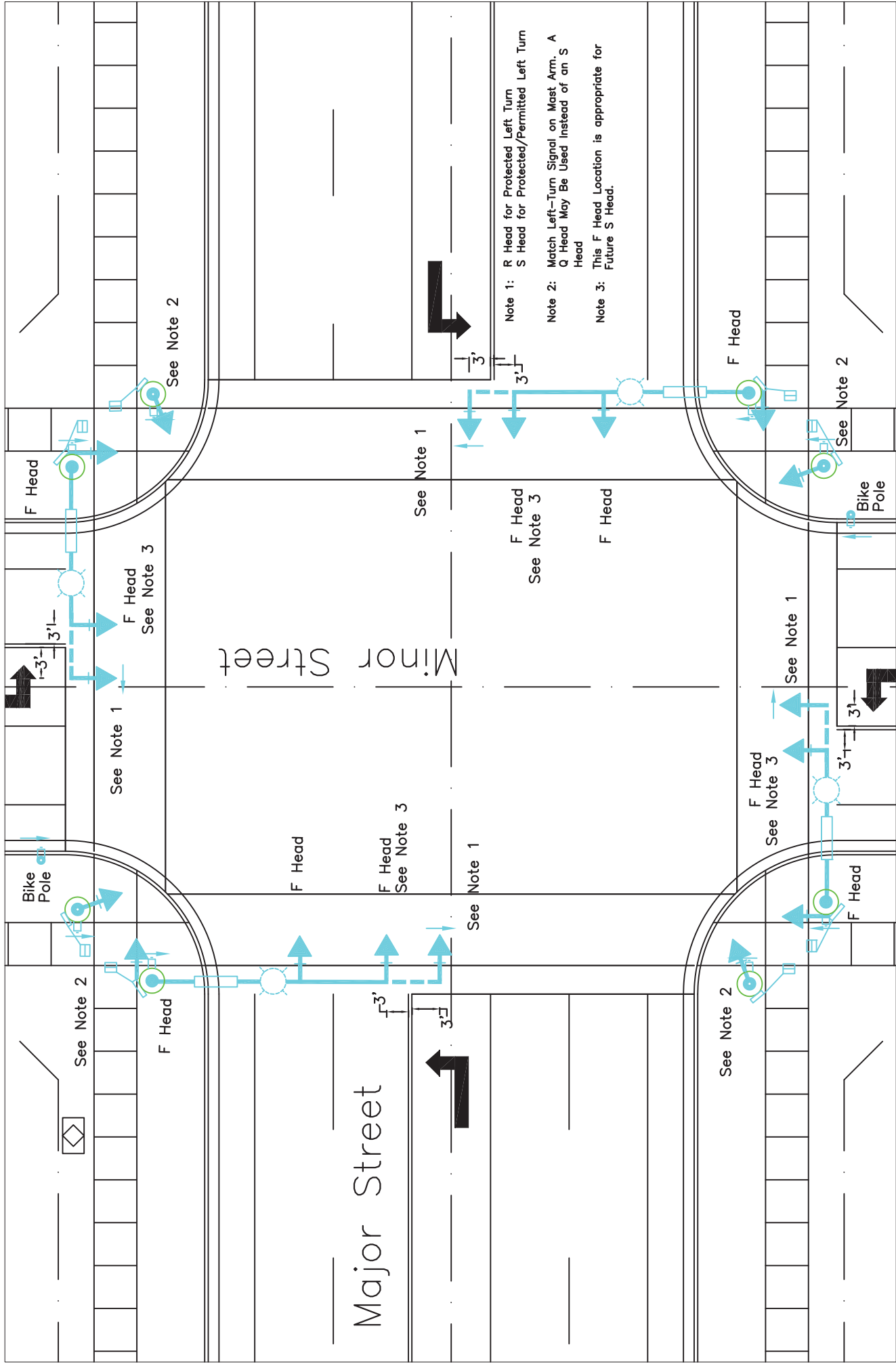
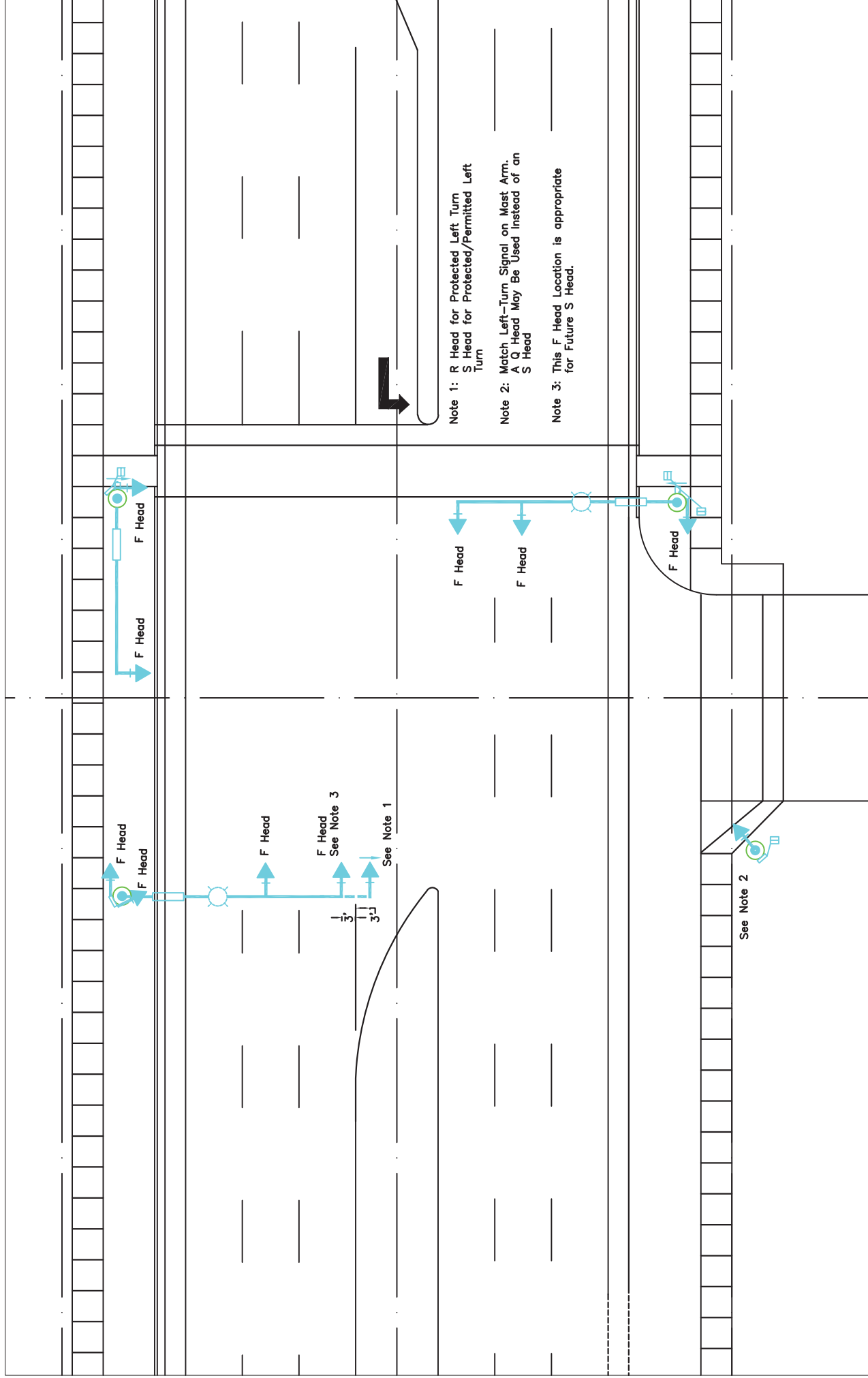


**Figure 3-2: Pole Placement Guidelines for Major to Minor Street Intersection**



## City of Mesa Traffic Signal Manual

Figure 3-3: Pole Placement Guidelines for Major Street to Driveway Intersection

NTS

# **Chapter 4 - Traffic Signal Faces and Mounting Hardware**

## **Section 401 - Traffic Signal Faces**

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

401.2. Optically programmed or louvered heads may be used if the geometry indicates their use. The City of Mesa Traffic Engineering group must approve the use of optically programmed or louvered heads.

401.3. Protected/permitted left turn signal faces shall be Type Q or S as illustrated in the COM and ADOT Traffic Signal Details. Type R faces are used for protected left-turn phasing.

401.4. Right turn signal faces shall be Type Q.

## **Section 402 - Placement Considerations for Traffic Signal Faces**

402.1. The requirements of MUTCD Sections 4D.15, 4D.16 and 4D.17 shall be satisfied.

402.2. The spacing of traffic signal faces on a mast arm for the same approach should match the spacing shown on City of Mesa Detail M-94.7.

402.3. Traffic signal faces for one direction of travel should not obstruct the visibility of traffic signal faces for the opposing direction of travel.

402.4. Typically, provide a far left pole mounted indication.

402.5. Position overhead signal faces for through movements to align in the middle of the lane, plus or minus two (2) feet. Avoid placing the overhead signal face directly over the lane stripes. This allows maintenance vehicles to work on the signals while closing only one of the two left-turn lanes.

402.6. Provide two (2) faces for left turn lanes as follows:

402.6.1. Single left-turn lane - Left turns can be controlled by a traffic signal for three types of operation: permitted, protected, or protected/permitted. Additionally, the type of left-turn control can change over time. Therefore, a traffic signal design should consider future potential modifications. The outboard signal face should be over the turn lane as follows:

402.6.1.1. Permitted left-turns simply are allowed to go on the same green phase as the through traffic. The driver must use judgment to determine an acceptable gap for turning. For this left-turn operation, a Type F signal head should be installed three-feet (3') right of the opposing double yellow lines as shown on Figures 3-2 and 3-3. This

signal head location can then be converted to a Type S signal head for protected/permitted operation if needed in the future.

402.6.1.2. Protected left-turns are given an exclusive phase in the signal timing where only the left-turns go while through vehicles remain stopped. Drivers stop or go depending on the arrow indication on the Type R signal head. For this left-turn operation, a Type R signal head should be installed three-feet (3') left of the opposing double yellow lines as shown on Figures 3-2 and 3-3.

402.6.1.3. If left turns are protected/permitted, the left-turns are given an exclusive phase, and then allowed to go along with the through movements, again using judgment for turning. For this left-turn operation, a Type S signal head should be installed three-feet (3') left of the opposing double yellow lines. This signal head location can then be converted to a Type R signal head for protected-only operation if needed in the future.

402.6.1.4. In some cases, an intersection will be designed for ultimate dual left-turn lanes, but only a single left-turn lane will be used initially. The unused lane is striped out with a carrot. In this case, the signal head will be positioned three-feet left of the double yellow line, which will align it adequately for future dual lanes.

402.6.2. Dual left-turn lanes – Protected-only operations are used for this type of condition. For dual left-turn lanes, provide one overhead Type R signal face aligned between the two left-turn lanes as shown on Figure 4-1.

402.6.3. Provide a second traffic signal face on the far left corner on a Type A pole or streetlight pole near the stop line for opposing traffic. The signal head should match the outboard head used on the mast arm. However, a Type Q signal head should be used instead of the Type S signal head on Type A poles or streetlight poles.

402.7. Provide two (2) signal faces for right-turn lanes with right-turn signal phasing, as detailed below:

402.7.1. Provide a far-side signal head mounted on the side of the signal pole.

402.7.2. Provide a near right signal face on a Type A pole or streetlight pole near the stop bar.

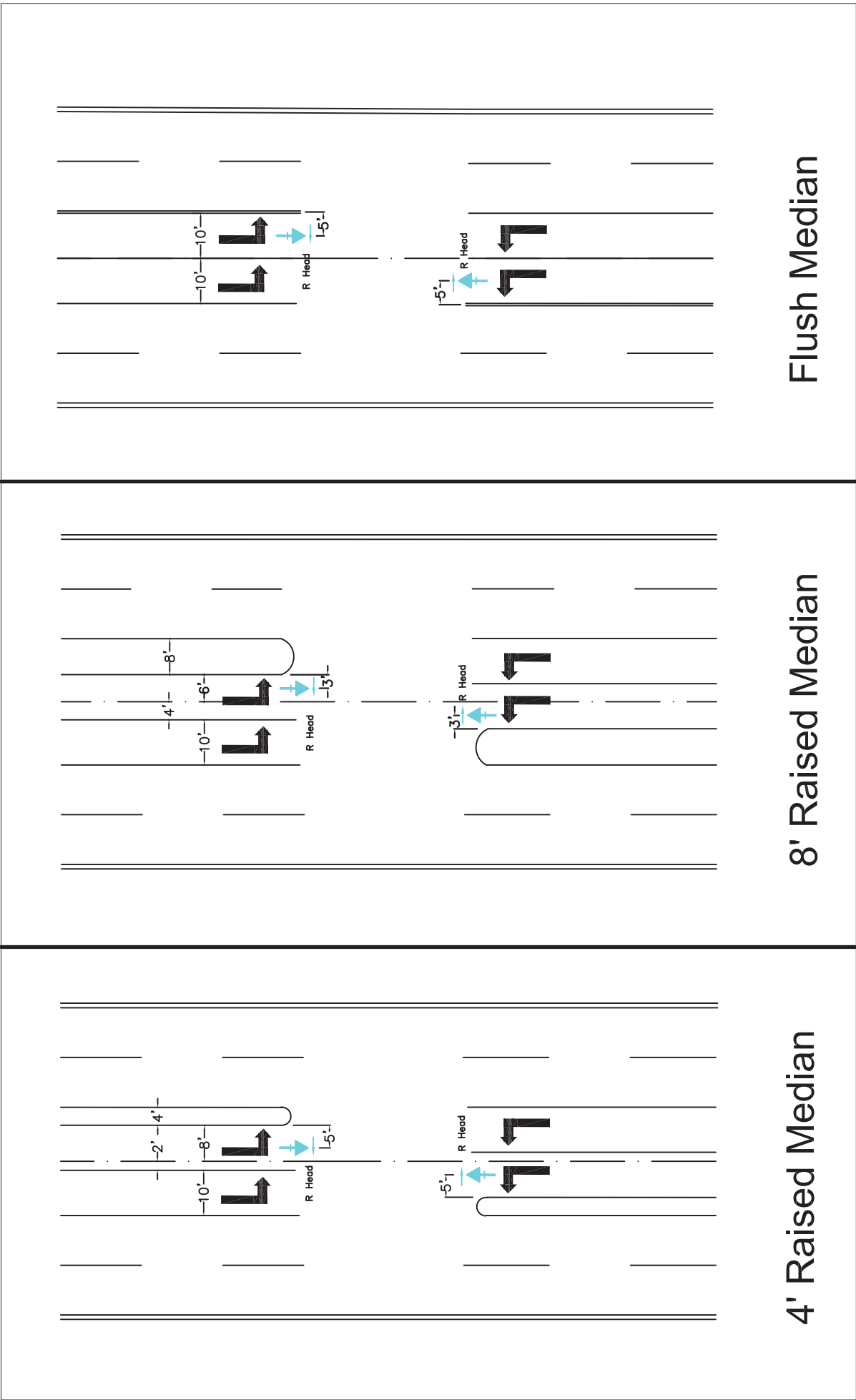
402.8. Additional signal faces may be needed when the view of the typical signal faces are concealed from approaching drivers due to horizontal or vertical alignment. Signal visibility must meet criteria based on approach speed in the MUTCD.

Refer to Figures 3-1 through 3-3 for sample drawings illustrating common intersection and signal configurations

## Section 403 - Traffic Signal Mounting Hardware

403.1 All mounting assemblies for traffic signals mounted on mast arms and poles should conform to City of Mesa Detail M-95.1 and ADOT details.

|                    |                                                                                     |                                               |                    |
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NTS

## City of Mesa Traffic Signal Manual

Figure 4-1: Outboard Traffic Signal Head Position for Dual Left-turn Lanes

## **Chapter 5 – Pedestrian and Bicycle Control Features**

As with sidewalk ramps, pedestrian control features shall meet ADA accessibility standards.

### **Section 501 - Pedestrian Signals**

501.1 Countdown pedestrian signals should be used when a traffic signal is newly built, or if an existing traffic signal improvement includes replacement of the pedestrian signals. If a countdown signal is only added to part of an existing traffic signal by a development project, the remainder of the traffic signal will be upgraded to countdown signals by the City of Mesa.

### **Section 502 - Placement Consideration for Pedestrian Signal Heads and Pedestrian Detectors**

502.1. Mount the pedestrian push button adjacent to the landing on the sidewalk area leading to the crosswalk. See City of Mesa Detail M-44.1 and Figures 3-1 through 3-3 for examples.

502.2. 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 Figures 3-1 through 3-3 for examples.

502.3. 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 (from the Final Report of the Public Rights of Way Access Advisory Committee of the US Access Board, January 10, 2001).

### **Section 503 - Bicycle Push Buttons and Loop Detectors**

503.1 All minor street approaches to a signalized arterial intersection will include bicycle detection. Bicycle detection can be implemented in three ways as follows:

503.1.1. If video detection is used at an intersection per Chapter 8 of this manual, then the video detection will also be used for bicycles at the intersection.

503.1.2. If video detection is not used and there is no right-turn lane at the minor street approach, then a bicycle push button will be installed per City of Mesa Details M-90.1 and M-94.0.

503.1.3. If video detection is not used and there is a right-turn lane at the minor street approach, then a bicycle detector loop will be installed in the bike lane per the City of Mesa M-96 series details.

## **Chapter 6 – Lighting Requirements for Traffic Signal Installation**

Intersection lighting is included at signalized intersections.

### **Section 601 - Considerations for Intersection Lighting**

601.1. 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.

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

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

601.4. 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.

601.5. 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.

### **Section 602 - Lighting Requirements for Traffic Signal Installations**

602.1. 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.

602.2. Street lighting photoelectric cells shall be mounted on all luminaires.

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

602.4. 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.

# **Chapter 7 - Controller Cabinet and Electrical Service**

## **Pedestal**

### **Section 701 - Equipment Requirements**

701.1. The electric service pedestal installed shall be 120/240 volt 100 amp split-metered system per City of Mesa Detail M-91.2.

701.2. The electric service cabinet must be TESCO (City of Mesa Detail M-91.2).

701.3. The controller cabinet shall be NEMA TS 2 Type 1, Size 7 per City of Mesa Detail M-92.1, and include all peripherals for a functional eight-phase traffic signal. Cabinet and controller specifications are available on the City of Mesa website.

701.4. An Econolite ASC/3-2100 NEMA TS-2 Type 2 traffic signal controller shall be supplied and installed.

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

701.6. The City of Mesa ITS group is responsible for ordering all new points of service from the appropriate power company. Designer is responsible for obtaining point of service "Meter Spot Form" from the appropriate power company and providing form to the City of Mesa ITS group.

701.7. Uninterruptable Power Supply (UPS) must be provided at all major street to major street intersections.

### **Section 702 - Placement Requirements**

702.1. Place the controller cabinet and service pedestals to maximize corner visibility and decrease visual obstruction where feasible and practical.

702.2. Ideally, the controller cabinet should be placed beyond the returns of the corner radius, behind poles. The door of the cabinet should open toward the street, but not block the sidewalk when open. (See figures 3-1 to 3-3).

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

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

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# **Chapter 8 - Vehicle Detection Standards and Guidelines**

## **Section 801 - Detection Types and Considerations**

801.1 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 used at all 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.

## **Section 802 - Detection Guidelines**

### **802.1 Major and Minor Street Intersection**

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

802.1.2. Typically, vehicle detection is only used on the major street legs in left-turn lanes with a specific left-turn signal.

802.1.3. Vehicle detection is used on all minor street approach lanes.

802.1.4. Bicycle detection will be per Chapter 5 of this manual.

802.1.5. If the minor leg of an intersection is a private driveway, video detection should be used for the entire intersection.

### **802.2 Major and Major Street Intersection**

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

## **Chapter 9 - Conductor Cable Requirements**

### **Section 901 - General**

901.1. Wiring for City of Mesa traffic signals shall be designed per City of Mesa Details M-97.0, M-97.1, M-97.2, M-97.3 and M-97.4.

901.2. Signal conductors installed shall be IMSA 19-1 multi-conductor cable in 14 AWG solid 2, 5, 7 and 20 conductor configurations per City of Mesa Detail M-97.0.

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

901.4. Two (2) un-spliced IMSA 19-1 20 conductor cables shall be installed between adjacent corners of an intersection.

### **Section 902 - Streetlight Conductor Requirements**

902.1. Intersection streetlight luminaires (120V AC) should be fed from the electrical service pedestal per COM Detail M-91.2.

902.2. 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-73.7.

902.3. 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.

### **Section 903 - Internally Illuminated Street Name Sign (IISNS) Conductor Requirements**

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

903.2 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-98.2.

### **Section 904 - Loop Detector Conductor Requirements**

904.1. All vehicle roadway detection loop wire shall be 14 AWG IMSA 51-5-1984 (Detect-a-Duct) stranded wire per City of Mesa Detail M-97.0.

904.2. Loop detector lead-in-cable from the loop pull box to the cabinet shall be 18 AWG/ four-conductor, shielded cable per City of Mesa Detail M-97.0.

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

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

904.5. Loop stub out conduit shall be 2" schedule 40 PVC per City of Mesa Detail M-96.3.

### **Section 905 - Communications Cabling**

905.1 Every new or existing traffic signal requires communications media. Contact the City of Mesa ITS group for guidance on media type and standards.

### **Section 906 - Emergency Vehicle Pre-Emption Conductor Requirements**

906.1 The emergency vehicle pre-emption sensor cable shall be per City of Mesa Detail M-97.0.

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# **Chapter 10 - Conduit and Pull Box Requirements**

## **Section 1001 - General Requirements**

1001.1. Provide conduit to each corner of the intersection in a ring configuration under all intersection approaches per City of Mesa Detail M-93.5.

1001.2. Provide low-voltage and high-voltage conductors in separate conduits in road crossings per City of Mesa Detail M-93.5.

1001.2.1. Low voltage conductors include: emergency vehicle pre-emption sensors, detector cable, video feed back to controller cabinet, and communication cables.

1001.2.2. High voltage conductors include signal and street lighting conductors.

1001.3. Provide fiber optic quad duct per City of Mesa Details M-93.3 and M-93.4.

## **Section 1002 - Conduit Size and Placement**

1002.1. Reference City of Mesa Detail M-93.5 for roadway conduit and pull box layout.

1002.2. All Type J, K, Q and R poles get a 3" conduit from pole base to pull box.

1002.3. All Type A and Streetlight poles (only Streetlight poles with Traffic Signal equipment on them) get a 2" conduit from pole base to pull box.

1002.4. Use 2" conduit for loop detectors.

1002.5. Conduit should be bored under existing paved driveways that are not scheduled to be reconstructed as a part of the project.

## **Section 1003 - Pull Box Considerations**

1003.1. Install pull boxes per City of Mesa Details M-93.1 (sheets 1 & 2), M-93.2 M-93.3 and M-93.5.

1003.2. Use #7 pull boxes on all corners and medians (City of Mesa Detail M-93.1, Sheet 1 of 2).

1003.3. Use #8 pull boxes on all corners with controller cabinets (City of Mesa Detail M 93.1B).

1003.4. Pull boxes shall not be located in drainage areas susceptible to water immersion or flooding.

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1003.5. Pull boxes should not be installed within wheelchair ramps. In addition, any pull boxes installed beyond curbs shall consider future sidewalk locations.

1003.6. 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.

# **Chapter 11 - Other Traffic Signal Related Equipment**

## **Section 1101 - Internally Illuminated Street Name Signs (IISNS)**

1101.1. Internally Illuminated Street Name Signs are provided at some signalized intersections per City of Mesa Details M-98.1, M-98.2 and M-98.3. However, conventional metros may still be used at some locations. Therefore, contact the City of Mesa ITS Group for additional guidance on which type of sign to use at each location.

1101.2. Generally, IISNS are installed under the following scenarios:

1101.2.1. On all legs of a major to major roadway intersection.

1101.2.2. On minor roadway legs to commercial or industrial land uses.

1101.2.3. On all roadway intersection legs within the Town Center.

1101.2.4. On minor roadway legs or driveways to major destinations or traffic generators such as shopping centers, colleges, hospitals, sports facilities, etc.

## **Section 1102 - Emergency Vehicle Pre-emption Sensors**

1102.1. All City of Mesa traffic signals should include emergency vehicle pre-emption cabling per City of Mesa specifications.

1102.2. 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.

# Appendix

|                    |                                                                                     |                                       |                    |
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[illegible]

### 4 $\phi$ PHASE SEQUENCE

Diagram illustrating the intersection layout and signage for the proposed intersection of South Mesquite Canyon, South 96th Street, East Guadalupe Road, and S Mesquite Canyon.

The diagram shows four street segments meeting at a central intersection:

- South Mesquite Canyon (Left):** Features a rectangular sign with an arrow pointing left labeled "S Mesquite Canyon" and a distance of "2800 S ↑".
- South 96th Street (Right):** Features a rectangular sign with an arrow pointing right labeled "S 96TH St" and "S Mesquite Canyon" with an arrow pointing left.
- East Guadalupe Road (Bottom):** Features a rectangular sign with an arrow pointing down labeled "E Guadalupe Rd" and a distance of "2800 S ↑".
- S Mesquite Canyon (Top):** Features a rectangular sign with an arrow pointing up labeled "S 96TH St" and "S Mesquite Canyon" with an arrow pointing left.

A north arrow is located in the bottom left corner, pointing towards the top of the diagram.

[illegible]

STANDARD IMSA CABLE, 20 CONDUCTOR  
CABLE #1, ONE WHITE TAPE WRAP  
CONDUCTORS WITHIN CABLE PHASE CODING

STANDARD IMSA CABLE, 20 CONDUCTOR  
CABLE #1, ONE WHITE TAPE WRAP  
CONDUCTORS WITHIN CABLE PHASE CODING

### VEHICULAR INDICATIONS

| PHASE | TYPE @ COLORS | ATTENDING WIRE COLORS                    |
|-------|---------------|------------------------------------------|
| 1     | RED           | RED, ORANGE, GREEN                       |
| 2     | RED           | RED, WHITE, BLACK                        |
| 3     | BLUE          | RED, WHITE, GREEN, WHITE                 |
| 4     | GREEN         | RED, W/GREEN, ORANGE, W/RED, BLUE, W/RED |

**PEDESTRIAN INDICATIONS**

| PHASE | TYPE @ COLORS | INTERVAL, WIRE COLORS |
|-------|---------------|-----------------------|
| 1     | WHITE         | BLUE, BLACK           |

### PEDESTRIAN INDICATIONS

| PEDESTRIAN PUSH BUTTONS                                                                                                                                                                                                              |            |        |                       |                        |  |      |          |      |            |      |           |      |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------|-----------------------|------------------------|--|------|----------|------|------------|------|-----------|------|------------|
| PHASE                                                                                                                                                                                                                                | TYPE       | COLOES | INTERNAL WHITE COLOES |                        |  |      |          |      |            |      |           |      |            |
| 2                                                                                                                                                                                                                                    |            | WHITE  | WHITE W/RED           |                        |  |      |          |      |            |      |           |      |            |
| 4                                                                                                                                                                                                                                    |            | GREEN  | BLACK W/RED           |                        |  |      |          |      |            |      |           |      |            |
| SPARE                                                                                                                                                                                                                                |            |        | SOLID WHITE           |                        |  |      |          |      |            |      |           |      |            |
| PHS COMMON                                                                                                                                                                                                                           |            | BLACK  | WHITE W/BLACK         |                        |  |      |          |      |            |      |           |      |            |
| <table><tr><th colspan="2">WARNING TAPE PER PHASE</th></tr><tr><td>a1 =</td><td>RED TAPE</td></tr><tr><td>a2 =</td><td>WHITE TAPE</td></tr><tr><td>a3 =</td><td>BLUE TAPE</td></tr><tr><td>a4 =</td><td>GREEN TAPE</td></tr></table> |            |        |                       | WARNING TAPE PER PHASE |  | a1 = | RED TAPE | a2 = | WHITE TAPE | a3 = | BLUE TAPE | a4 = | GREEN TAPE |
| WARNING TAPE PER PHASE                                                                                                                                                                                                               |            |        |                       |                        |  |      |          |      |            |      |           |      |            |
| a1 =                                                                                                                                                                                                                                 | RED TAPE   |        |                       |                        |  |      |          |      |            |      |           |      |            |
| a2 =                                                                                                                                                                                                                                 | WHITE TAPE |        |                       |                        |  |      |          |      |            |      |           |      |            |
| a3 =                                                                                                                                                                                                                                 | BLUE TAPE  |        |                       |                        |  |      |          |      |            |      |           |      |            |
| a4 =                                                                                                                                                                                                                                 | GREEN TAPE |        |                       |                        |  |      |          |      |            |      |           |      |            |

## GENERAL NOTES

- [illegible]

IMSA CABLE 19-1, 1984 #14 AWG, 7 CONDUCTOR, 5 CONDUCTOR, AND 2 CONDUCTOR

IMSA CABLE 19-1, 1984 #14 AWG, 7 CONDUCTOR, 5 CONDUCTOR, AND 2 CONDUCTOR

| 7 CONDUCTOR CABLE |                 |
|-------------------|-----------------|
| BASIC COLOR       | SIGNAL INTERVAL |
| RED               | RED             |
| ORANGE            | YELLOW          |
| GREEN             | GREEN           |
| BLACK             | YELLOW ARROW    |
| BLUE              | GREEN ARROW     |
| WHITE             | VEHICLE COMMON  |
| WHITE/BLACK       | SPARE           |

| 7 CONDUCTOR CABLE |                 |
|-------------------|-----------------|
| BASIC COLOR       | SIGNAL INTERVAL |
| RED               | RED             |
| ORANGE            | YELLOW          |
| GREEN             | GREEN           |
| BLACK             | YELLOW ARROW    |
| BLUE              | GREEN ARROW     |
| WHITE             | VEHICLE COMMON  |
| WHITE/BLACK       | SPARE           |

## INBOARD &amp; SIDEMOUNT

| 5 CONDUCTOR CABLE |              |
|-------------------|--------------|
| BASIC COLOR       | SIGNAL INT.  |
| RED               | RED          |
| ORANGE            | YELLOW       |
| GREEN             | GREEN        |
| WHITE             | VEHICLE CODE |
| BLACK             | SPARE        |

## PEDESTRIAN HEADS

| PEDESTRIAN HEADS  |                  |
|-------------------|------------------|
| 5 CONDUCTOR CABLE |                  |
| BASIC COLOR       | SIGNAL INTERVAL  |
| RED               | DON'T WALK       |
| GREEN             | WALK             |
| WHITE             | PEDESTRIAN CROSS |
| BLACK             | SPACE            |
| ORANGE            | SPACE            |

**PUSH BUTTON**

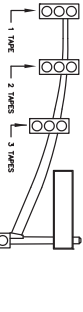
|                |            |
|----------------|------------|
| PUSH BUTTON    |            |
| 2 CONDUCTOR CA |            |
| BASIC COLOR    | PUSH BUTTO |
| BLACK          | PUSH BUTTO |
| WHITE          | PUSH BUTTO |

## DOUBLE PEDESTRIAN HEADS

| 7 CONDUCTOR CABLE |                 |         |
|-------------------|-----------------|---------|
| BASIC COLOR       | SIGNAL INTERVAL | RED P/1 |
| RED               | DO NOT WALK     | 4 dk    |
| ORANGE            | SPARE           | 4 dk    |
| GREEN             | WALK            | 4 dk    |
| BLACK             | DO NOT WALK     | 2 dk    |
| BLUE              | WALK            | 2 dk    |
| WHITE             | COMMON          | 2 dk    |
| WHITE/BLACK       | SPARE           | RED     |

ALL CABLES SHALL BE TAGGED AS TO THEIR ASSIGNED PHASE IN THE PULL BOX

- [illegible]



RECORD DRAWING  
By: Date: 8-04-08

By: \_\_\_\_\_ Date: 8-04-08  
Inspected By: COM-Transportation  
Year Installed: 2008

**602-263-1100**  
INSIDE MARICOPA COUNTY



|                                      |                      |                                                                   |              |                             |
|--------------------------------------|----------------------|-------------------------------------------------------------------|--------------|-----------------------------|
| CITY OF MESA<br>ENGINEERING DIVISION | TRAFFIC SIGNAL PLANS | EAST GUADALUPE ROAD AND SOUTH<br>MESQUITE CANYON<br>(96TH STREET) | SHEET<br>2 2 | CATALOG NUMBER<br>A-125910A |
|--------------------------------------|----------------------|-------------------------------------------------------------------|--------------|-----------------------------|

BENCHMARK:  
BRASS TAG TO SE CORNER ELLSMORTH  
& GUADALUPE  
ELEVATION=1424.42 (CITY OF MESA DATUM)